

Australian National University

Double Burden of Malnutrition at Household-Level in South and Southeast Asia

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A thesis submitted for the degree of Doctor of Philosophy of
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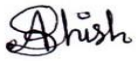
Declaration

I hereby declare that this thesis, titled "**Double Burden of Malnutrition at Household-Level in South and Southeast Asia**," is my own original work. The work presented is an accurate account of the research undertaken during my candidature and is submitted in fulfilment of the requirements for the degree of Doctor of Philosophy at the Australian National University. The research was conducted in accordance with the ethical standards of the Australian National University and relevant human research ethics approvals.

I certify that this thesis has not been submitted, either in whole or in part, for the award of any other degree or diploma at any university or other tertiary institution. To the best of my knowledge, it contains no material previously published or written by another person, except where appropriate acknowledgment and reference have been made. This thesis is presented in the format of a thesis by publication. The contributions of all co-authors in jointly authored papers are clearly stated, and all papers have been approved by the co-authors.

Signature: 

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Abstract

Background and Aim

The double burden of malnutrition (DBM) refers to the coexistence of undernutrition (stunting, wasting, underweight and micronutrient deficiencies) and overnutrition (overweight and obesity) within populations, households or individuals. It is an emerging public health challenge in South and Southeast Asia, where rapid nutrition transition, urbanisation and economic development have contributed to rising adult overweight and obesity, while child undernutrition remains prevalent. At the household-level, DBM typically occurs when maternal overweight or obesity coexists with child undernutrition. Evidence from the region indicates that household-level DBM has increased substantially over the past two decades, with prevalence exceeding 10% in several countries. Despite growing recognition of this challenge, important gaps remain in how DBM is conceptualised and measured, as well as in understanding its determinants and policy responses. This thesis therefore aimed to investigate the prevalence, trends and determinants of household-level DBM in selected countries in South and Southeast Asia and to examine national policy responses using Bangladesh as a case study.

Methods

A sequential mixed-methods approach was adopted across seven papers. First, a systematic narrative review synthesised existing definitions of DBM at the individual, household and population levels, providing the conceptual foundation and operational definitions for the subsequent analyses. Building on this foundation, nationally representative Demographic and Health Survey data from Bangladesh, Cambodia, Nepal and Timor-Leste were analysed to estimate the prevalence and trends of household-level DBM and examine socioeconomic disparities. A systematic review and meta-analysis then synthesised evidence on factors associated with household-level DBM across South and Southeast Asia, while multivariable and multilevel regression analyses further examined these associations using socioeconomic, maternal, child, behavioural and healthcare-related factors. Finally, the thesis examined the policy context in Bangladesh through a review of national nutrition policy documents and key informant interviews with 12 senior-level nutrition stakeholders. The qualitative data were analysed thematically to explore how DBM is understood and addressed within existing policy frameworks, identify implementation challenges and examine opportunities to strengthen policy and governance responses to DBM.

Results

The narrative review revealed substantial variation in how DBM is conceptualised and measured across individual, household and population levels, and this variation informed the standardised operational definitions used in later analyses. Across all four countries studied, household-level DBM increased consistently, rising from 4.0% to 13.8% in Bangladesh (2004–2018; 14.2% in 2022), 7.4% to 14.3% in Cambodia (2005–2022), 5.6% to 12.3% in Nepal (2006–2022), and 9.4% to 15.8% in Timor-Leste (2009–2016). Higher household wealth (pooled OR=1.55, 95% CI: 1.31–1.83) and urban residence (pooled OR=1.38, 95% CI: 1.20–1.59) were associated with higher odds of DBM. Older maternal age, short stature and lower educational attainment were also associated with higher odds, whereas breastfeeding and adequate antenatal care were associated with lower odds. Households with higher economic resources but lower maternal educational attainment had the higher odds of DBM. Caesarean delivery was associated with higher odds of household-level DBM in Bangladesh (AOR=2.60, 95% CI: 1.55–4.37) and Nepal (AOR=1.72, 95% CI: 1.09–2.70), with delayed initiation of breastfeeding contributing to this association. In Bangladesh, only one of five reviewed documents explicitly acknowledged DBM and none addressed household-level DBM. Interviews with 12 senior nutrition stakeholders identified weak multisectoral coordination, limited DBM-specific indicators, inadequate workforce capacity and insufficient attention to unhealthy food environments as key implementation challenges.

Conclusions

Household-level DBM represents a multidimensional and intergenerational challenge in South and Southeast Asia arising from the interaction of nutrition transition, socioeconomic conditions, maternal factors and healthcare practices. The findings identify maternal education, breastfeeding and antenatal care as important intervention points, while caesarean delivery, particularly when followed by delayed initiation of breastfeeding, represents an underrecognised upstream risk factor. The policy findings from Bangladesh indicate that existing nutrition governance has not fully adapted to the changing nutritional landscape, with limited attention to overnutrition and integrated responses. A shift towards double-duty nutrition approaches is therefore needed to address both forms of malnutrition through stronger maternal and child nutrition interventions, healthier food environments and multisectoral governance.

Keywords: Double burden of malnutrition; household-level DBM; maternal overweight; child undernutrition; nutrition policy analysis; South Asia; Southeast Asia; Bangladesh; Cambodia; Nepal; Timor-Leste.

Publications Included in this Thesis

This thesis by compilation comprises seven papers to which I contributed substantially as the first author.

[1] **Talukder A,** Kelly M, Sayeed MA, Gray D, Sarma H. Defining double burden of malnutrition across individual, household and population level: A narrative review. ***Nutr Diet.*** 2025;83(1):8-22. https://doi.org/10.1111/1747-0080.70037

[2] **Talukder A,** Kelly M, Gray D, Sarma H. Prevalence and trends of double burden of malnutrition at household level in South and Southeast Asia. ***Discover Public Health.*** 2024;21(1):221. https://doi.org/10.1186/s12982-024-00339-y

[3] **Talukder A,** Kelly M, Sayeed MA, Gray D, Sarma H. Determinants of household-level double burden of malnutrition in South and Southeast Asia: A systematic review and meta-analysis. ***Curr Dev Nutr.*** 2026;10(5):107683. https://doi.org/10.1016/j.cdnut.2026.107683

[4] **Talukder A,** Kelly M, Gray D, Sarma H. Influence of maternal education and household wealth on double burden of malnutrition in South and Southeast Asia. ***Matern Child Nutr.*** 2025;21: e70049. https://doi.org/10.1111/mcn.70049

[5] **Talukder A,** Kelly M, Gray D, Sarma H. Caesarean deliveries and double burden of malnutrition: A multicountry analysis in South and Southeast Asia. ***J Public Health (Oxf).*** 2025;47(4):e546-e556. https://doi.org/10.1093/pubmed/fdaf117

[6] **Talukder A,** Kelly M, Gray D, Sarma H. Addressing the double burden of malnutrition in Bangladesh: Evidence from national policy documents and gaps in policy integration. ***Glob Epidemiol.*** 2026; 11:100258. https://doi.org/10.1016/j.gloepi.2026.100258

[7] **Talukder A,** Kelly M, Chanda SK, Gray D, Sarma H. The double burden of malnutrition in Bangladesh: Policy architecture, implementation realities, and future directions. ***Curr Dev Nutr.*** **2026**.109433. https://doi.org/10.1016/j.cdnut.2026.109433

Conference participation During Candidature

[1] **Talukder A,** Kelly M, Gray D, Sarma H. Nutritional consequences of cesarean births: exploring the link to the double burden of malnutrition in South and Southeast Asia. ***18th Asia Pacific Rim Universities (APRU) Global Health Conference 2025,*** Universiti Malaya, Kuala Lumpur, Malaysia, 28–31 October 2025.https://www.apru.org/event/the-18th-apru-global-health-conference-2025/

[2] **Talukder A,** Kelly M, Gray D, Sarma H. Double Burden of Malnutrition Among Urban Women of Reproductive Age: A Multicounty Analysis in South and Southeast Asia. ***The International Conference on Applied Statistics and Data Science****,* Dhaka, Bangladesh. December 28-29. https://isi-web.org/article/international-conference-applied-statistics-and-data-science-2025

[3] **Talukder A,** Kelly M, Gray D, Sarma H. Determinants of Double Burden of Malnutrition in South and Southeast Asian Households: A Systematic Review and Meta-Analysis. ***Nutrition 2026: Annual Meeting of the American Society for Nutrition****,* Washington, D.C. 25-28 July 2026. https://nutrition.org/meetings/

[4] **Talukder A,** Kelly M, Gray D, Sarma H. Addressing the Double Burden of Malnutrition in Bangladesh: Policy Challenges and the Path to Progress. ***Nutrition 2026: Annual Meeting of the American Society for Nutrition****,* Washington, D.C. 25-28 July 2026. https://nutrition.org/meetings/

Awards Arising During Candidature

[1] **Second Place**, Postgraduate Student Poster Competition, ***18th Asia Pacific Rim Universities (APRU) Global Health Conference 2025,*** Universiti Malaya, Kuala Lumpur, Malaysia, 28–31 October 2025. https://www.apru.org/event/the-18th-apru-global-health-conference-2025/

Poster title: Urbanisation and Double Burden of Malnutrition at the Household-Level in South and Southeast Asia: Insights from Night-Time Lights Data.

[2] Winner of the 2026 Dennis Trewin Prize, awarded by the **Statistical Society of Australia, ACT Branch**

Presentation title: Caesarean Births and the Double Burden of Malnutrition (BDM): A Multilevel Modelling Approach Using National Survey Data from South and Southeast Asia

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List of Abbreviations

ANC	Antenatal Care
ANOVA	Analysis of Variance
AOR	Adjusted Odds Ratio
BAZ	Body Mass Index-for-Age Z-score
BCC	Behaviour Change Communication
BDHS	Bangladesh Demographic and Health Survey
BMI	Body Mass Index
BNNC	Bangladesh National Nutrition Council
CDC	Centers for Disease Control and Prevention
CDHS	Cambodia Demographic and Health Survey
CI	Confidence Interval
COREQ	Consolidated Criteria for Reporting Qualitative Research
C-section	Caesarean Section
DBM	Double Burden of Malnutrition
DHS	Demographic and Health Survey
DoHAD	Developmental Origins of Health and Disease
EA	Enumeration Area
FAO	Food and Agriculture Organization
GNR	Global Nutrition Report
HAZ	Height-for-Age Z-score
HPT	Health Policy Triangle
ICC	Intraclass Correlation Coefficient
ICF	ICF International
IDHS	Indonesia Demographic and Health Survey
IDD	Iodine Deficiency Disorder
IFAD	International Fund for Agricultural Development
KII	Key Informant Interview
LMIC	Low- and Middle-Income Country
MDHS	Myanmar Demographic and Health Survey
MICS	Multiple Indicator Cluster Survey
MUAC	Mid-Upper Arm Circumference
NCD	Non-Communicable Disease
NDHS	Nepal Demographic and Health Survey
NFHS	National Family Health Survey (India)
NGO	Non-Governmental Organization
NIPORT	National Institute of Population Research and Training (Bangladesh)
NNP	National Nutrition Policy
NNS	National Nutrition Survey
NOS	Newcastle-Ottawa Scale

NPAN	National Plan of Action for Nutrition
OR	Odds Ratio
OWM	Mother with overweight
PDHS	Pakistan Demographic and Health Survey
PICOS	Population, Intervention/Exposure, Comparator, Outcomes, Study Design
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSU	Primary Sampling Unit
SD	Standard Deviation
SDG	Sustainable Development Goal
SE	Standard Error
SES	Socioeconomic Status
SSA	Sub-Saharan Africa
TDHS	Timor-Leste Demographic and Health Survey
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
VIF	Variance Inflation Factor
WASH	Water, Sanitation, and Hygiene
WAZ	Weight-for-Age Z-score
WFP	World Food Program
WHA	World Health Assembly
WHO	World Health Organization
WHZ	Weight-for-Height Z-score

Section I: Foundation

Chapter 1: Introduction

1.1 Background

The double burden of malnutrition (DBM) refers to the simultaneous presence of undernutrition (stunting, wasting, underweight and micronutrient deficiencies) and overnutrition (overweight and obesity) within the same population, household, or individual across the life course [1]. Although DBM was initially recognised at the population level, growing evidence shows that it increasingly occurs within households, most commonly where an undernourished child lives with an adult with overweight or obesity, most often the mother [1,2]. This pattern reflects rapid shifts in nutrition and lifestyle, marked by greater consumption of energy-dense, nutrient-poor foods and declining physical activity, which together increase the risk of adult overweight and obesity [3,4]. At the same time, structural constraints such as suboptimal infant and young child feeding practices, poor sanitation and hygiene, and limited access to affordable, nutritious foods continue to sustain child undernutrition [5,6]. As a result, contrasting forms of malnutrition now coexist within the same households, creating a complex nutritional reality that conventional, single-issue nutrition policies are poorly equipped to address.

Globally, DBM is becoming increasingly evident. While childhood stunting has declined from an estimated 33% (204.2 million children) in 2000 to 22.3% (148.1 million) in 2022 [7,8], rates of overweight and obesity have risen sharply, now affecting nearly 390 million children and adolescents worldwide in 2022 [9]. A study analysing data from 126 countries between 1999 and 2017 reported that household-level DBM prevalence ranged from 3% to 35% across countries [2]. Among these households, the most frequently observed patterns were pairs of stunted children and mothers with overweight (1–24%), followed by mothers with overweight and wasted children (0.3–10%), and mothers with underweight and children with overweight (0.1–4%) [2], highlighting the growing complexity of DBM across households and populations.

In South and Southeast Asia, DBM has also become a major public health concern. A systematic review and meta-analysis conducted in 2020 found that 28% of the South Asian population was underweight and 17% overweight, while in Southeast Asia, underweight and overweight each affected around 20% of the population [10]. Household-level DBM has also shown a marked upward trend over time. In Bangladesh, prevalence increased from 4% in 2004 to 13.8% in 2018, while similar rises were observed in Nepal (5.6% in 2006 to 12.3% in 2022), Cambodia (7.4% in

2005 to 14.3% in 2022), and Timor-Leste (9.4% in 2009 to 15.8% in 2016) [11]. By 2021, household-level DBM affected one in four families in India [12]. These estimates illustrate the rapid emergence and widespread distribution of DBM in South and Southeast Asia, indicating the urgent need for targeted interventions and policy responses.

1.2 Statement of the Problem

1.2.1 Structural and Systemic Drivers of Household-Level DBM

Despite increasing recognition of DBM, households in South and Southeast Asia remain unable to achieve optimal nutrition for all members. Household-level DBM is sustained by interacting with structural, behavioural, and environmental constraints that simultaneously promote adult overnutrition and perpetuate child undernutrition. Rising household purchasing power has increased consumption of energy-dense, ultra-processed foods [13,14], while their low cost, widespread availability and accessibility have made them increasingly affordable even for lower-income households. At the same time, persistent poverty continues to constrain access to diverse and nutritious diets [15,16]. Rapid urbanisation and lifestyle transitions have reduced physical activity and increased reliance on convenience foods, particularly among urban and peri-urban households [17,18]. As a result, children in rural-to-urban migrant households often experience insufficient dietary diversity [19].

Maternal nutrition and education play a central role in shaping household nutritional outcomes. Mothers with undernutrition are more likely to give birth to low-birth-weight infants [20, 21], which increases children's vulnerability to undernutrition. On the other hand, limited knowledge of nutrition constrains healthy dietary practices [22, 23]. At the systems level, weak regulation of food environments permits the aggressive marketing of ultra-processed foods, and agricultural policies continue to prioritise staple grains over fruits and vegetables. As a result, per-capita fruit and vegetable intake remains well below WHO recommendations [24]. Fragmented health systems further worsen these challenges, as programmes targeting undernutrition are rarely integrated with initiatives to prevent overweight and obesity, such as double-duty actions [4], limiting opportunities for coordinated and synergistic interventions. Together, these interconnected maternal, food-system, and health-system factors reinforce a persistent household-level paradox in which adult overnutrition coexists with child undernutrition

1.2.2 The Gap between Ideal and Reality

Ideally, households should serve as protective environments in which all members achieve optimal nutritional status, with children growing free from stunting, wasting, and micronutrient deficiencies and adults maintaining healthy body weight without developing diet-related NCDs. In South and Southeast Asia, however, this fundamental expectation is routinely undermined by the coexistence of undernutrition as well as overnutrition within the same household. Evidence from eight South and Southeast Asian countries demonstrates that household-level DBM is no longer marginal: 10.0% of households comprise mothers with overweight and stunted children, while 7.0% involve mothers with overweight and wasted children, resulting in an overall 12.0% prevalence of households experiencing maternal overweight alongside child undernutrition [25]. These patterns are not randomly distributed but are concentrated among households with lower maternal education, those living in urban slums and peri-urban settings, and even among wealthier households where rapid dietary change has outpaced nutrition knowledge and health system support [26,27]. Such households are increasingly shaped by urbanisation driven lifestyle changes and food environments characterised by the widespread availability of inexpensive, energy-dense processed foods, which further intensify the prevalence of household-level DBM [2, 26].

1.2.3 Consequences of Household-Level DBM

Household-level DBM imposes serious and interrelated health consequences across the life course. Within the same household, children may suffer from undernutrition, most commonly expressed as stunted growth, while adults experience overweight or obesity and associate NCDs such as hypertension, type 2 diabetes, and certain cancers [4, 28]. This coexistence of contrasting nutritional conditions reflects not only concurrent health risks but also a compounding effect over time. Evidence suggests that children exposed to early-life undernutrition face a heightened risk of being overweight and chronic disease in later life, reinforcing intergenerational cycles of poor health [29-31]. As a result, household-level DBM is not merely a co-occurrence of separate nutritional problems but reflects a continuing pattern of vulnerability that spans from early life into adulthood.

Beyond its health implications, DBM also generates substantial economic burdens for households and wider society. Managing undernutrition and obesity simultaneously often requires prolonged, diverse medical care, thereby increasing healthcare utilisation and associated costs [4]. In many South and Southeast Asian contexts, limited health financing and inadequate insurance coverage

force households to bear a substantial portion of these costs through out-of-pocket expenditures [32]. At the same time, illness-related declines in work capacity and productivity reduce household earnings, further undermining economic security and increasing vulnerability to poverty [4]. Together, these health and economic consequences illustrate why household-level DBM constitutes a critical public health and development challenge that demands integrated and context-specific policy responses.

1.2.4 Knowledge Gap and Rationale of the Study

Despite growing recognition of DBM as a critical public health challenge, substantial knowledge gaps constrain effective policy and programmatic responses. A major challenge in advancing research on household-level DBM lies in the lack of conceptual and definitional consistency [33]. Existing studies employ diverse definitions and indicators, which limit comparability across studies, complicate evidence synthesis, and weaken the translation of research findings into policy and practice [33]. Moreover, empirical evidence on the prevalence and trends of household-level DBM in South and Southeast Asia also remains fragmented. Many studies are country-specific [34,35], or based on outdated data [35-37], providing limited insight into how household-level DBM has evolved over time. Given the rapid pace of socioeconomic and dietary change in the region, understanding trends is essential for anticipating future public health needs and designing responsive interventions.

Evidence on the determinants of household-level DBM is similarly inconsistent. Socioeconomic status, household wealth, maternal education, urban residence, and employment have all been identified as potential risk factors, however, their associations with DBM vary across contexts [26,38-40]. In some settings, higher socioeconomic status increases DBM odds through greater exposure to obesogenic environments [41], while in others, poverty and food insecurity remain key drivers [42]. These mixed findings emphasise the necessity of both systematic synthesis of existing evidence and robust, comparative empirical analyses that can disentangle shared and context-specific determinants across regions and countries.

An emerging and relatively underexplored determinant of household-level DBM is the mode of delivery, particularly caesarean section. Caesarean rates have increased sharply across South and Southeast Asia, frequently surpassing WHO recommendations [43,44]. Evidence suggests that caesarean delivery can affect breastfeeding practices, the early-life gut microbiota, and long-term obesity risk, which may, in turn, contribute to the coexistence of undernutrition and overnutrition within households [45-47]. Despite these biological and behavioural pathways, the association

between caesarean delivery and household-level DBM remains poorly understood, particularly in multi-country analyses across the region.

Furthermore, most national nutrition policies continue to prioritise undernutrition, with insufficient attention to the growing prevalence of overnutrition and the simultaneous occurrence of both forms of malnutrition within households [48,49]. Research assessing how these policies address DBM is limited, and existing frameworks rarely integrate strategies to prevent and manage undernutrition and overnutrition concurrently [48,49]. This gap is particularly pronounced in South and Southeast Asian countries that are shifting from a focus on undernutrition to tackling rising overnutrition, where current policy structures may not yet reflect the evolving epidemiological landscape.

To address these gaps, this thesis generates comprehensive evidence on household-level DBM by reviewing existing definitions and proposing definitions that are practicable to measure, analysing prevalence and trends, identifying key determinants, and critically evaluating policy responses, with Bangladesh as a case study. The findings aim to inform integrated, equity-oriented interventions and policy strategies designed to mitigate household-level DBM across the region. The quantitative analyses focus on four countries in South and Southeast Asia: Bangladesh, Cambodia, Nepal and Timor-Leste. The reasons for selecting these four countries and excluding other countries in South and Southeast Asia are explained in detail in Section 3.2.3.

1.3 Aim of the Study

The overall aim of this thesis is to investigate the prevalence, trends, and determinants of household-level DBM in South and Southeast Asia to explore evidence-based policies and interventions to enhance public health outcomes in the region.

1.3.1 Specific Objectives

This thesis is guided by four interrelated objectives, which are addressed through a series of seven manuscripts that collectively fulfil the research aim:

- **Objective 1:** To examine and synthesise existing definitions of DBM across individual, household, and population levels

  Clear and consistent definitions of DBM at different levels are essential for advancing research, monitoring, and policy development. Therefore, the first objective of this thesis

is to critically review and synthesise the existing definitions and conceptualisations of DBM as reported in the literature.

- ✓ **Paper 1:** Defining Double Burden of Malnutrition Across Individual, Household and Population Levels: A Narrative Review

- **Objective 2:** To estimate the prevalence and examine trends of household-level DBM across South and Southeast Asian countries using nationally representative data.

  Building on the conceptual foundation established in Objective 1, the second objective quantifies the magnitude of household-level DBM and examines its trends across countries in South and Southeast Asia using nationally representative datasets.

  - ✓ **Paper 2:** Prevalence and Trends of Double Burden of Malnutrition at Household Level in South and Southeast Asia

- **Objective 3:** To identify and examine risk factors associated with household-level DBM in South and Southeast Asia

  The third objective adopts a sequential evidence-building approach to investigate factors associated with household-level DBM. This objective progresses from synthesising existing evidence to examining specific determinants using multi-country analyses.

  - **Objective 3.1:** To synthesise existing evidence on the determinants of household-level DBM using a systematic review and meta-analysis.

    A systematic review and meta-analysis were conducted to identify and summarise the factors associated with household-level DBM across the region.

    - ✓ **Paper 3:** Factors Associated with the Double Burden of Malnutrition at Household Level in South and Southeast Asia: A Systematic Review and Meta-Analysis

  - **Objective 3.2:** To examine the interaction between two key risk factors, maternal education and household wealth, and their influence on household-level DBM using multi-country quantitative analyses.

    Given the inconsistent evidence regarding the roles of maternal education and household wealth, this component investigates how these two key socioeconomic factors are jointly associated with the odds of household-level DBM.

- ✓ **Paper 4:** Influence of Maternal Education and Household Wealth on Double Burden of Malnutrition in South and Southeast Asia

➢ **Objective 3.3:** To investigate the association between caesarean delivery, and household-level DBM using multi-country quantitative analysis.

Recognising caesarean delivery as a potential but relatively underexplored determinant, this component examines its association with household-level DBM using multi-country data from South and Southeast Asia.

- ✓ **Paper 5:** Caesarean Deliveries and Double Burden of Malnutrition: A Multicountry Analysis in South and Southeast Asia

- **Objective 4:** To analyse policy responses to DBM and identify gaps, challenges, and opportunities for integrated policy action

The final objective extends beyond epidemiological analysis to explore policy responses to DBM. Using Bangladesh as a case study, this objective examines existing policy frameworks, implementation challenges, and opportunities for strengthening integrated approaches to address DBM.

- ✓ **Paper 6:** Addressing the Double Burden of Malnutrition in Bangladesh: Evidence from National Policy Documents and Gaps in Policy Integration

- ✓ **Paper 7:** The Double Burden of Malnutrition in Bangladesh: Policy Architecture, Implementation Realities, and Future Directions

The research objectives follow a logical progression from defining and measuring household-level DBM to examining its associated factors and policy responses. The relationships among these objectives and the sequential integration of the seven papers are described in the following section.

1.4 Logical Progression and Integration of the Seven Papers

The seven papers included in this thesis follow a logical and cumulative research process, progressing from conceptualisation and measurement to understanding determinants and examining policy responses. Each paper contributes to addressing the overall research objectives while building on the conceptual or empirical evidence generated by the preceding studies.

Paper 1 (Objective 1) established the conceptual foundation of the thesis through a narrative review of definitions of DBM at the individual, household and population levels. This review provided a basis for selecting a consistent operational definition of household-level DBM for the subsequent quantitative analyses.

Building on this foundation, Paper 2 (Objective 2) examined the prevalence and trends of household-level DBM across selected countries in South and Southeast Asia. Household-level DBM was operationalised as the coexistence of a mother with overweight or obesity and an undernourished child (stunted, wasted or underweight) within the same household. This mother–child combination was selected based on the availability of relevant anthropometric information in nationally representative Demographic and Health Surveys (DHS). The findings provided a comparative understanding of the magnitude and changing patterns of household-level DBM across the selected countries.

Paper 3 (Objective 3.1) extended this evidence through a systematic review and meta-analysis of factors associated with household-level DBM. The review highlighted maternal education and household wealth as important determinants, although the magnitude and direction of their associations varied across studies. These inconsistencies motivated Paper 4 (Objective 3.2), which examined the interaction between maternal education and household wealth to better understand their combined association with household-level DBM. The review also identified limited evidence regarding the association between caesarean delivery and household-level DBM, providing the rationale for Paper 5 (Objective 3.3). This study investigated the association between caesarean delivery and household-level DBM, including potential pathways involving maternal and child nutritional outcomes.

The final two papers (Objective 4) extended the research from epidemiological evidence to policy responses, using Bangladesh as a case study. Bangladesh was selected because of its established national nutrition policy framework and the researcher's academic and professional experience in the country. Paper 6 reviewed national policy documents to assess the extent to which DBM was recognised and addressed within existing policy frameworks. Building on these findings, Paper 7 explored stakeholder perspectives on policy implementation, institutional challenges and priorities for strengthening responses to DBM through qualitative interviews with senior nutrition stakeholders.

Together, the seven papers provide an integrated understanding of household-level DBM, progressing from conceptual definition and epidemiological measurement to associated factors and policy responses. This sequential approach combines evidence from multiple countries with an in-depth policy analysis of Bangladesh, contributing to a broader understanding of DBM in South and Southeast Asia.

1.5 Significance of the Study

This thesis makes several important contributions to policy and practice in the field of public health nutrition. Conceptually, it advances clarity in understanding DBM by systematically examining and synthesising definitions at the individual, population, and household levels. By identifying the household as the primary unit of analysis, this study provides a clearer framework for defining and measuring DBM, thereby improving the consistency and comparability of findings across studies.

Empirically, this thesis provides comprehensive assessments of household-level DBM conducted to date in South and Southeast Asia. Using nationally representative, multi-country datasets and rigorous analytical approaches, it generates robust evidence on prevalence, trends, and determinants that extend beyond fragmented single-country studies. The inclusion of both synthesis-based and original quantitative analyses enhances the reliability and policy relevance of the findings.

Methodologically, the thesis demonstrates the value of integrating multiple study designs, including narrative review, systematic review and meta-analysis, multi-country quantitative analyses, and qualitative policy analysis within a single, coherent research programme. This integrated approach aligns with contemporary expectations for complex public health research and offers a transferable framework for studying DBM in other regions.

From a policy perspective, the thesis contributes actionable insights by critically examining policy responses to DBM and identifying gaps in governance, coordination, and implementation. The Bangladesh case study provides context-specific lessons and broader implications for countries across South and Southeast Asia seeking to develop integrated, double-duty nutrition strategies. Collectively, these contributions support evidence-informed decision-making and the development of more effective and equitable public health interventions.

1.6 Structure of the Thesis

This thesis is presented as a thesis by publication and comprises seven interrelated papers organised into eleven chapters and five thematic sections: Foundation, Evidence Generation, Determinants, Policy Insights, and Knowledge Integration (**Figure 1**).

The Foundation section:

This section establishes the conceptual and methodological basis of the thesis. Following this introductory chapter, **Chapter 2** presents a comprehensive literature review that synthesises existing definitions, conceptualisations, and evidence on household-level DBM, identifies key research gaps, and lays the foundation for the studies that follow.

Chapter 3 outlines the research methods employed throughout the thesis, including data sources, study designs, and analytical approaches.

Chapter 4 (Paper 1) presents a systematic narrative review that synthesises existing definitions and conceptualisations of household-level DBM.

The Evidence Generation section:

This comprises **Chapter 5 (Paper 2),** which examines the prevalence and trends of household-level DBM across South and Southeast Asia using nationally representative survey data.

The Determinants section:

This consists of three interconnected studies that investigate factors associated with household-level DBM. **Chapter 6 (Paper 3)** presents a systematic review and meta-analysis for identifying key determinants of household-level DBM.

Chapter 7 (Paper 4) examines the interaction between two key determinants of household-level DBM using multi-country quantitative analyses.

Chapter 8 (Paper 5) investigates the association between household-level DBM and caesarean delivery, an emerging and underexplored risk factor, using nationally representative data from multiple countries.

The Policy Insights section:

This section focuses on policy responses to DBM in Bangladesh. **Chapter 9 (Paper 6)** presents a policy document analysis examining the extent to which DBM is integrated into national nutrition, food security, health, and agriculture policies, and identifying key policy gaps.

Chapter 10 (Paper 7) explores policy architecture, implementation realities, stakeholder perspectives, and future directions for addressing household-level DBM through qualitative key-informant interviews.

Finally, the **Knowledge Integration** section comprises **Chapter 11,** which synthesises findings from all seven papers to provide an integrated understanding of household-level DBM. This chapter discusses the theoretical, empirical, and policy implications of the findings, highlights their contribution to the evidence base, outlines the study's limitations, and presents recommendations for future research, policy, and practice.

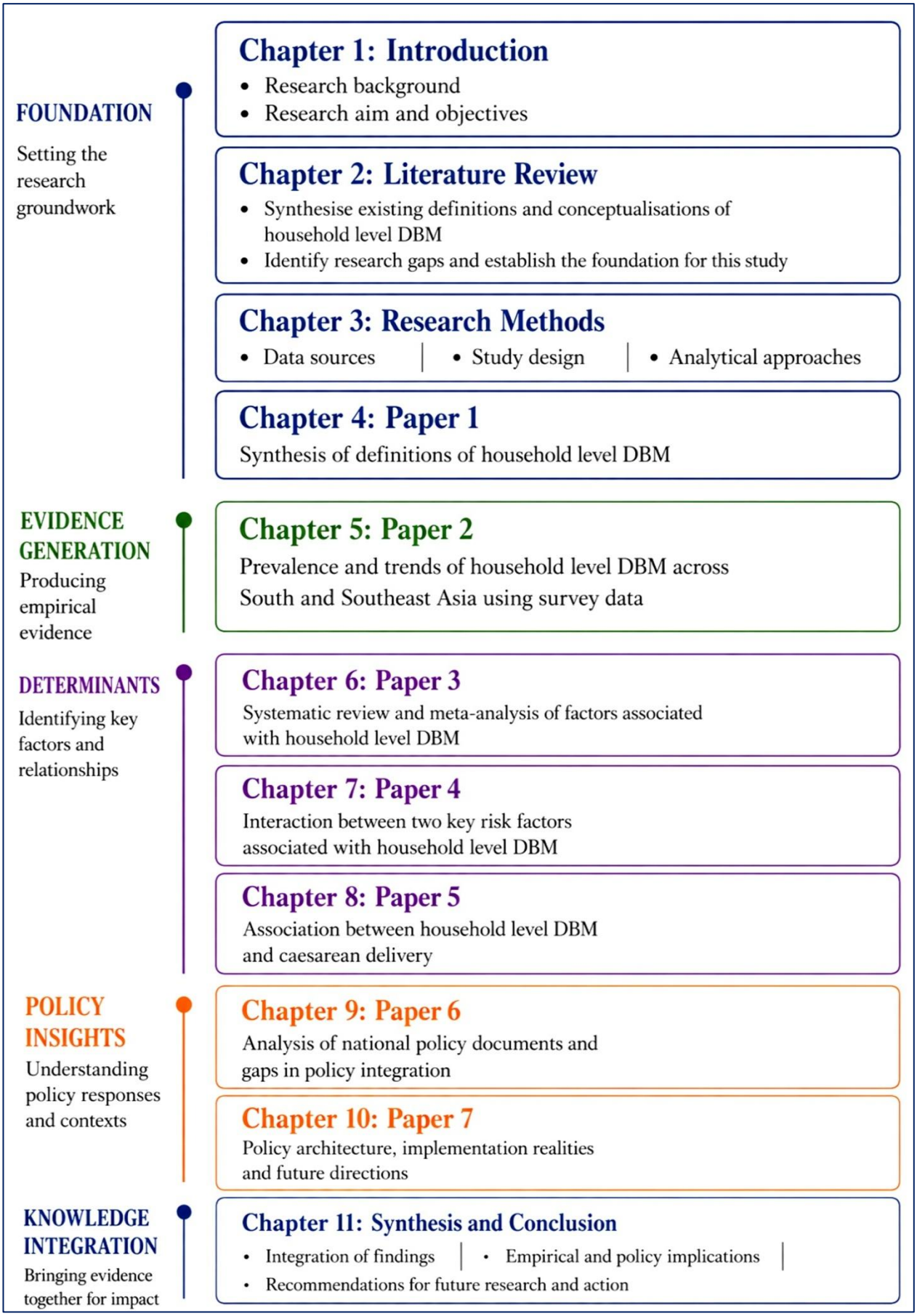

Figure 1: Overall thesis structure

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Chapter 2: Literature Review

2.1 Definition and Conceptualisation of DBM

The concept of DBM gained international recognition during the 1992 International Conference on Nutrition, which was jointly organised by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) [1,2]. Initially, DBM was considered as the coexistence of undernutrition and overnutrition at the national level, reflecting two distinct nutritional challenges within the same country [1,2]. At that time, it was widely assumed that countries would progress from undernutrition to overnutrition as they underwent economic development, with undernutrition considered a challenge of low- and middle-income countries (LMICs) and overnutrition a challenge of high-income countries [2]. However, growing evidence has shown that these two forms of malnutrition can coexist not only within populations but also within communities, households, and individuals [3–14]. This changing understanding reflects the rapid nutrition transition occurring across many LMICs, where changes in food systems, dietary patterns, and lifestyles have driven a rise in overweight and obesity while undernutrition persists [3–14]. In recognition of this evolving evidence, the WHO defines DBM as the coexistence of undernutrition and overnutrition, including overweight, obesity, and diet related non-communicable diseases (NCDs), within populations, households, or individuals and across different stages of life [15]. Therefore, understanding DBM requires a broader perspective that considers both who is affected and the settings in which different forms of malnutrition coexist [5,15]. To illustrate this concept, the WHO presents an infographic in its DBM policy brief that highlights the coexistence of multiple forms of malnutrition across individuals, households, populations and the life course (Figure 1).

Before considering how DBM manifests, it is useful to first define the individual forms of malnutrition it comprises. Stunting refers to impaired linear growth, defined as height-for-age more than 2 standard deviations below the WHO reference median, and reflects chronic undernutrition. Wasting refers to low weight for height and reflects acute undernutrition or recent weight loss. Overweight and obesity refer to excess body weight relative to height, commonly measured using body mass index (BMI) in adults or weight-for-height or BMI-for-age in children, and they reflect chronic energy excess.

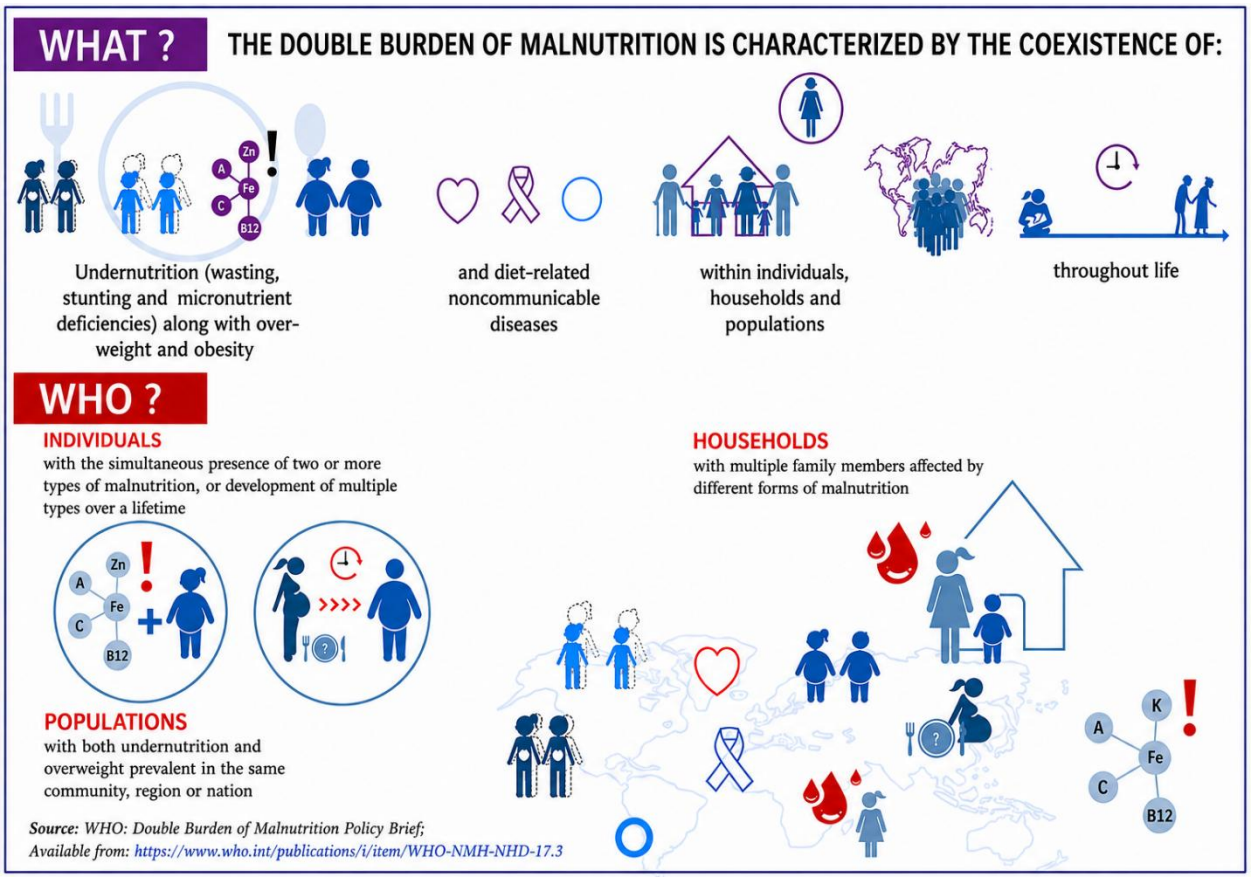

Figure 1: WHO definition and overview of DBM across individual, household, and population levels.
Source: *Adapted from World Health Organization (WHO): Double Burden of Malnutrition Policy Brief [15]; Available from: https://www.who.int/publications/i/item/WHO-NMH-NHD-17.3. Text has been presented in* ***bold*** *to improve readability and visual presentation.*

DBM can occur at three levels. At the individual level, DBM can manifest either at the same point in time or across different stages of the life course [10,14,15]. At this level, DBM may be observed when different forms of malnutrition occur in the same person simultaneously, such as the coexistence of overweight or obesity with micronutrient deficiencies or nutritional anaemia [10,15]. In contrast, life-course DBM refers to situations in which undernutrition experienced earlier in life, such as childhood stunting, is followed by the development of overweight, obesity, or diet-related NCDs in adulthood as nutritional environments change due to economic development or urbanisation [3,16].

DBM also manifests at the household level, where different members experience contrasting forms of malnutrition despite sharing the same socioeconomic and food environment. For example, a household may include an undernourished child alongside an adult with overweight or a mother with nutritional anaemia living with a child with overweight [17,18]. Such dual-

burden households are increasingly common in LMICs undergoing rapid nutrition transition, where improvements in food availability coexist with persistent inequalities in diet quality, maternal and childcare practices, birth outcomes, and access to health services [15,16,19].

Additionally, DBM is evident at the population level when undernutrition and overweight, obesity, or diet-related NCDs coexist within the same community, region, or country [11,14,15]. Many countries now face this dual challenge, with undernutrition declining more slowly than anticipated and overweight and obesity rising rapidly, particularly among women [7,20,21]. This overlapping burden places substantial strain on health systems, economies, and social structures, as countries are required to address persistent undernutrition alongside escalating NCD-related morbidity and mortality [22,23].

It is important to note that substantial heterogeneity exists in how DBM is defined and measured across studies at the individual, household, and population levels. Definitions differ in the anthropometric indicators used, which household members or age groups are included, and whether micronutrient deficiencies or diet-related NCDs are considered [16]. This variability poses challenges for comparing findings across contexts and synthesising evidence for policy and intervention design. In this thesis, I address these inconsistencies more deeply in my first paper, using a systematic narrative review to provide comprehensive and practically measurable definitions of DBM at the individual, household, and population levels. The full published paper is presented in **Chapter 4.**

2.2 Understanding Household-Level DBM through a Structured Framework

The household-level manifestation of DBM is the central focus of this thesis. To develop a deeper understanding of how DBM emerges within households, it is necessary to examine the interactions between shared socioeconomic conditions and the differing nutritional vulnerabilities of household members. In this context, a structured framework provides a useful way to organise and interpret the complex pathways through which DBM occurs at the household level. In the next section, I present a framework that illustrates these mechanisms and helps explain how DBM can arise within households.

2.2.1 Nutrition Transition and Population Shifts

The concept of the nutrition transition helps explain how societies gradually shift from

undernutrition and infectious diseases to patterns dominated by overnutrition and NCDs [24,25]. In Popkin's early study, this shift is explained through five broad changes in diet quality and physical activity, all of which are linked to economic growth, urbanisation, and technological advancement [24]. According to the original framework, this transition occurs over time. Rising incomes, changing diets and food habits, and increasing sedentary lifestyles are gradually reshaping what people eat and how they live [25].

However, the growing prevalence of DBM at household-level challenges the assumption that changes in diet and nutritional status follow a uniform or sequential pattern. Rather than experiencing a complete epidemiological shift from undernutrition to overnutrition, households in South and Southeast Asia increasingly exhibit both conditions simultaneously [3,6,26]. This phenomenon suggests that the nutrition transition does not operate uniformly across all household members. Therefore, the structural constraints may limit the extent to which nutritional shifts are fully realised [3,27]. Children may remain vulnerable to undernutrition due to inadequate complementary feeding, infectious disease, and poor sanitation [28–30]. On the other hand, adults in the same household consume energy-dense foods that promote weight gain; however, they fail to ensure adequate micronutrient intake [31–35].

The coexistence of under- and overnutrition within households reflects what Popkin and colleagues (2020) [3] describe as the 'dynamics of the double burden.' Rapid economic change, urbanisation, and transformations in food systems enable different forms of malnutrition to occur simultaneously. This perspective recognises that nutrition transitions are neither linear nor inevitable. Households can remain in intermediate stages where they do not fully address undernutrition or overnutrition [3]. Understanding household-level DBM therefore requires moving beyond stage-based assumptions and recognising that nutritional risks can coexist and affect household members in different ways.

2.2.2 Socioecological Conditions and Multilevel Determinants

Complementing the concept of nutrition transition, socioecological perspectives situate household-level DBM within interconnected systems of influence operating at the individual, household, community, and societal levels [36,37]. These frameworks emphasise that malnutrition outcomes are shaped not only by individual dietary behaviours but also by the broader environments in which households exist, including food systems, health systems, social norms, and policy contexts [15].

At the individual-level, biological factors such as age, sex, metabolic disorder, and genetic susceptibility influence nutritional status [38–40]. Undernutrition during early life may induce metabolic adaptations that increase the risk of obesity later in adulthood. This phenomenon is explained by the Developmental Origins of Health and Disease (DOHaD) hypothesis [41,42]. This mechanism also helps to explain why children exposed to undernutrition may face elevated risks of overweight and chronic disease later in life, thereby contributing to intergenerational cycles of DBM [36,43].

At the household level, maternal education, household wealth, food security, caregiving practices, and intra-household resource allocation shape nutritional outcomes for both children and adults [6,26,44]. Households characterised by lower maternal education may lack the nutrition knowledge necessary to make informed dietary choices, while constrained household wealth limits access to diverse, nutrient-dense foods [45]. Simultaneously, increased household purchasing power in transitioning economies may facilitate consumption of ultra-processed foods, which contribute to adult obesity without addressing child undernutrition [3].

At the community and societal levels, food environments, urbanisation patterns, healthcare infrastructure, agricultural policies, and social protection systems create the structural conditions within which household nutrition outcomes are determined [46–48]. Weak regulation of food marketing permits aggressive promotion of ultra-processed products, particularly in urban and peri-urban settings [49,50], while agricultural policies that prioritise staple grains over fruits and vegetables constrain dietary diversity [51].

A key driver of this pattern is the economics of food pricing. Within the global food system, ultra-processed, energy-dense foods are often the cheapest and most accessible sources of dietary energy [5,24,27]. In contrast, nutrient-dense foods, including fruits, vegetables, and animal-source foods, remain comparatively more expensive and less accessible. This pricing dynamic has fuelled the nutrition transition in LMICs and contributed to an inverted social gradient in overweight and obesity [27]. As a result, lower-income populations are now at greater risk of overweight and obesity than wealthier groups. The same economic pressures also shape infant and young child feeding practices. Inexpensive processed foods are increasingly used to replace nutrient-rich complementary foods. This increases the risk of childhood overweight while perpetuating undernutrition by displacing nutrient-dense diets. Consequently, shared food-system drivers can promote both child undernutrition and adult overnutrition within the same household. These challenges are further exacerbated by fragmented health systems, which often address

undernutrition and overnutrition through separate, uncoordinated programmes. This limits the implementation of integrated double-duty actions to prevent household-level DBM [15].

2.2.3 Life-Course Perspective

The life-course perspective provides a temporal dimension to understanding household-level DBM by emphasising that nutritional status at any given point reflects accumulated exposures and experiences across the lifespan [52]. From this perspective, household-level DBM is not merely a snapshot of coexisting nutritional conditions but rather a dynamic process in which early-life exposures influence later-life outcomes and intergenerational transmission of nutritional vulnerability perpetuates patterns of malnutrition across generations [53].

Maternal undernutrition during pregnancy increases the risk of low-birth weight, which in turn elevates children's vulnerability to stunting, impaired cognitive development, and increased susceptibility to infection [54,55]. Simultaneously, these early-life insults may programme metabolic adaptations that predispose individuals to obesity and cardiometabolic disease in adulthood, particularly when coupled with energy-dense diets and sedentary lifestyles [53,56]. This phenomenon, often referred to as the "thrifty phenotype hypothesis", suggests that foetal and early-childhood undernutrition creates a metabolic mismatch when individuals are later exposed to obesogenic environments, thereby increasing the risk of chronic disease [57].

The life-course perspective also highlights critical periods and sensitive windows during which nutritional exposures exert disproportionate effects on long-term health trajectories [52]. The first 1,000 days represent a particularly critical window during which undernutrition can produce irreversible developmental consequences [58]. Similarly, adolescence and the preconception period represent sensitive windows during which nutritional status influences reproductive outcomes and intergenerational health [59]. Understanding household-level DBM through a life-course lens therefore requires attending to these critical periods and recognising that interventions must be timed appropriately to interrupt cycles of intergenerational malnutrition.

2.2.4 Structured Framework for Household-Level DBM

Building on the nutrition transition concept, socioecological conditions, and life-course perspectives, this thesis adopts a framework to understand how DBM can occur at the household-level (Figure 2). This framework illustrates how household-level DBM emerges when children and adults within the same household experience opposing forms of malnutrition despite sharing

a common socioeconomic environment. Broader policy and systems-level determinants, including economic policies, agricultural and food systems, urbanisation, food regulation, and health systems, shape household conditions such as wealth, maternal education, food security, access to healthcare, the food environment, and water, sanitation, and hygiene (WASH) practices. Within this shared context, household members face age-specific vulnerabilities. Children are more likely to experience undernutrition (stunting, wasting, and underweight) due to inadequate dietary intake and repeated infections, particularly during the critical first 1,000 days from conception to two years of age. In contrast, adults are more likely to develop overnutrition (overweight and obesity) because of increased consumption of ultra-processed foods and sedentary lifestyles. This coexistence of undernutrition and overnutrition within the same household creates the DBM. The framework further highlights early-life effects, whereby childhood undernutrition elevates the risk of obesity in adulthood, as well as an intergenerational cycle in which undernourished children become nutritionally vulnerable adults and mothers, thereby perpetuating malnutrition across generations.

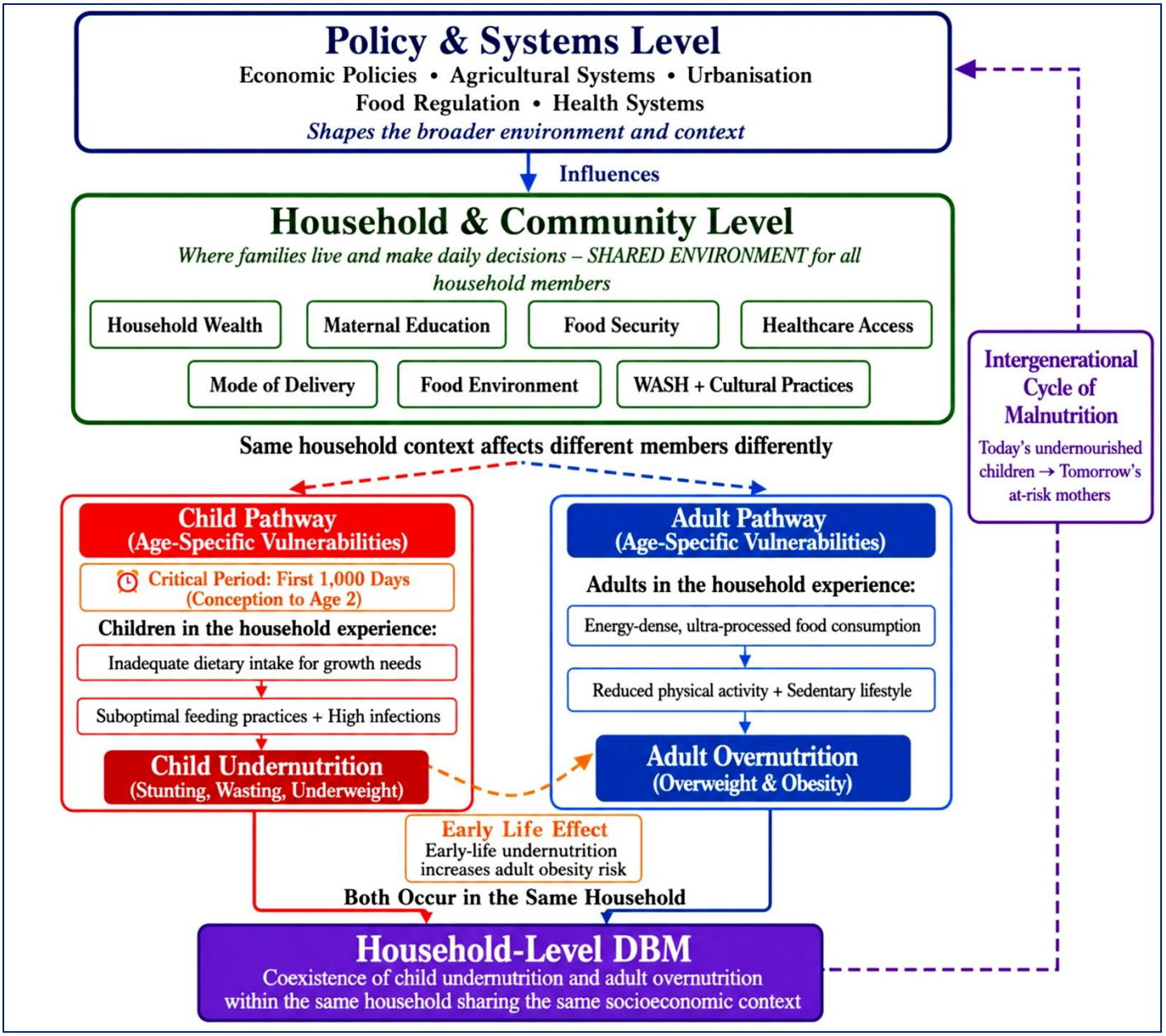

Figure 2: Framework for understanding household-level DBM

Note: *This framework shows how household-level DBM emerges when children and adults experience contrasting forms of malnutrition within a shared socioeconomic environment. Policy and system-level factors shape household conditions such as wealth, maternal education, food security, healthcare access, food environments, and WASH. Within this context, children are more susceptible to undernutrition, particularly during the first 1,000 days, while adults are more likely to develop overnutrition due to energy-dense diets and sedentary lifestyles. The framework also highlights early-life effects and intergenerational cycles that perpetuate DBM across generations.*

2.3 Prevalence and Trends of DBM

2.3.1 Global Prevalence of Malnutrition

Globally, malnutrition is undergoing a shift, with undernutrition and overnutrition increasingly occurring alongside one another. According to the UNICEF, WHO, and World Bank Group Joint Malnutrition Estimates (2025 edition), global childhood stunting declined from 33.1% (207.2 million children) in 2000 to 23.2% (150.2 million) in 2024 [60]. However, undernutrition still remains a major public health concern. For example, 42.8 million children under-five years of age continue to suffer from wasting, including 12.2 million with severe wasting [60]. At the same time, overweight and obesity have risen sharply, with 35.5 million children under five living with overweight worldwide, an increase of 2.4 million since 2000 (Figure 3). The burden of child malnutrition remains heavily concentrated in Africa and Asia, while childhood overweight has emerged as a growing public health concern across nearly all regions (Figure 4). Among adults, the most recent global estimates indicate that approximately 2.5 billion people were overweight in 2022, including 890 million living with obesity [60], highlighting the rapid expansion of overnutrition alongside persistent undernutrition.

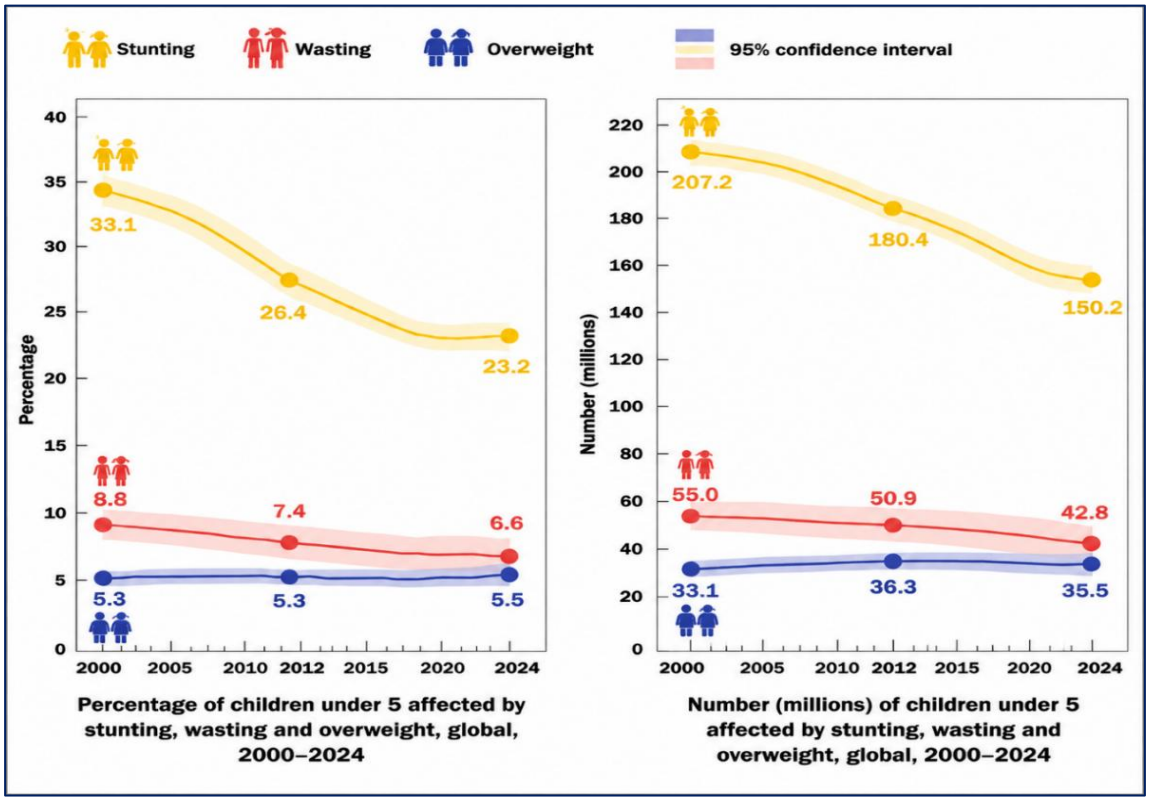

Figure 3: Global prevalence and trends of stunting, wasting and overweight among under-five children. ***Source:*** *Adapted from UNICEF, WHO, and World Bank Group. Joint Child Malnutrition Estimates: 2025 [60])*

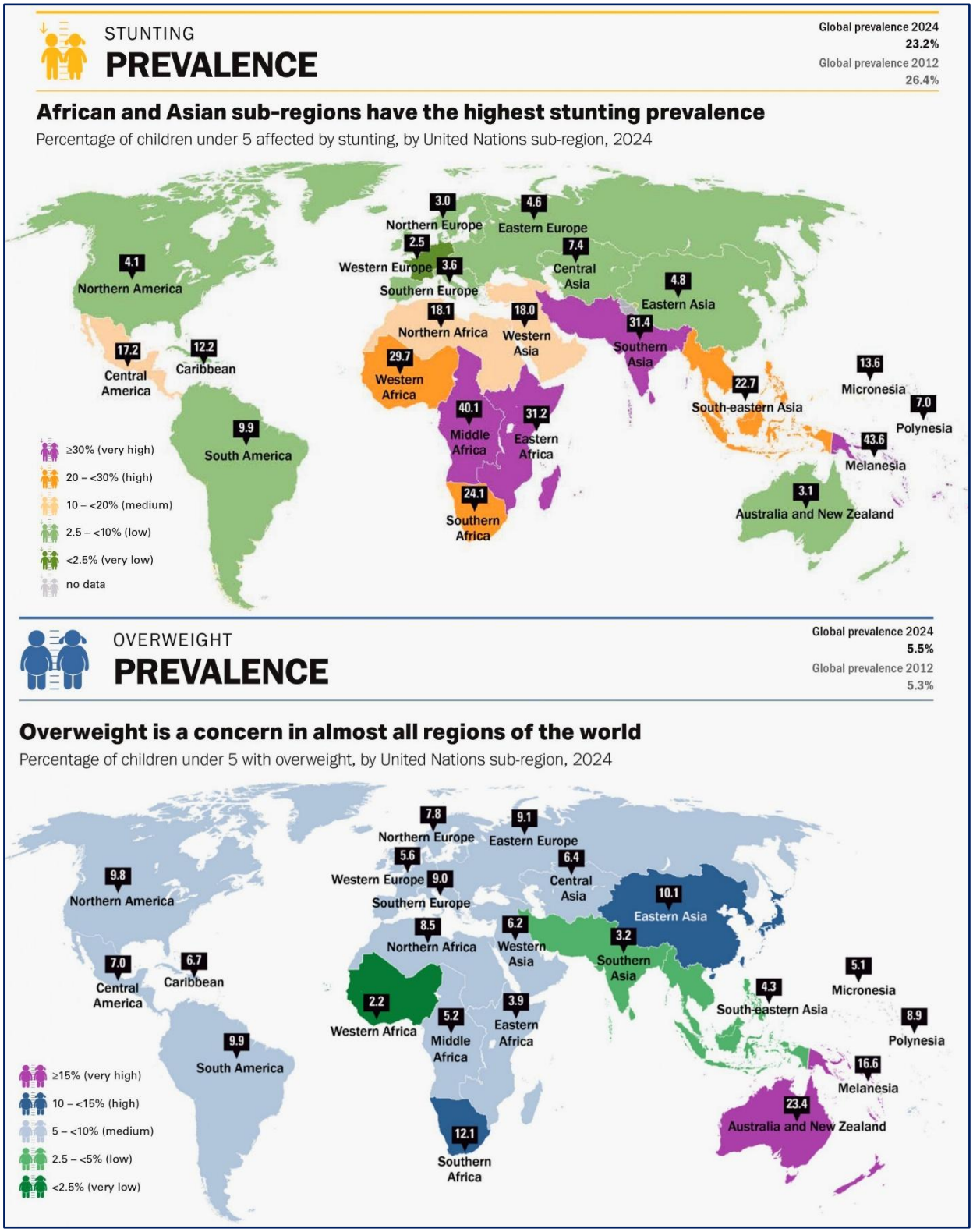

Figure 4: Regional prevalence of stunting and overweight among children under five years.

Source: *Adapted from UNICEF, WHO, and World Bank Group. Joint Child Malnutrition Estimates: 2025 [60]*

2.3.2 Global Patterns of Household-Level DBM

In recent years, DBM has increasingly been recognised as a major global public health challenge. Although global data on DBM remain limited, evidence from the Global Nutrition Report 2020 [61] highlights its widespread presence (Figure 5). The report assessed three key indicators at the country level: stunting among children under five years, anaemia among women of reproductive age (15–49 years), and overweight, including obesity, among adult women (18 years and above). Among 194 countries reviewed, 143 had complete data for all three indicators. Of these 143 countries, 124 experienced high levels of at least two forms of malnutrition, with the most frequent combinations being anaemia and overweight (56 countries), anaemia and stunting (28 countries), and stunting and overweight (3 countries). Moreover, 37 countries, predominantly in Africa, were burdened by all three forms simultaneously [61].

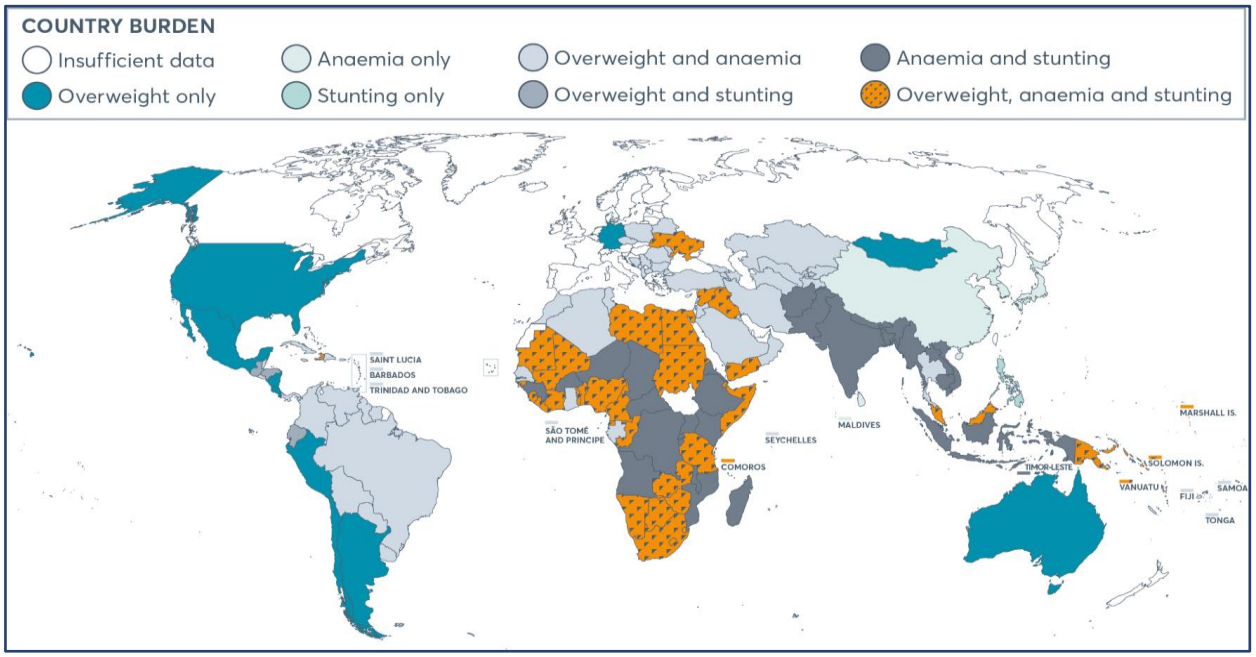

Figure 5: Global distribution of high prevalence of stunting in children under five, anaemia in women of reproductive age, and overweight including obesity in adult women.

Note: *High prevalence thresholds were defined as stunting ≥20% of children under five years, anaemia ≥20% of women of reproductive age, and overweight including obesity ≥35% of adult women.*

Source: *Adapted from Global Nutrition Report 2020: Inequalities in the Global Burden of Malnutrition (based on UNICEF/WHO/World Bank Joint Child Malnutrition Estimates Expanded Database: Stunting, Wasting and Overweight, March 2019; NCD Risk Factor Collaboration 2019; WHO Global Health Observatory 2019; Available from: https://globalnutritionreport.org/reports/2020-global-nutrition-report/inequalities-global-burden-malnutrition/ [61]*

At the household-level, DBM has also emerged as a significant phenomenon, particularly in LMICs undergoing a rapid nutrition transition. A multicountry analysis by Popkin et al. (2020) [3] examined household-level DBM across 126 countries between 1999 and 2017 and reported prevalence ranging from 3% to 35%. The most common household patterns were pairs of stunted children and mothers with overweight (1–24%) and mothers with overweight and wasted children (0.3–10%) [3]. The study also documented temporal increases in household-level DBM across many countries, driven mainly by rising adult overweight and obesity, while child undernutrition remained persistently high [3]. These results indicate the growing importance of addressing DBM within households and the need for integrated strategies that simultaneously target multiple forms of malnutrition.

2.3.3 Prevalence of Household-Level DBM in South and Southeast Asia

The prevalence of DBM at the household level across South and Southeast Asia has been documented by a growing body of empirical literature, though direct comparisons across studies remain challenging due to variations in how DBM is defined, the anthropometric indicators employed, and the data sources utilised. Despite these methodological heterogeneities, the available evidence consistently demonstrates that DBM at the household-level is a significant and, in several contexts, escalating public health concern across the region.

A pooled analysis spanning eight South and Southeast Asian countries conducted by Biswas et al. (2020) [26] reported that the prevalence of any form of household-level DBM, encompassing the coexistence of a mother with overweight or obesity and a stunted, wasted, or underweight child, was 12.0% across all households [26]. Disaggregated by child nutritional status, the prevalence of mothers with overweight or obesity and a stunted child was 10.0%, with a wasted child was 7.0%, and with an underweight child was 7.0% [26].

In Bangladesh, Das et al. (2019) [62] found that 6.3% of households experienced the coexistence of a mother with overweight or obesity and an underweight, stunted, or wasted child. Disaggregated estimates showed that 3.8% of households had a mother with overweight or obesity and an underweight child, 4.7% with a stunted child, and 1.7% with a wasted child [62]. Using a narrower definition restricted to the coexistence of a stunted child and a mother with overweight, Anik et al. (2019) [6], drawing on the 2014 Bangladesh DHS, reported a household-level DBM prevalence of 4.10%. In Nepal and Myanmar, the same study based on 2016 DHS data reported DBM prevalence of 1.54% and 5.54%, respectively [6].

Evidence from Pakistan reveals a markedly elevated and increasing burden of DBM. Anik et al. (2019) [6] reported a prevalence of 3.93% based on the 2012–13 Pakistan DHS. However, using data from the 2017–18 DHS survey, Khaliq et al. (2025) [63] documented a substantially higher DBM prevalence of 18.9%, defined as the coexistence of maternal overweight or obesity and child stunting. This near fivefold increase over approximately five years points to a rapid nutritional transition in Pakistan and warrants effective policy attention. Subnational analyses further revealed that Baluchistan, Khyber Pakhtunkhwa (KPK), and the Federally Administered Tribal Areas (FATA) had significantly higher DBM prevalence compared to the Islamabad Capital Territory [63].

In India, national and subnational estimates of DBM illustrate considerable variation. At the national level, Singh et al. (2023) [64], utilising data from the fifth wave of the National Family and Health Survey (NFHS-5, 2019–21), estimated that approximately 7% of Indian households experienced DBM, defined as the coexistence of a maternal overweight or obesity and child stunting, wasting, or underweight. Subnational estimates, however, reveal substantially higher burdens in certain states. In Kerala, Jayalakshmi et al. (2019) [65], through a secondary analysis of the India Human Development Survey (IHDS-II), found that 10.7% of households had a stunted child and a mother with overweight or obesity pair. In Maharashtra, Jeyakumar (2024) [66] reported an overall DBM prevalence of 19.7%, employing a similarly broad definition of overnourished mother and undernourished child.

In Southeast Asia, DBM at household-level has been documented across multiple national contexts. In Malaysia, Wong et al. (2015) [67] reported a household-level DBM prevalence of 19.4% for the coexistence of a stunted child and a mother with overweight, and 12.5% for the coexistence of a child with underweight and a mother with overweight. In Indonesia, Wibowo et al. (2015) [68], analysing data from the 2015 Basic Health Survey (Riskesdas), reported that 29.8% of households contained a child aged 2–5 years with at least one form of undernutrition (stunting, underweight, or wasting) alongside a mother with overweight, representing one of the highest national estimates in the available literature. An earlier study by Oddo et al. (2012) [69], based on data from eight Indonesian provinces collected in 2012, documented a more conservative prevalence of 5.8% for pairs of a mother with overweight and a stunted child among children aged 6–59 months, suggesting considerable temporal change and possible methodological variation. In Vietnam, Doak et al. (2005) [5] found that approximately 5% of 4,600 surveyed households had a combination of underweight or overweight among children and adults. In the Philippines, Angeles-Agdeppa et al. (2003) [70] reported that 8.2% of households

were characterised by the coexistence of a mother with overweight and a child with underweight.

2.4 Consequences of DBM

DBM creates a complex and compounding set of health, developmental, economic, and intergenerational consequences. Unlike single-burden contexts, DBM affects individuals across the life course in multiple ways and places significant strain on health systems that struggle to address both undernutrition and overnutrition simultaneously. The WHO has identified DBM as one of the most pressing global public health challenges of the twenty-first century, warning that it threatens to reverse decades of progress in nutrition, child survival, and the prevention of NCDs [15]. Understanding these multidimensional consequences is crucial for shaping integrated policy responses and ensuring that investments are directed towards effective, evidence-based interventions (Figure 6).

2.4.1 Health Consequences: Undernutrition and Its Persistent Burden

Undernutrition remains a major component of DBM, with severe and long-lasting health consequences, particularly during early childhood. Children who experience stunting face higher risks of morbidity and mortality, weakened immune function, and impaired physical and organ development [19]. Wasting, a form of acute undernutrition, is especially life-threatening, increasing the risk of death five- to ten-fold and contributing substantially to the global under-five mortality burden. In 2024, undernutrition is estimated to account for approximately 45% of child deaths worldwide [71]. Micronutrient deficiencies, often called “hidden hunger,” further compound these risks. For instance, iron deficiency anaemia is associated with impaired cognitive development, reduced physical capacity, and elevated maternal and perinatal mortality [72,73]. Collectively, these forms of undernutrition are responsible for an estimated 4.9 million child deaths in 2024, underscoring their continued significance even as overnutrition rises in many of the same populations [71].

2.4.2 Health Consequences: Overnutrition, Obesity, and Diet-Related NCDs

Alongside persistent undernutrition, overnutrition, including overweight, obesity, and excessive consumption of energy-dense, nutrient-poor foods, has become a rapidly escalating health concern in LMICs undergoing nutrition transitions. Obesity is a well-established risk factor for type 2 diabetes, cardiovascular diseases, certain cancers, non-alcoholic fatty liver disease, and musculoskeletal disorders [74]. In populations where child undernutrition remains high, the rising

prevalence of overweight and obesity creates a complex epidemiological scenario: communities face the dual challenge of managing infectious and undernutrition-related diseases linked to poverty while simultaneously confronting chronic conditions associated with diets high in ultra-processed, energy-dense foods [3].

Diet-related NCDs, such as ischaemic heart disease, stroke, type 2 diabetes, and diet-attributable cancers, now rank among the leading causes of premature death and disability worldwide. According to the Global Burden of Disease (GBD) 2019 study, poor dietary quality, characterised by low intake of whole grains, fruits, vegetables, legumes, and nuts, alongside high consumption of sodium, red and processed meats, and sugar-sweetened beverages, was responsible for 22% of all adult deaths and 15% of disability-adjusted life years (DALYs), making it the largest behavioural risk factor for mortality in 2019 [75]. In many LMICs, these diet-related NCD deaths occur among younger populations [36] and at lower BMI thresholds compared to high-income countries, partly attributable to the metabolic consequences of early-life undernutrition discussed in subsequent sections.

2.4.3 Developmental and Cognitive Consequences

The consequences of DBM extend beyond physical health, particularly affecting cognitive development, educational attainment, and human capital formation. Early-life undernutrition, particularly during the first 1,000 days from conception to age two, can permanently impair brain development, synaptic connectivity, and neurocognitive function, with effects that persist throughout life even if nutrition improves later [76]. In a landmark longitudinal study, Victora and colleagues found that stunting in early childhood was significantly associated with lower educational attainment, reduced cognitive performance in adulthood, and diminished economic productivity across four LMICs [77]. Iron deficiency anaemia during critical periods of brain development further exacerbates cognitive impairment, reducing school performance and test scores even in children who are not clinically anaemic but have depleted iron stores [72,73].

Overnutrition also has important cognitive and developmental implications. Childhood obesity is increasingly linked to insulin resistance, chronic low-grade inflammation, and impaired executive function. Emerging evidence further associates obesity with poorer academic outcomes, psychological distress, and social stigmatisation during childhood and adolescence [78]. The co-occurrence of undernutrition-related cognitive deficits and overnutrition-related metabolic and psychosocial consequences within the same populations creates a compounded developmental disadvantage. This dual burden threatens human capital accumulation at the national level,

particularly in LMICs, where losing productive workforce potential has profound economic and social implications [79].

2.4.4 Intergenerational Consequences and the Developmental Origins of Health and Disease

One of the most consequential features of DBM is its ability to perpetuate across generations through both biological and socioeconomic pathways. The Developmental Origins of Health and Disease (DOHaD) hypothesis, pioneered by Barker and colleagues, shows that poor nutrition in the womb and early postnatal life can increase the risk of long-term metabolic vulnerabilities. Children exposed to early-life undernutrition are at higher risk of obesity, insulin resistance, type 2 diabetes, and cardiovascular disease later in life [80]. This "thrifty phenotype" mechanism (a foetus adapts its metabolism to anticipated postnatal food scarcity but is then exposed to an obesogenic food environment) is considered a key driver of the accelerated NCD transition observed across Asia and sub-Saharan Africa [81].

Maternal undernutrition and short stature increase the risk of intrauterine growth restriction (IUGR), low birthweight, and preterm delivery, which are important predictors of child stunting, impaired cognitive development, and cardiometabolic disease in adulthood [82]. In contrast, maternal overweight and gestational diabetes mellitus (GDM) increase the risk of macrosomia and birth complications and are associated with a higher risk of obesity and insulin resistance in offspring during childhood and later life [83]. These pathways illustrate how the effects of DBM can extend across generations. Maternal undernutrition can increase the risk of growth restriction and later NCDs in offspring, whereas maternal overweight can increase the risk of excess weight and metabolic disorders in the next generation. When these risks persist without effective intervention, they can be passed from mothers to their children and contribute to the continuation of malnutrition across generations [84]. Popkin and colleagues have described this process as a “double burden transition”, in which the health consequences of historical undernutrition and contemporary overnutrition increasingly coexist within the same populations and birth cohorts [3].

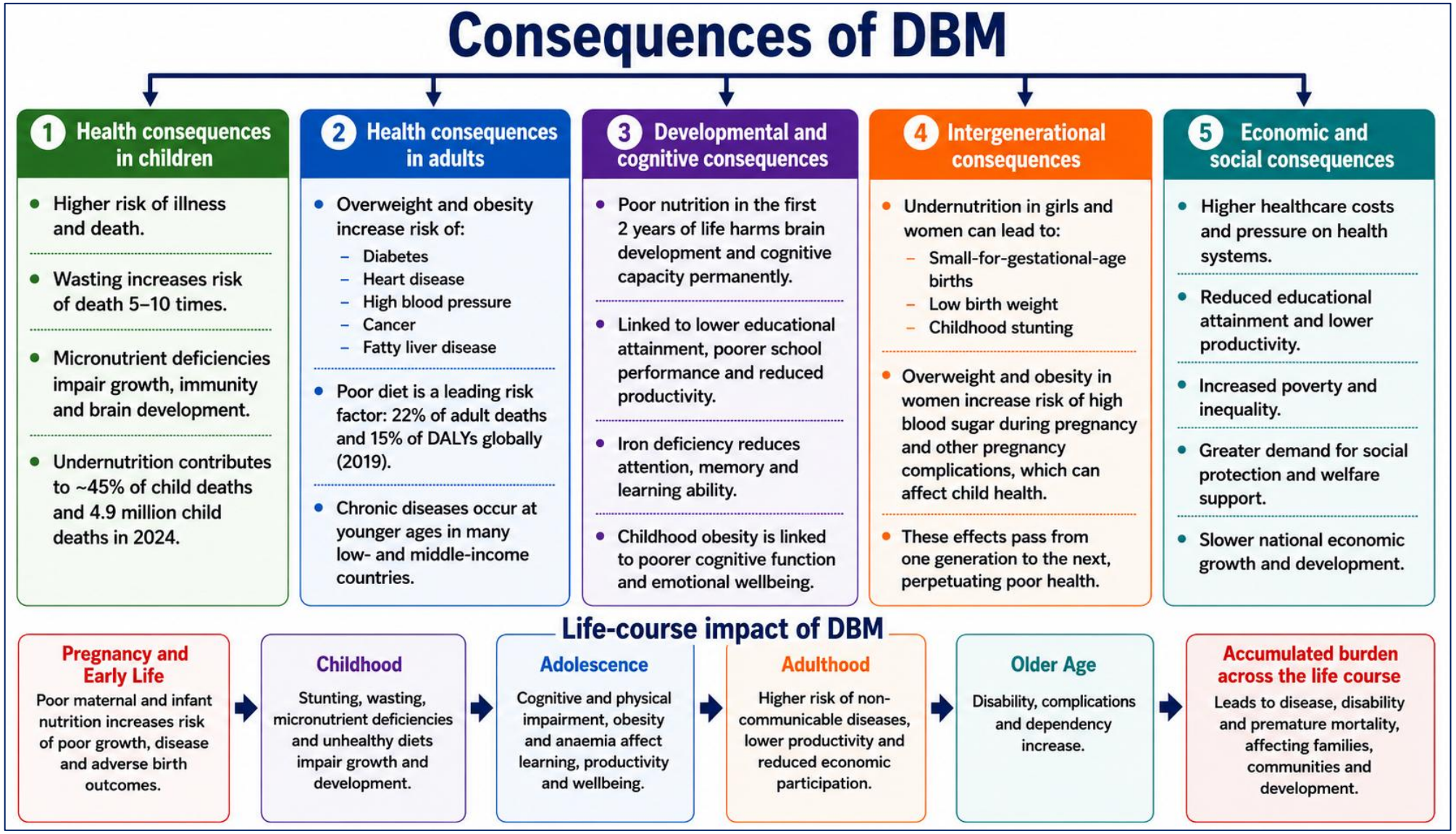

Figure 6: Multidimensional Consequences of DBM

2.4.5 Economic Consequences and the Double Burden on Health Systems

Beyond health, DBM imposes substantial economic costs at individual, household, and national levels [85]. Undernutrition reduces educational attainment and labour productivity, as children who experience stunting or wasting are more likely to suffer from cognitive impairments and diminished human capital formation [85]. Concurrently, overweight and obesity increase the prevalence of chronic diseases, generating higher healthcare expenditures and long-term treatment costs [85]. In LMICs, these economic consequences are amplified by health systems that are often designed around single-burden models (either addressing infectious diseases and undernutrition or shifting towards NCD management) without the integrated service platforms, human resources, or institutional capacity needed to respond to both simultaneously [15]. The coexistence of wasting and obesity within the same communities, or undernutrition and hypertension within the same households, creates diagnostic complexity and competing clinical priorities that overwhelm under-resourced primary care systems [25]. At the household level, out-of-pocket healthcare costs for diet-related NCDs, including hospitalisation for cardiovascular events, renal dialysis for diabetic nephropathy, and cancer treatment, can be catastrophic in settings without universal health coverage, pushing affected families further into poverty and limiting access to adequate nutrition [86]. Collectively, these factors create a dual economic burden at the national level, as countries must simultaneously invest in interventions to address undernutrition and manage the rising costs of diet-related NCDs [85]. This cycle underscores the urgent need for integrated policies and multi-sectoral strategies to mitigate both health and economic consequences of DBM.

2.4.6 Social and Equity Consequences

The consequences of DBM are not evenly distributed across populations. Low-income and marginalised households experience a disproportionate share of both undernutrition and overnutrition, facing persistent food insecurity alongside increasing exposure to ultra-processed, energy-dense foods of poor nutritional quality through expanding informal food markets [86]. In many LMICs, urban poor households are especially vulnerable. As subsistence agriculture declines and reliance on purchased foods increases, these households are exposed to obesogenic food environments and lack adequate access to diverse, nutrient-rich foods [26]. Women and girls are particularly affected by the DBM, facing higher risks of iron deficiency anaemia, calcium depletion during pregnancy and lactation, and rising rates of overweight and obesity driven by hormonal factors, reduced physical activity, and social norms that limit dietary diversity [87].

The DBM therefore acts as a powerful amplifier of existing social inequalities, concentrating its most severe consequences among the most vulnerable. Swinburn and colleagues conceptualise obesity, undernutrition, and climate change as a global syndemic (three interrelated epidemics driven by common systemic factors, including unhealthy food systems, inadequate social protection, and unequal resource distribution) whose combined impacts disproportionately affect low-income populations in LMICs [88]. Addressing the consequences of the DBM requires not only targeted nutritional interventions but also structural reforms in food systems, social protection, gender equity, and health systems that tackle the root causes of nutritional inequity.

2.5 Determinants of Household-Level DBM in South and Southeast Asia

A range of factors have been identified in the literature as potential determinants of DBM at the household-level, including household socioeconomic status, maternal education, urban or rural residence, access to healthcare services, and household food environments. These include household socioeconomic status and wealth, maternal education, urban or rural residence, access to healthcare services, mode of delivery, and household food environments and dietary patterns. The interplay of these determinants is complex and context-dependent, and their relative importance varies across different national and regional settings. A detailed systematic review and meta-analysis examining the determinants of household-level DBM specifically in South and Southeast Asia is presented in Chapter 5 of this thesis.

2.6 Policy Responses to DBM

2.6.1 Overview of the Global Nutrition Policy Landscape & Double-Duty Actions Framework

Interventions addressing the individual components of DBM are well documented in policy frameworks and programmatic guidelines. Historically, most nutrition policies and programmes have focused on addressing specific forms of malnutrition separately, such as undernutrition or overweight and obesity. Over the past two decades, however, the nutrition policy literature has increasingly recognised the need for more integrated and multisectoral approaches capable of addressing multiple forms of malnutrition within the same populations. Since the early 2000s, a series of global targets, declarations, and programmatic initiatives has progressively shaped this transition, which is now reflected in the 2030 nutrition agenda [89,90].

A key policy document frequently cited in the literature is the Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition, adopted at the 65th World Health Assembly in 2012 and later extended to 2030 at the 78th World Health Assembly [89–91]. The plan outlines six global nutrition targets, two of which are particularly relevant to the double burden of malnutrition: (1) achieving a 40% reduction in the number of stunted children under five years of age by 2030 relative to the 2012 baseline, and (2) reducing and maintaining the prevalence of childhood overweight to below 5% by 2030 [89,90]. The prevalence of both conditions is also used to monitor progress towards Sustainable Development Goal (SDG) Target 2.2, which aims to end malnutrition in all its forms.

One of the most influential conceptual developments in recent literature on policies addressing DBM is the double-duty actions framework, introduced through a dedicated policy brief by the WHO in 2017 [15]. The framework defines double-duty actions as interventions, programmes, or policies that can simultaneously reduce the risk or burden of both undernutrition and overweight, obesity, or diet-related NCDs. The framework is based on the premise that different forms of malnutrition share common biological, environmental, and socioeconomic drivers [15]. It further suggests that integrated responses can be delivered through existing service platforms without requiring entirely new systems or infrastructure.

The WHO policy brief identifies three categories of shared drivers that contribute to DBM (Figure 7). From a biological perspective, poor maternal nutrition and inadequate nutrition during early life can create pathways that increase the risk of both undernutrition and later-life metabolic disorders [15]. From an environmental perspective, factors such as inadequate food systems, limited access to health services, poor water, sanitation, and hygiene (WASH) infrastructure, and increasingly obesogenic urban environments can contribute simultaneously to undernutrition and unhealthy dietary transitions. Socioeconomic factors also play a critical role [15]. Poverty is described as a cross-cutting determinant that can lead to food insecurity and childhood stunting while also limiting access to diverse and nutritious foods and increasing reliance on inexpensive, energy-dense foods associated with overweight and NCDs [15]. These shared drivers provide a strong rationale for integrated policy responses rather than separate interventions addressing different forms of malnutrition [3,15].

The WHO policy brief also proposes a three-level typology for implementing double-duty actions, which has been widely applied in subsequent research. At the first level, existing programmes are assessed to ensure that they do not unintentionally worsen other forms of

malnutrition. At the second level, programmes originally designed to address a single form of malnutrition are modified to generate additional benefits for other forms of malnutrition. At the third level, new integrated interventions are developed from the outset with explicit objectives to address multiple forms of malnutrition simultaneously.

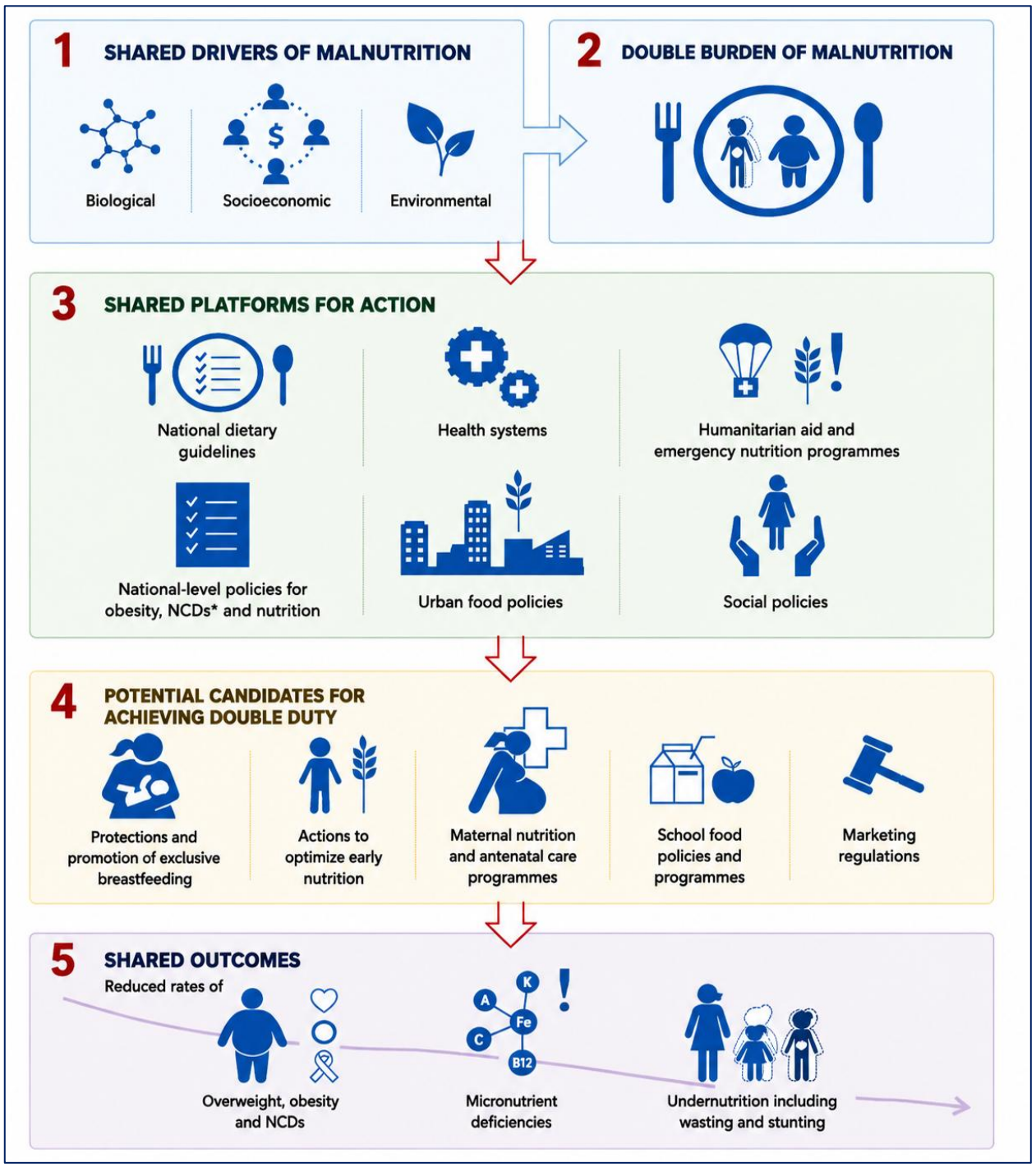

Figure 7: Shared drivers with double-duty action framework proposed by WHO

Source: *Adapted from World Health Organization (WHO): Double Burden of Malnutrition Policy Brief; Available from: https://www.who.int/publications/i/item/WHO-NMH-NHD-17.3. Text has been presented in* ***bold*** *to improve readability and visual presentation.*

The framework identifies five priority domains that offer strong opportunities for implementing double-duty actions across these levels: (i) promotion and protection of exclusive breastfeeding; (ii) optimisation of complementary feeding for children aged 6–23 months; (iii) maternal nutrition and antenatal care programmes; (iv) school food policies and programmes; and (v) regulations on the marketing of breast-milk substitutes and unhealthy foods. These domains, together with other DBM-related interventions documented in the literature, are summarised in Table 1.

Table 1: Summary of priority interventions targeting undernutrition, overweight, and integrated approaches to DBM

Intervention domain	Key policy actions	Malnutrition target
Maternal & early-life nutrition		
Maternal nutrition & antenatal care	• Balanced energy-protein supplements. • folic acid & iron supplementation. • antenatal nutritional counselling. • cash transfers for food-insecure pregnant women.	DBM
Exclusive breastfeeding promotion	• Maternity protection policies. • restrictions on breast-milk substitute marketing. • Baby-Friendly Hospital & Community Initiatives (BFHI/BFCI).	DBM
Complementary feeding (6–23 months)	• National complementary feeding guidelines aligned with global standards. • community nutrition worker counselling; micronutrient supplementation. • food support for vulnerable families.	DBM
Food environment & food systems		
Food fortification & supplementation	• Targeted/blanket fortification of staple foods. • Vitamin A supplementation (6–59 months). • zinc supplementation during diarrhoeal episodes.	Stunting
Taxation of unhealthy foods	• Excise taxes on sugar-sweetened beverages. • subsidies for healthier foods. • front-of-pack interpretive labels.	Overweight
Marketing regulations	• Ban child-directed advertising of unhealthy foods. • restrict digital marketing. • front-of-pack warning labels.	DBM
Food product reformulation	• Mandatory reformulation targets on sugar, salt, saturated fat.	Overweight

	• elimination of harmful trans fats.	
Universal primary health care	• IMCI. • Immunisation. • growth monitoring at child health visits. • ORT for diarrhoea; malaria treatment	DBM
Overweight screening & management	• Routine weight/height measurement against WHO growth standards. • integrated management of overweight in primary care; pre-conception nutrition advice	Overweight
Water, sanitation & hygiene (WASH)		
WASH infrastructure	• Safe water supply; latrines and toilets. • vector control for malaria (insecticide-treated nets, indoor residual spraying)	Stunting
Education, School & Social Systems		
School food policies	• Healthy food procurement standards. • elimination of SSBs and energy-dense foods from school settings. • physical activity in curricula; school feeding for adolescent girls.	DBM
Social protection & gender equity	• Conditional cash transfers. • female education. • paid maternity leave, • nutrition-sensitive social protection.	DBM

Sources: *WHO & UNICEF: stunting brief (2025) [89]; WHO & UNICEF: Childhood Overweight Brief (2025) [90]; WHO Policy Brief (2017) [15]; Popkin et al. (2020) [3].*

Abbreviations: *BFCI = Baby-Friendly Community Initiative; BFHI = Baby-Friendly Hospital Initiative; DBM = double burden of malnutrition; IGF-1 = insulin-like growth factor 1; IMCI = Integrated Management of Childhood Illness; NCDs = non-communicable diseases; ORT = oral rehydration therapy; SSB = sugar-sweetened beverage; WASH = water, sanitation & hygiene.*

2.6.2 Kenya's Experience: Lessons for Double-Duty Actions in National Policy

Kenya provides a compelling example of how national-level strategies can simultaneously address multiple forms of malnutrition. This evidence is highlighted in the childhood overweight policy brief document [90]. In 2012, around 5% of children under five were overweight, a figure that declined to 4.3% by 2024 [60]. At the same time, the country is on track to meet the 2025 targets for stunting, wasting, and exclusive breastfeeding [90]. These achievements reflect the impact of sustained political commitment, coordinated policy action, and the deliberate integration of interventions across multiple sectors. Kenya's experience demonstrates that operationalising double-duty actions is feasible at a national scale and can yield measurable

improvements across the spectrum of malnutrition [90].

The Kenyan experience is anchored in the Kenya Nutrition Action Plan (KNAP) [92], which explicitly integrates interventions to tackle both undernutrition and overweight simultaneously [90]. Efforts to reduce undernutrition include scaling up the Baby-Friendly Hospital Initiative (BFHI) and Baby-Friendly Community Initiative (BFCI), enforcing the Code of Marketing of Breast-milk Substitutes, deploying Community Health Promoters (CHPs) for nutrition education, and strengthening maternal, newborn, infant, and young child nutrition services. Parallel strategies targeting overweight and unhealthy diets involve implementing the National Guidelines on Healthy Diets and Physical Activity, nationwide media campaigns, food labelling and marketing restrictions for children, regulation of salt, saturated fats, trans fats, and refined sugars in processed foods, an excise tax on soft drinks, development of the Kenya Nutrient Profile Model, and integration of nutrition education into school curricula [90,92,93].

Kenya's experience offers several key insights for DBM policy [90]. First, it highlights the importance of integrating interventions into existing health and social platforms, thereby reducing implementation costs and enhancing coverage. Second, it illustrates that policies targeting different forms of malnutrition can be aligned through shared mechanisms and governance structures, thereby avoiding conflicting objectives and inefficiencies. Third, the Kenyan case demonstrates the value of coordinated multisectoral action, linking health, food systems, education, and social protection policies to address both immediate nutritional needs and the structural determinants of malnutrition. Collectively, these lessons indicate that double-duty actions are not merely theoretical constructs but practical strategies capable of delivering measurable national-level impact. Kenya's approach therefore provides a valuable model for other countries seeking to implement integrated strategies to address DBM.

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Chapter 3: Research Methods

3.1 Overview of Research Design

This thesis utilised a mixed-methods research design, integrating both quantitative and qualitative approaches to examine DBM at the household level in South and Southeast Asia. The mixed-method design was selected because DBM is not only an epidemiological pattern that can be measured and modelled, but also a policy challenge that requires an understanding of how governments, institutions, and stakeholders recognise, interpret, and respond to the coexistence of undernutrition and overnutrition. The quantitative component of this thesis establishes the epidemiological dimensions of DBM, including its prevalence, trends, and risk factors. On the other hand, the qualitative components examine the policy landscape, stakeholder perspectives, and implementation realities that shape the public health response to DBM.

This thesis comprises seven papers organised into four interrelated studies. Study 1 (Paper 1) presents a systematic narrative review that establishes operational definitions of DBM. Study 2 (Paper 2) examines the prevalence and trends of household-level DBM across South and Southeast Asia. Study 3 (Papers 3, 4, and 5) explores the determinants of household-level DBM through three complementary approaches: a systematic review and meta-analysis, an interaction analysis between maternal education and household wealth, and an assessment of the association between caesarean delivery and DBM. Study 4 (Papers 6 and 7) constitutes the qualitative component, investigating DBM policy integration and stakeholder perspectives in Bangladesh through policy document analysis and key informant interviews (KII).

This chapter outlines the overall methodological approach, including data sources, analytical strategies, and ethical considerations applied across all seven articles. Figure 1 shows the research diagram and Table 1 provides a study-wise summary of all articles and their key methodological characteristics. Detailed methods specific to each study are presented in the respective chapters.

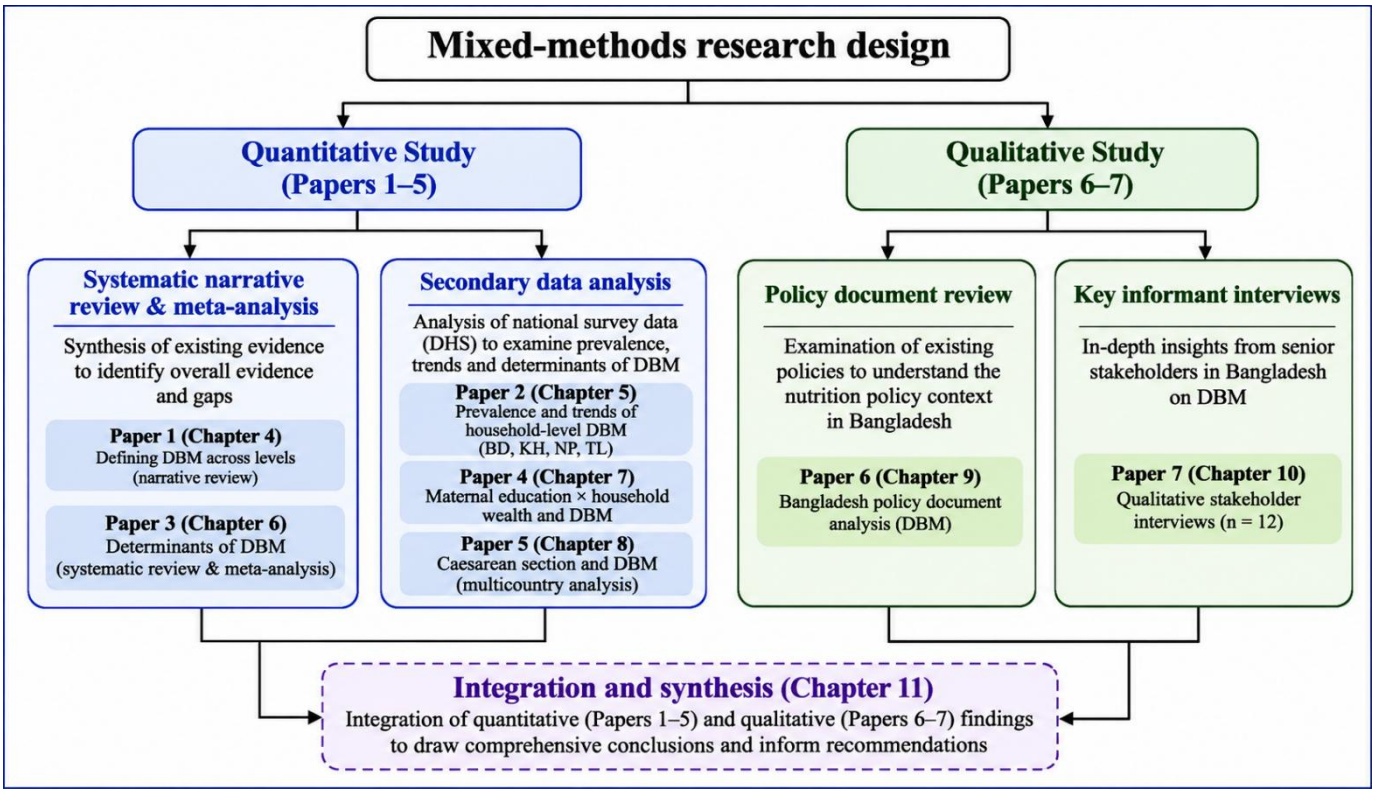

Figure 1: Mixed-method research design for examining DBM at the household-level in South and Southeast Asia

Note: *The quantitative component comprises systematic narrative reviews and meta-analysis, and secondary data analysis of Demographic and Health Surveys across four countries. The qualitative component includes policy document review and KII interviews conducted with senior nutrition stakeholders in Bangladesh. Findings from both components were integrated to provide a comprehensive understanding of the epidemiological and policy dimensions of DBM and to provide evidence-based recommendations for reducing its prevalence.*

3.2 Review and Quantitative Component

3.2.1 Review Papers (Papers 1 and 3)

Two review papers contribute to the evidence base of this thesis, incorporating both narrative and quantitative synthesis approaches. Paper 1 is a systematic narrative review that critically examines and synthesises existing operational definitions of DBM at the individual, household, and population levels and proposes standardised definitions based on the available evidence. The review followed PRISMA 2020 guidelines [1] and was based on a structured search of PubMed, Web of Science, and Scopus for studies published between January 2010 and December 2024. Two reviewers independently screened studies, with disagreements resolved through discussion. Data were extracted using a structured framework focusing on definitions, indicators, and cut-off points, and findings were synthesised using a narrative approach.

Table 1: Overview of thesis articles and their methodological characteristics

Paper	Aim	Study Design	Data Source	Population / Setting	Chapter
Study 1: Definitional Review (Paper 1)					
Paper 1	To evaluate existing definitions of DBM and propose operational definitions at individual, household and population levels	Narrative systematic review	PubMed, Scopus, Web of Science (Jan 2010 – Dec 2024); 60 peer-reviewed articles	Global Studies related to DBM	**Chapter 4**
Study 2: Prevalence and Trends (Paper 2)					
Paper 2	To estimate the prevalence and trends of household-level DBM in South and Southeast Asia	Cross-sectional secondary data analysis of repeated DHS rounds	DHS: Bangladesh (2004–2018), Cambodia (2005–2022), Nepal (2006–2022), Timor-Leste (2009–2016)	Mother-child pairs in households with valid anthropometric data	**Chapter 5**
Study 3: Determinants of Household-Level DBM (Papers 3, 4 & 5)					
Paper 3	To synthesise evidence on factors associated with household-level DBM in South and Southeast Asia through systematic review and meta-analysis	Systematic review and meta-analysis	PubMed, Scopus, Web of Science (Jan 2000 – Sep 2025); 30 observational studies (26 in meta-analysis)	Household-level DBM studies; South and Southeast Asia	**Chapter 6**

Paper 4	To examine the interaction between maternal education and household wealth in shaping household-level DBM	Cross-sectional secondary data analysis; interaction modelling	DHS: Bangladesh (2017-18), Cambodia (2022), Nepal (2022), Timor-Leste (2016)	Mother-child pairs in households with valid anthropometric data	**Chapter 7**
Paper 5	To investigate the association between caesarean section delivery and household-level DBM	Cross-sectional secondary data analysis; two-level multilevel logistic regression; spatial analysis	DHS: Bangladesh (2022), Cambodia (2022), Nepal (2022)	Mother-child pairs with complete delivery mode and anthropometric data	**Chapter 8**
Study 4: Policy Analysis (Papers 6 & 7)					
Paper 6	To analyse national nutrition and related policies in Bangladesh to assess DBM integration and identify policy gaps	Policy document analysis	5 purposively selected national policy documents (2015–2030)	Available national nutrition policy documents in Bangladesh	**Chapter 9**
Paper 7	To examine senior stakeholder perspectives on DBM policy architecture, implementation realities and reform priorities in Bangladesh	Qualitative study with semi-structured key informant interviews (KII)	12 purposively selected nutrition stakeholders (June–August 2025) in Bangladesh	Senior-level nutrition policymakers, programme implementers and researchers	**Chapter 10**

Paper 3 is a systematic review with meta-analysis that examines factors associated with household-level DBM in South and Southeast Asia. Unlike Paper 1, this study includes a quantitative synthesis of evidence. It was registered in PROSPERO (CRD420251155844) and involved a systematic search of PubMed, Scopus, and Web of Science for observational studies published between January 2000 and September 2025. Study selection, data extraction, and quality assessment were conducted independently by two reviewers using the Newcastle-Ottawa Scale adapted for cross-sectional studies [2]. Quantitative synthesis was undertaken using random-effects meta-analysis for determinants reported in at least five studies and estimated pooled odds ratios with 95% confidence intervals (CIs). Statistical heterogeneity was assessed using the I^2 statistic and Cochran Q test [3].

The study-wise key methodological components are available in Table 2.

Table 2: Study-wise summary of key methodological components

Paper	Outcome Variable	Primary Exposure / Focus	Analytical Method	Software
Paper 1	DBM definitions and indicators at individual, household and population levels	Level of DBM assessment; terminology used to define DBM; cut-off points applied	Narrative synthesis	Excel; R 4.4.0
Paper 2	Household-level DBM (mother with overweight or obesity and child with undernutrition).	Prevalence and trend analysis	Survey-weighted prevalence; chi-square tests; multivariable logistic regression	R 4.4.0
Paper 3	Household-level DBM (pooled prevalence and determinants)	Identification of key determinants of DBM with meta-analysis	Random-effects meta-analysis; pooled ORs with 95% CIs; I^2 and Cochran Q for heterogeneity; Newcastle-Ottawa Scale for quality assessment	R 4.4.0 (Packages: meta; metafor)
Paper 4	Household-level DBM (mother with overweight or obesity and child with undernutrition).	Interaction analysis of maternal education and household wealth	Survey-weighted multivariable logistic regression; interaction analysis; AIC model selection; Hosmer-Lemeshow test	R 4.4.0; SPSS

Paper 5	Household-level DBM (mother with overweight or obesity + undernourished child)	Assessing association between caesarean section delivery and household level DBM	Two-level multilevel logistic regression Getis-Ord Gi* spatial hot spot analysis	R 4.4.0 (Packages: lme4; margins)
Paper 6	Policy integration of DBM across 3 dimensions: recognition/framing; intervention content; implementation systems	Analysis of national nutrition policy documents	Narrative synthesis	Excel
Paper 7	Stakeholder themes on DBM policy recognition, implementation barriers and reform priorities	Exploring perception of key nutrition stakeholders in Bangladesh with semi-structured KII interview	Reflexive thematic analysis (Braun and Clarke 6-phase) with HPT-CDC policy framework	NVivo 15

3.2.2 Demographic and Health Survey: Data Source for Analysis

The Demographic and Health Survey (DHS) programme is a globally recognised source of nationally representative data on health, nutrition, and population in low- and middle-income countries (LMICs). Since its establishment in 1984, the DHS programme has supported the collection of standardised, high-quality survey data in over 90 countries, with more than 400 surveys completed to date (ICF, 2024) [4]. The programme is funded by the United States Agency for International Development (USAID) and implemented by ICF International in partnership with national governments [4].

The DHS employs a two-stage stratified cluster sampling design. In the first stage, census enumeration areas (EAs) are selected using probability proportional to size sampling, stratified by urban and rural areas and, in most countries, by administrative region. In the second stage, a fixed number of households are randomly selected within each EA [4]. Data collection is conducted through face-to-face interviews with women of reproductive age (15 to 49 years) and includes standardised anthropometric measurements of both mothers and their children under five years of age. Anthropometric data are collected by trained field personnel following rigorous standard operating procedures, using calibrated digital scales and portable height and length

boards. A subset of children is randomly selected for repeat measurements to ensure data quality, and extreme values are rechecked according to DHS protocols [4]. Comprehensive descriptions of DHS sampling procedures, questionnaire validation, and data collection methods are available on the DHS website [4].

For this thesis, DHS data were extracted from multiple survey rounds conducted between 2004 and 2022 in Bangladesh, Cambodia, Nepal, and Timor-Leste. The analytical unit across the three secondary data analyses (Papers 2, 4, and 5) was the mother–child pair. Mother–child pairs were included if both the mother and child had valid anthropometric measurements. Mother–child pairs were excluded due to missing maternal BMI data or child undernutrition indicators. Missing maternal BMI information included mothers who were ineligible for BMI measurement because they were pregnant or had given birth within the preceding two months, as well as eligible mothers with missing or flagged height or weight measurements. Missing child undernutrition information included children with missing anthropometric measurements. The final analytical sample sizes varied by country and survey round, with details provided in the respective empirical chapters. The numbers excluded for each reason, together with the initial and final analytical sample sizes, are presented separately by country and survey round in Supplementary Figure 2 (Appendix B).

Regarding geographical comparability across survey rounds, the administrative divisions of Bangladesh changed during the study period. Rangpur Division was established in 2010 from the former Rajshahi Division, while Mymensingh Division was established in 2015 from Dhaka Division. These changes involved the subdivision of existing administrative areas rather than changes to the national geographical boundaries. Therefore, every round of the BDHS remains nationally representative of the same population, and national prevalence estimates are comparable across rounds. Moreover, division was not included as an analytical variable in this thesis. A previous study by Abir et al. conducted multivariable analyses both with and without Rangpur division and reported no substantial differences in the results [5]. Sensitivity analyses were not conducted because this thesis focused on national-level estimates rather than division-level comparisons, and the creation of new administrative divisions did not alter the national geographical coverage of the surveys.

3.2.3 Rationale for Country Selection

This thesis considers four countries for the quantitative secondary data analyses in South and Southeast Asia: Bangladesh, Cambodia, Nepal and Timor-Leste. These countries were selected

based on several criteria. First, all four are undergoing nutrition transitions characterised by shifts towards more processed and energy-dense foods and reduced physical activity, contributing to the coexistence of undernutrition and overnutrition [6–9].

Second, the availability and comparability of maternal and child anthropometric data across countries and survey years were key selection criteria. Data availability was assessed based on whether the DHS included measured height and weight for non-pregnant women of reproductive age (15–49 years) and anthropometric measurements for children under five years (0–59 months), with sufficient information to link mothers and children within the same household. Comparability was assessed by considering the consistency of anthropometric indicators, age eligibility criteria and variable definitions across survey rounds. Maternal overweight or obesity was defined using a consistent body mass index (BMI) threshold, while child undernutrition was assessed using height-for-age, weight-for-height and weight-for-age z-scores based on the WHO 2006 Child Growth Standards. The availability of these measurements across multiple survey rounds was considered essential for examining temporal trends in household-level DBM.

Third, the selected countries represent diverse socioeconomic contexts and different stages of economic and epidemiological development, allowing meaningful cross-country comparisons. An additional consideration was to maintain a geographical balance by including two countries from South Asia (Bangladesh and Nepal) and two from Southeast Asia (Cambodia and Timor-Leste). India was excluded because of its substantially larger population, survey size and state-level heterogeneity, which would require additional analytical considerations to ensure meaningful cross-country comparisons. Pakistan was a potential candidate. However, in the 2012–13 Pakistan Demographic and Health Survey (PDHS), maternal and child anthropometric measurements were collected from a subsample of households, due to security conditions, particularly in Balochistan [10], which may have limited the comparability of trends across survey rounds. Furthermore, including Pakistan would have resulted in three South Asian countries, while no additional Southeast Asian country with the necessary DHS data was identified to maintain the intended regional balance. The selected countries are shown in Figure 2.

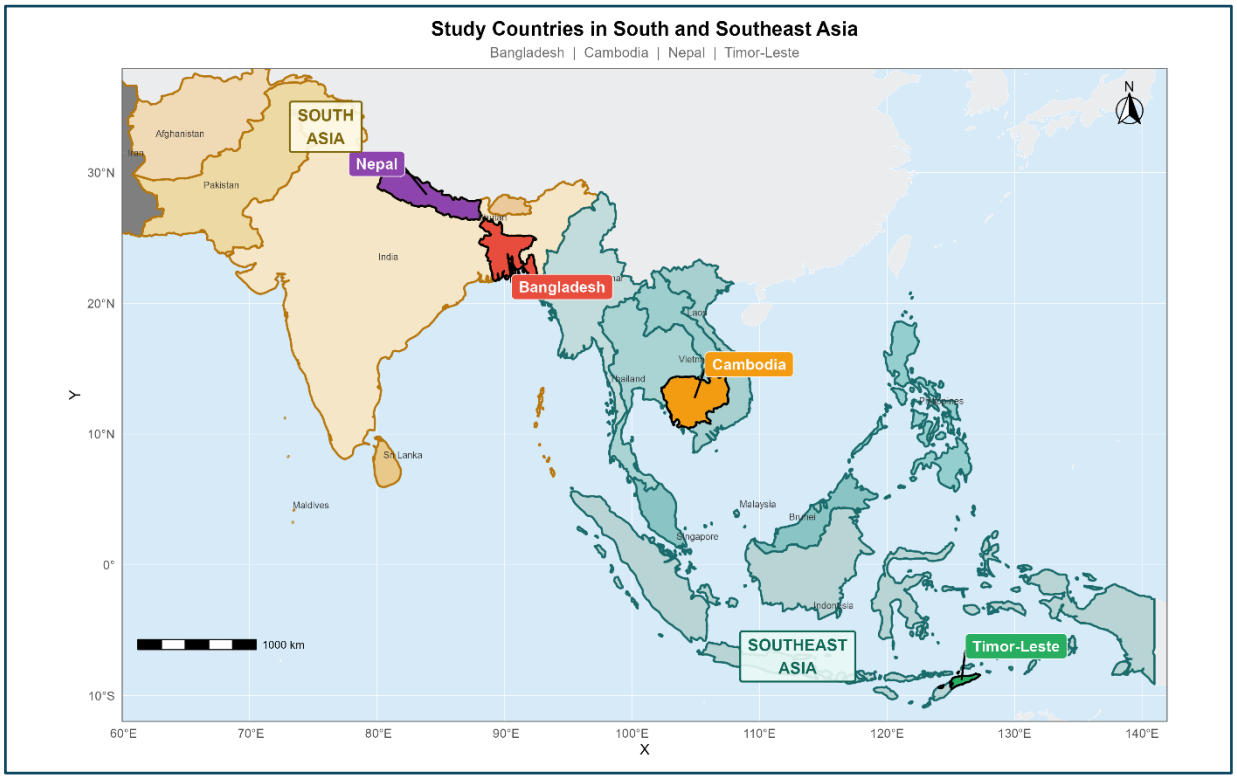

Figure 2: Showing study countries in South and Southeast Asia

Note: *Map produced with R (Version: 4.4.0)*

3.2.4 Definition and Measurement of DBM in Quantitative Analysis

In this thesis, household-level DBM across papers 2, 4, and 5 was defined as a household in which the mother had overweight or obesity and the child under five years of age had any form of undernutrition, including underweight, stunting, or wasting. The mother-child pair was considered because it reflected the primary caregiving relationship within households, where mothers were typically responsible for child feeding and related food decisions. In addition, the DHS data provided detailed and comparable information on both maternal and child nutritional status, making this operational definition feasible and appropriate for analysis. Although micronutrient deficiencies are included in the broader conceptual definition of DBM, they were not incorporated into the operational definition used in these analyses because data on several key micronutrient deficiencies were unavailable or inconsistently collected across the DHS surveys. For example, although anaemia data were available for some countries [11,12], their availability was not consistent across all surveys. Furthermore, biomarkers for other micronutrient deficiencies, such as vitamin A and iron deficiency (measured using serum retinol and ferritin, respectively), were not routinely collected [11]. In the existing literature, micronutrient deficiencies have also been considered as a distinct component of the triple burden of malnutrition, alongside undernutrition and overweight or obesity [12]. Therefore, the operational

definition of household-level DBM in this thesis was restricted to anthropometric indicators to ensure consistency and comparability across countries and survey years.

For this thesis, a composite binary outcome variable was created, coded as 1 if a mother with overweight or obesity coexisted with at least one form of child undernutrition (stunted, wasted or underweight), and 0 otherwise.

$$\mathbf{DBM} = \begin{cases} \mathbf{1, Coexistence\ of\ a\ mother\ with\ overweight\ or\ obesity\ and\ a\ child\ with\ stunting, wasting, or\ underweight\ within\ the\ same\ household.} \\ \mathbf{0, Otherwise} \end{cases}$$

Several indicators, including height-for-age, weight-for-age, and weight-for-height, were used to assess the nutritional status of participants. Child nutritional status (aged 0-59 months) was determined using the 2006 World Health Organization (WHO) Child Growth Standards to calculate anthropometric z-scores. Children were classified as stunted (height-for-age z-score < −2 standard deviations), underweight (weight-for-age z-score < −2 standard deviations), and wasted (weight-for-height z-score < −2 standard deviations) [13,14]. Maternal body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared (kg/m²). In this thesis, mothers were classified as underweight (BMI < 18.5 kg/m²), normal weight (BMI 18.5–22.9 kg/m²), and overweight or obese (BMI ≥ 23.0 kg/m²) using Asian-specific BMI cut-offs [15,16].

3.2.5 Statistical Approaches

The four quantitative papers used statistical methods suited to their designs and research questions. In the analyses of DHS data (Papers 2, 4 and 5), DHS sampling weights were applied so that estimates represent the population of mother–child pairs in each country and allow for the unequal probability of selecting households. The cluster and strata information of the DHS survey design was not used in these analyses. The weights are therefore reflected in the point estimates, whereas the standard errors and confidence intervals do not fully incorporate the clustering and stratification of the DHS sample and may be narrower than design-based estimates. These limitations are discussed in Sections 3.4 and 11.8.

Paper 2 estimated weighted prevalence of household-level DBM, child undernutrition and maternal overweight or obesity across countries and survey rounds. Associations between DBM and household wealth index, place of residence and child sex were examined using chi-square

tests. Socioeconomic disparities were then assessed using weighted multivariable logistic regression with maximum likelihood estimation.

Paper 3, a systematic review and meta-analysis, calculated pooled odds ratios with 95% confidence intervals as the primary effect measure. Meta-analyses were conducted for factors reported in at least five studies with extractable data. A random-effects model using the DerSimonian–Laird method was applied to account for expected heterogeneity across diverse populations. Subgroup analyses were stratified by DBM definition and geographic region. Heterogeneity was quantified using the I^2 statistic and Cochran's Q test, and sensitivity was assessed through leave-one-out analyses. Publication bias was evaluated using Egger's regression test and funnel plots. Forest plots displayed the pooled estimates. Factors with insufficient data for meta-analysis were synthesised narratively.

Paper 4 conducted descriptive analyses and bivariate analyses using chi-square tests, followed by weighted multivariable logistic regression to examine the associations between maternal education, household wealth and household-level DBM. The joint association of maternal education and household wealth was assessed by cross-classifying three levels of maternal education with three levels of household wealth, with poor households whose mothers had no or primary education as the reference group. All models were adjusted for potential confounders, including place of residence, child sex, maternal employment, antenatal care visits, breastfeeding status and household size.

Paper 5 conducted descriptive and bivariate analyses using weighted chi-square tests and analysis of variance (ANOVA). ANOVA compared mean breastfeeding duration (a continuous variable) between households with and without household-level DBM. With two groups, this is equivalent to an independent-samples t-test ($F = t^2$). The test assumes independent observations, approximately normally distributed means and similar variances in the two groups. These assumptions were not formally tested. However, because the groups were large, the test is generally robust to moderate departures from normality, and group means and standard deviations are reported. Because the cluster information was not used in this test, observations within the same cluster may not be fully independent. The association between breastfeeding duration and DBM was examined in the multilevel regression models described below.

Two-level multilevel logistic regression models were fitted using the glmer function in R to examine the association between caesarean delivery and household-level DBM, with individuals

(level 1) nested within DHS sampling clusters (level 2) and random intercepts for clusters. Interaction terms between caesarean delivery and delayed initiation of breastfeeding, and between caesarean delivery and place of residence, were included to examine whether the association varied by these characteristics. Adjusted odds ratios, standard errors and 95% confidence intervals for the interactions were obtained using the delta method via the margins package. The intraclass correlation coefficient, calculated from an empty multilevel model, was used to assess the degree of clustering. The DHS sampling weight was applied through the weights argument of glmer, which does not rescale weights across levels. Therefore, the weighted estimates are approximate. Spatial clustering of DBM and caesarean deliveries was also examined at the district level using the Getis–Ord Gi* statistic, which identifies statistically significant hotspots by comparing local with global spatial patterns [17].

Model diagnostics were performed for Papers 4 and 5. Multicollinearity was assessed using the variance inflation factor (VIF), calculated for all explanatory variables in each model (Paper 4: maternal education, household wealth, place of residence, child sex, maternal employment, antenatal care visits, breastfeeding status and household size; Paper 5: caesarean delivery, maternal age, early initiation of breastfeeding, breastfeeding duration, birth order, place of residence and community-level antenatal care coverage). A VIF below 5 was taken to indicate no serious multicollinearity. VIF depends only on the correlations among the explanatory variables, not on the outcome model or the survey design. In Paper 4, the Akaike Information Criterion (AIC) was used to compare candidate model specifications fitted to the same analytical sample (for example, with and without interaction terms), with lower values indicating better relative fit. Model calibration was assessed using the Hosmer–Lemeshow test (Papers 4 and 5). AIC and the standard Hosmer–Lemeshow test were calculated from the weighted models and are not design-based. Therefore, results are interpreted as approximate guides to relative fit and calibration, not as formal tests, and this is acknowledged as a limitation (Sections 3.4 and 11.8).

3.3 Qualitative Component

3.3.1 Rationale for Selecting Bangladesh

The qualitative component of this thesis (Study 4, Articles 6 and 7) was conducted in Bangladesh. This choice was deliberate and theoretically motivated for several interconnected reasons.

First, Bangladesh presents one of the most compelling and well-documented examples of household-level DBM in the region. As demonstrated in Paper 2 of this thesis, household-level

DBM in Bangladesh increased from 4% in 2004 to 13.8% in 2018, representing the largest absolute increase (9.8 percentage points) and the largest relative increase (approximately 3.5-fold) among the four countries studied [18]. However, Timor-Leste recorded the highest prevalence in its latest available survey (15.8% in 2016), although the survey periods differed across countries. More recent findings from Paper 5 showed that the prevalence of household-level DBM in Bangladesh reached 14.2% in 2022. At the same time, the country has achieved remarkable reductions in childhood stunting, with the national prevalence declining from approximately 51% in 2004 to 23.6% in 2022, while the proportion of women aged 15 to 49 years women with overweight or obesity has risen sharply, from 9% in 2004 to 36.5% in 2022 [19]. This simultaneous trajectory of declining undernutrition and rising overnutrition makes Bangladesh one of the most illustrative cases of the nutrition transition in South Asia and one in which the tensions between established undernutrition policy frameworks and the emerging overnutrition burden are particularly visible and consequential. Second, Bangladesh has one of the most comprehensive and institutionally developed national nutrition policy architectures in the region, spanning the health, food security, agriculture, and social protection sectors and coordinated through the Bangladesh National Nutrition Council (BNNC) [20–22]. This policy architecture provides a substantive and analytically rich body of material for document analysis, and a well-established institutional landscape within which senior stakeholders operate. This makes Bangladesh particularly well-suited to a policy-focused qualitative study.

Third, the nutrition transition in Bangladesh shares key features with those observed across South and Southeast Asia more broadly. These include rapid urbanisation, a dietary shift towards processed and energy-dense foods, growing sedentary behaviour, and persistent intra-household nutritional inequalities driven by poverty and gender norms. As such, the policy challenges and implementation realities identified in Bangladesh are likely to have considerable relevance for other countries in the region undergoing similar transitions.

Fourth, the candidate of this thesis has an extensive professional and academic background in Bangladesh, with established networks across government, non-governmental organisations, and research institutions engaged in nutrition policy. This insider knowledge facilitated purposive access to senior-level key informants and enhanced the depth and contextual richness of the qualitative data collected.

3.3.2 Policy Document Analysis

Paper 6 employed a narrative analysis of policy documents to critically examine how

Bangladesh's national nutrition, food security, health, and agriculture policies address DBM. Five major national policy documents were purposively selected due to their direct relevance to nutrition. These documents also represent key formal government instruments that guide nutritional programming at the national level.

The analysis was guided by an integrated analytical framework that drew on three established international approaches. These included Hawkes et al.'s (2020) double duty actions framework [23], which identifies interventions addressing both undernutrition and overnutrition, the WHO Essential Nutrition Actions (2019) [24], which guide integration of nutrition interventions across the life course and health systems, and the Global Nutrition Report (2020) policy integration principles [25], which emphasise cross-sector coordination, food environment regulation, multisectoral accountability, and equity-focused targeting. These frameworks were translated into a structured assessment tool consisting of three analytical dimensions: recognition and framing of DBM, intervention content and design, and implementation systems.

3.3.3 Key Informant Interviews (KIIs)

Paper 7 employed semi-structured key informant interviews (KIIs) to examine the perspectives of senior-level nutrition stakeholders in Bangladesh on DBM policy architecture, implementation realities, and reform priorities. A total of 12 participants were purposively selected based on their expertise in nutrition policy and their direct involvement in nutrition policy development, programme implementation, or nutrition research in Bangladesh. Participants were drawn from four institutional categories: national government officials, representatives of international non-governmental organisations, national NGO representatives, and nutrition researchers and academics.

Interviews were conducted between June and August 2025 in Bangladesh. A semi-structured interview guide was used, covering four domains: stakeholders' understanding and framing of DBM within Bangladesh's nutrition transition context; their perceptions and assessment of current national nutrition policy frameworks in relation to DBM; implementation challenges constraining the translation of policy commitments into action; and stakeholder-identified priorities for policy reform and programme development.

All interviews were audio-recorded with participants' written informed consent and transcribed verbatim. Transcripts were imported into NVivo 15 for systematic management and analysis. Data were analysed using reflexive thematic analysis following the six-phase approach of Braun

and Clarke: familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report [26]. Themes were generated inductively from participants' accounts to ensure that emergent stakeholder perspectives were captured authentically. The integrated Health Policy Triangle and CDC Policy Process Framework (HPT-CDC) was employed as an interpretive lens to contextualise and organise the emergent themes within an established health policy framework.

3.3.4 Ethical Considerations

This study was conducted in accordance with national and international ethical standards for research involving human participants. Ethical approval was obtained from the Human Research Ethics Committee at the Australian National University, Australia (Project H/2025/0278), and the Research and Innovation Centre, Khulna University, Bangladesh (KUECC-2025-04-32).

Prior to data collection, oral informed consent was obtained from all participants. Each participant was informed about the purpose of the study, the procedures involved, potential risks and benefits, and their rights as research participants. It was clearly explained that participation was voluntary and that participants could withdraw from the study at any time without any penalty or need to provide a reason.

To ensure confidentiality, all participants were assigned unique alphanumeric codes (P1 to P12) at the time of data collection. No personal identifiers were included in the transcripts or analysis files. Audio recordings and other identifying information were stored separately in password-protected digital folders, accessible only to the first author. All data will be securely stored for five years in line with institutional requirements and then permanently destroyed.

3.4 Limitations of Research Design

Several limitations of the overall research design should be acknowledged. The quantitative analyses in Papers 2, 4, and 5 are based on cross-sectional Demographic and Health Survey data, which limits the ability to establish causal relationships. Although longitudinal data would allow stronger causal inference, such data were not available for the countries and time periods examined. In addition, the DHS datasets do not include detailed information on dietary intake or physical activity, so the analyses focus on nutritional outcomes rather than the underlying behavioural and environmental factors. The geographic scope of the quantitative analysis is also limited to four countries with comparable data across multiple survey rounds. Moreover, the

analyses of DHS data applied sampling weights but did not use the cluster and strata information of the survey design, and the model diagnostics were not design-based. The implications of these limitations are discussed in detail in Section 11.8.

The qualitative component was conducted only in Bangladesh. While this provides in-depth and context-specific insights, the findings may not be directly applicable to other countries with different policy environments and institutional contexts. The policy document analysis in Article 6 relies on the content of selected national documents and may not capture informal policy processes, subnational implementation practices, or other relevant programmatic materials. For the key informant interviews, the number of participants was limited due to time and resource constraints, as well as the broader political context.

Despite these limitations, the mixed-methods design remains a key strength of this thesis, enabling a more comprehensive and policy-relevant investigation of household-level DBM that would be difficult to achieve using a single-method approach.

3.5 References

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Chapter 4: Synthesising Definitions of DBM

4.1 Chapter Context

This chapter addresses **Objective 1**, which aimed to define and standardise the measurement of DBM at the individual, household, and population levels. The study systematically reviewed the definitions and measurement approaches used to assess DBM in the existing literature across these three levels. Based on this review, the study proposed operational definitions for DBM at each level and introduced evidence informed population-level prevalence thresholds. The operational definitions developed in this study provide a standardised framework for measuring DBM consistently throughout the subsequent studies of this thesis. This chapter comprises one publication, which has been published in ***Nutrition & Dietetics*** journal.

Note: Table 3 presents the cut-off points for different nutritional indicators, which are assessed in specific age groups. Anthropometric undernutrition indicators (stunting, wasting, underweight) are assessed in children aged 0–59 months using the WHO 2006 Child Growth Standards. Micronutrient indicators are generally assessed from 6 months of age, depending on the deficiency, the measurement method and survey eligibility criteria. For example, anaemia is assessed in children aged 6–59 months (haemoglobin < 11.0 g/dL), whereas the haemoglobin cut-offs in Table 3 (< 12.0 g/dL for females and < 13.0 g/dL for males) apply to non-pregnant adult women and men.

4.2 Article on Defining DBM at Individual, Household and Population Levels

The following published article forms the foundation of this chapter:

Talukder A, Kelly M, Sayeed MA, Gray D, Sarma H. Defining double burden of malnutrition across individual, household and population level: A narrative review. ***Nutr Diet.*** 2025;83 (1):8-22. https://doi.org/10.1111/1747-0080.70037

Defining Double Burden of Malnutrition at Individual, Household and Population Level: A Narrative Review

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Statement of Contribution

This thesis is submitted as a Thesis by Compilation in accordance with https://policies.anu.edu.au/ppl/document/ANUP_003405

I declare that the research presented in this Thesis represents original work that I carried out during my candidature at the Australian National University, except for contributions to multi-author papers incorporated in the Thesis where my contributions are specified in this Statement of Contribution.

Title: Defining double burden of malnutrition at individual, household and population level: A narrative review

Authors: Ashis Talukder, Matthew Kelly, Md Abu Sayeed, Darren Gray, Haribondhu Sarma

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Contribution to paper: AT and HS conceptualized and designed the study. AT and MAS conducted the literature search, while HS resolved the discrepancies in the selected articles. AT led the data analysis and interpretation of the results. AT drafted the manuscript, with HS, MK, and DG supervising the analysis output. HS, MK, MAS, and DG critically revised the manuscript for intellectual content. All authors reviewed and edited subsequent drafts, read and approved the final version, and contributed to the decision to submit for publication.

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Abstract

Aims

This study aims to evaluate the existing definitions of double burden of malnutrition (DBM) and to synthesise and propose operational definitions at different levels, with the goal of improving consistency in measurement and policy development.

Methods

We conducted a narrative review that used structured search and narrative synthesis to review and summarise how DBM has been defined at different levels. We performed a structured search across PubMed, Web of Science, and Scopus, focusing on peer-reviewed articles published between January 2010 and December 2024. We screened articles for relevance to DBM and categorised them based on the level of the definition, such as households, individuals, and populations.

Results

Of the 60 selected studies, the majority originated from Latin America (n = 19, 32%), followed by South Asia (n = 10, 17%) and Southeast Asia (n = 8, 13%). At the household- level, the most common definition of DBM was the coexistence of an overweight/obese mother and a stunted child. Individual-level definitions commonly included the coexistence of overweight/obesity with anaemia or stunting. However, definitions at the population-level varied considerably and lacked consistency across studies.

Conclusion

Our findings highlight the need for consistent operational definitions of DBM across different levels of analysis. Drawing on existing literature, we synthesise practical definitions at different levels to more accurately reflect the coexistence of different forms of malnutrition. Clarifying these definitions can improve the comparability of prevalence estimates across contexts and support the development of more effective, evidence-based strategies to address the growing burden of DBM.

Key words: Double burden of malnutrition, definition of DBM, level of DBM assessment, systematic narrative review

Introduction

The double burden of malnutrition (DBM) refers to the simultaneous presence of undernutrition and overnutrition within households, individuals, or populations [1-5]. This concept was first formally introduced at the 1992 International Conference on Nutrition, where it was defined primarily at the national level as the coexistence of overweight or obesity alongside undernutrition within a country [6]. Since then, significant shifts in dietary patterns, physical activity, disease burdens, and life expectancy have transformed the global nutritional landscape, especially in many low- and middle-income countries (LMICs) [7,8].

As a result, DBM is now increasingly recognised not only as a national-level issue but also as a phenomenon occurring at more localised levels—within households and even individuals [1,9]. It remains a critical public health challenge, as highlighted in major research and publications, including *The Lancet* series titled *The Double Burden of Malnutrition*, published in December 2019 [1,10-12]. DBM undermines progress towards global health goals, exacerbates health inequalities, and places dual pressure on healthcare systems by contributing to both infectious diseases and non-communicable diseases (NCDs) [11,12]. This evolving nutritional reality—characterised by persistent undernutrition (e.g., stunting, wasting, and micronutrient deficiencies) alongside a growing prevalence of overweight, obesity, and diet-related NCDs—poses significant challenges to achieving sustainable development and advancing health equity in LMICs [9,13-15].

Globalisation and urbanisation are exacerbating this nutritional burden by creating environments where processed foods high in fats, sugars, and salts increasingly replace traditional diets rich in whole grains, fruits, and vegetables [13]. This shift has increased DBM prevalence, especially in low- and middle-income countries, where undernutrition persists in children and overnutrition occurs in adults living in the same households [1,16,17]. In these contexts, the coexistence of undernutrition and overnutrition within the same individual is also becoming more common, as children who are undernourished in early childhood are more likely to become overweight in adulthood, heightening their risk for NCDs [11]. These overlapping challenges demand integrated interventions that address both aspects of malnutrition.

Despite growing recognition of DBM, a key research gap lies in the absence of specific operational definitions and indicators, which hampers the development, implementation, and evaluation of effective nutrition-related initiatives [17]. While the World Health Organization

(WHO) outlines a broad conceptual framework [9], it does not provide detailed operational guidance for defining and measuring DBM across individual, household, and population levels. Early studies typically defined DBM as the presence of an overweight or obese mother and a stunted child within the same household [18-20], but recent research has expanded this to include a wider range of anthropometric and biochemical outcomes [21]. This heterogeneity in operational definitions and measurement criteria not only results in inconsistent estimates of DBM prevalence but also hampers trend monitoring, cross-study comparability, and the formulation of coordinated public health strategies [22, 23]. Although a previous review identified existing operational definitions of DBM and their frequency of use [17], it neither proposed specific definitions tailored to individual, household, and population levels nor attempted to construct a universal framework requiring global consensus. This gap may limit the ability to assess the full scope of DBM and develop consistent, evidence-based responses.

It is important to note that the term 'triple burden of malnutrition' (TBM) has recently gained attention in research and practice to describe the simultaneous presence of undernutrition, micronutrient deficiencies, and overnutrition [24-26]. TBM builds on the idea of DBM by specifically including micronutrient deficiencies as a separate issue [27, 28], broadening the conceptualisation of malnutrition challenges. Moreover, micronutrient deficiencies can accompany either over or under nutrition in different ways and therefore we are focusing on the most clearcut concept. Accordingly, this review focuses on the DBM definitions and indicators, where ongoing inconsistencies continue to hinder effective policy and programme development [17].

In response to this challenge, this paper aims to review the definitions and indicators of DBM used in current literature so far, with the goal of identifying gaps in the operationalisation of this concept. By exploring the different levels of DBM—individuals, households, and populations—and analysing the indicators used to assess malnutrition at each of these levels, this study seeks to provide a clearer framework for future research. This paper also aims to propose specific operational definitions of DBM at different levels, along with practical measurement criteria that are essential for improving the accuracy of prevalence estimates and for guiding the development and monitoring of effective nutrition policies that address both undernutrition and overnutrition.

Methods

We performed a narrative review guided by systematic search strategies. We adopted a structured, transparent, and rigorous approach, including clearly defined inclusion and exclusion criteria, PRISMA reporting, and independent screening by two reviewers, with disagreements resolved by consensus involving a third reviewer if necessary. We did not register a protocol, conduct a formal risk of bias assessment, or perform meta-analysis, as the heterogeneity of definitions and conceptual approaches made quantitative synthesis inappropriate. This hybrid approach aligns with the methodology of structured narrative reviews described previously [29, 30], and the review process is reported in accordance with the checklist PRISMA 2020 statement [31]. As the primary aim was to synthesise existing operational definitions of DBM rather than to conduct a quantitative synthesis, we did not register a formal systematic review protocol.

To aid readers from diverse disciplines, we provided detailed explanations of key technical terms used in this paper, such as the operational definition of DBM, systematic narrative review, stunting, wasting, obesity, and diet-related NCDs, in Table 1.

We conducted a structured search for peer-reviewed journal articles to ensure methodological transparency and quality. This search focused on articles published between January 2010 and December 2024. This timeframe was selected to capture the most recent developments in the conceptualisation and measurement of DBM. For instance, the WHO Global Nutrition Policy Review, based on a 2009–2010 survey, which highlighted growing policy interest in integrated approaches to undernutrition, micronutrient deficiencies, and overnutrition —the key components of the DBM framework [33].

In our search strategy, we used DBM-related terms, such as “double burden of malnutrition”, “dual burden of malnutrition”, “stunted child or overweight mother”, and DBM-related acronyms (such as DBM, SCOWT, and SCOM). The acronym “SCOWT” (stunted child and overweight mother) has been used in previous literature to define DBM [34]. A detailed overview of the search strategy is provided in the Supplementary Table 1 (Appendix A).

To meet the objectives of our review, we included those studies published in scientific peer-reviewed journals based on the following criteria: (1) studies that provide clear definitions or conceptual frameworks of DBM at the individual, household, or population level; (2) analyses assessing the overlap between “overnutrition” and “undernutrition”; (3) studies that focus on

households where one member is undernourished and another is overweight; (4) studies focused on individuals experiencing both undernutrition and overnutrition at the same time (e.g. overweight individual who is suffering from anemia, etc); (5) studies aiming to address DBM at the country level.

Table 1: Explanation of key terminologies used in this study

Key terminologies	Explanation
Operational Definition of DBM	A specific and measurable definition used to identify or assess a concept in research or practice. In this study, it refers to how DBM is conceptually described in the literature and measured or assessed in applied research.
Systematic Narrative Review	A method of reviewing literature that follows a structured process but presents the findings through a narrative synthesis.
Stunting [a]	Stunting means a child is shorter than expected for their age. It usually happens when they do not get enough nutritious food for a long time or suffer from frequent illnesses. Stunting is often linked to poverty, poor health, and lack of proper care in early childhood. It can affect both a child's growth and brain development.
Wasting [a]	Wasting means a child is too thin for their height. It usually happens because of not getting enough food or from losing weight due to illnesses like diarrhoea. Wasting can be serious and increase the risk of death in young children, but it can be treated with the right care and nutrition.
Overweight and Obesity [a]	Overweight and obesity occur when a person has too much body fat for their height, which can harm their health. These conditions happen when a person takes in more energy (calories) than they burn through activity. Globally, people are eating more high-sugar and high-fat foods and are less physically active, which contributes to this problem.
Diet-related NCDs [a]	Diet-related NCDs include heart disease, stroke, certain cancers, and diabetes. They are mainly caused by unhealthy eating habits and poor nutrition, which are major causes of illness around the world.

[a] **Source: (World Health Organization, 2024)** [32]

The exclusion criteria for this review are: (1) studies that focused exclusively on either undernutrition or overweight/obesity, without addressing their coexistence; (2) review articles; (3) research dealing solely with the clinical or biochemical aspects of malnutrition, without any link to DBM; (4) studies that examined nutrition interventions but did not define or conceptualise DBM; (5) grey literature; (6) we limited our review to English-language publications.

Furthermore, we included studies that explicitly defined and operationalised DBM, either by formulating their own definitions or by explicitly applying a recognised definition, such as those from WHO. Studies that only mentioned DBM without specifying how it was defined or

measured were excluded. This ensured that the review focused on studies that contributed clear and applicable definitions of DBM, though we acknowledge this may have excluded some studies reflecting heterogeneity in practice.

We conducted a comprehensive literature search using three major electronic databases: PubMed, Scopus, and Web of Science. The initial search yielded 2,675 articles in total: 868 from PubMed, 936 from Scopus, and 871 from Web of Science. These records were imported into EndNote™ X9.2, where duplicates were identified and removed. After removing duplicate articles, we retained 1,204 unique articles for the title and abstract screening phase.

Two reviewers independently screened the titles and abstracts of the 1,204 unique articles using predefined inclusion and exclusion criteria. This initial screening identified 258 articles as potentially relevant, which were then selected for full-text review. At this stage, both reviewers were blinded to each other's selections to minimise bias. The interrater agreement during this phase was substantial, with a Cohen's kappa of 0.84, indicating a high level of consistency between reviewers. Discrepancies in selection were discussed to reach a consensus, and a third reviewer was consulted when necessary to resolve disagreements.

During the full-text screening phase, the same pre-defined inclusion and exclusion criteria were applied as in the abstract screening stage. Specifically, we included studies that explicitly defined and operationalised DBM at any level (individual, household, or population), presenting empirical analysis or conceptual frameworks. We excluded studies that merely mentioned DBM without operationalisation, as well as reviews, editorials, letters, and commentaries. Each of the 258 articles was read in full by both reviewers, and detailed notes were maintained on the reasons for exclusion. The inter-rater agreement at this stage was also strong, with a Cohen's kappa of 0.81, reflecting consistent application of the criteria. As before, any differences in judgment were resolved through discussion, with the involvement of the third reviewer if consensus could not be achieved. Following this thorough review, 198 articles were excluded for not meeting the eligibility criteria. As a result, 60 articles were included in the final analysis. The complete selection process is illustrated in Figure 1.

For each of the 60 articles included in the final review, we used a structured data extraction process to collect detailed information relevant to the review objectives. The extracted data focused on three core domains: (a) how DBM was defined in each study; (b) the anthropometric or nutritional indicators used to measure undernutrition and overnutrition; and (c) the cut-off

points or thresholds applied to classify nutritional status. Additional contextual information, such as year of publication, country or region of study, and the level of analysis (individuals, households, or populations), was also recorded (see, Appendix A: Supplementary Table 2).

We used a narrative synthesis approach to examine how DBM has been conceptualised and measured across the included studies. Full-text articles were imported into NVivo 12, where a coding framework was developed to identify both the level of DBM assessment (individual, household, or population) and the relevant definitions. Text segments containing definitions were coded under a dedicated node, allowing for systematic extraction and organisation of DBM definitions by assessment level. In addition, each article was coded to identify the presence of key terms such as 'double burden,' 'dual burden,' 'co-occurrence,' 'co-existence,' and 'double and triple burden' within the text segments defining DBM. Frequency counts for these terms were generated using NVivo's text query functions. All coding was independently verified by a second reviewer to ensure consistency. The coded data were exported into Microsoft Excel (2016) to facilitate tabulation and preparation for figure generation in R (version 4.4.0). Based on this synthesis, we proposed a set of operational definitions for DBM at each level of assessment, incorporating practical and feasible cut-off points to enhance consistency and comparability in future research.

This review article is based on previously published studies and does not involve any new studies with human participants or animals conducted by the authors. As such, ethical approval and informed consent were not required.

Results

Of the 60 included articles, the majority (62%, n = 37) focused on the household level, followed by 23% (n = 14) at the individual level, and 5% (n = 3) at the population level. Additionally, 10% (n = 6) of studies examined both household and individual levels. The term "double burden" appeared most frequently in literature (80% of articles, n=48) followed by "dual burden" (6.7%, n=4). Other related terms such as "co-occurrence," "co-existence," and "double and triple burden" appeared too rarely to be reported separately. In terms of geographical distribution, Latin America and the Caribbean accounted for the highest proportion of studies (32%, n = 19), followed by South Asia (20%, n = 12), Southeast Asia (13%, n = 8), and Sub-Saharan Africa (15%, n = 9). A

smaller number of studies were conducted in East Asia (3%, n = 2). Furthermore, 17% (n = 10) of the studies included data from multiple countries (Figure 2).

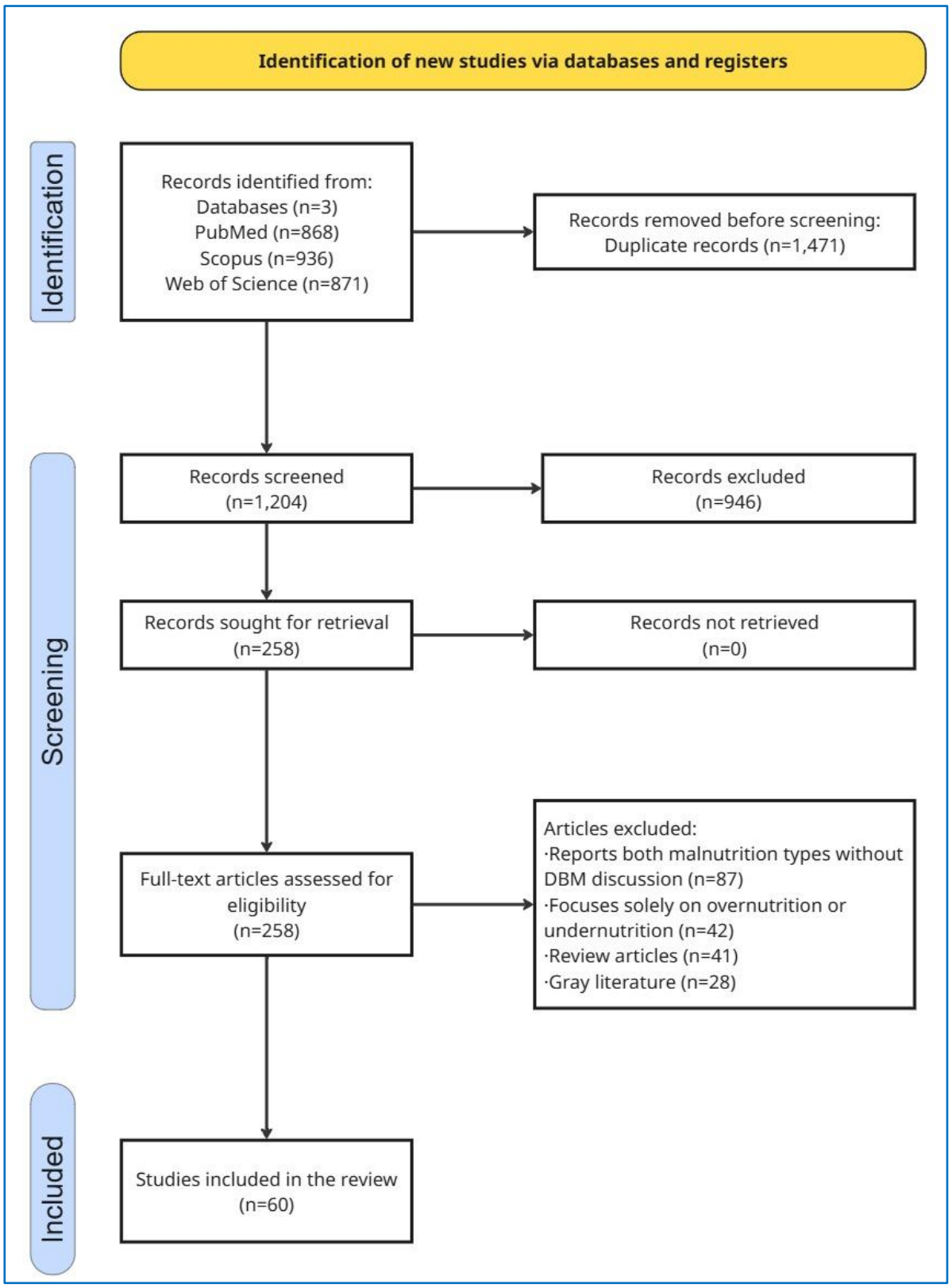

Figure 1: Flow diagram illustrating the identification, screening, eligibility assessment, and inclusion of studies for the review

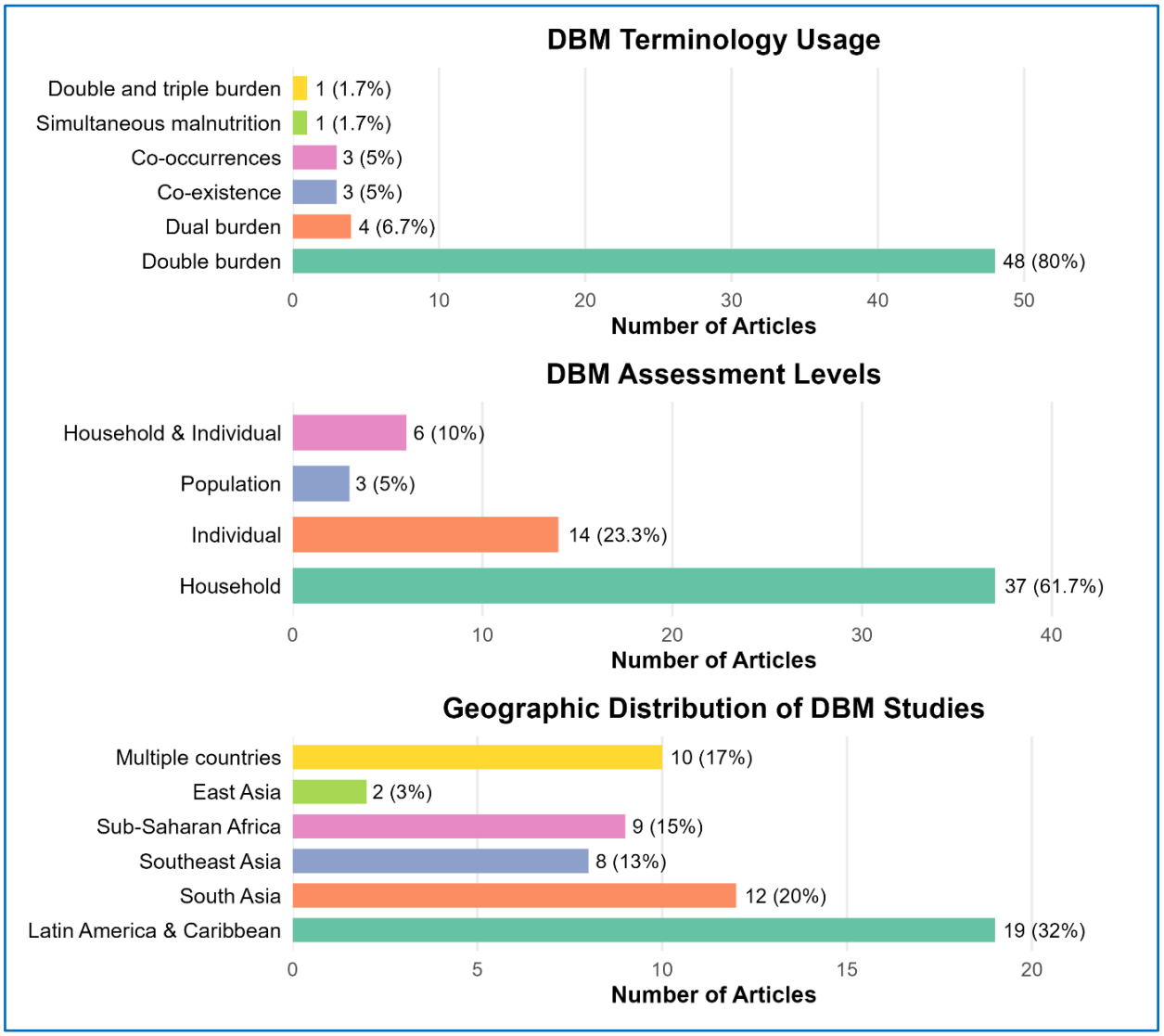

Figure 2: Key dimensions and research contexts based on geographical setting of DBM reported across 60 included studies.
Note: *The usage of DBM-related terminology was assessed by reviewing the definitions of included articles to identify which specific terms each article used to describe the double burden of malnutrition. For example, 48 articles used the term 'double burden' and 4 articles used 'dual burden' when defining or identifying DBM.*

Table 2 shows how DBM has been operationally defined at different levels of measurement (households, individuals, and populations) and shows the frequency of each specific definition across the 60 included studies. At the household level, a total of 62 coded definitions of DBM were identified. The most common definition—used in 25 studies (40.3%)—was the coexistence of an overweight or obese mother and a stunted child. A broader definition, pairing an overweight or obese mother with any form of child malnutrition (stunting, wasting, or underweight), appeared in 19 studies (30.6%). Less frequent definitions included households with an overweight or obese mother and a wasted child (3 studies, 4.8%), an overweight/obese mother and a child with

micronutrient deficiency (2 studies, 3.2%), or an anemic child (5 studies, 8.1%). Combinations such as an overweight child with an underweight mother, an overweight/obese mother with an underweight child, or an overweight child with an anemic mother were each reported in 2 studies (3.2%). Rare definitions included adult overweight paired with child overweight or adult underweight paired with child underweight (1 study each, 1.6%).

At the individual level, 32 coded definitions were identified. The most frequently used definitions—each reported in 9 studies (28.1%)—were: (a) coexistence of overweight or obesity and a micronutrient deficiency (e.g., vitamin A, iodine, or vitamin D); and (b) coexistence of overweight or obesity and anemia within the same individual. The combination of overweight and stunting among children under-five was used in 8 studies (25.0%). Less common definitions included micronutrient deficiency combined with at least one cardiometabolic risk factor (2 studies, 6.3%), underweight combined with a cardiometabolic risk factor (1 study, 3.1%), anemia combined with a cardiometabolic risk factor (1 study, 3.1%), and the coexistence of underweight and anemia (2 studies, 6.3%).

At the population level, three distinct definitions of DBM were identified, each used in a single study (33.3%). Although the limited number of studies restricts generalisability, these examples reflect considerable variability in how DBM is defined at this level. All three definitions assessed DBM based on the simultaneous high prevalence of undernutrition and overweight/obesity within a population. One study applied thresholds such as stunting >30% and overweight >20%, or wasting >15% and overweight >20%, or underweight in women >20% and overweight >20%. Another defined DBM as the coexistence of adult overweight and underweight, each exceeding 10% within the same year. The third used a combination of stunting >20% and overweight >10% to identify DBM. This variation in indicator selection and threshold values highlights the need for clearer, evidence-based definitions to improve consistency and comparability across future studies

Table 2: Summary of available operational definitions of DBM by assessment level

Level of measurement	Operational definition of DBM	Total number of occurrences n(%)[b]
Household level	• Overweight/obese mother and stunted child	25 (40.3)
	• Overweight/obese mother and child having any form of malnutrition (stunting, wasting and underweight)	19 (30.6)
	• Overweight/obese mother and wasted child	3 (4.8)
	• Overweight/obese mother and child facing micronutrient deficiency	2 (3.2)
	• Overweight/obese mother and anemic child	5 (8.1)
	• Overweight child and underweight mother	2 (3.2)
	• Overweight/obese mother and underweight child	2 (3.2)
	• Overweight child and anemic mother	2 (3.2)
	• Adult overweight and child overweight	1 (1.6)
	• Adult underweight and child underweight	1 (1.6)
Individual level	• Micronutrient deficiency and at least one cardiometabolic risk factor	2 (6.3)
	• Underweight and at least one cardimetabolic risk factor	1 (3.1)
	• Overweight/obesity and micronutrient deficiency within an individual/children	9 (28.1)
	• Overweight/obesity and anemia within an individual/children	9 (28.1)
	• Overweight and stunting among under-five children	8 (25.0)
	• Anemia and at least one cardiometabolic risk factor	1 (3.1)
	• Underweight and anemia within an individual/children	2 (6.3)
Population level	• DBM measured by stunting and overweight thresholds: if (stunting >30% and overweight in children or adults > 20%) or (wasting >15% and overweight in children or adults > 20%) or (thinness in women > 20% and overweight in children or adults > 20%)	1 (33.3)
	• DBM in a country when adult overweight and underweight prevalence >10%	1 (33.3)
	• DBM is measured by the prevalence of stunting and overweight, using thresholds of 20% for stunting and 10% for overweight	1 (33.3)

[b] Many articles included multiple DBM definitions. In the table, the total number of occurrences of specific DBM definitions across the 60 included articles is 97; percentages are calculated based on occurrences within each assessment level: household (n = 62), individual (n = 32), and population (n = 3).
Micronutrient deficiency includes vitamin A deficiency or iodin deficiency or vitamin D deficiency or any combination of these indicators.

Table 3: Cut-off points for measuring under and overnutrition with their rationale

Level of measurement	Category	Cut-off points	Reason for considering the cut-off [c]
Household & Individual level DBM	Anthropometric measurements		
	Undernutrition		
	Stunting	• HAZ $< -2SD$	Global standard cut off proposed by WHO [100].
	Wasting	• WHZ $< -2SD$	
	Underweight	• WAZ $< -2SD$ • BAZ < -2 SD	
	Underweight for adult	• BMI $<$18.5 kg/m2	
	Overnutrition		
	Overweight for adults	• BMI $>$ 25 kg/m2	
	Overweight for under five children	• WHZ $> +2$ SD • BAZ $> +2$ SD	
	Overweight for adults (Asian population)	• BMI $>$ 23 kg/m2	Due to the increased risk of cardiovascular disease and diabetes at lower BMI levels among Asians compared to non-Asians, the WHO recommended in 2004 using a modified threshold of 23.0 kg/m² to define overweight for Asians instead of 25.0 kg/m² [101]
	Biochemical measurements		
	Anemia	• hemoglobin concentrations $<$ 12.0 g/dL (Female) • hemoglobin concentrations $<$ 13.0 g/dL (Male)	Worldwide accepted cut-off proposed by WHO [102].
	Vitamin A deficiency	• serum retinol levels, with a cut-off of $< 10\ \mu g/dL$	Worldwide accepted cut-off proposed by WHO [103].
	Iodine insufficiency	• A urinary iodine excretion (UIE) of < 50 µg/dL indicate iodine insufficiency	Previous studies used this cut-off [104].

	Vitamin D deficiency	• Based on the guidelines of the American Society of Endocrinology, vitamin D deficiency can be characterized by Serum 25-Hydroxyvitamin D [25(OH)D] concentration levels below $20\ ng/mL$.	Previous studies used this cut-off [105].
Population level DBM	Population level	• For adults: prevalence of both over and undernutrition is greater than 10% • For children under five: Stunting prevalence $> 20\%$; Wasting prevalence $> 10\%$; Overweight prevalence $> 10\%$	For adult: A 10% prevalence was selected as a threshold for public health concern, as WHO and previous studies in LMICs indicate that adult underweight (BMI <18.5 kg/m²) or overweight at this level signals poor nutrition and warrants public health attention [92]. For children under 5 years of age, a national prevalence of stunting above 20% or wasting above 10% and a prevalence of overweight above 10% has been suggested as indicating public health concerns [106].

Note: HAZ= Height for Age Z score; WHZ= Weight for Height Z score; BAZ= body-mass-index-for-age Z-scores; BMI: body-mass-index; SD= Standard deviation

[c] The cut-off points summarised in the Table were selected based on established global standards and widely accepted benchmarks, primarily drawing from World Health Organization (WHO) guidelines and commonly cited thresholds in nutrition literature. While some referenced reports and studies were not part of the primary pool of articles included in this review, they were incorporated to provide authoritative and practical guidance for defining malnutrition indicators relevant to DBM.

Discussion

The diverse definitions of DBM identified in our review point to deeper conceptual and methodological challenges in establishing a unified definition. This variability is driven by the complexity of malnutrition, shifting nutrition patterns in LMICs, and inconsistent data availability [1,35,36]. Since DBM typically encompasses undernutrition, micronutrient deficiencies, and overweight/obesity, which may coexist at the individual, household, or population levels [1-3], these overlapping conditions make standardisation particularly challenging. Researchers often adapt definitions to fit specific study goals, populations, or datasets, leading to inconsistent indicators, cut-offs, and measurement approaches [37-40]. The absence of universally accepted criteria from global bodies further widens this gap. While some degree of heterogeneity is methodologically justifiable, it limits comparability across studies and complicates the design of coherent public health responses [17]. This review revealed considerable heterogeneity in how DBM is conceptualised and defined across studies. At the individual level, definitions often combined overweight with undernutrition within the same individual, though specific indicators and cut-offs varied. At the household level, most studies define DBM narrowly as an overweight mother and undernourished child dyad, ignoring other intra-household combinations. At the population level, definitions varied in the indicators and thresholds used, with some deviating from WHO standards.

These variations reflect differences in theoretical frameworks, data availability, and cultural contexts, which complicate comparability. Recognising these gaps, we proposed operational definitions that address the observed inconsistencies. Specifically, our definitions expand the household-level conceptualisation beyond the mother–child dyad, align individual- and population-level indicators with WHO benchmarks, and ensure measurability using commonly available data sources such as DHS and MICS. This approach bridges the conceptual and methodological gaps identified in the literature.

We found that household-level studies most defined DBM as the coexistence of an overweight or obese mother and a stunted child [17,19,20,34,35,41-56]. While this definition is practical, largely due to the availability of maternal and child data, it overlooks other important within-household nutritional disparities. Several studies called for broader definitions to include other dyads (e.g., underweight mothers with overweight children, or intergenerational combinations involving elderly members) [57-74]. Building on these insights, our proposed household-level definition

encompasses a wider range of within-household nutritional imbalances, making it more inclusive and context-sensitive.

At the individual level, we found a wide range of definitions [37-40, 75-87]. Most commonly, the double burden of malnutrition is defined as the coexistence of overweight, obesity and anaemia in the same individual [37-40,49,75-77]. Some studies also examine combinations involving overweight or obesity with micronutrient deficiencies or stunting [77-83]. A few have extended the definition further to include cardiometabolic risk factors such as diabetes and hypertension [76,84]. Although these risk factors are important for understanding overall health, they reflect the consequences or risks of chronic diseases [88], rather than the core nutritional imbalances central to the double burden of malnutrition concept. To preserve conceptual clarity, it is important to distinguish it from the broader double burden of disease. In line with the previous literature, we argue that the double burden of malnutrition should primarily focus on the coexistence of undernutrition and overnutrition [1-5], particularly in nutritional terms, rather than encompassing broader health risks. Including cardiometabolic risk factors may mix up nutrition problems with broader health issues that require different policy solutions. However, we acknowledge that the topic remains an area of ongoing debate, and future research may wish to explore hybrid definitions, especially in ageing or urban populations where such overlaps are more prevalent [89,90].

At the population level, definitions often vary due to the use of different prevalence thresholds for undernutrition and overweight or obesity. For instance, one study defines the double burden of malnutrition based on a stunting prevalence of 20% and an overweight prevalence of 10% [87], while others use thresholds such as 10% or more for both adult underweight and overweight in a year [91]. These inconsistencies in threshold selection led to varying estimates prevalence, making cross-country comparisons and trend analyses difficult. As a result, monitoring global progress and evaluating policy effectiveness become challenging. Previous research has highlighted that the absence of standardised thresholds can result in underestimating or overestimating the burden of the double burden of malnutrition [92], potentially misguiding resource allocation and public health responses. In light of these issues, one study recommended establishing globally consistent criteria based on empirical evidence of associated health risks [92]. Our proposed threshold values aim to reflect this balance between empirical relevance and feasibility, but we also acknowledge the need for future validation in diverse country settings.

In our review, most studies relied on anthropometric indicators—such as stunting, wasting, underweight and overweight—to define and measure the double burden of malnutrition. While these indicators are widely used and offer useful insights, researchers always need to take special care so that the choice aligns with the specific aims of a study [17]. For instance, studies focused on maternal and child health commonly use the combination of maternal BMI and child stunting [35,45], whereas research on adult population may require measures such as anaemia status and thinness or overweight [38,70]. This variation highlights that definitions and the selection of indicators should be informed by the research context and clearly aligned with study objectives [17,93]. Choosing indicators that match the population, setting and purpose of the study, enhances the accuracy assessment and ensures that the resulting findings are more relevant and effective in addressing both the prevalence and underlying causes of DBM in different settings. On the other hand, misalignment between indicators and study objectives can lead to inaccurate assessments and misleading conclusions. For example, while BMI is a widely used measure, it does not reflect body fat distribution and can underestimate obesity-related health risks in certain demographic groups [94].

While our review highlights the importance of consistent definitions, it is equally important to recognise that its manifestation and measurement are shaped by environmental and contextual factors. Socioeconomic conditions, urbanisation, food systems, healthcare access and cultural practices all influence how different forms of malnutrition coexist [95-99]. For instance, rapid urbanisation often leads to greater consumption of energy-dense, nutrient-poor foods and sedentary lifestyles, contributing to overweight and obesity [95-97]. In contrast, rural areas may continue to struggle with food insecurity and undernutrition [98,99]. Therefore, adopting a definition that is grounded in its core concept but adapted to the study's specific objectives can enhance the relevance of research findings and increase the effectiveness of existing policies across diverse settings.

Given the existing challenges in defining DBM using consistent nutrition indicators, we propose operational definitions for DBM at the individual, household, and population levels. These definitions are derived from our synthesis of how DBM has been conceptualised across the included studies, and they are informed by both empirical patterns in the literature and international guidance to ensure consistency with global public health standards. Importantly, these definitions are designed to be both conceptually robust and practically measurable. Specifically, they can be operationalised using widely available data sources such as Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), and other

routine surveillance systems that collect anthropometric and micronutrient data at the individual and household levels. This approach bridges conceptual and methodological gaps and improves comparability of findings across contexts.

The specific operational definitions and corresponding cut-off points for each nutrition indicator are described below and further explained in Table 3, along with the justification for each selected threshold. Researchers can use these definitions based on the aim of the research. Proposed definitions at different levels are:

Household-level: At the household level, DBM occurs when there is a coexistence of contrasting forms of malnutrition within the same household. This can manifest as an adult member being overweight or obese while a child is undernourished, or an adult member being underweight while a child is overnourished, or when two household members—adults or children—experience opposite forms of malnutrition, with one being overweight and the other undernourished.

Individual-level: DBM is defined as the simultaneous presence of overweight or obesity alongside stunting, anaemia, or other micronutrient deficiencies in the same individual, occurring at the same developmental stage (e.g., childhood, adolescence, or adulthood).

Population-level: DBM refers to the coexistence of high prevalence of undernutrition and overweight or obesity within the same population. It is identified when the prevalence of overweight or obesity in children or adults exceeds 10%, alongside a stunting prevalence of over 20% or a wasting prevalence of over 10% or a underweight prevalence of over 10%.

This study has several advantages. By systematically examining definitions and indicators across individual, household, and population levels, this study provides a comprehensive framework that supports more targeted and effective interventions. Our rigorous methodology, which includes well-defined inclusion and exclusion criteria as well as independent screening by multiple reviewers, enhances the reliability of our analysis and minimises selection bias. Additionally, all data extraction was cross-checked by a second reviewer to ensure consistency and accuracy. However, this study also has limitations. We did not register a protocol or conduct formal risk-of-bias assessments. Excluding grey literature from the systematic search may have omitted relevant evidence, although authoritative grey literature (e.g., WHO guidelines) was cited to justify our proposed thresholds. The heterogeneity of study designs (e.g., cross-sectional vs. longitudinal) and our focus on explicit definitions may have excluded studies reflecting real-world diversity.

In our research, we propose practical definitions of DBM at the household, individual, and population levels that are more feasible for measurement. These proposed definitions may inform researchers and policymakers in the development of more effective strategies to address its rising prevalence. We also emphasis that clear and specific definitions are critical for designing robust research methodologies and formulating effective policy initiatives. Importantly, using consistent definitions can help incorporate DBM indicators more effectively into national health surveillance systems and global monitoring frameworks, such as the Sustainable Development Goals (SDGs) and the WHO Global Nutrition Targets. Moreover, by carefully selecting indicators that align with the specific objectives of the research, whether for prevalence estimation, trend analysis, or intervention evaluation, we can ensure those findings are both relevant and impactful.

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Section II: Evidence Generation

Chapter 5: Prevalence and Trends of DBM

5.1 Chapter Context

This chapter addresses **Objective 2**, which aimed to estimate the prevalence of household-level DBM and examine its trends across South and Southeast Asia. The study used Demographic and Health Survey (DHS) data from Bangladesh, Cambodia, Nepal, and Timor-Leste spanning approximately two decades. By providing an updated multi-country assessment of the prevalence and trends of household-level DBM, the study establishes the epidemiological basis for analysing the factors associated with DBM, which are presented in the subsequent chapters. This chapter comprises one publication, which has been published in ***Discover Public Health*** journal.

Note on terminology: In the published article, the term 'risk' is used to describe associations with household-level DBM. As the study used cross-sectional data and the associations were estimated using logistic regression and reported as odds ratios, any reference to an increase or decrease in 'risk' should be interpreted as an increase or decrease in the odds of DBM, rather than a change in risk. These findings represent statistical associations and do not establish causality. The original published text has been retained without alteration.

Note for figures: For improved readability, revised versions of Figures 3 and 4, incorporating different line styles to distinguish between groups, are provided as supplementary figures in Appendix B (Supplementary Figure 3 & 4). The original figures have been retained in the published article reproduced in this chapter.

5.2 Article on Prevalence and Trends of DBM at Household-Level

The following published article forms the foundation of this chapter:

Talukder A, Kelly M, Gray D, Sarma H. Prevalence and trends of double burden of malnutrition at household level in South and Southeast Asia. ***Discov Public Health.*** 2024;21(1):221. https://doi.org/10.1186/s12982-024-00339-y

Prevalence and Trends of Double Burden of Malnutrition at Household-Level in South and Southeast Asia

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Statement of Contribution

This thesis is submitted as a Thesis by Compilation in accordance with
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I declare that the research presented in this Thesis represents original work that I carried out during my candidature at the Australian National University, except for contributions to multi-author papers incorporated in the Thesis where my contributions are specified in this Statement of Contribution.

Title: Prevalence and trends of double burden of malnutrition at household-level in South and Southeast Asia

Authors: Ashis Talukder, Matthew Kelly, Darren Gray, Haribondhu Sarma

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Delegated Authority – Print Name	Signature	Date

Abstract

Background

The double burden of malnutrition (DBM), which involves both undernutrition and overweight/obesity, has become a significant global health concern. Significant research gaps exist in understanding the prevalence and trends of DBM among mother-child pairs in South and Southeast Asia, as existing studies frequently concentrate on single countries or specific populations. Therefore, the objective of this study is to estimate the prevalence and trends of DBM by utilising the most updated nationally representative data from four selected countries in these regions.

Methods

We analyzed cross-sectional, nationally representative secondary data from the Demographic and Health Survey, conducted from 2004 to 2022. The survey included households with at least one mother-child pair for Bangladesh, Cambodia, Nepal, and Timor-Leste. Using survey weights, we calculated the weighted prevalence of household level DBM, underweight children (<5 years old), and overweight mothers ($BMI \geq 23 kg/m^2$) for each country. Using chi-square tests, we investigated associations between DBM prevalence and factors such as wealth index, place of residence, and child sex. We assessed socioeconomic disparities using odds ratios obtained from a multivariable logistic regression model.

Results

The prevalence of DBM at household level in Bangladesh rose from 4% in 2004 to 13.8% in 2018, with underweight children decreasing from 47.6% to 21.5% and overweight or obese mothers increasing from 11.6% to 42.3%. We observed similar trends in Cambodia (DBM prevalence: 7.4% in 2005 to 14.3% in 2022; underweight child: 28.3% in 2005 to 16.5% in 2022; overweight/obese mother: 18.6% in 2005 to 48.8% in 2022), Nepal (DBM prevalence: 5.6% in 2006 to 12.3% in 2022; underweight child: 38.6% in 2006 to 19% in 2022; overweight/obese mother: 14.4% in 2006 to 48.7% in 2022), and Timor-Leste (DBM prevalence: 9.4% in 2009 to 15.8% in 2016; underweight child: 44.1% in 2009 to 40.8% in 2016). In all four nations, households with a higher socioeconomic level (richest) consistently had a higher likelihood of developing DBM (odds ratio > 1) compared to households with a lower socioeconomic status

(poorest). Furthermore, mother-child pairs living in rural regions had a lower likelihood of developing DBM compared to urban settings.

Conclusion

DBM is on the rise in households across South and South-east Asian nations, particularly in urban areas and among richest households. Despite several improvements in reducing underweight prevalence, persistent undernutrition remains a significant challenge in the region. Simultaneously, the rising prevalence of obesity is a growing concern. Future research should prioritise identifying country-specific risk factors of DBM and understanding factors contributing to the high prevalence of maternal overweight.

Keywords Undernutrition, Overweight, Double burden of malnutrition, South and Southeast Asia, Prevalence, Trends

Introduction

The double burden of malnutrition (DBM) is the simultaneous presence of undernutrition (underweight, wasting, stunting, and micronutrient deficiencies) along with overnutrition (obesity or overweight) at various population levels, such as country, community, or household, as well as within individuals over their lifetimes [1]. DBM is frequently observed in households where a mother is overweight or obese and her child (<5 years old) suffers from undernutrition [1]. The primary cause of this dual burden is the nutrition transition [2], which is associated with major shifts in the diet towards more refined carbohydrates, added sugars, edible oils, and foods derived from animals, as well as a decrease in physical activity, contributing to overweight or obesity in adults [3]. This major shift in dietary behaviour resulted in a transition from being mostly undernourished to having an increased risk of being overweight or obese [4]. Moreover, a combination of inadequate infant feeding practices, poor sanitation and hygiene, and limited access to nutritious foods may lead to an increased prevalence of undernutrition among children [5, 6].

The prevalence of DBM on a global scale is increasing. A recent study using data from 126 countries between 1999 and 2017 highlighted that the prevalence of total household-level DBM ranges between 3% and 35% [2]. During this period, the most common DBM pairs were stunted child-overweight mother pairs (1–24%), followed by overweight mother-wasted child pairs (0.3–10%), and underweight mother-overweight child pairs (0.1–4%) [2]. DBM is also a concern in

several South and South-east Asian countries. In 2020, a systematic review and meta-analysis found that 28% of the South Asian population was underweight and 17% was overweight, while in South-east Asia, the rates were 20% for both conditions [15]. Another study across eight South and South-east Asian countries found a pooled prevalence of 10.0% for overweight mother-stunted child pairs, 7.0% for overweight mother-wasted child pairs, and 7.0% for overweight mother-underweight child pairs [7]. Additionally, this research found a 12.0% prevalence of DBM coexistence (overweight mothers and any kind of child undernutrition) at the household level [7]. Over time, India has experienced a rising prevalence of DBM at the household level, which will affect one out of every four families in 2021 [16]. In Nepal, one prior study showed that DBM impacted 6.6% of mother-child pairings [17]. In Cambodia, approximately one-fourth of stunted children under the age of five have an overweight or obese mother [18].

Household-level DBM has significant health and economic consequences. In terms of health, households with DBM experience immediate health impacts, such as stunted growth in children due to undernutrition, along with long-term obesity-related conditions in adults, including type 2 diabetes, hypertension, and certain cancers [4, 8]. This dual burden also increases the risk of chronic diseases, as children who experience stunting may become overweight in adulthood [11–13]. Managing these diverse health issues often requires costly medical interventions, which impose a substantial financial burden on families and increase national healthcare costs [4]. The economic impact is further worsened by reduced productivity due to illness, leading to lower household income [4]. Additionally, the cost of managing both undernutrition and obesity within the same household can lead to increased out-of-pocket expenses [14]. This financial strain can push families into deeper poverty, which continues the cycle of poverty and malnutrition. On a larger scale, DBM also hinders a country's economic development by reducing its gross national product [4].

While research on DBM has gained attention globally, significant gaps remain in estimating its prevalence and trends among mother-child pairs in South and South-east Asia. Existing studies on DBM often focus on single-country analyses or specific population groups [19–22], limiting our understanding of the broader regional context. Additionally, most studies in these regions use small-scale samples [47–50] and focus separately on the nutritional status of either the mother or the child, rather than both simultaneously. While some studies have estimated DBM prevalence at the household level within individual countries in South and South-east Asia, few have taken a region-wide perspective and often rely on outdated datasets [7, 23]. Therefore, this study aims to

estimate the prevalence and trends of DBM using the most up-to-date nationally representative data from multiple countries in South and South-east Asia.

Methods

Study Design and Study Area

We conducted a multi-country secondary data analysis that focused on four countries in South and Southeast Asia: Bangladesh, Cambodia, Nepal, and Timor-Leste. We chose these countries because they are currently experiencing nutrition transitions involving increased intake of hazardous processed foods, leading to a dual challenge of undernutrition and overnutrition [24-27], which further exacerbates the issue of DBM. These nations also represent diverse socio-economic contexts and different stages of economic development, providing the valuable opportunity to explore how various phases of nutritional transition affect DBM. While many South and Southeast Asian countries are experiencing similar nutritional transitions, we selected these four specifically due to the availability of necessary maternal and child nutrition data, including multiple time-point datasets, which enabled us to analyze trends over time. Some of the other countries in the region were excluded because they did not have adequate or complete access to the data on maternal and child nutrition, which is required to identify DBM at household level.

Data Sources

We extracted necessary information from nationally representative cross-sectional data from the Demographic and Health Surveys (DHS), conducted between 2004 and 2022, for four South and Southeast Asian countries, Bangladesh (2004, 2007, 2011, 2014, 2018), Cambodia (2005, 2010, 2014, 2022), Nepal (2006, 2011, 2016, 2022), and Timor-Leste (2009-10 & 2016). DHS used a two-stage, stratified random sampling method. First, census enumeration areas (EAs) were chosen based on a probability proportional to size approach. Households were then randomly selected from the EA. Data were collected by face-to-face interviews with women aged 15 to 49 years and their children aged 0 to 5 years within these selected households. Participants provided voluntary written informed consent before interviews. Ethical approval was granted by both the ICF International institutional review board in Calverton, MD, USA, and individual review boards in each participating country. The DHS dataset is accessible from the DHS programme website, in compliance with a data-sharing policy. Comprehensive descriptions of DHS sampling

procedures, questionnaire validation, and data collection methods are available on the DHS website [28].

Study Population

We included households in this research that had a minimum of one mother-child pair. We then considered mother-child pairs from households that had information on both the mother's and her child's nutritional status. This resulted in different samples for each country and year. Samples missing information on child's nutrition status or mother's BMI were excluded. Details on the final sample included for each country and each time point are in Figure 1.

Variables

We used several indicators, including height-for-age, weight-for-age, and weight-for-height, to identify the nutritional health of the participants. To determine the nutritional status of children, we applied the 2006 World Health Organization (WHO) growth standard to calculate anthropometric z-scores. Children were classified into three categories based on these z-scores: stunted (height-for-age z-score < −2 standard deviation), underweight (weight-for-age z-score < −2 standard deviation), and wasted (height-for-height z-score < −2 standard deviation) [29, 30]. We calculated the maternal body mass index (BMI) as the product of $weight/height^2 (kg/m^2)$. We classified each mother into underweight ($BMI < 18.5\, kg/m^2$) normal ($BMI: 18.5 - 22.9\, kg/m^2$), and overweight/obese ($BMI \geq 23\, kg/m^2$) by using Asian-specific BMI cutoffs [7, 31]. To determine household-level DBM, we identified households where the mother was overweight or obese and the child was undernourished, categorised as underweight, stunted, or wasted based on the three indicators mentioned above. Subsequently, we created a composite outcome variable indicating households where an overweight or obese mother coexisted with at least one form of child undernutrition, including being underweight, stunting, or wasting.

DBM: In the same household, there is an overweight or obese mother and a stunted, wasted, or underweight child.

We consider three exposure variables, including place of residence (urban or rural), child's sex (male or female), and household wealth index. The DHS utilised principal component analysis (PCA) to calculate the wealth index factor scores, which represent the overall living standard of a household. Based on these scores, we further categorised the wealth index into five quintiles: poorest, poorer, middle, richer, and richest. Initially, the DHS programme computed a wealth

score based on household characteristics via PCA and subsequently grouped households into quintiles based on this score [28].

Statistical Analysis

We computed the weighted prevalence of DBM, underweight children, and overweight mothers for each country and available time points, taking into account the clustered sampling design and survey weights. Then, we performed a descriptive analysis to identify the characteristics of the study population. Using the chi-square test, we examined the significant association between DBM prevalence and various factors like wealth index, place of residence, and child sex. To assess socioeconomic disparities, we used odds ratios from a multivariable logistic regression model that used maximum likelihood estimation to find out how each predictor variable affected the chance of a mother-child pair developing DBM. We calculated odds ratios for extreme categories in the household wealth index (lowest quintile vs. highest quintile).

Results

Figure 2 displays the final analytical samples for each country and year, as well as the frequency distribution of background characteristics among mother-child pairs in Bangladesh, Cambodia, Nepal, and Timor-Leste. From 2004 to 2018, the percentage of mother-child pairs residing in urban regions of Bangladesh increased from 30.1% to 34.9%. In Cambodia, this proportion rose from 20.3% in 2005 to 35.2% in 2022. In Nepal, the proportion of urban mother-child pairs ranged from 22.5% in 2006 to 49.5% in 2022. Similarly, this proportion in Timor-Leste ranged from 21.6% in 2009 to 29.2% in 2016. In 2022, Nepal had the highest proportion of mother-child pairs living in the poorest households, with a rate of 33.2%, and Bangladesh had the lowest proportion, around 20% in 2007. On the other hand, the proportion of mother-child pairs living in the richest households was lowest in Nepal (11.3% in 2022) and highest in Cambodia (24% in 2014). Children's sex distribution is relatively equal across countries and time periods.

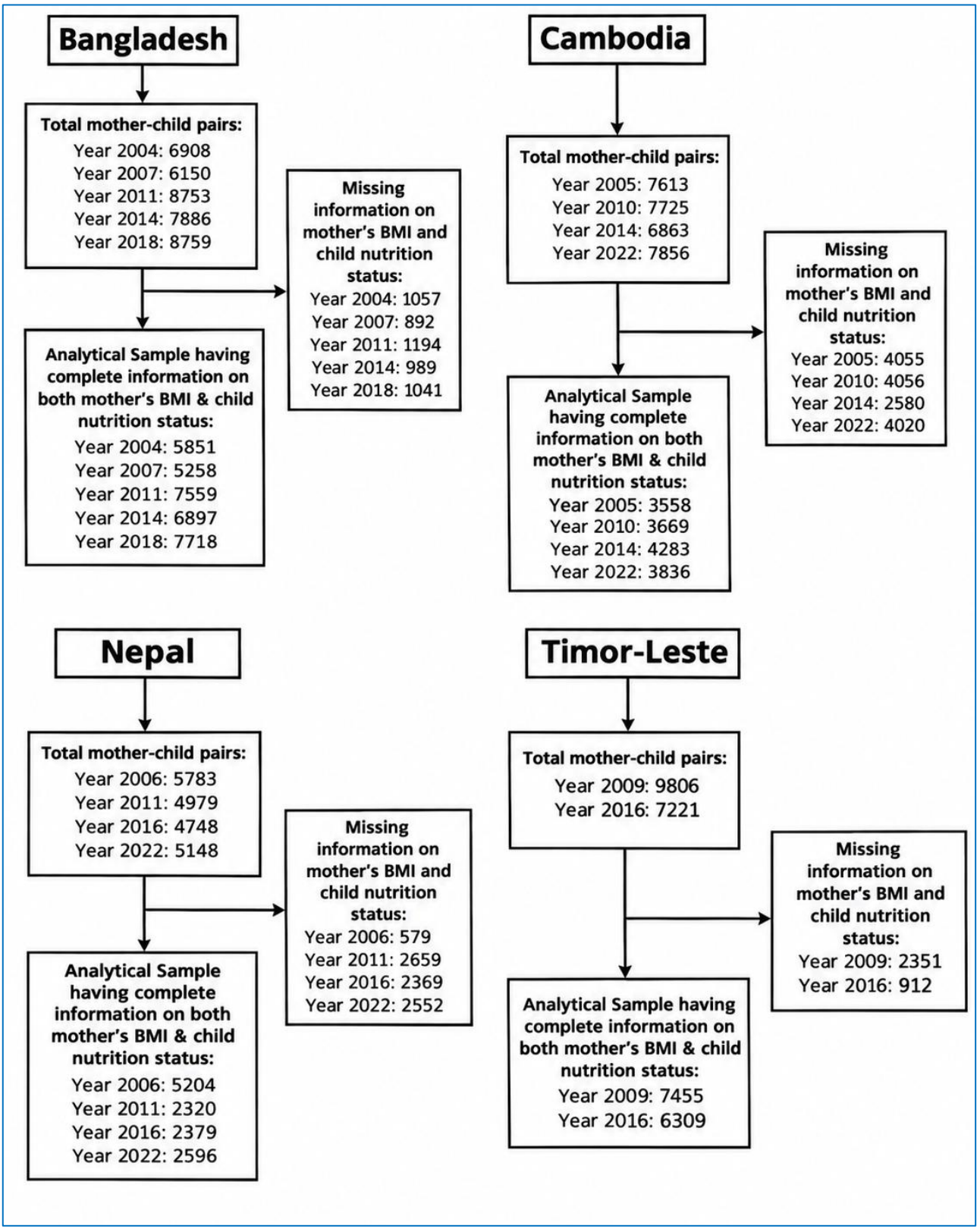

Figure 1: Flow chart showing sample selection procedure

Table 1: Prevalence of household level DBM by covariates among mother-child pairs of Bangladesh, Cambodia, Nepal and Timor-Leste

Covariates	Bangladesh					Cambodia				Nepal				Timor-Leste	
	Year: 2004	Year: 2007	Year: 2011	Year: 2014	Year: 2018	Year: 2005	Year: 2010	Year: 2014	Year: 2022	Year: 2006	Year: 2011	Year: 2016	Year: 2022	Year: 2009	Year: 2016
Place of residence															
Urban	7.7	8.9	12.4	14.8	15.8	10.7	11.1	13.2	19.4	7.1	9.9	10.0	14.2	12.5	20.0
Rural	3.2	5.2	7.6	11.2	11.9	7.1	8.1	11.6	12.1	5.3	7.8	9.6	11.1	8.5	12.8
Wealth Index															
Poorest	2.1	2.9	4.4	8.3	11.1	6.0	6.7	11.2	11.0	5.5	6.4	10.9	11.2	5.7	9.0
Poorer	2.1	3.6	8.1	12.0	10.9	5.9	7.9	12.5	13.7	3.9	5.9	8.0	10.0	7.9	16.6
Middle	3.8	5.0	7.6	13.3	14.5	7.8	9.7	12.4	15.6	4.8	7.0	8.2	13.1	8.8	16.0
Richer	5.6	9.0	12.0	13.6	16.4	10.9	9.7	10.7	14.2	6.0	10.4	10.7	13.6	10.9	18.5
Richest	8.9	11.5	13.9	14.7	13.9	11.1	10.6	14.2	16.5	9.3	14.6	12.5	19.4	15.6	20.0
Child sex															
Male	3.9	6.9	9.0	12.4	13.5	7.4	9.1	12.0	15.4	5.5	7.6	9.7	12.4	10.0	15.5
Female	5.2	6.0	9.2	12.2	13.1	8.3	8.4	12.1	13.9	5.9	9.0	10.0	12.9	8.8	14.2

Note: Each cell in the table denotes the prevalence of DBM among mother-child pairs across different covariates in Bangladesh, Cambodia, Nepal, and Timor-Leste. In both Bangladesh and Timor-Leste, DBM exhibits statistically significant associations with place of residence and wealth index throughout all observed years ($p<0.05$). In Cambodia, these associations were significant in the years 2005, 2010, and 2022 ($p<0.05$). In Nepal, the wealth index demonstrates a significant association with DBM across all years, while place of residence shows significance only in 2006 and 2022 ($p<0.05$). Also, note that the p values were derived from chi-square tests.



Figure 2: Frequency distribution of the background characteristics of study participants from Bangladesh, Cambodia, Nepal, and Timor-Leste, displayed across countries and years.

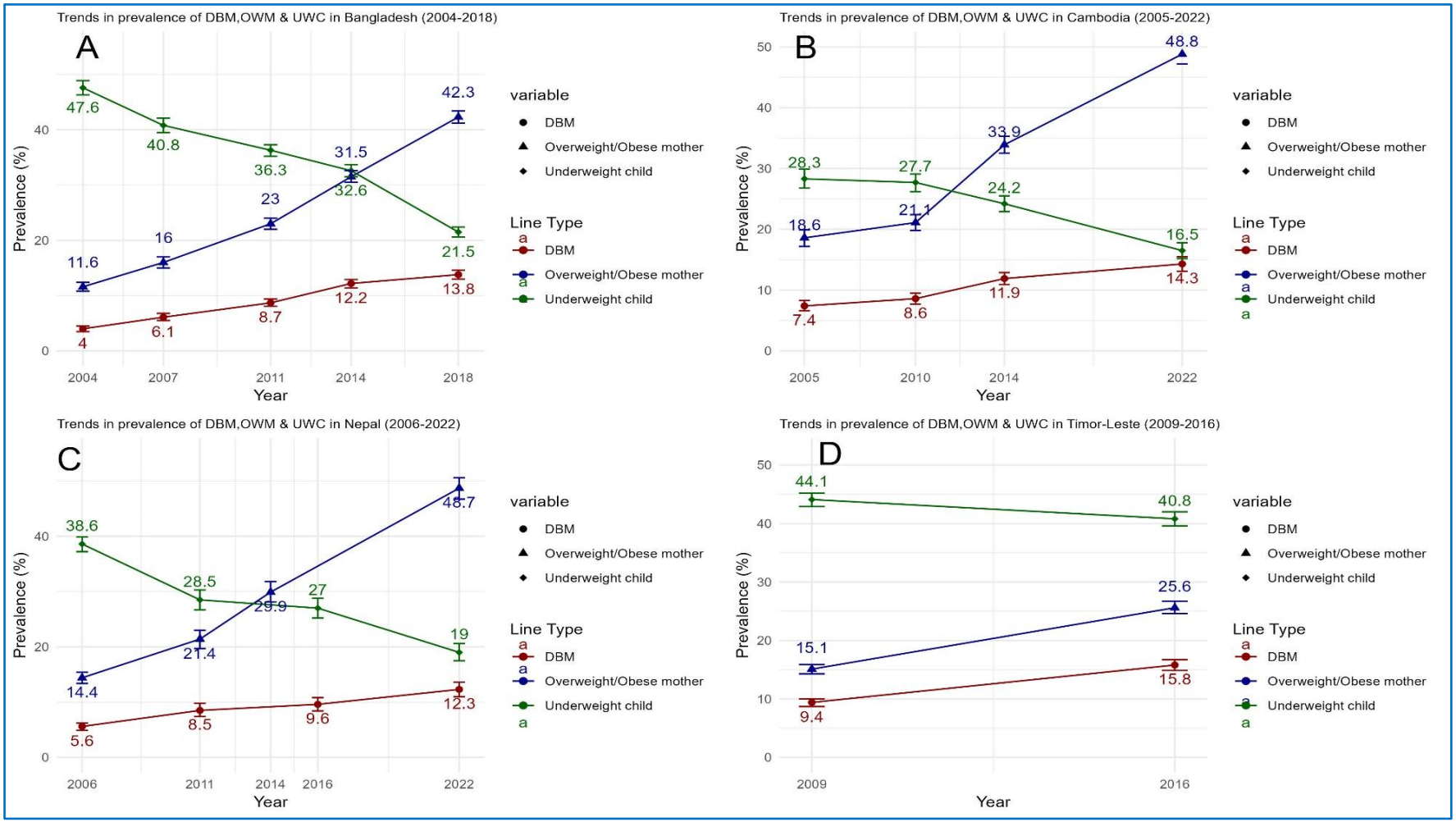

Figure 3: Changes in the prevalence of household-level double burden of malnutrition (DBM) among mother–child pairs in Bangladesh (A), Cambodia (B), Nepal (C), and Timor-Leste (D).

Note: *The figure illustrates the trends in DBM across these countries over time, highlighting variations in the prevalence rates within each country and providing a comparative view of how the DBM issue has evolved in different contexts. Each subfigure (A-D) corresponds to a specific country, showing how the prevalence of DBM among mother–child pairs has shifted over the years.*

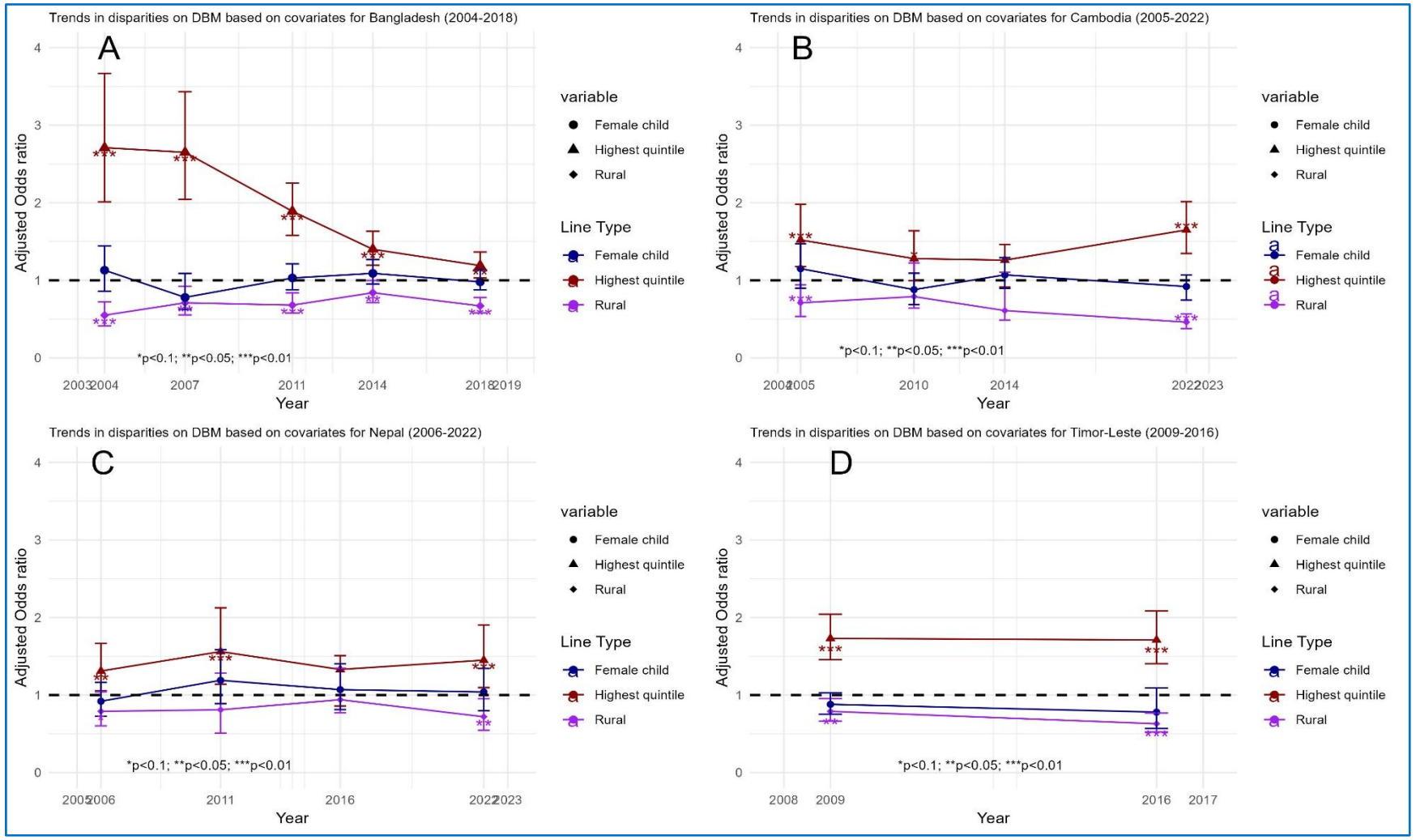

Figure 4: Trends in disparities for household level DBM among mother–child pairs in Bangladesh (A), Cambodia (B), Nepal (C) & Timor-Leste (D) based on wealth index, place of residence, and child sex.

Note: *Odds ratio was estimated by mutually adjusting for each other, considering wealth index: lowest quintile (Ref) & highest quintile; place of residence: urban (Ref) & rural, and child sex: male (Ref) & female. "Ref" is the reference category for the odds ratio.*

Figure 3 depicts changes in DBM prevalence, underweight children, and overweight or obese mothers across different survey years in four countries. In Bangladesh, DBM prevalence has steadily risen from 4% in 2004 to 13.8% in 2018. During the same period, the prevalence of overweight or obese mothers in Bangladesh increased from 11.6% to 42.3%, while the prevalence of underweight children decreased from 47.6% to 21.5%. We observed comparable trends in Cambodia (DBM prevalence: 7.4% in 2005 to 14.3% in 2022; underweight child: 28.3% in 2005 to 16.5% in 2022; overweight/obese mother: 18.6% in 2005 to 48.8% in 2022), Nepal (DBM prevalence: 5.6% in 2006 to 12.3% in 2022; underweight child: 38.6% in 2006 to 19% in 2022; overweight/obese mother: 14.4% in 2006 to 48.7% in 2022), and Timor-Leste (DBM prevalence: 9.4% in 2009 to 15.8% in 2016; underweight child: 44.1% in 2009 to 40.8% in 2016; overweight/obese mother: 15.1% in 2009 to 25.6%). Although DBM is increasing over time for all countries, the overweight mother-stunted child has a higher prevalence than the other two types of DBM combination (overweight mother-wasted child and overweight mother-underweight child), indicating that stunting is more important to drive DBM prevalence than being underweight or wasted (Appendix B: Supplementary Figure 1).

Table 1 presents the distribution of DBM across various background factors. We found that the latest survey data indicates a higher prevalence of DBM across different categories of each covariate in all the nations examined. In Bangladesh in 2018, we observed a higher prevalence of DBM among mother-child pairs living in urban settings (15.8%) and in richer households (16.4%). We also observed similar patterns in Nepal, where the prevalence of DBM was higher in the richest households (19.4%) and households in urban areas (14.2%) in 2022. Furthermore, in 2022, the prevalence of DBM in Cambodia was higher among urban families (19.4%) and the richest households (16.5%). In Timor-Leste, the richest (20%) and urban households (20%) had higher DBM incidence in 2016. It should be noted that, in Bangladesh and Timor-Leste, household-level DBM was significantly associated with place of residence and wealth index across all years ($p<0.05$). In 2005, 2010, and 2022, we observed that both the wealth index and the place of residence were statistically significant in Cambodia. On the other hand, in Nepal, wealth index was significantly associated with DBM across all years, whereas place of residence was significant only in 2006 and 2022 ($p<0.05$).

Figure 4 illustrates the changes in the prevalence of DBM among mother-child pairs in four countries, stratified by wealth index, place of residence, and child sex. In all four nations, households with higher wealth indexes are more likely to experience DBM (odds ratio > 1) than

those with lower wealth indexes. In 2004, for example, households in the upper income quintile in Bangladesh were 2.71 times more likely to have DBM than those in the lowest quintile (95% CI: 2.01, 3.66). By 2018, the risk had declined but remained considerable, with families in the top quintile 1.19 times more likely to acquire DBM (95% CI: 1.03, 1.36). From the beginning to the most recent survey years, we observed similar trends in Cambodia, Nepal, and Timor-Leste, where higher income quintiles were associated with an increased risk of DBM. This indicates the presence of socioeconomic disparity in each of these countries. Figure 3 also highlights that mother-child pairs in rural households have a lower likelihood of experiencing DBM compared to those in urban areas. [Bangladesh (2004): OR=0.55 (CI: 0.41, 0.72); Bangladesh (2018): OR=0.67 (CI: 0.58, 0.77); Cambodia (2005): OR=0.71 (CI: 0.53, 0.94); Cambodia (2022): OR=0.46 (CI: 0.37, 0.56); Nepal (2006): OR=0.79 (CI: 0.60, 1.04); Nepal (2022): OR=0.72 (CI: 0.54, 0.95); Timor-Leste (2009): OR=0.79 (CI: 0.71, 0.98); Timor-Leste (2016): OR=0.63 (CI: 0.53, 0.76)]. This relation indicates that the disparities exist between rural and urban regions in each country. However, we observed no notable patterns in relation to child sex across the nations.

Discussion

We performed a multi-country analysis to estimate the prevalence and trends of household-level DBM by using data from Bangladesh, Cambodia, Nepal, and Timor-Leste. Results indicate that the prevalence of DBM increased in all countries: from 4% to 13.8% in Bangladesh (2004–2018), 7.4% to 14.3% in Cambodia (2005–2022), 5.6% to 12.3% in Nepal (2006–2022), and 9.4% to 15.8% in Timor-Leste (2009–2016). Although the prevalence of underweight children decreased, the proportion of overweight or obese mothers increased substantially. DBM was notably higher in urban areas and rich households across all countries. We found significant associations between DBM, place of residence, and wealth index. Rich households continuously had a higher likelihood of DBM, indicating that urban-rural disparities were prominent, with urban areas showing higher DBM prevalence.

We found similar trends in all four countries: the number of DBM cases went up, the number of underweight children went down, and the number of overweight or obese mothers went up. This suggests that the increase in overweight mothers may be a factor in the rise in DBM cases, which is consistent with other studies [7, 32, 34]. Several societies are shifting towards diets that are high in processed foods, unhealthy fats, sugars, and refined carbohydrates, which are contributing to rising rates of overweight and obesity as well as decreased physical activity [2, 3]. Despite the decreasing prevalence of underweight children, the persistence of undernutrition remains a

critical issue, exacerbated by factors such as limited access to nutritious foods, inadequate feeding practices, and susceptibility to infectious diseases [35]. Furthermore, in many societies, there exists a societal norm that compels women to prioritise their own dietary requirements, which may result in excessive eating and contribute to the growing prevalence of overweight and obesity [36]. Similarly, cultural restrictions that limit children's access to certain nutrients can exacerbate malnutrition issues. However, more research is necessary to know the actual reasons for these trends and the increasing prevalence of DBM [32].

Our study revealed that mother-child pairs residing in richest households have a higher risk of DBM in comparison to those residing in poorest households. One possible cause of these disparities is mothers' dietary practices in wealthy households. Mothers from wealthy households may be more likely to choose meals that are insufficient in essential nutrients and rich in fat, therefore increasing their potential to develop overweight or obesity [38-42]. While existing literature extensively suggests that children from poorer households are more likely to have underweight conditions compared to their wealthier counterparts [39–44], understanding why undernutrition persists among children in rich households requires further investigation.

We found significant differences between urban and rural regions in each of the four countries. Compared to households in urban areas, those in rural areas usually have a lower DBM burden. A variety of factors could potentially cause this phenomenon. First and foremost, we anticipate that the physically demanding nature of jobs like farming will encourage rural residents to engage in more physical activity [43]. Consequently, this might help prevent weight gain and lower the prevalence of metabolic disorders among pregnant women living in rural areas. Moreover, studies from Bangladesh [45] and China [44] indicate that urban women are more likely than rural women to be overweight or obese. As a result, urban families are more vulnerable to metabolic diseases due to an increased incidence of obesity [44]. Nevertheless, while urban children generally have a lower likelihood of experiencing undernutrition in comparison to their rural counterparts, this circumstance does not apply equally to all urban children, especially those who struggle with poverty. Challenges such as substandard housing, restricted access to services, susceptibility to environmental hazards, and inadequate and inconsistent incomes in densely populated low-income nations exacerbate the issue of food insecurity and malnutrition [46].

Strengths and Limitations of the Study

This research has several noteworthy strengths. The analysis is based on survey datasets that are nationally representative and have substantial sample sizes. This guarantees that the findings are statistically sound, accurate, and reliable. Furthermore, the DHS included all administrative divisions for the relevant nation, therefore ensuring the generalizability of these results to the whole country. Nevertheless, there are limitations. Given its cross-sectional design, the survey is unable to evaluate long-term changes in nutritional status. Moreover, relying only on BMI as a parameter for evaluating the nutritional condition of mothers is less reliable in comparison to more precise indicators such as waist-hip ratio and skinfold thickness.

Conclusion

In conclusion, the prevalence of DBM is increasing at the household level in selected South and Southeast Asian countries, especially in urban areas and rich households. Despite the reduction in underweight prevalence, the region continues to grapple with a significant undernutrition issue. Simultaneously, the rising prevalence of obesity presents a challenge. Further research is necessary to provide pragmatic remedies and preventive measures to address this complex problem. Future research should prioritize identifying country-specific risk factors that lead to a high prevalence of DBM and factors that contribute to a higher prevalence of maternal overweight. Furthermore, it is essential to explore risk factors specific to urban and rural locations for DBM, since this study revealed differences between these settings.

Research in Context

Evidence before this Study

We searched PubMed, Scopus, and Google Scholar to identify relevant studies of double burden of malnutrition using the keywords “double burden of malnutrition”, “dual burden of malnutrition”, “nutrition transition”, “prevalence of double burden of malnutrition”, “double burden households”, “overweight mothers”, “undernourished children,” “South Asia”, “Southeast Asia”, “Bangladesh”, “Cambodia”, “Nepal”, and “Timor-Leste”. While research on DBM has increased, significant gaps remain in estimating its prevalence and trends in South

and South-east Asia. Most studies in these areas only examine the nutritional status of either the mother or the child, with few taking a comprehensive regional perspective.

Added Value of This Study

This study provides a comprehensive cross-country analysis of household-level DBM prevalence and trends in Bangladesh, Cambodia, Nepal, and Timor-Leste, revealing consistent increases in DBM across all four countries. Our findings highlight a rising prevalence of overweight or obese mothers alongside a declining prevalence of underweight children, suggesting that maternal overweight is a significant factor in DBM trends. This study also identified that there exist socioeconomic and urban-rural disparities of DBM prevalence among these countries.

Implications of All the Available Evidence

Increased consumption of ultra-processed foods and decreased physical activity led to an increase in overweight mothers, while inadequate infant feeding and a lack of healthy foods at home may be the causes of persistent child undernutrition in households. The continuation of undernourished children and the increasing number of overweight mothers in the same households further increase the prevalence of DBM at the household level in the countries studied. The findings of this study indicate that wealthier households experience a higher DBM burden, possibly due to high-calorie diets and sedentary lifestyles, although the reasons for child undernutrition in rich families are unclear. Urban households experience greater DBM challenges than rural ones, possibly due to less physically demanding lifestyles and greater access to processed foods. Further research is critical for developing effective strategies for addressing DBM and exploring its complex socioeconomic determinants.

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Section III: Determinants

Chapter 6: Systematic Review and Meta-Analysis of Household-Level DBM

6.1 Chapter Context

This chapter addresses **Objective 3.1**, which aimed to synthesise evidence on the determinants of household-level DBM in South and Southeast Asia. The study conducted a systematic review and meta-analysis of existing evidence on the socioeconomic, maternal, and behavioural factors associated with household-level DBM in the region. By providing region-specific pooled estimates of these factors, the study establishes a consolidated evidence base for the more detailed analyses presented in the subsequent chapters. This chapter comprises one publication, which has been published in ***Current Developments in Nutrition*** journal.

Note: January 2000 was chosen as the starting point because the concept of DBM began gaining prominence in global health research around this time. This search period allowed the inclusion of studies published both before and after the introduction of the WHO Child Growth Standards in 2006. Two studies included in the systematic review (References 31 and 39) used earlier growth references; however, these studies were excluded from the meta-analysis because sufficient numerical data could not be extracted to calculate the effect estimates required for pooling. Therefore, the use of earlier growth references in these two studies did not directly influence the pooled estimates.

Note on terminology: In the published article, the term ‘risk’ is used to describe associations with household-level DBM. As the study used cross-sectional data and the associations were estimated as odds ratios, any reference to an increase or decrease in ‘risk’ should be interpreted as an increase or decrease in the odds of DBM, rather than a change in risk. The original published text has been retained without alteration.

6.2 Article on Systematic Review and Meta-Analysis of Household-Level DBM

The following published article forms the foundation of this chapter:

Talukder A, Kelly M, Sayeed MA, Gray D, Sarma H. Determinants of household-level double burden of malnutrition in South and Southeast Asia: A systematic review and meta-analysis. ***Curr Dev Nutr.*** 2026;10(5):107683. https://doi.org/10.1016/j.cdnut.2026.107683

Determinants of Household-Level Double Burden of Malnutrition in South and Southeast Asia: A Systematic Review and Meta-Analysis

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Statement of Contribution

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I declare that the research presented in this Thesis represents original work that I carried out during my candidature at the Australian National University, except for contributions to multi-author papers incorporated in the Thesis where my contributions are specified in this Statement of Contribution.

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Abstract

Background

The double burden of malnutrition (DBM), defined as the coexistence of undernutrition and overnutrition within the same household, is an increasing public health concern in South and Southeast Asia, yet evidence on its household-level determinants remains fragmented.

Objectives

This systematic review and meta-analysis aimed to synthesize evidence on factors associated with household-level DBM in South and Southeast Asia.

Methods

PubMed, Scopus, and Web of Science were searched for observational studies published between January 2000 and September 2025. Two reviewers independently screened studies, extracted data, and assessed quality using the Newcastle–Ottawa Scale adapted for cross-sectional studies. Random-effects meta-analyses were conducted for factors reported in at least five studies, and pooled odds ratios with 95% confidence intervals were estimated.

Results

Thirty studies were included, of which 26 were eligible for meta-analysis. Urban residence (OR = 1.38, 95% CI: 1.20–1.59), higher household wealth (OR = 1.55, 95% CI: 1.31–1.83), older maternal age (OR = 2.22, 95% CI: 1.97–2.50), maternal short stature (OR = 1.90, 95% CI: 1.69–2.13), older child age (OR = 1.79, 95% CI: 1.44–2.23), and cesarean delivery (OR = 1.76, 95% CI: 1.20–2.57) were associated with higher likelihood of DBM. Higher maternal education and breastfeeding were found to be protective factors.

Conclusions

Effective interventions should adopt integrated, life-course approaches that simultaneously address undernutrition and overnutrition across critical stages, particularly during adolescence, pregnancy, and early childhood. Policies should prioritize maternal education, breastfeeding promotion, and adolescent nutrition to break intergenerational cycles of malnutrition.

Keywords: Double burden of malnutrition; household; systematic review; meta-analysis; South Asia; Southeast Asia

Registration: PROSPERO CRD420251155844

Introduction

The double burden of malnutrition (DBM) is a growing public health concern in South and Southeast Asia, where undernutrition, such as stunting, wasting, and micronutrient deficiencies, occurs alongside rising rates of overweight, obesity, and diet-related non-communicable diseases [1,2]. This paradoxical coexistence has emerged as countries undergo rapid demographic and socioeconomic transitions that reshape dietary patterns and lifestyles [3]. As a result, many households face both forms of malnutrition simultaneously. Limited household resources, unequal food distribution, and poor diet quality combine with reduced physical activity to create conditions where children remain undernourished while adults gain excess weight [4,5].

Early-life malnutrition also carries profound consequences for child development. Stunting during the first 1,000 days of life impairs early brain development, reduces cognitive performance, and is associated with lower educational attainment and diminished economic productivity in adulthood [6–8]. It is estimated that more than 200 million children under five years of age in low- and middle-income countries are failing to reach their developmental potential as a direct consequence of undernutrition, poverty, and inadequate caregiving environments [6]. The consequences extend beyond immediate health concerns, as stunted children often become short-statured mothers who are more likely to deliver low-birth-weight infants with increased risk of growth faltering, thereby transmitting malnutrition risk to the next generation and threatening long-term development progress across the region [4].

The magnitude of this problem is particularly alarming in South and Southeast Asia, which together account for approximately 54% of the global burden of child stunting, while simultaneously experiencing the fastest rates of increase in adult overweight and obesity [9]. In Bangladesh, Nepal, and India, DBM affects between 8% and 14% of households, where undernourished children and overweight or obese mothers coexist under the same roof [5,10]. In various Indian districts, school-aged children experience high rates of both undernutrition and overnutrition at the population level, with notable gender disparities in the distribution of these conditions [11]. These two regions share critical characteristics that make them ideal for comparative analysis: they are home to over one-third of the world's population, have experienced rapid but uneven economic growth, are undergoing accelerated nutrition transition, yet continue to face persistent poverty and food insecurity [3,12–14]. These epidemiological trends are systematic manifestations of broader societal transformations. Globalisation and rapid urbanisation have fundamentally altered food environments throughout the region, increasing

availability and affordability of processed foods laden with fats, sugars, and refined carbohydrates while simultaneously transforming occupational structures towards more sedentary work [3,13]. Yet amid these changes, poverty and food insecurity persist, continuing to restrict access to the diverse, nutrient-dense foods necessary for optimal child growth and development [14]. The consequence is a widening nutritional inequality where economic progress and urbanization do not automatically translate into improved health outcomes for all household members.

These epidemiological patterns are shaped by profound socioeconomic inequities in the distribution of undernutrition and overnutrition. An analysis of 80 countries shows that stunting among children under five is inversely associated with family wealth, with the poorest families bearing the greatest burden, particularly in South Asia [15]. In contrast, overweight children are more common among wealthier households in low- and middle-income countries, although obesity rates are increasing more rapidly among socioeconomically vulnerable populations [15]. This creates a double inequity at the household level, where poorer families face persistent child undernutrition alongside rising adult overweight, while wealthier households experience growing overnutrition even as pockets of child undernutrition persist[13]. The intergenerational transmission of stunting and obesity is embedded in these socioeconomic structures, including food insecurity, gender inequity, and limited access to healthcare and education, indicating that nutrition-specific interventions alone cannot break these cycles [15,16].

These population-level patterns manifest clearly at the household-level, which acts as the fundamental unit for understanding and addressing DBM. Within households, the mother-child dyad represents an important relationship, as maternal nutritional status, knowledge, and behaviors exert profound influences on children's growth trajectories [17,18]. However, complex intra-household dynamics, shaped by economic resources, structures, educational attainment, and cultural norms, determine how food and care are distributed among family members [19,20]. Among these factors, maternal education stands out as an important determinant, influencing nutrition knowledge, child feeding practices, dietary choices, and healthcare-seeking behaviors [13,21]. Mothers with higher education demonstrate greater capacity to navigate complex and changing food environments, making informed decisions that help prevent child undernutrition while avoiding their own overnutrition [13,22]. Effective interventions must therefore address these interconnected household dynamics rather than treating child and maternal malnutrition as isolated problems.

Drawing on the established conceptual pathways described above, this review is guided by a conceptual framework that organizes the determinants of household-level DBM across three interrelated domains—contextual, household and maternal, and child-level factors—operating within an intergenerational cycle of malnutrition. At the contextual level, urbanisation, economic growth, and globalisation reshape food environments and lifestyles by increasing access to energy-dense foods and sedentary behaviors, while persistent poverty and food insecurity constrain access to diverse, nutrient-rich diets. At the household and maternal level, socioeconomic position, maternal education, age, and stature influence resource allocation and health-related behaviors, with maternal education playing a central role in shaping nutrition knowledge, feeding practices, dietary choices, and healthcare utilisation. At the child level, factors such as age, breastfeeding practices, and mode of delivery directly affect growth trajectories and nutritional outcomes, with suboptimal feeding practices increasing the likelihood of undernutrition. These domains are interconnected through an intergenerational pathway, whereby undernourished girls are more likely to become short-statured mothers and give birth to low-birth-weight infants, thereby perpetuating DBM across generations (Figure 1).

Despite growing recognition of DBM as a critical public health priority in South and Southeast Asia, significant gaps persist in the understanding of its household-level determinants. Although numerous studies have investigated potential risk factors across sociodemographic, economic, dietary, behavioral, and environmental domains, the evidence base remains fragmented and inconsistent [10,23–26]. These inconsistencies stem from two main sources. First, genuine contextual heterogeneity exists across countries at different stages of nutritional transition, whereby the same determinants, such as household wealth or urbanisation show divergent associations depending on the local economic and food environment, as evidenced by differing findings across Myanmar [23], India [25], and Bangladesh, Nepal, Pakistan, and Myanmar collectively [26]. Second, substantial methodological variation limits comparability, including differences in the operational definition of DBM. Some studies restrict the definition to overweight or obese mothers with stunted children [23,24] while others apply broader criteria encompassing additional malnutrition combinations [25,26]. Variation in sample selection and covariate adjustment strategies further compounds this problem. Together, these contextual and methodological sources of variation produce a scattered evidence base that is difficult to interpret and challenging to translate into coherent policy guidance.

An important contribution to this field was made by Biswas et al. [24], who drew on large, harmonized Demographic and Health Survey data from multiple countries in South and Southeast

Asia to characterise the patterns and determinants of household-level DBM across the region. That study provided valuable cross-national evidence on the sociodemographic correlations of DBM and established a foundational understanding of how household and maternal characteristics relate to the coexistence of child undernutrition and maternal overweight. However, by relying on a single harmonized dataset and a predominantly descriptive analytical framework, it was not designed to systematically pool effect estimates across independently conducted studies or to formally quantify the magnitude and consistency of associations identified in the broader primary literature. Consequently, several important questions remain unresolved. First, when the full body of independently conducted studies is considered, how robust and generalizable are the associations identified using a single harmonised survey dataset? Second, do the direction and magnitude of key associations vary systematically with the geographic sub-region examined or the operational definition of DBM used? Third, given the rapidly evolving nutritional landscape across South and Southeast Asia, do more recently published studies corroborate or challenge the conclusions of that earlier work?

To address these critical knowledge gaps, we conducted a comprehensive systematic review and meta-analysis to synthesise evidence on household-level factors associated with DBM in South and Southeast Asia. While a previous systematic review examined the global prevalence and predictors of household-level DBM [27], its focus was mainly on methodological heterogeneity and prevalence patterns and did not conduct a meta-analysis or specifically synthesise household-level determinants in South and Southeast Asia. In addition, a recent systematic review and meta-analysis assessed DBM among mother–child pairs in Ethiopia [28], but its findings were restricted to a single-country context. No previous review has comprehensively synthesised household-level factors associated with DBM specifically across the diverse contexts of South and Southeast Asia, where the burden is particularly high and rapidly evolving [5]. Through systematic identification of relevant studies, rigorous quality assessment, and pooling effect estimates using meta-analytical techniques, we sought to identify consistent patterns across diverse settings and populations. This review was designed to answer two fundamental questions: First, what household-level factors show consistent associations with DBM across South and Southeast Asian contexts? Second, how strong are these associations, and do they vary systematically by geographic region or operational definition of DBM? By providing a comprehensive synthesis of household-level determinants of DBM in this region, this review aims to establish a robust evidence foundation for designing integrated nutrition policies and programs capable of breaking

the cycle of dual malnutrition that threatens the health and prosperity of millions of families across South and Southeast Asia.

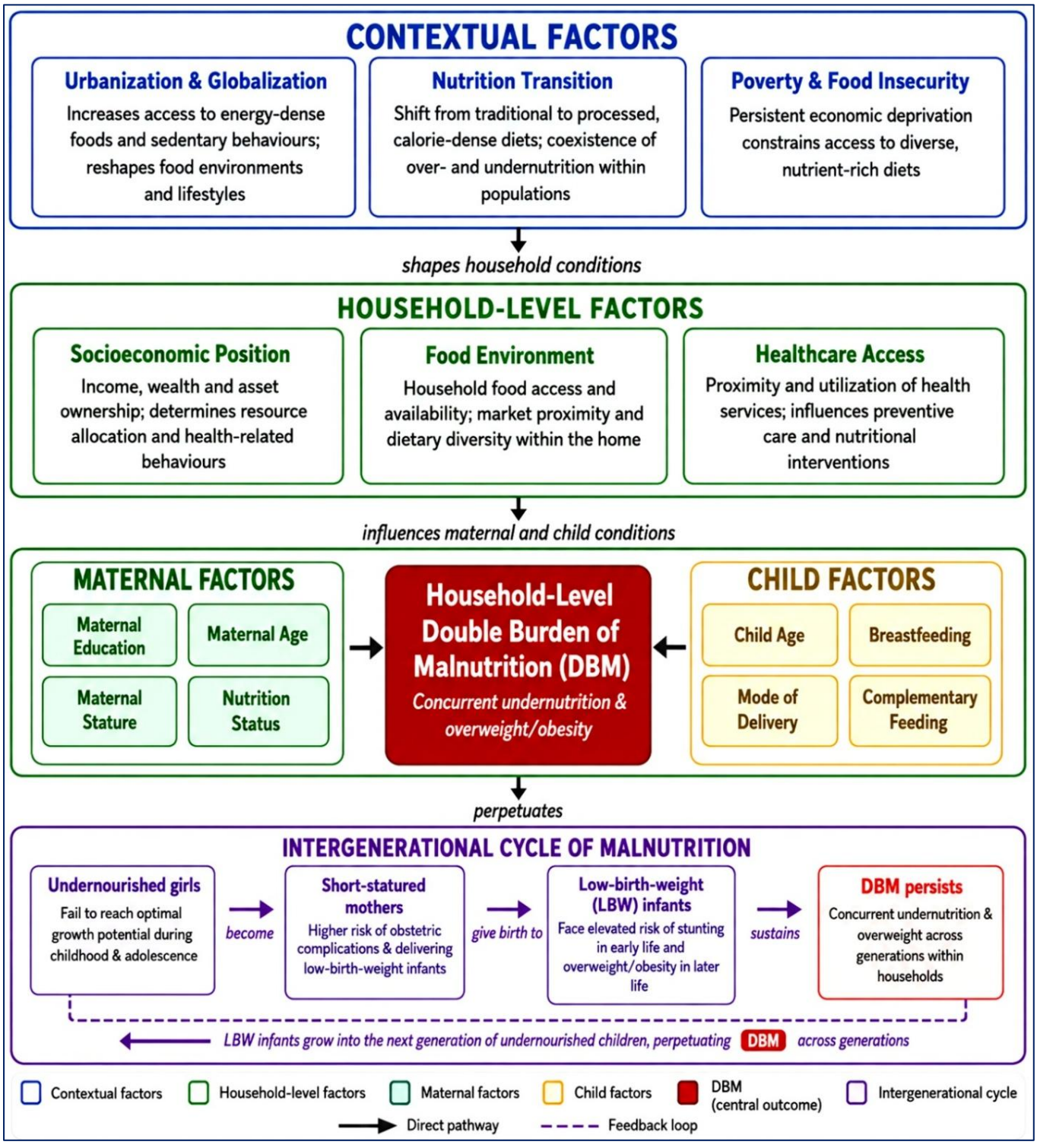


Figure 1: Conceptual framework illustrating the hypothesised pathways through which contextual, household-level, maternal, and child factors contribute to DBM within households in South and Southeast Asia.

Note: *Solid arrows represent direct hypothesised associations; the curved feedback arrow denotes the intergenerational cycle of malnutrition.*

Methods

We conducted this systematic review following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure a rigorous and transparent approach. The review was prospectively registered with PROSPERO (CRD420251155844), and the completed PRISMA checklist outlining all stages of the review process is provided in Supplementary file (Appendix C).

Study Selection and Eligibility Criteria

Observational and longitudinal studies that investigated factors associated with DBM at the household-level were included according to our research questions and guided by Population, Intervention/Exposure, Comparator, Outcomes, Study design (PICOS) framework (Table 1).

Table 1: PICOS criteria for inclusion of studies

Component	Inclusion criteria
P (Population)	Households or mother–child pairs in South Asia (Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, Sri Lanka) and Southeast Asia (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Vietnam).
I (Exposure / Risk Factor)	Sociodemographic, economic, dietary, behavioral, environmental, and maternal or child characteristics that may be associated with DBM (e.g., household wealth, parental education, dietary diversity, urban or rural residence).
C (Comparator)	Not applicable.
O (Outcome)	DBM defined at household level (e.g., mother overweight/obese & child stunted/wasted/underweight; household with undernourished and overnourished members)
S (Study design)	Quantitative observational studies (cross-sectional, case-control, cohort) and longitudinal studies that investigated factors associated with DBM at the household level.

Exclusion Criteria

Studies were excluded if they were conducted outside South and Southeast Asia or focused on only a single form of malnutrition, such as stunting, wasting, underweight, or overweight/obesity. We also excluded studies conducted solely at the population or national level, without disaggregated household-or mother–child level data. Additionally, reviews, editorials, commentaries, conference abstracts without full data, study protocols, and letters were not

considered. Studies lacking sufficient information on risk factors of DBM, as well as publications in languages other than English, were also excluded.

Search Strategy

We conducted a comprehensive literature search in three major electronic databases: PubMed, Scopus, and Web of Science for studies published between January 1, 2000, and September 15, 2025. The year 2000 was chosen as the starting point because the concept of DBM began gaining prominence in global health research around this time [29]. To identify additional relevant studies not captured in the database search, grey literature and reference lists of included articles were also hand-searched. The search strategy incorporated key terms, including "double burden of malnutrition," "households," "mother–child pair," and "risk factors." Detailed search strategies for each database are provided in Supplementary Table S1 (Appendix C).

Study Screening and Data Extraction

Study screening and data extraction were conducted independently and in duplicate to minimise the risk of error and bias. Two reviewers (AT and MAS) independently screened all retrieved records at the title and abstract stage to assess relevance, followed by an independent full-text review of potentially eligible studies to confirm eligibility. Any disagreements at either screening stage were resolved through discussion or, when necessary, by consultation with a third reviewer (HS). Data extraction was subsequently performed independently by the same two reviewers (AT and MAS). Each reviewer extracted data from all included studies separately, without access to the other reviewer's extractions. The extracted information included first author, year of publication, country or region, study design, sample size, study population, definitions used to identify household-level DBM, outcome measures, exposure factors examined, and the main findings on associations between these factors and DBM. Once both reviewers had completed independent extractions for all included studies, the two sets of extracted data were compared systematically, and any discrepancies were identified and resolved through discussion and cross-checking against the original study reports. Where disagreement persisted, the third reviewer (HS) provided a final decision to ensure consistency and accuracy across all extracted data.

Risk of Bias Assessment

Two independent reviewers assessed the risk of bias for each included study using a modified version of the Newcastle–Ottawa Scale adapted for cross-sectional studies (NOS-xs) [30]. The

adapted scale comprised three domains: (1) Study Sample Selection (maximum 2 stars), (2) Assessment of Exposure and Outcome (maximum 4 stars), and (3) Confounding Factors (maximum 3 stars), with a total possible score of 9 stars. The assessment evaluated the representativeness of the study sample, the adequacy of the sample size, the validity and reliability of the measurement tools for exposure and outcome, and the appropriate control and measurement of confounders. Each item within the domains was rated according to predefined criteria, and a single best answer was selected per item. Studies scoring 7–9 stars were considered to have a low risk of bias (good quality), 5–6 stars indicated a moderate risk of bias (satisfactory quality), and 0–4 stars reflected a high risk of bias (unsatisfactory quality) [30]. Any discrepancies between reviewers were resolved through discussion and consensus.

Statistical Methods

We used Microsoft Excel 2019 to organise our data and RStudio (R version 4.3.1) to perform the analyses. To address our first research question on identifying factors associated with DBM, we calculated odds ratios (OR) with 95% confidence intervals (CI) as the summary measures of effect. Although not all factors were reported in every study, meta-analyses were conducted for those factors reported in at least five studies with extractable raw data. For studies that examined multiple forms of child undernutrition (stunting, wasting, or underweight) in combination with maternal overweight/obesity, we extracted data for each DBM definition separately. When studies reported results for more than one DBM definition, we included all available combinations in the overall meta-analysis and subsequently conducted subgroup analyses based on DBM definition categories: (1) overweight mother with stunted child (OWM+SC), and (2) composite definitions that included overweight mother with stunted, wasted, or underweight child (OWM+SC/WC/UW).

To address our second research question regarding how associations vary by strength and geographic location, we performed subgroup analyses stratified by: (1) DBM definition (OWM+SC vs. composite definitions), and (2) geographic region (South Asia vs. Southeast Asia). For each subgroup, we calculated pooled OR and 95% CIs separately and compared effect sizes across subgroups. Factors not suitable for meta-analysis due to insufficient data (fewer than five studies) were summarised qualitatively in a narrative synthesis.

Heterogeneity was assessed for clinical, methodological, and statistical differences using the I^2 statistic and Q-test (P-value). Given the expected heterogeneity across diverse populations and settings, a random-effects model was applied for all meta-analyses using the DerSimonian-Laird

method. Interpretation of I^2 values followed standard guidelines: 0-40% indicating low heterogeneity, 30-60% moderate heterogeneity, 50-90% substantial heterogeneity, and 75-100% considerable heterogeneity.

To evaluate the robustness of our findings, we performed leave-one-out sensitivity analyses by sequentially removing each study and recalculating the pooled effect estimates. This approach assessed whether any single study disproportionately influenced the overall results. Publication bias was assessed using Egger's regression test and visual inspection of funnel plots for asymmetry. A P-value < 0.05 in Egger's test was considered indicative of potential publication bias.

All statistical analyses were conducted using the 'meta' and 'metafor' packages in R. Forest plots were generated to visualise pooled effect estimates and their confidence intervals for each factor, and funnel plots were created to assess publication bias.

Ethical consideration

No ethical approval is required as we are doing this research based on published papers.

Results

Overview of the Literature Screening Process

A total of 1021 records were identified through three database searches (PubMed = 237, Scopus = 367, and Web of Science = 417) and other sources such as citation searching and grey literature (n = 17). After removing 436 duplicate records (8 manually and 428 using Covidence software), 602 studies remained for title and abstract screening. Of these, 512 studies were excluded as they did not meet the inclusion criteria (Figure 2). The full texts of 90 studies were reviewed for eligibility, and 60 were excluded for reasons such as focusing only on women or children, failing to define DBM, failing to assess associated factors, or being conducted outside South and Southeast Asia. Finally, 30 studies [10,13,23–26,31–54] met the inclusion criteria and were included in this systematic review, of which 26 were eligible for meta-analysis (the list of articles is available in Table 3) as we were able to extract raw data from these studies. We were unable to extract raw data from 4 studies because the data were presented in an unsuitable format; therefore, these studies were excluded from the meta-analysis. The selection process is summarised in Figure 2, which presents the PRISMA flow diagram of study inclusion.

Characteristics of Included Studies

The key characteristics of studies included in the systematic review on factors associated with DBM at the household-level in South and Southeast Asia are presented in Supplementary Table S2 (Appendix C). All studies employed a cross-sectional design and covered a wide range of countries, including Bangladesh, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, Myanmar, Cambodia, and Timor-Leste. Sample sizes varied considerably, ranging from fewer than 300 households in small-scale studies to over 700,000 households in large multi-country analyses. Most studies (17 studies) defined DBM as the coexistence of an overweight or obese mother and a stunted child (OWM+SC). However, several studies (14 studies) used broader definitions that also considered other forms of child undernutrition, such as wasting or underweight, resulting in alternative combinations like OWM+WC (overweight mother–wasted child), OWM+UWC (overweight mother–underweight child), or OWM+SC/WC/UW (overweight mother with any stunted, wasted, or underweight child). Most studies reported adjusted odds ratios (AOR) as the main effect measure, while a few presented crude OR, or descriptive statistics. The methodological quality of the studies assessed using the NOS-xs, ranged from 7 to 9, indicating that the included studies were of good quality [30]. The NOS-xs ratings by each domain are available in Supplementary Table S3 (Appendix C).

Table 2: Definitions of the 12 key factors included in meta-analysis

Category	Factor	Definition/Measurement
Household-level	Place of residence	Urban vs. Rural household location
	Wealth status	Household wealth quintile (Rich vs. Poor). Studies used wealth index factor scores derived from household asset ownership. The wealth index was operationalised in two ways across the included literature: • Five-category scale (Poorest / Poorer / Middle / Richer / Richest): To ensure comparability, the two lowest quintiles (Poorest + Poorer) were merged to form the 'Poor' group and the two highest quintiles (Richer + Richest) were merged to form the 'Rich' group. The middle quintile was excluded from the binary comparison. • Three-category scale (Poor / Middle / Rich): The 'Poor' and 'Rich' categories were used

Category	Factor	Definition/Measurement
		directly as reported, with the middle category excluded from the binary comparison.
Parental-level	Maternal age	Mother's age at time of survey (≥25 years vs. 15-24 years)
	Maternal stature	Mother's height (<150 cm vs. ≥150 cm)
	Maternal education	Maternal educational attainment was categorised as 'High' for secondary or higher education and 'Low' for no or primary education.
	Paternal education	Father's educational attainment was categorised as 'High' for secondary or higher education and 'Low' for no or primary education.
	Maternal working status	Whether mother was employed outside home (Yes vs. No)
Child-level	Child age	Age of child in household (24-59 months vs 0-23 months)
	Child sex	Sex of child (Male vs Female)
Behavioral & Healthcare	Breastfeeding status	Current breastfeeding status was assessed at the time of the survey, with children coded as 'Yes' if they were currently breastfeeding and 'No' otherwise.
	C-section	Among mother-child pairs where the baby was born via C-section is coded as 'Yes' Otherwise 'No'.
	Media Exposure	Household media exposure was coded as 'Yes' if the respondent watched TV, listened to the radio, or read newspapers at least once a week, and 'No' otherwise.

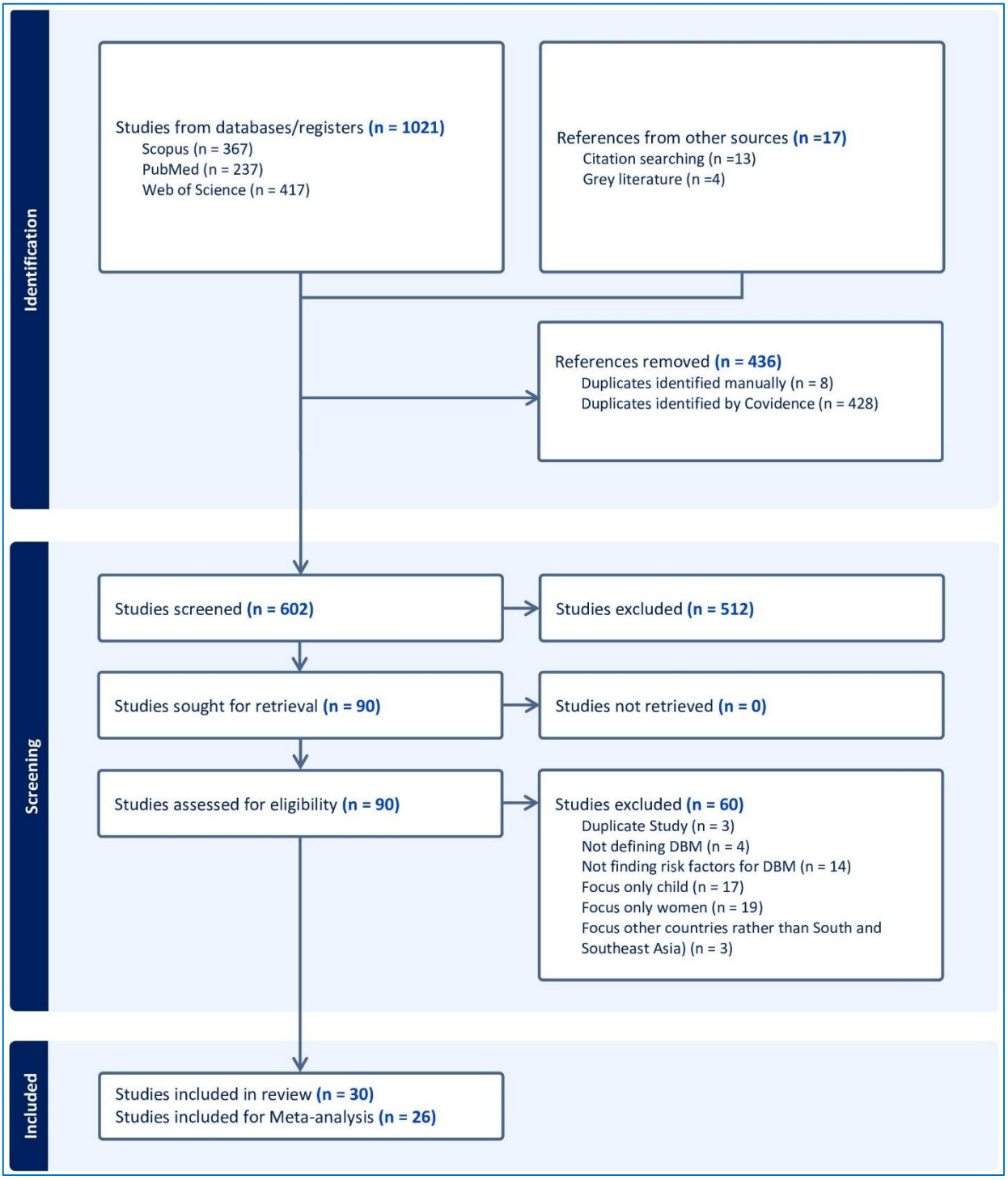


Figure 2: PRISMA flow diagram illustrating the selection process of studies included in the systematic review.

Table 3: Characteristics of Included Studies and Distribution of selected 12 Sociodemographic Factors Across Study Populations

Study (Author, Year)	Country	Data Collection Period (Related Survey)	Sample Size (n)	Effect Measure	Household-level Factors (2)			Parental-level Factors (5)					Child-level Factors (2)		Behavioural & Healthcare Factors (3)		
					Place of Residence Urban vs Rural	Wealth Status Rich vs Poor		Maternal Age ≥25 yrs vs 15–24 yrs	Maternal Stature <150 cm vs ≥150 cm	Maternal Education High (sec/higher) vs Low (none/primary)	Paternal Education High (sec/higher) vs Low (none/primary)	Maternal Working Status Yes (Employed) vs No	Child Age 24–59 mo vs 0–23 mo	Child Sex Male vs Female	Breastfeeding Status Yes vs No	C-Section Yes vs No (vaginal)	Media Exposure Yes vs No
					Urban (%)	Rich (%)	Poor (%)	≥25 yrs (%)	<150 cm (%)	High (%)	High (%)	Yes (%)	24–59 mo (%)	Male (%)	Yes (%)	Yes (%)	Yes (%)
Anik et al. (2019) [26]	**Bangladesh**	**2014 (BDHS)**	**6,478**	**Adjusted OR**	**25.8**	**40.2**	**39.1**	**51.5**	—	**57.1**	—	**25.5**	**54.2**	**52.7**	**56.6**	—	**37.2**
Anik et al. (2019)	**Nepal**	**2016 (NDHS)**	**2,670**	**Adjusted OR**	**53.9**	**35.1**	**42.9**	**51.6**	—	**50.3**	—	**46.1**	**28.1**	**53.4**	**92.7**	—	**77.5**
Anik et al. (2019)	**Pakistan**	**2012–13 (PDHS)**	**5,770**	**Adjusted OR**	**30.2**	**35.2**	**45.9**	**79.9**	—	**27.1**	—	**26.2**	**45.1**	**52.5**	**50.7**	—	**45.4**
Anik et al. (2019)	**Myanmar**	**2015–16 (MDHS)**	**3,541**	**Adjusted OR**	**22.9**	**33.9**	**48.8**	**81.7**	—	**38.5**	—	**56.8**	**52.9**	**51.2**	**54.9**	—	**82.7**
Das et al. (2018) [32]	**Bangladesh**	**2014 (BDHS)**	**5,951**	**Adjusted OR**	—	**41.0**	**39.2**	**49.6**	—	**58.1**	**46.4**		—	—	—	**24.0**	**36.5**
Gaupholm et al. (2023) [34]	**Philippines**	**2013 (NNS)**	**5,837**	**Adjusted OR**	—	**37.1**	**42.1**	—	—	**15.7**	—	**42.48**	—	—	—	—	—
Hauqe et al. (2017) [35]	**Bangladesh**	**2014 (BDHS)**	**5,697**	**Adjusted OR**	**26.0**	**40.3**	**39.4**	**52.1**	—	—	—	**26.1**	**52.7**	—	—	—	—
Hong et al. (2020) [23]	**Myanmar**	**2015–16 (MDHS)**	**5,687**	**Adjusted OR**	**21.8**	**35.3**	**32.3**	**81.9**	**31.4**	**36.2**	—			—	—	—	—
Ihab et al. (2013) [36]	**Malaysia**	**2012 (Primary Data)**	**223**	**Unadjusted OR**	—	—	—	—	—	**66.0**	—	**69.0**	—	—	—	—	—
Jayalakshmi et al. (2019) [37]	**India**	**2012 IHDS-II**	**344**	**Unadjusted OR**	**56.4**	—	—	—	—	—	**33.7**	—	—	—	—	—	—
Khaliq et al. (2025) [38]	**Pakistan**	**2017–18 (PDHS)**	**6,198**	**Adjusted OR**	**45.1**	**35.4**	**45.2**	—	—	**34.2**	—	**15.6**	—	**48.7**	—	**17.5**	—
Krismanita et al. (2022) [40]	**Indonesia**	**2019 (Primary data)**	**274**	**Adjusted OR & Unadjusted OR**	—	**34.7**	**65.3**	—	**47.1**	**21.9**	**42.3**	—	—	—	**35.8**	—	—
Limon et al. (2021) [41]	**Bangladesh**	**2017–18 (BDHS)**	**3,772**	**Adjusted OR**	**33.3**	**37.2**	**41.5**	—	—	**62.3**	**42.9**	—	—	—	—	—	—

Study (Author, Year)	Country	Data Collection Period (Related Survey)	Sample Size (n)	Effect Measure	Household-level Factors (2)			Parental-level Factors (5)					Child-level Factors (2)		Behavioural & Healthcare Factors (3)		
					Place of Residence Urban vs Rural	Wealth Status Rich vs Poor		Maternal Age ≥25 yrs vs 15–24 yrs	Maternal Stature <150 cm vs ≥150 cm	Maternal Education High (sec/higher) vs Low (none/primary)	Paternal Education High (sec/higher) vs Low (none/primary)	Maternal Working Status Yes (Employed) vs No	Child Age 24–59 mo vs 0–23 mo	Child Sex Male vs Female	Breastfeeding Status Yes vs No	C-Section Yes vs No (vaginal)	Media Exposure Yes vs No
					Urban (%)	Rich (%)	Poor (%)	≥25 yrs (%)	<150 cm (%)	High (%)	High (%)	Yes (%)	24–59 mo (%)	Male (%)	Yes (%)	Yes (%)	Yes (%)
Mahmudiono et al. (2018) [54]	Indonesia	2013 (RISKESDAS)	685	Adjusted OR	—	—	—	—	—	53.3	—	—	—	—	—	—	—
Nakphong et al. (2021) [42]	Cambodia	2014 (CDHS)	14,988	Adjusted OR	—	22.2	33.4	75.7	30.6	—	—	66.4	60.1	—	—	—	—
Oddo et al. (2012) [43]	Indonesia	2007 (IDHS)	247,126	Adjusted OR	—	32.6	43.7	68.4	51.6	36.1	—	—	—	51.0	55.2	—	—
Oddo et al. (2012)	Bangladesh	2004 (BDHS)	168,317	Adjusted OR	—	29.3	45.2	60.7	45.4	29.9	—	—	—	52.0	65.3	—	—
Patel et al. (2020) [25]	India	2015–16 (NFHS-4)	184,680	Adjusted OR	29.1	34.9	45.1	66.0	—	58.2	—	—	62.0	52.9	46.7	18.4	—
Rachmah et al. (2021) [44]	Indonesia	2018 (Primary Data)	436	Adjusted OR	—	—	—	—	—	61.9	69.4	25.7	—	—	—	—	—
Rahman et al. (2021) [45]	Bangladesh	2017–18 (BDHS)	7,662	Adjusted OR	30.9	38.9	41.7	85.2	—	56.0	44.0	—	—	—	58.2	15.3	49.6
Ramasubramani et al. (2024) [10]	India	2019–21 (NFHS-5)	167,380	Adjusted OR	26.5	30.5	49.8	89.2	—	67.2	—	—	67.8	51.7	61.9	21.5	—
Saibul et al. (2009) [46]	Malaysia	2002–05 (Primary Data)	227	Unadjusted OR	—	—	—	—	—	—	—	24.7	—	—	—	—	—
Sarker et al. (2022) [47]	Bangladesh	2017–18 (BDHS)	8,697	Adjusted OR	—	38.3	44.8	75.2	—	—	49.4	40.8	—	—	—	—	42.4
Sekiyama et al. (2015) [48]	Indonesia	2006-07 (ENVRERA Project)	242	Unadjusted OR	—	—	—	—	54.2	21.5	—	24.7	—	—	—	—	—
Sengupta et al. (2025) [49]	India	2019–21 (NFHS-5)	360	Adjusted OR	—	—	—	—	—	56.1	35.0	—	—	51.1	—	—	—
Shariff et al. (2024) [50]	Malaysia	2017– 19 (Primary Data)	451	Adjusted OR	—	—	—	—	—	5.7	39.5	16.2	54.8	49.9	—	—	—
Singh et al. (2023) [52]	India	2019–21 (NFHS-5)	122,922	Adjusted OR	26.4	35.2	45.2	60.3	—	69.3	—	—	—	52.2	81.2	23.6	—

Study (Author, Year)	Country	Data Collection Period (Related Survey)	Sample Size (n)	Effect Measure	Household-level Factors (2)			Parental-level Factors (5)					Child-level Factors (2)		Behavioural & Healthcare Factors (3)		
					Place of Residence Urban vs Rural	Wealth Status Rich vs Poor		Maternal Age ≥25 yrs vs 15–24 yrs	Maternal Stature <150 cm vs ≥150 cm	Maternal Education High (sec/higher) vs Low (none/primary)	Paternal Education High (sec/higher) vs Low (none/primary)	Maternal Working Status Yes (Employed) vs No	Child Age 24–59 mo vs 0–23 mo	Child Sex Male vs Female	Breastfeeding Status Yes vs No	C-Section Yes vs No (vaginal)	Media Exposure Yes vs No
					Urban (%)	Rich (%)	Poor (%)	≥25 yrs (%)	<150 cm (%)	High (%)	High (%)	Yes (%)	24–59 mo (%)	Male (%)	Yes (%)	Yes (%)	Yes (%)
Sunuwar et al. (2020) [51]	**Nepal**	**2016 (NDHS)**	**2,261**	**Adjusted OR**	—	**35.9**	**42.1**	**58.9**	**10.0**	**46.8**	**62.1**	**59.6**	**58.3**	**52.7**	**78.8**	**9.8**	—
Sutopa et al. (2022) [53]	**Bangladesh**	**2017–18 (BDHS)**	**4377**	**Adjusted OR**	**33.5**	**37.0**	**42.5**	**45.5**	—	**57.9**	**22.4**	**22.6**	—	—	**88.0**	**23.0**	**64.6**
Talukder et al. (2024) [13]	**Bangladesh**	**2017–18 (BDHS)**	**7,718**	**Adjusted OR**	**35.0**	**39.2**	**42.2**	—	—	**64.1**	—	—	—	**51.9**	**60.2**	—	—
Talukder et al. (2024)	**Cambodia**	**2014 (CDHS)**	**3,836**	**Adjusted OR**	**35.3**	**34.0**	**45.3**	—	—	**74.7**	—	—	—	**51.1**	**36.3**	—	—
Talukder et al. (2024)	**Nepal**	**2016 (NDHS)**	**2,596**	**Adjusted OR**	**49.4**	**36.6**	**42.9**	—	—	**71.0**	—	—	—	**50.2**	**65.8**	—	—
Talukder et al. (2024)	**Timor-Leste**	**2016 (TDHS)**	**6,309**	**Adjusted OR**	**29.2**	**38.7**	**45.8**	—	—	**55.8**	—	—	—	**51.7**	**53.4**	—	—

Notes

Data presentation: Each cell reports the percentage (%) distribution of the several categories of the selected covariates within the total analytic sample for that study. Values represent sample proportions, not effect sizes.

Effect measure: Adjusted OR = adjusted odds ratio; Unadjusted OR = crude odds ratio.

— (em dash): Indicates that the proportion of the factors was not able to extract or not reported in that study.

Variable categories (consistent with Table 2):

- **Place of Residence:** Urban (%) vs Rural
- **Wealth Status (Wealth Index):** Studies used wealth index factor scores derived from household asset ownership. The wealth index was operationalised in two ways across the included literature:
  - ✓ **Five-category scale** *(Poorest / Poorer / Middle / Richer / Richest):* To ensure comparability, the two lowest quintiles (Poorest + Poorer) were merged to form the 'Poor' group and the two highest quintiles (Richer + Richest) were merged to form the 'Rich' group. The middle quintile was excluded from the binary comparison.
  - ✓ **Three-category scale** *(Poor / Middle / Rich):* The 'Poor' and 'Rich' categories were used directly as reported, with the middle category excluded from the binary comparison.
- **Maternal Age:** ≥25 years vs 15–24 years
- **Maternal Stature:** <150 cm vs ≥150 cm
- **Maternal Education:** High = secondary or higher vs Low = none/primary
- **Paternal Education:** High = secondary or higher vs Low = none/primary
- **Maternal Working Status:** Yes = employed vs No = not employed

Study (Author, Year)	Country	Data Collection Period (Related Survey)	Sample Size (n)	Effect Measure	Household-level Factors (2)			Parental-level Factors (5)					Child-level Factors (2)		Behavioural & Healthcare Factors (3)		
					Place of Residence Urban vs Rural	Wealth Status Rich vs Poor		Maternal Age ≥25 yrs vs 15–24 yrs	Maternal Stature <150 cm vs ≥150 cm	Maternal Education High (sec/higher) vs Low (none/primary)	Paternal Education High (sec/higher) vs Low (none/primary)	Maternal Working Status Yes (Employed) vs No	Child Age 24–59 mo vs 0–23 mo	Child Sex Male vs Female	Breastfeeding Status Yes vs No	C-Section Yes vs No (vaginal)	Media Exposure Yes vs No
					Urban (%)	Rich (%)	Poor (%)	≥25 yrs (%)	<150 cm (%)	High (%)	High (%)	Yes (%)	24–59 mo (%)	Male (%)	Yes (%)	Yes (%)	Yes (%)

- **Child Age:** 24–59 months vs 0–23 months
- **Child Sex:** Male vs Female
- **Breastfeeding Status:** Yes = currently breastfeeding vs No
- **C-Section Delivery:** Yes vs No = vaginal delivery
- **Media Exposure:** Yes = exposed to TV/radio/newspaper vs No

Survey abbreviations:

BDHS = Bangladesh Demographic and Health Survey; **NDHS** = Nepal Demographic and Health Survey; **PDHS** = Pakistan Demographic and Health Survey; **MDHS** = Myanmar Demographic and Health Survey; **CDHS** = Cambodia Demographic and Health Survey; **IDHS** = Indonesia Demographic and Health Survey; **TDHS** = Timor-Leste Demographic and Health Survey; **NFHS** = National Family Health Survey (India); **NNS** = National Nutrition Survey (Philippines); **RISKESDAS** = Riset Kesehatan Dasar (Indonesia National Basic Health Research); ENVRERA: Environmental Research in Rural Asia; **IHDS-II** = India Human Development Survey, Wave 2

Studies included (n = 33 study-country observations from 26 unique publications):

Anik et al. (2019) [Bangladesh, Nepal, Pakistan, Myanmar]; Das et al. (2018); Gaupholm et al. (2023); Hauqe et al. (2017); Hong et al. (2020); Ihab et al. (2013); Jayalakshmi et al. (2019); Khaliq et al. (2025); Krismanita et al. (2022); Limon et al. (2021); Mahmudiono et al. (2018); Nakphong et al. (2021); Oddo et al. (2012) [Indonesia, Bangladesh]; Patel et al. (2020); Rachmah et al. (2021); Rahman et al. (2021); Ramasubramani et al. (2024); Saibul et al. (2009); Sarker et al. (2022); Sekiyama et al. (2015); Sengupta et al. (2025); Shariff et al. (2024); Singh et al. (2023); Sunuwar et al. (2020); Sutopa et al. (2022); Talukder et al. (2024) [Bangladesh, Cambodia, Nepal, Timor-Leste].

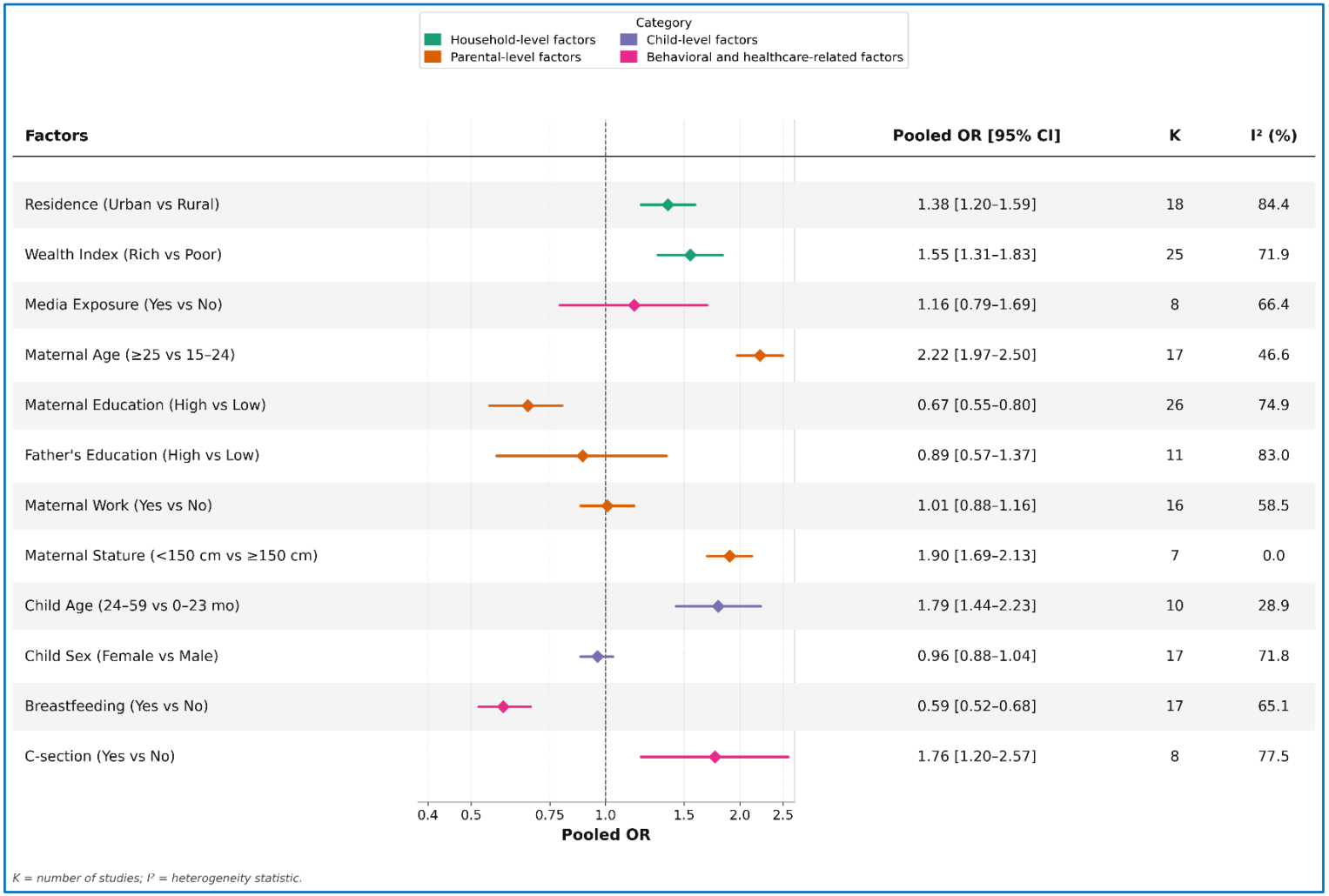
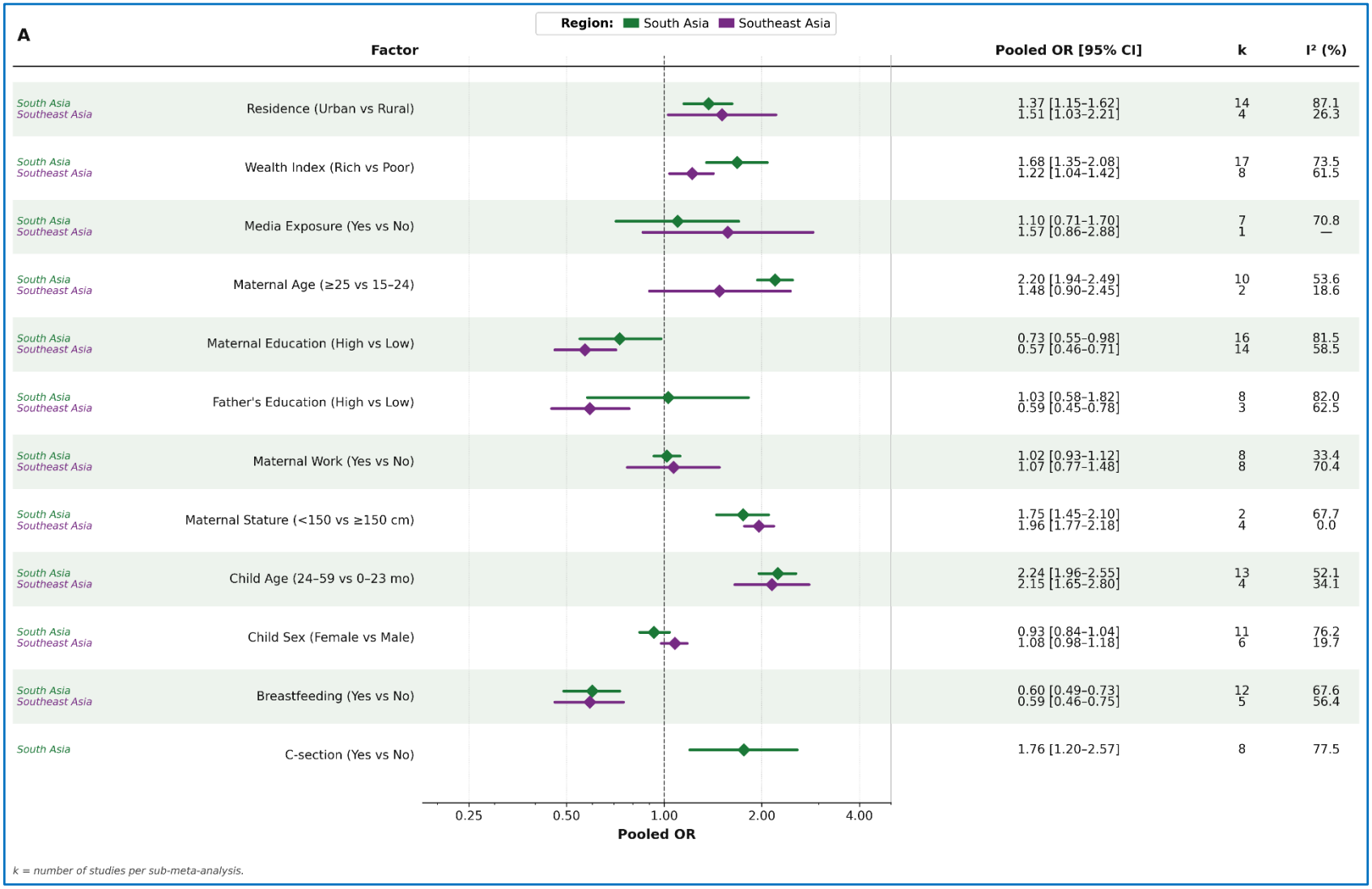


Figure 3: Pooled estimates of factors associated with household-level DBM in South and Southeast Asia. Last category of each factor is considered as reference category.

Note: *K= number of studies to estimate the pooled estimate.*

Factor-specific Forest plots are available in Supplementary Figures SF1–SF12 (Appendix C)


A
Region: South Asia Southeast Asia
Factor
Pooled OR [95% CI]
k
I² (%)
South Asia
Southeast Asia
Residence (Urban vs Rural)
1.37 [1.15–1.62]
1.51 [1.03–2.21]
14
4
87.1
26.3
Wealth Index (Rich vs Poor)
1.68 [1.35–2.08]
1.22 [1.04–1.42]
17
8
73.5
61.5
Media Exposure (Yes vs No)
1.10 [0.71–1.70]
1.57 [0.86–2.88]
7
1
70.8
—
Maternal Age (≥25 vs 15–24)
2.20 [1.94–2.49]
1.48 [0.90–2.45]
10
2
53.6
18.6
Maternal Education (High vs Low)
0.73 [0.55–0.98]
0.57 [0.46–0.71]
16
14
81.5
58.5
Father's Education (High vs Low)
1.03 [0.58–1.82]
0.59 [0.45–0.78]
8
3
82.0
62.5
Maternal Work (Yes vs No)
1.02 [0.93–1.12]
1.07 [0.77–1.48]
8
8
33.4
70.4
Maternal Stature (<150 vs ≥150 cm)
1.75 [1.45–2.10]
1.96 [1.77–2.18]
2
4
67.7
0.0
Child Age (24–59 vs 0–23 mo)
2.24 [1.96–2.55]
2.15 [1.65–2.80]
13
4
52.1
34.1
Child Sex (Female vs Male)
0.93 [0.84–1.04]
1.08 [0.98–1.18]
11
6
76.2
19.7
Breastfeeding (Yes vs No)
0.60 [0.49–0.73]
0.59 [0.46–0.75]
12
5
67.6
56.4
South Asia
C-section (Yes vs No)
1.76 [1.20–2.57]
8
77.5
0.25
0.50
1.00
2.00
4.00
Pooled OR
k = number of studies per sub-meta-analysis.

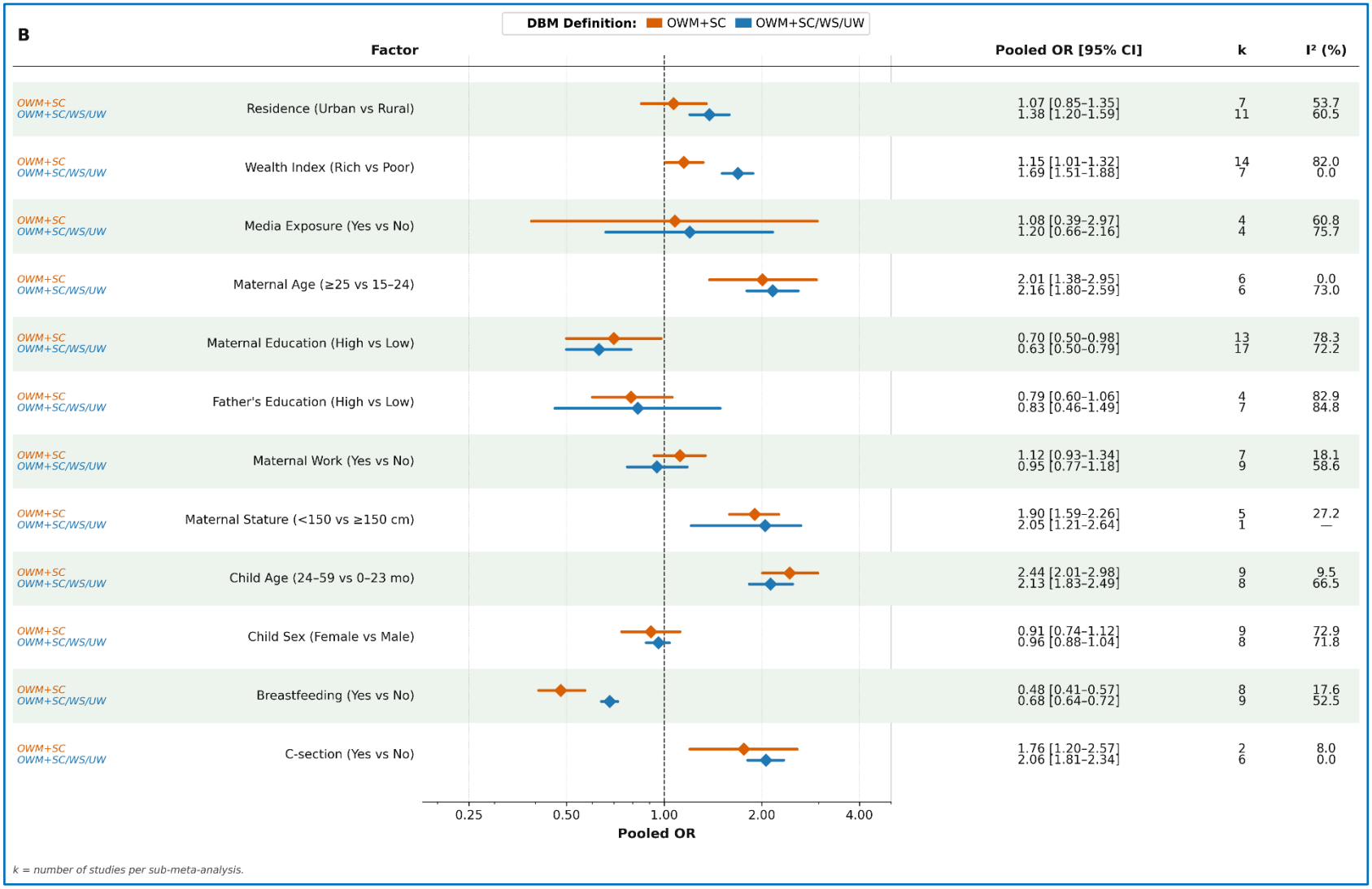


Figure 4: Subgroup analysis of factors associated with the double burden of malnutrition (DBM) by Region (A) and DBM definition (B). Last category of each factor is considered as reference category.
Note: K= number of studies to estimate the pooled estimate.

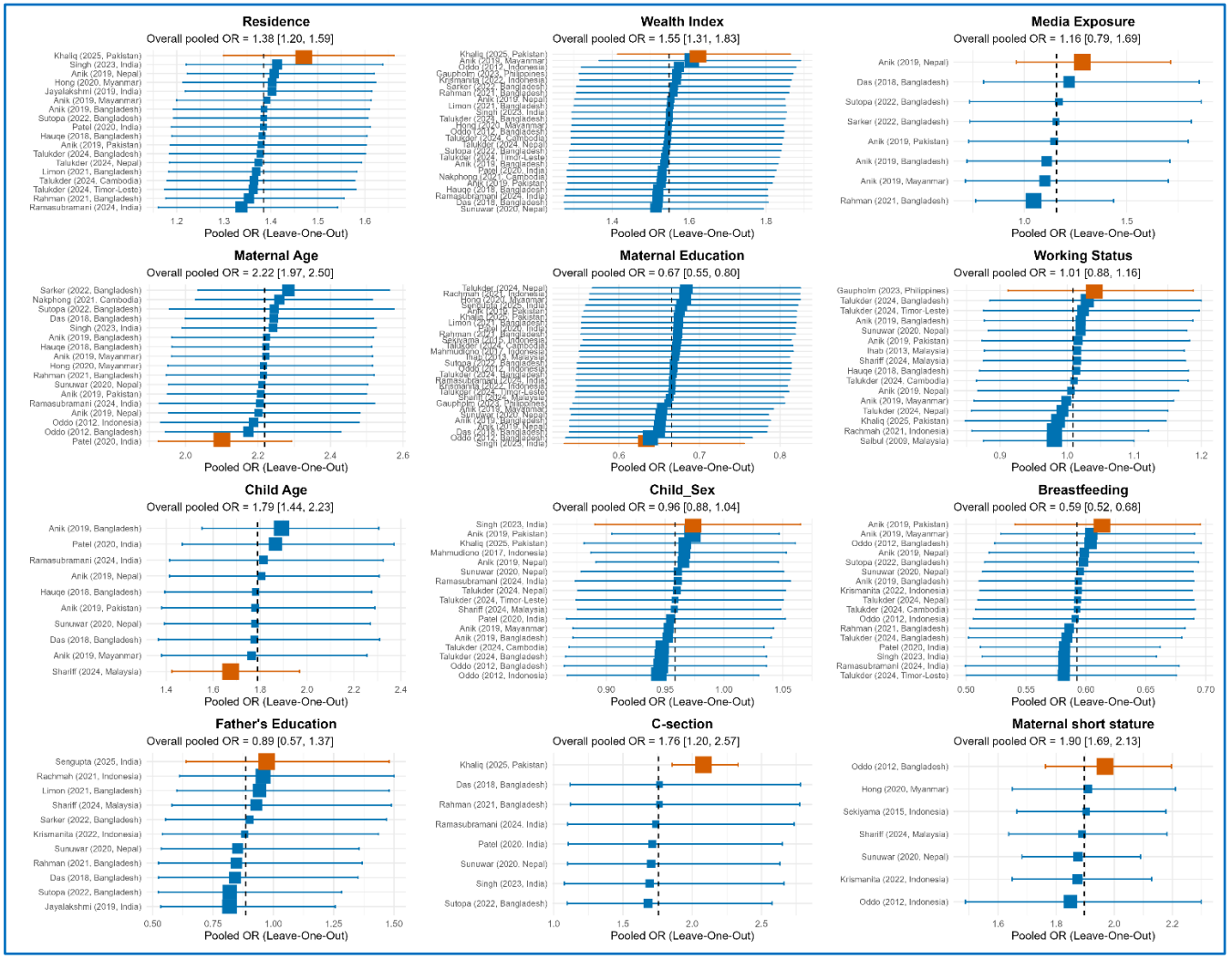


Figure 5: Sensitivity analysis showing the influence of individual studies on the pooled estimates of factors associated with DBM.
Note: Each data point represents the pooled odds ratio recalculated after sequentially removing one study at a time. Blue squares represent individual leave-one-out pooled estimates with their 95% confidence intervals. The orange square identifies the study whose removal produces the greatest change in the pooled estimate, indicating the single most influential study for that factor. The dashed vertical line represents the overall pooled estimate based on all included studies.

Meta-Analysis Results of Factors Associated with DBM

We conducted a meta-analysis reported in at least 5 studies, for which raw data could be extracted. This analysis summarised the pooled effects of these 12 factors associated with DBM in South and Southeast Asia. These factors were grouped into four major categories: household-level factors, parental-level factors, child-level factors, and behavioral and healthcare-related factors. Most of the included factors exhibited moderate to high heterogeneity, reflecting contextual variations across countries in the region. Table 2 presents the definitions and categorizations of the 12 factors included in the meta-analysis. The data collection periods of the included studies, along with the distribution of these sociodemographic factors across study populations, are provided in Table 3.

Household-Level Factors

Urban residence and higher household wealth were both significantly associated with increased likelihood of DBM (Figure 3; detailed in Appendix C: Supplementary figures SF1–SF12). Households in urban areas were 38% more likely to experience DBM than their rural counterparts (pooled OR = 1.38, 95% CI: 1.20–1.59; I^2 = 84.4%). Similarly, households in the richest wealth quintile were 55% more likely to experience DBM compared with the poorest households (pooled OR = 1.55, 95% CI: 1.31–1.83; I^2 = 71.9%).

Parental-Level Factors

Maternal characteristics showed stronger and more consistent associations with DBM than paternal factors. Households with older mothers (≥25 years) were more than twice as likely to experience DBM compared with those with younger mothers (pooled OR = 2.22, 95% CI: 1.97–2.50; I^2 = 46.6%). Maternal short stature was also associated with 90% higher likelihood of DBM (pooled OR = 1.90, 95% CI: 1.69–2.13; I^2 = 0%). Moreover, Higher maternal education reduced the odds of DBM by 33% (pooled OR = 0.67, 95% CI: 0.55–0.80; I^2 = 74.9%). On the other hand, neither paternal education nor maternal working status showed statistically significant associations with DBM.

Child-Level Factors

At the child level, both age and sex were examined as predictors of DBM. Children aged 24–59 months were 79% more likely to be in DBM-affected households compared with younger children aged 0–23 months (pooled OR = 1.79, 95% CI: 1.44–2.23; I^2 = 28.9%). However, child sex was not significantly associated with DBM (pooled OR = 0.96, 95% CI: 0.88–1.04; I^2 = 71.8%).

Behavioral and Healthcare-Related Factors

Behavioral and health service–related factors also showed notable associations. Current breastfeeding status of the child emerged as a strong protective factor against DBM (pooled OR = 0.59, 95% CI: 0.52–0.68; I^2 = 65.1%), with mother-child pairs where the child was currently being breastfed at the time of survey showing lower odds of DBM compared to pairs where the child was not currently breastfed. We acknowledge that this finding is most applicable to children younger than 24 months of age. Also, cesarean delivery for the birth of child was significantly associated with higher odds of DBM (pooled OR = 1.76, 95% CI: 1.20–2.57; I^2 = 77.5%) compared to vaginal delivery. Media exposure showed no significant association with DBM (pooled OR = 1.16; 95% CI: 0.79–1.69; I^2 = 66.4%).

Additional Factors Associated with DBM

Beyond the 12 factors included in the meta-analysis, several additional determinants were identified across individual studies. Five studies [35,43,45,52,53]found that households where the child was a later-born child (second or higher in the birth order) had an increased risk of DBM compared to households with firstborn children. Similarly, four studies [34,38,43,52] reported that larger household size, measured by the total number of household members, was associated with higher DBM risk. Two studies [13,53] indicated that antenatal care (ANC) visits reduced DBM risk, while four studies [19,34,49,50] linked household food insecurity with higher DBM likelihood. Evidence from one study [44] suggested that higher protein intake among children and higher fat intake among mothers were associated with an increased risk of DBM.

Subgroup Analysis

To explore potential sources of heterogeneity and assess whether associations differed by DBM definition and region, we conducted subgroup analyses based on two commonly used DBM definitions (overweight mother and stunted child [OWM+SC] versus composite definitions

including overweight mother–stunted/wasted/underweight child [OWM+SC/WS/UW]) and geographic region (South Asia versus Southeast Asia) (Figure 4).

Across DBM definitions, the direction and magnitude of associations were highly consistent (Figure 4). Older maternal age, higher household wealth, short maternal stature, older child age, and cesarean delivery were associated with increased likelihood of DBM under both definitions, with similar effect sizes (e.g., maternal age: OR = 2.01 vs 2.16; child age: OR = 2.44 vs 2.13). Likewise, maternal education and breastfeeding were protective under both definitions, with comparable effect estimates (maternal education: OR = 0.70 vs 0.63; breastfeeding: OR = 0.48 vs 0.68). These findings suggest that the associations between key determinants and DBM were robust and not meaningfully modified by DBM definition.

Similarly, regional subgroup analysis showed comparable effect sizes across South Asia and Southeast Asia (Figure 4). Higher wealth (OR = 1.68 vs 1.55), short maternal stature (OR = 1.96 vs 1.75), and older child age (OR = 2.24 vs 2.15) were associated with increased likelihood of DBM in both regions. Maternal education (OR = 0.73 vs 0.59) and breastfeeding (OR = 0.60 vs 0.59) were protective in both regions. Although minor differences in magnitude were observed, the overall similarity in effect estimates indicates no clear evidence that geographic region substantially modified the associations between these factors and DBM. Subgroup analyses also reduced heterogeneity for several factors, suggesting that variation in DBM definitions and study settings contributed to between-study variability without fundamentally altering the observed relationships.

Sensitivity Analysis

We conducted leave-one-out sensitivity analyses, removing one study at a time to assess the robustness of the pooled estimates (Figure 5). These analyses showed that the results for most factors were stable, suggesting that no single study had an undue influence. Urban residence, higher household wealth, older maternal age, maternal short stature, older child age, and cesarean delivery increased the risk of DBM across all iterations of the sensitivity analysis. On the other hand, maternal education and breastfeeding remained protective factors. However, a notable exception was observed for cesarean delivery, where the removal of the Khaliq et al. (2025) [38] study resulted in a meaningful upward shift in the pooled estimate, such that the lower bound of the 95% confidence interval exceeded the original overall point estimate. This indicates that the Khaliq study exerts a moderating influence on the cesarean delivery estimate, and that the

association between cesarean delivery and DBM may be stronger than the overall pooled estimate suggests when this study is excluded. This finding warrants cautious interpretation of the cesarean delivery result and highlights the need for additional studies on this association across diverse settings.

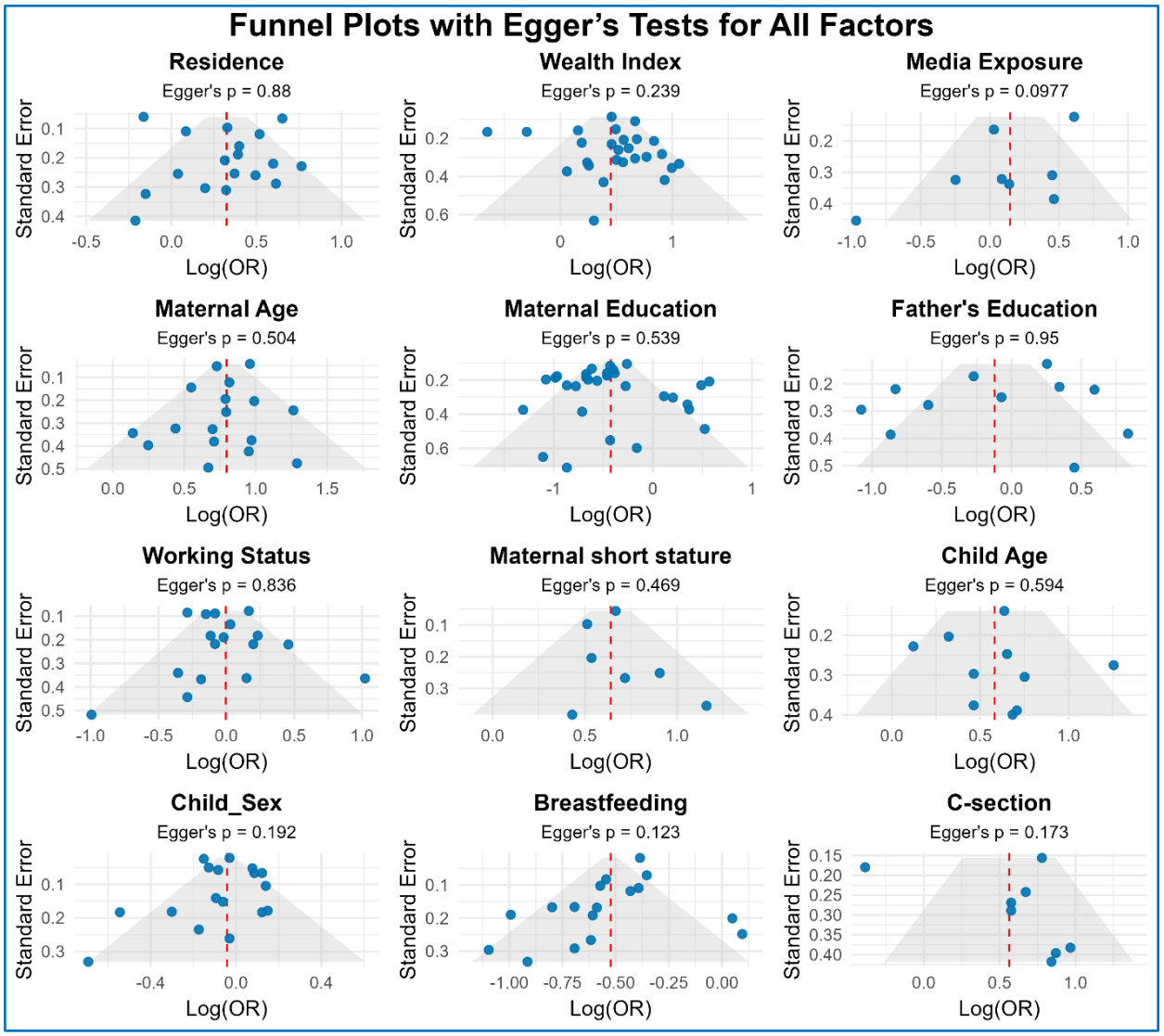


Figure 6: Funnel plots with results of Egger's test assessing publication bias across all identified factors.

Publication Bias

The funnel plots presented in Figure 6 showed a largely symmetrical distribution, suggesting minimal publication bias across the included studies. This visual assessment was supported by Egger's test, which yielded non-significant results ($P > 0.05$), further confirming that publication bias is unlikely to have influenced our findings.

Discussion

This study addresses a critical evidence gap by providing the first comprehensive meta-analytic synthesis of household-level determinants of DBM across South and Southeast Asia. While previous reviews have examined global prevalence and predictors without quantitative pooling, and a recent systematic review and meta-analysis was limited to a single-country context in Ethiopia, no prior study has generated region-specific pooled estimates for this diverse setting. By synthesising evidence from 30 studies across this region and conducting meta-analysis for 12 factors, this review makes several contributions to existing literature. It provides the first region-specific pooled estimates for key risk factors, including urban residence, household wealth, maternal short stature, and notably, cesarean delivery, an association previously identified only in isolated studies. These findings challenge the common assumption that DBM is predominantly driven by poverty, underscore the importance of intergenerational influences, and highlight cesarean delivery as a potentially under-recognised upstream factor. Overall, this study advances the evidence base from fragmented single-country findings to a coherent, regionally grounded synthesis that can inform more targeted nutrition strategies in South and Southeast Asia.

Household-level Factors: Urbanisation, Wealth, and Nutrition Transition

Our meta-analysis showed that both urban residence (38% higher likelihood) and higher household wealth (55% higher likelihood) were significantly associated with DBM, with both associations remaining robust across sensitivity analyses. These findings provide strong quantitative evidence that the burden is shifting towards more affluent and urban populations. This pattern is consistent with previous studies highlighting the role of rapid urbanisation and economic growth in reshaping dietary patterns and lifestyles across the region [1,2,5,13,24,26]. In such environments, greater access to energy-dense, nutrient-poor foods and more sedentary lifestyles contribute to maternal overweight, while persistent structural and social barriers—such as limited access to diverse child foods, suboptimal feeding practices, and inadequate childcare—continue to drive child undernutrition [3,55].

The positive association between household wealth and DBM observed in our pooled estimates indicates that economic resources alone are insufficient to ensure optimal nutrition for all household members, a pattern also reported in Indonesia, Nepal, and Bangladesh [44,51,56]. Rather, these findings suggest that DBM is shaped by how resources are distributed and utilised within households. This may explain why DBM persists in wealthier settings, where maternal

diets shift towards excess energy intake while children continue to experience inadequate dietary diversity or care, reflecting intra-household nutritional inequalities [57]. At the same time, poorer households in urban areas may face disproportionate barriers to healthy diets despite living in food-rich environments. Structural constraints such as unhealthy food environments, limited income, and poor access to fresh foods may increase the risk of both undernutrition and overnutrition within the same household [58]. The stronger associations observed in South Asia compared to Southeast Asia in our subgroup analysis suggest that the mechanisms driving DBM may differ between regions. This could reflect more pronounced intrahousehold nutritional inequalities in South Asian contexts, potentially influenced by deeper gender disparities, differential feeding practices, or other sociocultural factors that shape resource allocation within households. It is important to note that we are measuring the coexistence of overnutrition and undernutrition within households, which may have distinct drivers beyond the nutrition transition factors that influence overnutrition alone.

Maternal Factors: Central Role of Mothers

Our meta-analysis identified older maternal age (≥25 years) as one of the strongest risk factors for household-level DBM, with these mothers having more than twice the likelihood of DBM compared with younger mothers. This large effect likely reflects two concurrent processes within the same household: older mothers are at higher risk of overweight due to cumulative weight retention from multiple pregnancies, metabolic changes, and reduced physical activity [59], while their children (often from earlier pregnancies) may experience persistent stunting due to suboptimal nutrition during critical growth periods [17].

Maternal short stature also emerged as a strong risk factor, associated with a 90% higher likelihood of DBM. Short stature is not merely a biological trait but serves as a marker of chronic undernutrition during the mother's own childhood and adolescence [60,61]. This dual burden operates in two directions: short-statured mothers are more likely to have low-birth-weight infants and children with growth faltering [62,63], while simultaneously being at higher risk of overweight due to metabolic adaptations, lower lean body mass, and exposure to obesogenic environments [64]. Additionally, shorter individuals are more likely to be classified as overweight based on BMI, as BMI is a function of height and weight, making it easier for shorter people to reach the overweight threshold at lower absolute weights. These findings highlight the importance of improving adolescent nutrition as a strategy to prevent the intergenerational perpetuation of malnutrition.

In contrast, higher maternal education reduced the likelihood of DBM by 33%, making it one of the strongest modifiable protective factors. This protective effect is well-established in the nutrition literature, as educated mothers generally possess better knowledge of nutrition, greater autonomy in household decision-making, and improved access to health services [13,21]. By enhancing mothers' capacity to make informed feeding choices, access healthcare promptly, and support their children's nutritional needs, education directly contributes to improved household nutrition [21]. In contrast, the absence of a significant association between paternal education and DBM suggests that mothers have a much stronger influence on household nutrition, given their central role in caregiving and food preparation in most South and Southeast Asian settings. Interestingly, maternal working status showed no significant association with DBM, which may be due to variations in employment types, working conditions, and the availability of childcare support across different settings.

Child-Level Factors: Age and Developmental Vulnerability

Children aged 24–59 months were 79% more likely to be in a DBM-affected household compared with children aged 0–23 months. This age gradient reflects the cumulative effects of inadequate complementary feeding, repeated infections, and environmental exposures during early childhood [65,66]. Growth faltering often accelerates after six months of age, when breast milk alone becomes insufficient, and appropriate complementary foods are frequently unavailable or improperly introduced [67,68]. Meanwhile, maternal weight gain may continue or even accelerate during this period, particularly in households undergoing nutrition transition, further contributing to the household-level double burden.

Behavioral and Healthcare Factors

Breastfeeding was associated with a 37% lower likelihood of household-level DBM, and this protective association was consistent across subgroups defined by both DBM definition and geographic region, making it one of the most robust findings of this review. This finding is consistent with extensive evidence on its benefits for both child growth and maternal health [69,70]. Exclusive breastfeeding for the first six months, followed by continued breastfeeding up to two years or beyond, provides optimal nutrition for infants and young children while supporting maternal weight management through increased energy expenditure [23,71,72]. Additionally, breastfeeding reduces the risk of childhood infections, which are major contributors

to stunting, further reinforcing its protective role [73–75]. These findings highlight the importance of promoting and supporting breastfeeding as a cornerstone of DBM prevention strategies.

Cesarean delivery was associated with a 76% higher likelihood of household-level DBM, though this estimate warrants cautious interpretation, as sensitivity analysis indicated that removing a single influential study increased the pooled estimate, suggesting that the true association may be even stronger than the overall result. Multiple plausible pathways may explain this association. Cesarean delivery can delay lactation initiation, reduce breastfeeding duration, and alter infant gut microbiota, all of which may negatively impact child growth [72,76,77]. Furthermore, cesarean delivery is more common among overweight or obese women, who may face higher risks of surgical complications and challenges in postpartum weight management [78,79]. Reduced mobility and physical activity during recovery may also exacerbate postpartum weight retention, contributing to maternal overweight in the household [79,80].

Additional Factors: Emerging Evidence

Several factors identified in the narrative synthesis, however not included in the meta-analysis due to limited data, are also important to consider. Higher birth order and larger household size were associated with increased DBM risk, likely due to reduced availability of food and caregiving for each child within the household [34,36,38,43,52]. Attending ANC visits was linked to reduced DBM risk, highlighting the importance of prenatal nutrition counseling and maternal health monitoring in mitigating household malnutrition [13,53]. Household food insecurity was also consistently associated with higher DBM likelihood, emphasising the fundamental role of adequate food access in preventing malnutrition [19,34,49,50]. Moreover, several dietary factors—such as excessive protein intake in children, higher maternal fat intake, and imbalanced energy intake—may further contribute to DBM [34,44]. These findings indicate the need for longitudinal studies with detailed dietary assessments to clarify causal pathways and inform targeted dietary interventions.

Implications for policy and practice

The findings of this systematic review challenge the longstanding assumption that malnutrition is primarily a problem of poverty and food insecurity [81]. DBM is increasingly concentrated in urban and wealthier households, meaning that conventional poverty-targeted nutrition programs are misaligned with the population now most affected [2,5]. National nutrition policies, therefore,

need to expand beyond food security frameworks to include regulatory responses to obesogenic food environments, such as restrictions on unhealthy food marketing and fiscal policies on sugar-sweetened beverages [2]. At the same time, investment in child undernutrition programs must be sustained, as both forms of malnutrition coexist within the same households. Addressing the intergenerational nature of DBM is equally critical. Maternal short stature, older maternal age, and cesarean delivery all point to mechanisms that transmit nutritional risk across generations [4,62,63]. Investing in girls' education and women's empowerment directly disrupts these cycles by improving maternal nutrition knowledge, healthcare-seeking behavior, and household decision-making [13,21]. Programs targeting adolescent girls and young women before pregnancy can improve birth outcomes and reduce downstream DBM risk and must therefore be repositioned as explicit upstream prevention strategies rather than standalone health activities [69,82]. Supporting breastfeeding through enforcement of the International Code of Marketing of Breast-milk Substitutes [82], paid maternity leave, and workplace lactation programs can simultaneously reduce child undernutrition and maternal overweight [72].

Research Recommendations

Our findings highlight the need for longitudinal studies with detailed dietary assessments to clarify the causal pathways underlying household-level DBM. Understanding these mechanisms is essential, as it allows interventions to address not only observed associations but also the processes through which maternal and child nutrition risks are transmitted across generations. Moreover, evidence on the long-term consequences and temporal dynamics of DBM remains limited, making prospective studies critical to track how under- and overnutrition co-evolve within households and across the life course [83]. In addition, future research should assess the impact of specific policies and large-scale nutrition programmes, particularly those targeting obesity prevention, food environments, and social protection. Evidence from existing evaluations is limited and inconsistent, leaving gaps in understanding which interventions can simultaneously reduce both undernutrition and overweight [84]. Strengthening longitudinal research and conducting rigorous program evaluations will expand the evidence base needed to design and scale interventions that effectively reduce DBM in South and Southeast Asia.

Strengths and Limitations

This study represents one of the most comprehensive efforts to systematically review and quantitatively synthesise evidence on factors associated with household-level DBM in South and

Southeast Asia. By integrating findings from multiple countries, it captures regional diversity and identifies both common and context-specific determinants of DBM. A comprehensive search across multiple databases, supplemented with manual searches, minimised the likelihood of missing relevant literature. All included studies demonstrated good methodological quality as assessed using the NOS-xs tool. Meta-analyses of 12 factors allowed quantification of pooled effects and assessment of heterogeneity, while subgroup analyses by DBM definition and region helped explain contextual variations. Sensitivity analyses and publication bias assessments confirmed the robustness and reliability of our findings, providing a strong evidence base to inform regional policy and programmatic responses.

However, several limitations should be acknowledged. First, all included studies employed cross-sectional designs, precluding causal inference. Longitudinal studies are needed to establish temporal relationships and identify critical windows for intervention. Second, substantial heterogeneity was observed for most factors, reflecting variations in study populations, DBM definitions, measurement methods, and analytical approaches. Although subgroup analyses partially explained this heterogeneity, residual variability remained. Third, the definition of DBM varied across studies, with some using composite definitions that combined multiple forms of child undernutrition. While our subgroup analyses addressed this issue, standardised DBM definitions would facilitate more direct comparisons. Fourth, media exposure was consistently measured using a standard DHS definition (television, radio, or newspapers at least once per week). Although this supports comparability, it may not reflect current digital media landscapes, potentially limiting its validity in more recent study contexts. Fifth, we were unable to conduct meta-analyses for several potentially important factors due to insufficient data, including household size, birth order, food security, and dietary patterns. Sixth, a formal certainty of evidence assessment using the GRADE approach was not undertaken, as its application to observational etiological evidence remains methodologically debated [85]. Readers should therefore interpret the pooled estimates with appropriate caution, considering the cross-sectional nature of included studies, the substantial heterogeneity observed for several factors, and the variation in DBM definitions across studies.

Conclusions

This systematic review and meta-analysis provide a comprehensive synthesis of household-level determinants of DBM in South and Southeast Asia. Findings of this study highlight the need for integrated, context-specific interventions that address both undernutrition and overnutrition

across the life course. Policies should target not only poor and rural populations but also urban and affluent households experiencing nutrition transitions. Encouraging maternal education, promoting breastfeeding, and implementing interventions to prevent intergenerational malnutrition are critical to reducing DBM and achieving Sustainable Development Goals related to nutrition and health. Future research should utilise longitudinal designs to establish causality, standardise DBM definitions to enhance comparability, and investigate the role of dietary patterns, food security, and household dynamics in DBM etiology.

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Chapter 7: Joint Effects of Maternal Education and Household Wealth on DBM

7.1 Chapter Context

This chapter addresses **Objective 3.2,** which aimed to examine the interaction between household wealth and maternal education in relation to household-level DBM. Using DHS data and multivariable logistic regression, the study assessed this interaction in Bangladesh, Cambodia, Nepal, and Timor-Leste. The findings provide insight into how maternal education influences the relationship between household wealth and DBM and highlight maternal education as a potentially modifiable and policy relevant factor. This chapter comprises one publication, which has been published in ***Maternal & Child Nutrition*** Journal.

Note: The four-visit threshold for antenatal care (ANC) utilisation was based on the WHO focused antenatal care model, which recommended a minimum of four visits (≥4 visits). This threshold was commonly used in DHS reporting and was selected to maintain consistency across survey rounds. However, the published article contains the presentation of ANC categories, with the methods reporting ≤4 versus >4 visits and Tables 1 and 2 reporting <4 versus >4 visits, rather than the intended <4 versus ≥4 visits. This inconsistency relates to the reporting error of the categories in the published article. Although WHO introduced the recommendation of eight ANC contacts in 2016, many pregnancies covered by the surveys occurred before this change. An analysis using eight or more contacts was not conducted, and the findings should be interpreted in relation to the historical four-visit recommendation rather than the current WHO recommendation.

Note on terminology: In the published article, the term 'risk' is used to describe associations with household-level DBM. As the study used cross-sectional data and the associations were estimated using logistic regression and reported as odds ratios, any reference to an increase or decrease in 'risk' should be interpreted as an increase or decrease in the odds of DBM, rather than a change in risk. These findings represent statistical associations and do not establish causality. The original published text has been retained without alteration.

7.2 Article on the Influence of Maternal Education and Household Wealth on DBM

The following published article forms the foundation of this chapter:

Talukder A, Kelly M, Gray D, Sarma H. Influence of maternal education and household wealth on double burden of malnutrition in South and Southeast Asia. ***Matern Child Nutr.*** 2025;21: e70049. https://doi.org/10.1111/mcn.70049

Influence of Maternal Education and Household Wealth on Double Burden of Malnutrition in South and Southeast Asia

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I declare that the research presented in this Thesis represents original work that I carried out during my candidature at the Australian National University, except for contributions to multi-author papers incorporated in the Thesis where my contributions are specified in this Statement of Contribution.

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Abstract

The double burden of malnutrition (DBM), defined by the coexistence of undernutrition and overnutrition within households, poses significant public health challenges in South and Southeast Asia. While previous studies have examined the individual effects of maternal education and household wealth on DBM, findings remain inconsistent, and little is known about how these factors interact across different contexts. To address this gap, we used nationally representative Demographic and Health Survey (DHS) data from Bangladesh (2017–18), Cambodia (2022), Nepal (2022), and Timor-Leste (2016) to analyze the interaction between maternal education and household wealth in shaping DBM risk. These countries were selected due to their ongoing nutritional transition, which has contributed to the increasing prevalence of DBM. For the analysis, we used DHS data, which employs a standardized multistage cluster sampling method and probabilistic methods to ensure representativeness. In this study, we selected mother-child pairs from the DHS survey, focusing on children aged 0 to 59 months and non-pregnant mothers at the time of the survey. We included those pairs for which both the mother and child had valid weight and height measurements. Maternal education and household wealth were identified as the primary exposures. To examine their interaction and the impact of other covariates on DBM, we employed multivariable logistic regression models. Our study found that DBM prevalence was higher in urban and wealthier households, with the highest rates observed in Timor-Leste and Cambodia. Multivariable logistic regression indicated that lower maternal education increased DBM risk, especially in affluent households (OR 2.07–3.29). Conversely, higher maternal education was associated with lower DBM prevalence. Additionally, breastfeeding and antenatal care visits emerged as protective factors. These findings indicate the necessity for specific interventions aimed at enhancing maternal education and promoting healthy dietary practices, particularly in rich households. Additionally, reinforcing breastfeeding practices and increasing antenatal care visits are essential strategies to mitigate the risks associated with DBM.

Key words: Double burden of malnutrition, wealth index, maternal education, interaction effect, South and Southeast Asia

Summary

- DBM is highly prevalent in South and Southeast Asia, with urban and wealthier households showing elevated rates, such as 15.8% in urban Bangladesh and 20.0% in urban Timor-Leste.
- Lower maternal education significantly increases the risk of DBM, especially in rich households, with odds ratios (OR) of 2.07 in Bangladesh, 3.29 in Nepal, and 2.37 in Timor-Leste, while breastfeeding consistently acts as a protective factor.
- Specific interventions focusing on improving maternal education, promoting healthy dietary practices, reinforcing breastfeeding, and enhancing antenatal care are critical to mitigating DBM in the region.

Introduction

The coexistence of undernutrition (stunting, wasting, underweight, and micronutrient deficiencies) and overnutrition (obesity or overweight) is known as the double burden of malnutrition (DBM), which can be measured at individual, household, community, and country levels [1]. The primary driver of DBM is the nutrition transition, which involves significant shifts towards diets high in sugars, and fats alongside reduced physical activity [1, 2]. In South and Southeast Asia, this transition is marked by a growing reliance on processed and fast foods, which are replacing traditional, nutrient-dense diets rich in grains, vegetables, and legumes [4-6]. The shift is particularly evident in urban areas where economic growth, globalization, and increased availability of cheap, highly processed foods have changed eating habits [7]. This dietary shift is linked to rising rates of obesity and related non-communicable diseases, such as diabetes and hypertension, particularly among teenagers and adults [7-9]. At the same time, child undernutrition persists due to factors like limited access to nutritious food and poor sanitation [8, 9]. As a result, the region is experiencing a simultaneous increase in obesity and undernutrition, which presents unique public health challenges.

Household-level DBM, where one person is overweight and another is underweight within the same household, is a crucial area for research and policy development because households containing underweight and overweight members is challenging for nutrition policy to address [10]. In South and Southeast Asia, rapid nutrition transitions, coupled with persistent child malnutrition, have contributed to a rising prevalence of household-level DBM. In Bangladesh, DBM increased from 4% in 2004 to 13.8% in 2018, with similar trends seen in Cambodia, Nepal, and Timor-Leste [11]. Another study reported that 10.0% of households in this region had overweight mothers with stunted children, 7.0% had overweight mothers with wasted children [12]. Household-level DBM leads to severe health complications and higher healthcare costs, as addressing both undernutrition and obesity simultaneously requires more comprehensive and diverse medical care than treating either condition alone [8, 13, 14].

Previous studies have identified a number of risk factors for DBM [15-27], with maternal education consistently highlighted as a key determinant. However, its association with household level DBM remains inconsistent. For example, research in India found that households where mothers had secondary education were 38% higher likelihood of DBM compared to the mothers who had no education [28], while in Myanmar, mothers with primary education had a 62% higher

likelihood of DBM compared to those with no formal education [15]. In contrast, other studies indicate a protective effect, with higher maternal education linked to a lower DBM risk [12, 21, 22]. A study in Bangladesh reported that households with mothers who had primary education were 71% more likely to experience DBM than those where mothers had higher education [29]. In Ethiopia, mothers with college or higher education were 74% less likely to experience DBM compared to illiterate mothers [23], and in Indonesia, higher maternal education was associated with a 22% lower likelihood of DBM [24]. Meanwhile, some studies found no significant association between maternal education and DBM [16, 18].

The household wealth index is also a significant risk factor for DBM, with inconsistent results across previous studies. Some research suggests that higher income increases the risk of DBM [12, 15, 19, 23, 24]. A study in South and Southeast Asia found that wealthier households had a 44% higher likelihood of experiencing DBM [12]. Similarly, in India, the risk was found to be 97% higher among wealthier households [28]. In Bangladesh, wealthier households had a 38% greater likelihood of experiencing DBM [29]. In Pakistan and Ethiopia, the risk of DBM was more than double among richer households compared to poorer ones [16, 23]. Conversely, other studies indicate that lower income may be more strongly associated with DBM. Research in Malaysia found that lower-income households were 30% more likely to experience DBM than wealthier households [26]. Similarly, a study in Indonesia revealed that DBM prevalence was highest among the poorest population groups [24].

Based on the above literature review, it is evident that maternal education and household wealth index both have significant effects on DBM at the household-level, and both factors have contradictory relations with DBM. This inconsistency highlights the need for further research to clarify how these factors interact with DBM, particularly in South and Southeast Asia. Although, previous studies have explored the individual effects of maternal education and the wealth index on DBM [17-24]**,** none have investigated their interaction. Addressing this gap, our study contributes to literature by examining how maternal education modifies the association between household wealth and DBM, providing a more comprehensive understanding of the socioeconomic determinants of DBM. Moreover, it is critical for policymakers to explore their interaction in order to develop effective strategies for preventing and managing all forms of malnutrition in this region. Therefore, our study aims to identify potential risk factors for household-level DBM within specific countries in South and Southeast Asia, with a focus on the interaction between maternal education and the wealth index. This will help us to clarify the role

of maternal education in shaping the impact of wealth on DBM at the household level in South and South-east Asia.

Methods

Sources of Data and Study Population

We used the most recent data from the Demographic Health Survey (DHS) for four countries in South and South-east Asia: Bangladesh (BDHS 2017-18), Cambodia (CDHS 2022), Nepal (NDHS 2022), and Timor-Leste (TLDHS 2016). We have chosen these countries because they are experiencing a nutritional transition from traditional diets to processed foods [11, 30-33]. This shift has led to both undernutrition and overnutrition, thereby increasing the prevalence of DBM across these countries. Moreover, DHS in these countries provided detailed and extensive information on various aspects of nutritional status, including anthropometric measurements and several health indicators for both mothers and children, which was essential for our study.

The Demographic Health Survey (DHS) conducts cross-sectional surveys in low- and middle-income countries (LMICs). From the very beginning, the MEASURE DHS project has supported these standardized household surveys, focusing on health, socioeconomic status, nutrition, and fertility among women of reproductive age (15–49 years) [34]. To ensure that each unit has a specific chance of selection, the DHS employs a standardized sampling design that includes multistage cluster sampling and probabilistic methods [34]. The process begins with selecting proportional clusters, or enumeration areas, based on the latest population and housing census. We then systematically choose households from these clusters [34]. Although the DHS sampling framework and sample designs vary from country to country, in most of the included surveys, sampling was stratified according to urban and rural areas, as well as geographical or administrative regions. Detailed information about the DHS sampling methodology and data collection procedures is available in the DHS reports for each country [35-38].

In this study, we selected mother-child pairs from the DHS survey, focusing on children aged 0 to 59 months and non-pregnant mothers at the time of the survey. We included those pairs with valid measures of weight and height for both the mother and her child. Observations with missing data on essential variables required to calculate the child's nutritional status and the mother's BMI were excluded. This approach resulted in varying sample sizes by country and year. For instance,

in Bangladesh, we initially had 8,759 mother-child pairs from 2018. After excluding 1041pairs due to missing data on child nutrition and mothers' BMI, the final sample size for analysis was n=7718 pairs. We applied the same process to other three countries, yielding final sample sizes for Cambodia (n=3836), Nepal (n=2596), and Timor-Leste (n=6309).

Outcome Variable

The DHS used anthropometric measurements (weight and height/length) to assess the nutritional status of children under five. We used key indicators such as height-for-age, weight-for-age, and weight-for-height. We applied the 2006 World Health Organization (WHO) growth standards to calculate anthropometric z-scores for children. Based on these z-scores, children were classified as stunted (height-for-age z-score < -2), underweight (weight-for-age z-score < -2) or wasted (weight-for-height z-tally < -2). For mothers, we calculated body mass index (BMI) as weight (kg) divided by height squared (m^2). In most previous studies, maternal overweight or obesity was defined as a BMI of 25.0 kg/m^2 or higher. However, due to the increased risk of cardiovascular disease and diabetes at lower BMI levels among Asians compared to non-Asians, the WHO recommended in 2004 using a modified threshold of 23.0 kg/m^2 to define overweight for Asians instead of 25.0 kg/m^2 [39]. Consequently, in this study, maternal weight status was categorized as follows: underweight (BMI < 18.5 kg/m^2), normal weight (18.5–22.9 kg/m^2), overweight/obese (≥23 kg/m^2).

To identify household-level DBM, we looked for households where the mother was overweight or obese and the child was undernourished (underweight, stunted, or wasted). We created a composite outcome variable for households where a mother with overweight or obesity coexisted with at least one form of child undernutrition. Thus, DBM refers to a household with an overweight or obese mother and a stunted or wasted, or underweight child.

Exposures and Covariates

We used maternal education and the wealth index as key exposures in this study. We measured maternal education using the highest level of education obtained and the number of years of education completed. After that, maternal education was categorized into three levels: no or primary education, secondary education, and higher education. The wealth index, a composite measure reflecting overall household living standards, was derived using principal component

analysis (PCA) by the DHS program [35-38]. Households were initially divided into five quintiles (Q) based on PCA results: Q1: poorest, Q2: poorer, Q3: middle, Q4: richer, and Q5: richest. For our analysis, we simplified this into three categories: poor (Q1/Q2), middle (Q3), and rich (Q4/Q5).

We also considered several covariates that may also influence nutrition status based on existing literature, including both individual and household-level factors. Individual-level variables included the mother's employment status (employed or not), continuous breastfeeding status (yes, no), child sex (male, female), and the number of antenatal care (ANC) visits during pregnancy (≤4 visits or >4 visits). Household-level covariates included geographical location (rural or urban) and household size (≤4 members or >4 members).

Statistical Analysis

In the analysis, we applied the sampling weights provided in the DHS dataset to adjust for the complex survey design, including stratification and clustering. This approach ensured that the findings were nationally representative and accounted for design effects, reflecting the actual distribution of the population. We conducted a descriptive analysis to outline the characteristics of the study population. We employed bivariate chi-square tests to explore the association between all predictor variables and DBM, given that both the dependent and independent variables in the study were categorical. We then fitted binary logistic regression models to evaluate the impact of risk factors on DBM, considering two distinct categories of DBM (yes/no). We evaluated the effects of predictor variables on the dependent variable (household-level DBM) using odds ratios (OR), comparing each category to a reference category where the OR equals 1. An OR greater than 1 indicates higher odds of household-level DBM compared to the reference category, and vice versa.

To analyze the interaction effects of maternal education and household wealth on DBM, we applied multivariable logistic regression models using data from Bangladesh, Cambodia, Nepal, and Timor-Leste, as well as regional datasets for South Asia (Bangladesh and Nepal) and Southeast Asia (Cambodia and Timor-Leste). We selected these two variables for interaction analysis because both independently influence DBM, but their combined effect remains unclear. Investigating their interaction allows us to assess whether higher maternal education mitigates the DBM risk associated with wealth. The interaction terms were constructed by cross classifying the three categories of maternal education (primary, secondary, and higher) with the three categories

of household wealth (poor, middle, and rich), resulting in nine distinct groups. In all models, households with "poor wealth and no/primary education" were set as the reference category. The logistic regression analysis estimated odds ratios (ORs) and 95% confidence intervals (CIs) for each interaction category.

To account for potential confounding variables that could influence the relationship between the primary exposures and the outcome, we adjusted for several key factors, including child sex, maternal employment status, the number of antenatal care visits, breastfeeding status, and household size. These variables were selected based on their potential to confound the relationship between maternal education, household wealth, and the prevalence of DBM. To ensure that the predictors in our models were not highly correlated with each other, we tested for multicollinearity among predictors (variance inflation factor <5). We chose the final model based on the Akaike Information Criterion (AIC), with the model having the lowest AIC being preferred. We assessed the goodness of fit of the regression model using the Hosmer & Lemeshow test, which evaluates how well the predicted probabilities align with the observed outcomes across different risk groups. A non-significant result ($p > 0.05$) indicates that there is no substantial discrepancy between the observed and expected values, suggesting that the model adequately fits the data. This implies that the model's predictions are reliable and that it appropriately captures the relationship between predictor variables and the outcome. We performed all the data analysis using SPSS and R (R Foundation for Statistical Computing, Vienna, Austria) software.

Results

Prevalence of Household-Level DBM

Table 1 presents the prevalence of DBM at the household level across various background characteristics in Bangladesh, Cambodia, Nepal, and Timor-Leste. DBM was more prevalent in urban and wealthier households across all countries, with significant differences observed between socioeconomic groups. Households where mothers had lower educational attainment also exhibited higher DBM prevalence. While household size showed inconsistent associations, larger households (more than four members) in Cambodia (15.6%) and Timor-Leste (15.3%) had higher DBM prevalence. Maternal employment status displayed country-specific variations, with non-working mothers in Nepal associated with lower DBM prevalence (11%), while no significant differences were observed in other countries. Breastfeeding was consistently linked to lower DBM prevalence, suggesting its potential protective effect. Additionally, inadequate

antenatal care (fewer than four visits during pregnancy) was associated with higher DBM prevalence, emphasizing the importance of maternal healthcare access in mitigating nutritional disparities at the household level.

Distribution of Participants According to Maternal Education and Wealth Index

Figure 1 shows the distribution of participants by socioeconomic status (poor, middle, rich) and education level (no/primary, secondary, higher) across Bangladesh, Cambodia, Nepal, and Timor-Leste. The figure reveals that mothers with no or primary education are most prevalent among poor households, accounting for 53.7% in Bangladesh, 71.1% in Cambodia, 69.6% in Nepal, and 67.2% in Timor-Leste. Middle-income households show more varied distributions, typically having a higher percentage of mothers with secondary education, such as 55.2% in Bangladesh and 48.1% in Timor-Leste, whereas no or only primary education remains prevalent in Cambodia (51.4%) and Nepal (52.9%). Among rich households, mothers' education levels are more diverse, with secondary education being the most common in Nepal (51.4%), Cambodia (53.2%), and Timor-Leste (63.2%). Across all socioeconomic groups, particularly in poor households, the proportion of mothers with higher education remains consistently low.

Determinants of Household-Level DBM

Table 2 depicts the risk factors associated with household-level DBM among the four countries. To identify these risk factors, we used a multivariate logistic regression model and presented them as adjusted odds ratios (AOR) of explanatory variables with 95% confidence intervals (95% CI) and the Hosmer & Lemeshow goodness of fit test. The findings indicate that the place of residence was strongly associated with a higher prevalence of DBM in all four countries. For example, in Bangladesh, urban households were 43% (AOR 1.43; 95% CI: 1.17, 1.76) more likely to suffer from DBM compared to rural households. Wealthier households, particularly those classified as "rich," have a higher likelihood of DBM, with the most pronounced effect in Bangladesh (AOR 1.60; 95% CI: 1.27, 2.03) and Nepal (AOR 1.83; 95% CI: 1.20, 2.78). Similarly, households with mothers having no or only primary education face increased DBM risk, with the highest AORs observed in Nepal (AOR 2.98; 95% 95% CI: 1.06, 3.49). Larger households (more than four members) show increased odds of DBM in Cambodia (AOR 1.39; 95% CI: 1.06, 1.82), although the effect is not significant in other countries. In any country, the mother's working status does not show a significant relationship with DBM. However, breastfeeding status was found to be a

protective factor against DBM across all countries, with the strongest protective effect noted in Nepal (AOR 0.41; 95% CI: 0.25, 0.69). Moreover, households where mothers received less than four antenatal care visits are more likely to experience DBM, with significant associations found in Bangladesh, Cambodia, and Nepal. The Hosmer & Lemeshow test results, with p-values ranging from 0.14 to 0.82, confirm that the logistic regression models provide a good fit across all countries. These values indicate that the models appropriately capture the relationship between explanatory variables and household-level DBM, supporting the reliability of the findings. Region specific estimates are available in Supplementary Table 1 (Appendix D).

Table 1: Prevalence of double burden of malnutrition (DBM) at household-level by background characteristics in Bangladesh, Cambodia, Nepal and Timor-Leste along with associated p-values obtained from Chi-square test

Covariates	Bangladesh (N=7718)		Cambodia (n=3836)		Nepal (n=2596)		Timor-Leste (n=6309)	
	n (%)	P value	n (%)	P value	n (%)	P value	n (%)	P value
Place of residence								
Urban	427 (15.8)	p<0.01	262 (19.4)	p<0.01	182 (14.2)	p<0.05	368 (20.0)	p<0.01
Rural	597 (11.9)		300 (12.1)		146 (11.1)		571 (12.8)	
Child sex								
Female	487 (13.2)	0.598	260 (13.9)	0.202	160 (12.4)	0.650	433 (14.2)	0.147
Male	545 (13.6)		302 (15.4)		168 (12.9)		506 (15.5)	
Wealth index								
Poor	361 (11.0)	p<0.01	218 (11.9)	p<0.01	151 (10.8)	p<0.01	266 (10.3)	p<0.01
Middle	203 (14.5)		109 (15.5)		66 (13.1)		204 (16.0)	
Rich	460 (15.2)		235 (18.0)		111 (16.1)		469 (19.2)	
Mother's education								
No/Primary	390 (14.0)	p<0.01	379 (17.8)	p<0.01	211 (14.0)	p<0.05	355 (12.8)	p<0.01
Secondary	498 (13.6)		168 (11.0)		105 (10.5)		514 (17.0)	
Higher	136 (10.6)		115 (8.6)		112 (13.3)		70 (14.1)	
Household member								
<4	308 (12.6)	0.226	201 (13.2)	p<0.05	104 (12.4)	0.763	119 (12.8)	p<0.05
>4	716 (13.6)		361 (15.6)		224 (12.8)		820 (15.3)	
Working Status of Mother								
No	601 (13.1)	0.682	212 (14.3)	0.641	120 (11.0)	p<0.05	612 (15.1)	0.532
Yes	423 (13.5)		350 (14.9)		208 (13.8)		327 (14.5)	
Breastfeeding status								
No	494 (16.0)	p<0.01	417 (17.1)	p<0.01	152 (17.2)	p<0.01	508 (17.3)	p<0.01
Yes	530 (11.4)		145 (10.4)		176 (10.3)		431 (12.8)	
ANC visits								
<4	319 (13.3)	p<0.05	120 (15.6)	p<0.05	137 (11.8)	p<0.05	439 (15.8)	p<0.05
>4	245 (11.4)		172 (12.1)		115 (7.9)		207 (13.3)	

Note: ***p<0.01; **p<0.05

Country Wise Interaction Effects between Maternal Education and Wealth Index on Household-Level DBM

Table 3 presents the regression model estimates for the interaction effects of wealth index and mother's education on household-level DBM in Bangladesh, Cambodia, Nepal, and Timor-Leste. Interaction analysis confirmed that DBM risk was significantly higher in affluent households where mothers had lower education (ORs: 2.07–3.29), particularly in Nepal. However, high maternal education mitigated this risk, reducing odds of DBM by 51% in Nepal (OR: 0.49, 95% CI: 0.33–0.74), 54% in Cambodia (OR = 0.46; 95% CI: 0.48–0.88) and 47% in Timor-Leste (OR = 0.53; 95% CI: 0.38–0.74). This protective effect of higher maternal education is further highlighted in Nepal, where poor households with mothers having higher education also demonstrate a 51% lower likelihood of DBM (OR = 0.49; 95% CI: 0.31-0.79). However, rich households with mothers having secondary education show a 54% higher likelihood of DBM in Bangladesh (OR=1.54; 95% CI: 1.26-1.88) but not in Cambodia, Nepal, or Timor-Leste.

Region Wise Interaction Effects between Maternal Education and Wealth Index on Household-Level DBM

Table 4 highlights the interaction between the wealth index and maternal education on household-level DBM in South Asia (Bangladesh and Nepal) and Southeast Asia (Cambodia and Timor-Leste). In both regions, affluent households with mothers having no/primary education are more likely to experience DBM, with the risk higher in South Asia (OR = 2.17; 95% CI: 1.73-2.71). Conversely, affluent households with mothers who have higher education are 66% less likely to face DBM, especially in Southeast Asia (OR = 0.34; 95% CI: .19–0.49). Maternal education also lowers DBM risk by 41% at poor households in South Asia (OR = 0.59; 95% CI: 0.42-0.84), though this effect is not significant in Southeast Asia. Middle-income households with mothers having no/primary education show a higher likelihood of DBM across both regions, but no significant difference is found for those with secondary or higher education.

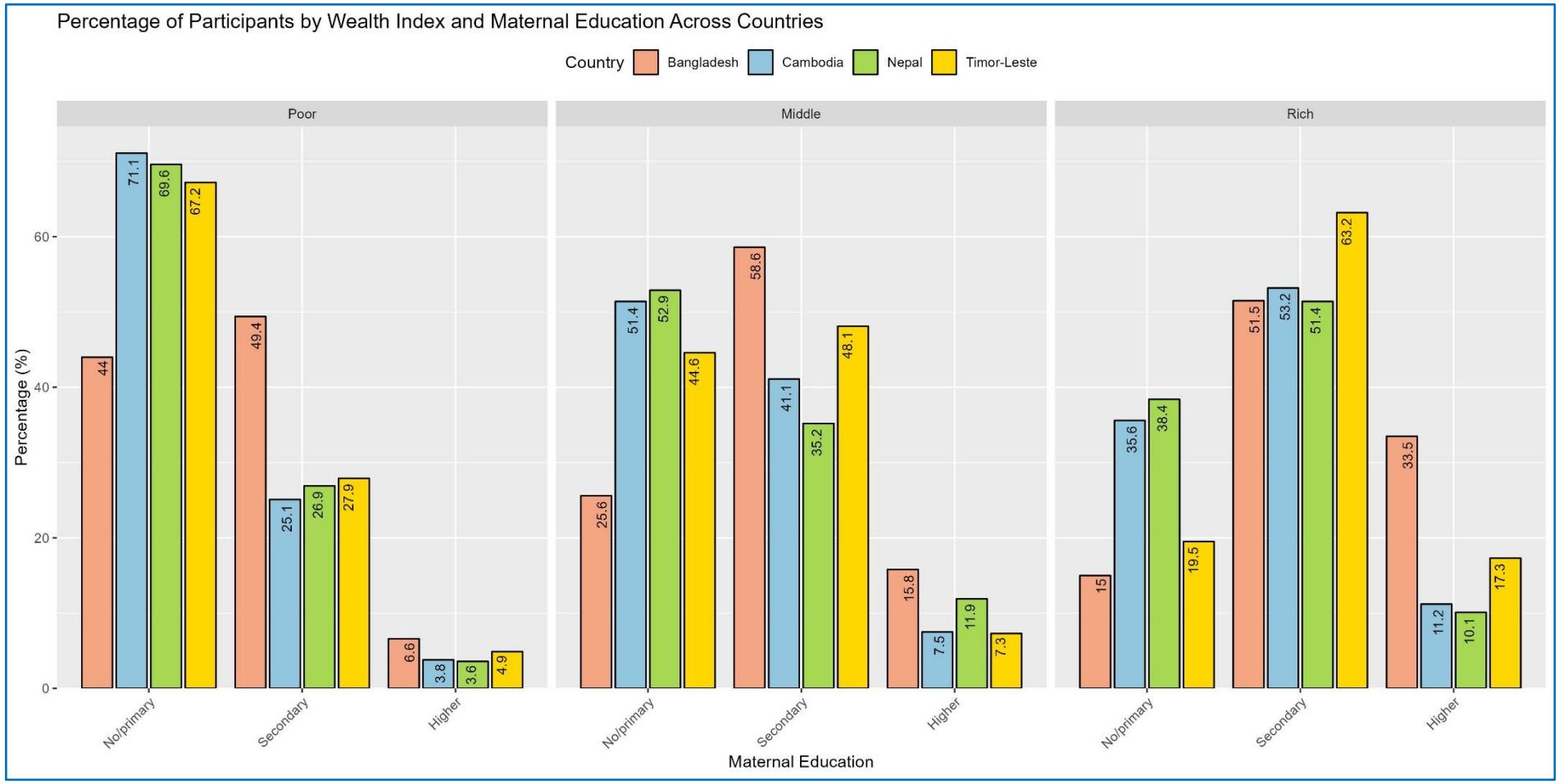

Figure 1: Percentage distribution of participants by wealth index and maternal education across countries.

Table 2: Regression model estimates of household-level DBM in Bangladesh, Cambodia, Nepal and Timor-Leste along with Hosmer & Lemeshow goodness of fit test

Covariates	Bangladesh	Cambodia	Nepal	Timor-Leste
	AOR (95% CI)	**AOR (95% CI)**	**AOR (95% CI)**	**AOR (95% CI)**
Place of residence				
Rural	**Reference**	**Reference**	**Reference**	**Reference**
Urban	1.43 (1.17, 1.76) ***	1.72 (1.29, 2.29) ***	1.54 (1.03, 2.33) **	1.55 (1.26, 1.91) ***
Child sex				
Female	**Reference**	**Reference**	**Reference**	**Reference**
Male	1.04 (0.91, 1.18)	1.12 (0.94, 1.35)	0.95 (0.75, 1.19)	1.11 (0.97, 1.27)
Wealth index				
Poor	**Reference**	**Reference**	**Reference**	**Reference**
Middle	1.42 (1.11, 1.82) ***	1.34 (0.94, 1.91)	1.02 (0.62, 1.69)	1.58 (1.25, 2.02) ***
Rich	1.60 (1.27, 2.03) ***	1.40 (1.03, 1.96) **	1.83 (1.20, 2.78) ***	1.69 (1.33, 2.16) ***
Mother's education				
No/ Primary	1.54 (1.15, 2.08) ***	2.06 (1.08, 3.95) **	2.98 (1.06, 3.49) **	1.47 (1.06, 2.05) **
Secondary	1.43 (1.09, 1.87) **	1.18 (0.62, 2.26)	2.78 (0.98, 3.72)	1.46 (1.08, 1.97) **
Higher	**Reference**	**Reference**	**Reference**	**Reference**
Household member				
<4	**Reference**	**Reference**	**Reference**	**Reference**
>4	1.09 (0.90, 1.32)	1.39 (1.06, 1.82) **	1.29 (0.88, 1.90)	0.97 (0.78, 1.19)
Working Status of Mother				
No	**Reference**	**Reference**	**Reference**	**Reference**
Yes	0.86 (0.72, 1.03)	1.03 (0.79, 1.34)	1.26 (0.88, 1.80)	0.92 (0.77, 1.09)
Breastfeeding status				
No	**Reference**	**Reference**	**Reference**	**Reference**
Yes	0.64 (0.52, 0.81) ***	0.68 (0.52, 0.89) ***	0.41 (0.25, 0.69) ***	0.74 (0.62, 0.87) ***
ANC visits				
<4	**Reference**	**Reference**	**Reference**	**Reference**
>4	0.71 (0.59, 0.86) ***	0.63 (0.48, 0.82) ***	0.56 (0.38, 0.84) ***	0.91 (0.76, 1.09)
Goodness of fit				
Hosmer & Lemeshow Test	$\chi^2 = 12.94$ $P\text{-}value = 0.14$	$\chi^2 = 9.33$ $P\text{-}value = 0.32$	$\chi^2 = 4.39$ $P\text{-}value = 0.82$	$\chi^2 = 8.14$ $P\text{-}value = 0.42$

Note: ***p<0.01; **p<0.05: AOR: Adjusted odds ratio, which is calculated by adjusting all the covariates in the model.

Table 3: Regression model estimates for the interaction effect of Wealth Index and Mother's Education for household-level DBM in Bangladesh, Cambodia, Nepal, and Timor-Leste

Interaction Effect: Wealth Index × Mother's Education	**Bangladesh**	**Cambodia**	**Nepal**	**Timor-Leste**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Poor × No/primary education	**Reference**	**Reference**	**Reference**	**Reference**
Poor × Secondary education	1.04 (0.84, 1.31)	0.33 (0.43, 2.49)	0.87 (0.59, 1.28)	0.87 (0.64, 1.18)
Poor × Higher education	0.67 (0.36, 1.27)	0.65 (0.28, 1.13)	0.49 (0.31, 0.79) ***	1.13 (0.34, 3.77)
Middle × No/primary education	1.59 (1.19, 2.12) ***	0.98 (0.73, 1.32)	1.53 (0.84, 2.79)	1.99 (1.12, 3.53) **
Middle × Secondary education	1.19 (0.93, 1.54)	0.92 (0.59, 1.28)	0.86 (0.51, 1.48)	1.09 (0.74, 1.59)
Middle × Higher education	1.27 (0.82, 1.97)	0.72 (0.47, 1.11)	0.89 (0.55, 1.46)	1.51 (0.63, 3.61)
Rich × No/primary education	2.07 (1.62, 2.65) ***	1.37 (1.03, 1.83) **	3.29 (1.88, 5.75) ***	2.37 (1.81, 3.13) ***
Rich × Secondary education	1.54 (1.26, 1.88)	0.37 (0.49, 2.91)	1.42 (0.62, 1.38)	0.86 (0.59, 1.25)
Rich × Higher education	0.98 (0.79, 1.28)	0.46 (0.48, 0.88) **	0.49 (0.33, 0.74) ***	0.53 (0.38, 0.74) ***

Note: ***p<0.01; **p<0.05; Estimates are obtained by controlling other covariates in the model.

Table 4: Regression model estimates for the interaction effect between Wealth index and Mother's education for household-level DBM in South Asia (Bangladesh & Nepal) and Southeast Asia (Cambodia & Timor-Leste)

Interaction Effect: Wealth Index × Mother's Education	**South Asia ($N = 10713$) (Bangladesh & Nepal)**	**Southeast Asia ($N = 10348$) (Cambodia & Timor-Leste)**
	OR (95% CI)	**OR (95% CI)**
Poor × No/primary education	**Reference**	**Reference**
Poor × Secondary education	1.01 (0.84, 1.22)	0.91 (0.75, 1.11)
Poor × Higher education	0.59 (0.42, 0.84) ***	0.68 (0.24, 1.91)
Middle × No/primary education	1.58 (1.21, 2.03) ***	1.55 (1.28, 1.89) ***
Middle × Secondary education	1.12 (0.89, 1.41)	1.07 (0.87, 1.32)
Middle × Higher education	1.13 (0.82, 1.54)	0.93 (0.42, 2.08)
Rich × No/primary education	2.17 (1.73, 2.71) ***	1.55 (1.27, 1.89) ***
Rich × Secondary education	1.31 (0.81, 1.61)	1.01 (0.77, 1.31)
Rich × Higher education	0.43 (0.27, 0.59) ***	0.34 (0.19, 0.49) ***

Note: ***p<0.01; **p<0.05; Estimates are obtained by controlling other covariates in the model.

Discussion

In this study, we observed substantial differences in the prevalence and determinants of household-level DBM across Bangladesh, Cambodia, Nepal, and Timor-Leste. Our findings indicate that urban and affluent households were more likely to experience higher DBM prevalence, with urban areas in Cambodia and wealthier households in Timor-Leste showing the highest levels. Additionally, households where mothers had lower educational attainment were disproportionately affected by DBM. In Cambodia, factors like larger household size and fewer antenatal care visits were further associated with increased DBM risk. Our multivariable logistic regression analysis confirmed that urban residence and household wealth were key risk factors for DBM, while continuous breastfeeding consistently emerged as a protective factor across all countries. Notably, our findings underscore the complex relationship between wealth and education, as we found that affluent households with less-educated mothers were more likely to experience DBM. In contrast, in Cambodia, Nepal, and Timor-Leste, rich households with more educated mothers showed a lower likelihood of facing DBM challenges. Overall, both South Asia and Southeast Asia demonstrated a heightened DBM risk among middle- or high-income households with less educated mothers, whereas wealthier households with more educated mothers were less likely to face such challenges in both regions.

Our study revealed that both maternal education and wealth significantly influence the likelihood of developing DBM at the household level. Specifically, households with less-educated mothers are more prone to experience DBM compared to those with higher-educated mothers, aligning with findings from previous studies [12, 21-24]. Conversely, wealthier households also demonstrate a higher likelihood of DBM when compared to poorer households, consistent with

research conducted in Bangladesh and neighboring countries [12, 15, 19, 23, 24]. These findings challenge the conventional link between higher wealth and greater educational attainment, suggesting the need for an interaction analysis between the wealth index and maternal education.

Our interaction analysis indicated that DBM is particularly prevalent in wealthy households with less-educated mothers across all studied countries, whereas it is less common in wealthy households with higher-educated mothers in Cambodia, Nepal, and Timor-Leste. This discrepancy may be attributed to dietary transitions in affluent households, which often lead to an increased consumption of energy-dense, nutrient-poor foods, thereby heightening the risk of overweight and obesity [40, 41]. Additionally, less-educated mothers may lack the knowledge and awareness necessary for making informed nutritional and lifestyle choices, which exacerbates the risk of DBM [42]. In contrast, higher-educated mothers in wealthier households are more likely to adopt healthier nutritional practices, contributing to a reduced prevalence of DBM [43, 44].

Our study also revealed that place of residence is a significant factor for household-level DBM in all the selected countries. Urban households were more likely to experience DBM than their rural counterparts, a finding consistent with previous studies conducted in India [19]. Research shows that women in urban areas have a higher prevalence of obesity compared to those in rural areas, which further increases the risk of metabolic diseases in urban households [45]. Unhealthy dietary practices and sedentary lifestyles with a lack of physical activity further elevate the risk of overweight and obesity in urban settings [19, 45]. Although urban children on average are less likely to suffer from undernutrition compared to rural children, this does not extend uniformly to all urban children, especially those living in poverty. In densely populated low-income urban areas, challenges such as inadequate housing, limited access to services, vulnerability to environmental dangers, and insufficient and irregular earnings contribute to food insecurity and malnutrition [11, 46].

Our findings indicated that breastfeeding is a crucial protective factor against DBM at the household level in all the selected countries. Households with mothers who engage in continuous breastfeeding for their child are less likely to experience DBM compared to those where mothers do not maintain continuous breastfeeding. This finding aligns with previous studies [15]. Breastfeeding not only meets children's daily nutritional needs by providing essential micronutrients but also helps mothers lose postpartum weight by burning extra calories [47, 48]. As a result, inadequate breastfeeding practices can lead to both maternal overweight and child malnutrition. Additionally, the duration of breastfeeding plays a key role in reducing the risk of

DBM. Studies show that exclusive breastfeeding for up to six months has been shown to improve children's health and nutritional outcomes and reduce postpartum weight retention [15]. Therefore, promoting optimal breastfeeding practices is essential for supporting children's growth and development and preventing maternal obesity.

Our study also identified that households where mothers received less than four antenatal care visits are more likely to experience DBM in all four countries. This is likely because antenatal visits are critical for providing nutritional guidance, early health issue detection, and necessary supplements like iron and folic acid [49, 50]. On the other hand, inadequate antenatal care leaves mothers without crucial information on proper nutrition during pregnancy and breastfeeding [51], potentially leading to poor dietary practices that result in undernutrition for the child and obesity for the mother. Additionally, fewer antenatal visits may result in undiagnosed or poorly managed maternal health conditions, which can negatively impact fetal growth and development [52], further exacerbating the risk of malnutrition in children. Therefore, increasing the frequency and quality of antenatal care visits is critical to reducing the risk of DBM by ensuring that both mothers and their children receive the necessary health support and nutritional guidance during this crucial period.

Household size is found to be an important predictor of DBM in Cambodia. Numerous factors related to resource management and nutritional challenges within Cambodian households may contribute to this increased risk. In larger families, distributing food and resources among more members can become a complicated effort to provide adequate and balanced nutrition for everyone [18]. This competition for limited food supplies may result in insufficient nutrient intake for some members [53]. Moreover, economic constraints often faced by larger households can further limit their access to quality food and healthcare services [17], exacerbating both undernutrition and overweight issues simultaneously. In contrast, households in other countries studied may experience different household dynamics or resource allocations that help to mitigate the effects of household size on DBM. Thus, the relationship observed in Cambodia indicates the importance of considering contextual factors when assessing nutritional outcomes in diverse settings.

The patterns of DBM observed across the studied countries can be better understood by considering their diverse cultural, economic, and social contexts. In South and Southeast Asia, rapid urbanization and dietary shifts have led to greater reliance on processed foods, especially in wealthier households with lower maternal education, contributing to the rise of DBM [3, 4, 6]. Deeply entrenched social hierarchies and gender norms in these countries often influence food

distribution within households, with men and older family members being prioritized [54, 55], which exacerbates child undernutrition and increases the risk of overweight among women. Timor-Leste, with its limited economic development and persistent food insecurity [56, 57], faces a unique challenge where DBM is emerging alongside ongoing efforts to address chronic malnutrition. These contextual differences highlight the need for targeted, culturally sensitive interventions that address the specific sociocultural and economic drivers of DBM in each country.

Strengths and Limitations

Our study has several strengths and limitations. One of its key strengths is its reliance on nationally representative surveys with large sample sizes and minimal missing data, which enhances the reliability and precision of the findings. The use of DHS data offers significant advantages, including high response rates, comprehensive national coverage, standardized data collection procedures, and rigorous interviewer training. Despite these advantages, the cross-sectional design of the study limits the ability to establish causal relationships, a limitation that could be addressed through a longitudinal study. Additionally, the study could not account for other potentially significant factors related to double burden of malnutrition and household-level factors, such as daily dietary patterns, physical activity, caregiving practices, cultural influences, and detailed pregnancy and birth information, as these variables are not included in the DHS dataset.

Conclusion

Our findings show that DBM particularly affects rich households with less educated mothers, while it is less likely to affect households with more educated mothers. We also found that breastfeeding and antenatal care visits serve as protective factors against DBM. To reduce the increasing rate of DBM, we recommend a number of policy actions. First, interventions should aim to enhance maternal education on nutrition and health, empowering mothers to make informed dietary choices. Targeted nutrition programs should focus on addressing the paradox of wealth and malnutrition by promoting dietary diversity and reducing the consumption of processed foods in affluent households. It is essential to prioritize the promotion of continuous breastfeeding for at least 12 months to support optimal child health and maternal well-being. Additionally, increasing antenatal care visits should be encouraged, as these visits offer crucial nutritional guidance and monitoring for both mothers and children. Policies should focus on improving dietary quality and nutritional practices in wealthier households to mitigate the risks

associated with high wealth and poor nutritional habits. Lastly, follow-up studies, including qualitative research and intervention trials, could provide valuable insights into effective strategies for reducing the prevalence of DBM in these regions.

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Chapter 8: Caesarean Delivery and Household-Level DBM

8.1 Chapter Context

This chapter addresses **Objective 3.3**, which aimed to examine the association between caesarean delivery and household-level DBM. The study used multilevel logistic regression and spatial analysis of DHS data from Bangladesh, Cambodia, and Nepal. By examining the relationship between caesarean delivery, early infant feeding practices, and household-level DBM, the study provides evidence on an underexplored determinant of DBM. This chapter comprises one publication, which has been published in the ***Journal of Public Health***.

Note on terminology: In the published article, the term 'risk' is used to describe associations with household-level DBM. As the study used cross-sectional data and the associations were estimated using logistic regression and reported as odds ratios, any reference to an increase or decrease in 'risk' should be interpreted as an increase or decrease in the odds of DBM, rather than a change in risk. These findings represent statistical associations and do not establish causality. The original published text has been retained without alteration.

8.2 Article on the Association Between Caesarean Delivery and Household DBM

The following published article forms the foundation of this chapter:

Talukder A, Kelly M, Gray D, Sarma H. Caesarean deliveries and double burden of malnutrition: A multicountry analysis in South and Southeast Asia. ***J Public Health (Oxf)*.** 2025;47(4): e546-e556. https://doi.org/10.1093/pubmed/fdaf117

Caesarean Deliveries and Double Burden of Malnutrition: A Multicountry Analysis in South and Southeast Asia

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I declare that the research presented in this Thesis represents original work that I carried out during my candidature at the Australian National University, except for contributions to multi-author papers incorporated in the Thesis where my contributions are specified in this Statement of Contribution.

Title: Caesarean deliveries and double burden of malnutrition: a multicountry analysis in South and Southeast Asia

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Abstract

Background

The increasing prevalence of C-section births in South and Southeast Asia poses potential public health challenges by influencing maternal and child nutrition. These changes may contribute to the growing double burden of malnutrition (DBM), where maternal overweight/obesity coexists with child undernutrition. This study explores how C-section deliveries are linked to household-level DBM in three countries in this region. Understanding this link is key for developing effective interventions to improve maternal and child nutrition and reduce health burdens.

Methods

We analysed 2022 DHS data from Bangladesh, Cambodia, and Nepal, including women aged 15–49 with at least one child, with available nutritional and delivery mode data. Chi-square tests, ANOVA, and two-level logistic regression were used to assess the association between C-sections and DBM.

Results

C-section deliveries were linked to a significantly higher risk of DBM in Bangladesh and Nepal. Delayed breastfeeding initiation after C-section further increased this risk. Urban households showed higher DBM rates, while longer breastfeeding duration was protective.

Conclusion

To reduce DBM, policies should focus on limiting unnecessary C-sections, promoting early and sustained breastfeeding, and supporting maternal postpartum health—especially in urban areas where risks are higher. Understanding local factors is crucial for effective interventions.

Key words: Caesarean section (C-section); double burden of malnutrition (DBM); breastfeeding practices; maternal obesity; multilevel logistic regression; South and Southeast Asia

Introduction

The health and nutritional impact of caesarean section (C-section) births on mothers and children is a major concern in maternal and child health. While C-sections are often necessary to prevent maternal and neonatal morbidity and mortality, they can also lead to significant health and nutritional challenges for both mothers and children [1,2]. C-section deliveries may increase the risk of maternal complications, including infections, prolonged recovery times, and difficulties in subsequent pregnancies [3-6]. These complications can interfere with optimal feeding practices, particularly breastfeeding, which is essential for child nutrition and immune protection [7,8]. Additionally, the surgical nature of C-sections may disrupt early mother-child bonding, potentially affecting the successful initiation of breastfeeding [8-10]. This can contribute to inadequate child nutrition and an increased risk of malnutrition in early childhood [11,12].

Infants delivered via C-section are less likely to be exclusively breastfed, often due to maternal recovery challenges such as pain, fatigue, and delayed lactation initiation [13-15]. This can lead to increased reliance on formula feeding [14-17], which may not provide the same immune and nutritional benefits as breast milk, potentially affecting child growth, metabolism, and increasing the risk of undernutrition [18-21]. Additionally, disruptions in gut microbiota composition among C-section-delivered infants can impair nutrient absorption and increase the risk of obesity, metabolic syndrome, and other non-communicable diseases later in life [22-24].

The postpartum period after a C-section presents unique challenges for mothers, including longer recovery times, limited mobility, and metabolic changes such as insulin resistance and altered lipid metabolism, which increase the risk of excessive weight gain and obesity [12, 25-28]. Postpartum fatigue and psychological stress may also influence dietary habits, worsening weight retention [28]. Recent evidence shows that mothers who undergo C-section deliveries are more likely to experience postpartum overweight and obesity [29-31]. For example, one study found that 21.5% of C-section mothers were obese compared to 13.2% of those with vaginal births, and their children also had a higher risk of obesity by age three [32]. A meta-analysis of 28 studies further reported a 34% increased risk of childhood obesity among caesarean delivered children [33]. In low-income settings such as Ghana, C-section births have also been linked to lower height-for-age z-scores, indicating a greater risk of stunting [18]. Similarly, India's NFHS-5 (2019–21) data shows that children born via C-section experience higher rates of stunting, wasting, and underweight than those born vaginally [34]. As maternal overweight is also a known risk factor for C-section delivery [35-37], these findings suggest a plausible bidirectional pathway

linking C-section births to the double burden of malnutrition (DBM) at the household level—where overnutrition in mothers and undernutrition in children coexist.

Although a few studies have highlighted this potential link, the evidence remains limited. One previous study examined the association between C-section births and household-level DBM using an earlier wave of Bangladesh DHS data [12], but it was restricted to a single-country context and did not consider broader regional patterns. Moreover, household nutrition dynamics may have shifted in recent years due to changing health systems, rising urbanization, and evolving food environments, making updated evidence essential. Our study responds to this need by analyzing the most recent DHS data from Bangladesh, Cambodia, and Nepal to assess the relationship between C-section deliveries and household-level DBM. By incorporating geographic and urban–rural dimensions, this study offers a regional and comparative perspective, providing timely evidence to inform integrated maternal and child nutrition strategies across South and Southeast Asia.

Methods

Data Source and Study Population

We analyzed data from the most recent Demographic and Health Surveys (DHS), conducted in 2022 in Bangladesh, Cambodia, and Nepal. These countries were purposefully selected based on three key criteria. First, all three are undergoing rapid nutritional transitions, characterized by a shift from traditional diets to increased consumption of processed and unhealthy foods—contributing to DBM at the household level [38-40]. Second, they represent a range of socio-economic and public health contexts, providing an opportunity to examine how differing stages of development influence the relationship between caesarean births and household nutritional outcomes [41]. Third, the DHS datasets from these countries offer rich, standardized, and nationally representative data on maternal and child health and nutrition, including anthropometric and health indicators essential for our analysis, and are collected using rigorous, comparable methodologies supported by the MEASURE DHS project [42].

The DHS employs a robust multistage cluster sampling design, ensuring every unit has a defined probability of selection. Clusters, often enumeration areas (EAs) from recent population and housing censuses, were selected proportionally. Households within these clusters were then

systematically sampled. While sampling designs vary slightly by country, most surveys stratify samples by urban and rural areas and geographical or administrative regions.

Height and weight of both mothers and children were measured by trained personnel following standardized procedures used in the DHS. Digital weighing scales (e.g., SECA or UNICEF models) were used to measure weight, while height and length were measured using portable measuring boards (such as ShorrBoard® or equivalent UNICEF devices). Children under 24 months were measured lying down (recumbent length), and older children and adults were measured standing. To ensure measurement accuracy, a subset of children was randomly selected for repeat measurements, and extreme anthropometric values were rechecked according to DHS guidelines [43-45].

For this study, we selected mother-child pairs from the DHS survey, focusing on non-pregnant women aged 15–49 years who had at least one child. We included those pairs with valid measures of weight and height for both the mother and her child. For assessing the association between C-section delivery and DBM, we included pairs where the mother had completed nutritional information and where data were available on the mode of delivery—specifically, whether the child was delivered via C-section or vaginal birth (normal delivery). Additionally, we ensured that nutritional information for the corresponding child was accessible. If a mother had more than one child, we selected the most recent birth with complete nutritional and delivery data. Observations with missing or flagged data for either maternal BMI or child nutritional status were excluded to ensure data quality and to accurately calculate the DBM outcome. For instance, in Bangladesh, 4,652 mother–child pairs were initially eligible, but 520 pairs (11.2%) were excluded due to missing or flagged values, resulting in a final analytic sample of 4,132 pairs. Similarly, after applying the same eligibility criteria, the final analytic samples were 3,836 in Cambodia and 2,596 in Nepal.

Outcome Variable

Our primary outcome was the household-level DBM, defined as a pair where the mother was overweight or obese (BMI ≥23.0 kg/m² for Asians) [46] and the child was undernourished (stunted, wasted, or underweight, with z-scores < -2). We focused on this pattern because it is more prevalent in these settings and widely documented in the literature [34]. The reverse pattern—undernourished mother and overnourished child—was rare in our data and thus excluded from analysis.

Exposures and Covariates

The main exposure variable was whether the child was delivered via C-section. We classified this as 'Yes' for C-section births and 'No' for vaginal deliveries. Based on existing literature, we included several covariates. At the individual level, we considered maternal age (15–23, 24–30, >30 years), early initiation of breastfeeding (within or after 1 hour), breastfeeding duration (in months), and birth order (1st birth, 2nd birth, otherwise). At the cluster level, we included place of residence (urban/rural) and community-level antenatal care (ANC) coverage. To estimate community ANC coverage, we calculated the proportion of women in each cluster who attended at least four ANC visits during pregnancy and categorized them as either low (<50%) or high (≥50%).

Statistical Analysis

We applied DHS sampling weights to account for the complex survey design, including stratification and clustering. Descriptive statistics and bivariate analyses (chi-square and ANOVA) were conducted. To address clustering, we used two-level multilevel logistic regression models with the 'glmer' function in R, including interaction terms between C-section and delayed breastfeeding initiation, and between C-section and household wealth. Adjusted odds ratios, standard errors, and 95% CIs for interactions were obtained using the delta method via the 'margins' package. We checked for multicollinearity (VIF < 5) and assessed model fit using the Hosmer–Lemeshow test. We also used the Getis-Ord Gi* statistic to identify spatial clusters of DBM and C-section deliveries at the district level [46-48]. This method allowed us to detect statistically significant hotspots by comparing local and global means [46]. More details on the statistical analysis are available in the supplementary file (Appendix E).

Results

The prevalence of DBM and C-section deliveries revealed distinct patterns across the three countries (Figure 1). Bangladesh had an alarmingly high prevalence of C-section deliveries (45.6%), indicating a possible overuse of surgical births that far exceeded the WHO recommended threshold. In contrast, Cambodia (14.6%) and Nepal (16.9%) had much lower rates, suggesting relatively more conservative use of C-sections. Despite these differences, DBM prevalence remained somewhat similar between Bangladesh (14.2%) and Cambodia (14.3%), with Nepal slightly lower (12.3%).

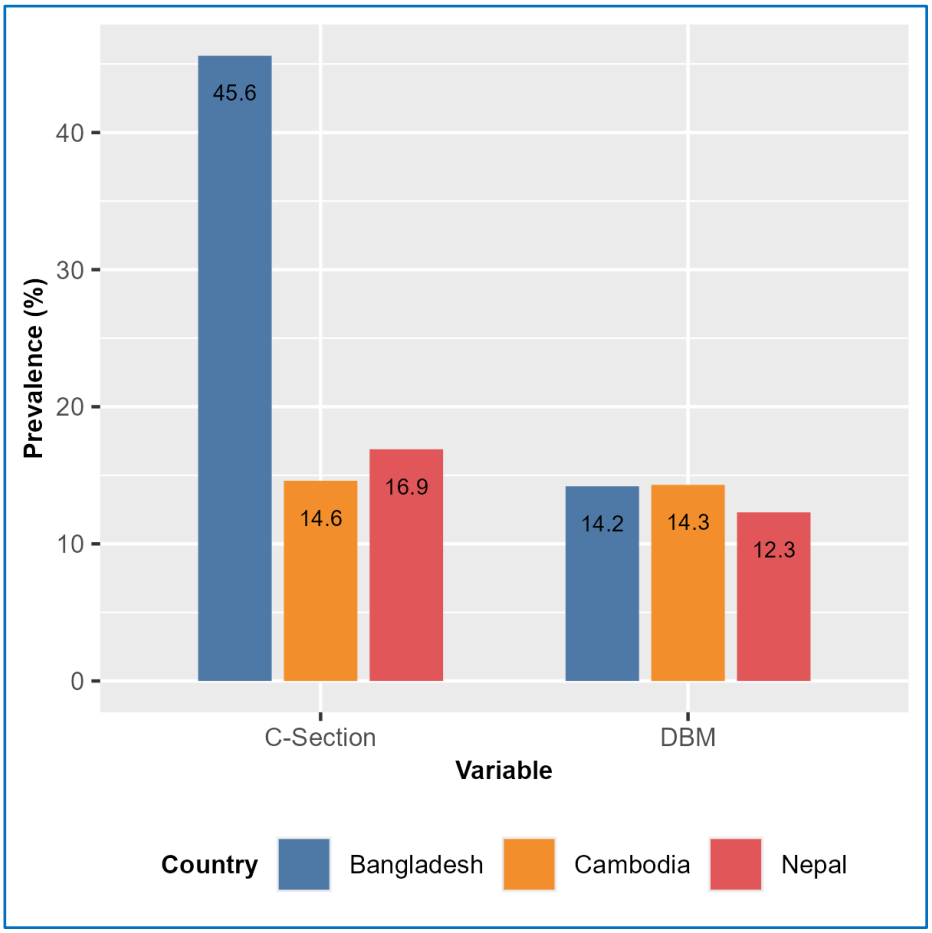

Figure 1: Prevalence of DBM (response variable) and C-section (exposure variable) for Bangladesh, Cambodia, and Nepal.

Table 1 highlights the prevalence of DBM across the selected countries. DBM was prevalent among mothers who had C-section deliveries—15.4% in Bangladesh, 16.4% in Cambodia, and 25.2% in Nepal—indicating that surgical birth may disrupt early maternal and child nutritional dynamics. The increasing prevalence with maternal age, especially among those aged 30 and above, may reflect cumulative nutritional risks and lifestyle changes. Households with delayed initiation of breastfeeding (after one hour) and those in urban areas had higher DBM prevalence, suggesting that surgical delivery practices and urban dietary transitions could be contributing factors. Lower community ANC coverage had higher DBM prevalence in Nepal and Cambodia, possibly pointing to gaps in prenatal nutrition education and follow-up. Moreover, households affected by DBM had shorter mean breastfeeding durations—14.5 months in Bangladesh, 13.7 in Cambodia, and 16.2 in Nepal—supporting the hypothesis that reduced breastfeeding may limit child nutrition while maternal overweight persists. These findings suggest that both clinical practices and broader socio-environmental contexts shape the dual burden of malnutrition within

households. Proportions of caesarean deliveries by background characteristics, along with their corresponding explanations, are presented in Supplementary Figure 1 (Appendix E).

Table 1: Prevalence of double burden of malnutrition (DBM) at household level by background characteristics in Bangladesh, Cambodia and Nepal along with associated p-values obtained from Chi-square test (categorical variable) and ANOVA (continuous variable)

Variable	Type	Bangladesh		Cambodia		Nepal	
		DBM n (%)	P-Value	DBM n (%)	P-Value	DBM n (%)	P-Value
C-Section (CS)	**Categorical**						
No		167 (12.2)	<0.05	262 (13.4)	0.144	258 (11.1)	<0.01
Yes		177 (15.4)		56 (16.4)		170 (25.2)	
Mother's Age (Year)	**Categorical**						
15-23		170 (12.5)		89 (13.4)		101 (11.8)	
24-30		242 (14.4)	<0.05	203 (13.6)	<0.05	153 (12.5)	0.382
30+		177 (16.2)		270 (16.1)		74 (14.4)	
Early initiation breastfeeding (EIB)	**Categorical**		<0.05		<0.01		<0.01
Within 1 hour		104 (12.1)		273 (13.3)		186 (12.3)	
After 1 hour		246 (15.4)		30 (20.4)		163 (17.2)	
Birth order	**Categorical**						
1st Birth		224 (14.1)	0.363	184 (14.1)		131 (12.1)	
2nd Birth		212 (15.2)		189 (13.9)	0.223	103 (12.6)	0.660
Otherwise		153 (13.3)		189 (16.1)		94 (13.5)	
Place of residence	**Categorical**						
Rural		377 (13.4)	<0.05	300 (12.1)	<0.01	146 (11.1)	<0.05
Urban		212 (16.0)		262 (19.4)		182 (14.2)	
Community ANC coverage	**Categorical**		0.455		<0.10		<0.05
Low		375 (14.6)		80 (14.9)		272 (13.3)	
High		214 (13.7)		469 (11.5)		51 (10.1)	
Months of Breastfeeding	**Continuous**	**Mean (SD): 14.5 (5.64)**	<0.01	**Mean (SD): 13.7 (5.21)**	<0.01	**Mean (SD): 16.2 (6.22)**	<0.05

Table 2: Multilevel logistic regression model estimates for DBM in Bangladesh, Cambodia and Nepal

Variable	Category	Bangladesh		Cambodia		Nepal	
		AOR (95% CI)	**P-Value**	**AOR (95% CI)**	**P-Value**	**AOR (95% CI)**	**P-Value**
Individual factors							
C-section (CS)	**No (Ref)**						
	Yes	2.60 (1.55, 4.37)	<0.01	1.71 (0.72, 4.07)	0.227	1.72 (1.09, 2.70)	<0.05
Mother's age (Year)	**15-23 (Ref)**						
	24-30	1.01 (0.72, 1.42)	0.934	0.97 (0.63 1.48)	0.895	0.96 (0.69, 1.32)	0.815
	30+	0.89 (0.58, 1.35)	0.576	0.83 (0.50, 1.36)	0.483	1.11 (0.73, 1.70)	0.621
Early initiation breastfeeding (EIB)	**Within 1 hour (Ref)**						
	After 1 hour	1.82 (1.15, 2.88)	<0.01	3.12 (1.28, 7.61)	<0.05	1.66 (1.26, 2.19)	<0.01
Birth order	**1st Birth (Ref)**						
	2nd Birth	1.16 (0.84, 1.61)	0.364	0.86 (0.57, 1.28)	0.451	0.97 (0.71, 1.34)	0.881
	Otherwise	1.06 (0.71, 1.59)	0.779	1.39 (0.88, 2.21)	0.158	1.05 (0.72, 1.53)	0.798
Months of breastfeeding	**Continuous**	0.69 (0.51, 0.94)	<0.05	0.47 (0.32, 0.71)	<0.01	0.67 (0.51, 0.91)	<0.01
Interaction ($CS \times EIB$)	CS: $Yes \times EIB$: $After\ 1\ hour$	1.90 (1.07, 3.38)	<0.05	1.47 (1.01, 2.14)	<0.05	3.26 (1.79, 5.94)	<0.01
Cluster level factors							
Place of residence (PR)	**Rural (Ref)**						
	Urban	2.11 (1.41, 3.16)	<0.01	1.80 (1.21, 2.68)	<0.01	2.09 (1.47, 2.98)	<0.01
Community ANC coverage	**Low (Ref)**						
	High	0.96 (0.68, 1.31)	0.785	0.97 (0.61, 1.61)	0.995	0.58 (0.39, 0.85)	<0.01
Interaction ($CS \times PR$)	CS: $Yes \times PR$: $Urban$	1.82 (1.08, 3.06)	<0.05	1.52 (0.66, 3.51)	0.318	1.92 (1.41, 4.09)	<0.01
		$CRE = 0.58$		$CRE = 0.69$		$CRE = 0.63$	
		$ICC = 0.10$		$ICC = 0.20$		$ICC = 0.11$	
Hosmer & Lemeshow Test		$\chi^2 = 18.66$ $P\text{-}value = 0.28$		$\chi^2 = 11.38$ $P\text{-}value = 0.23$		$\chi^2 = 5.44$ $P\text{-}value = 0.65$	

Note: CRE= Cluster Random Effect; Interaction effects are estimated for C-section (CS) with early initiation of breastfeeding (EIB) and C-section (CS) with place of residence (PR). Estimates are obtained by controlling other covariates in the model.

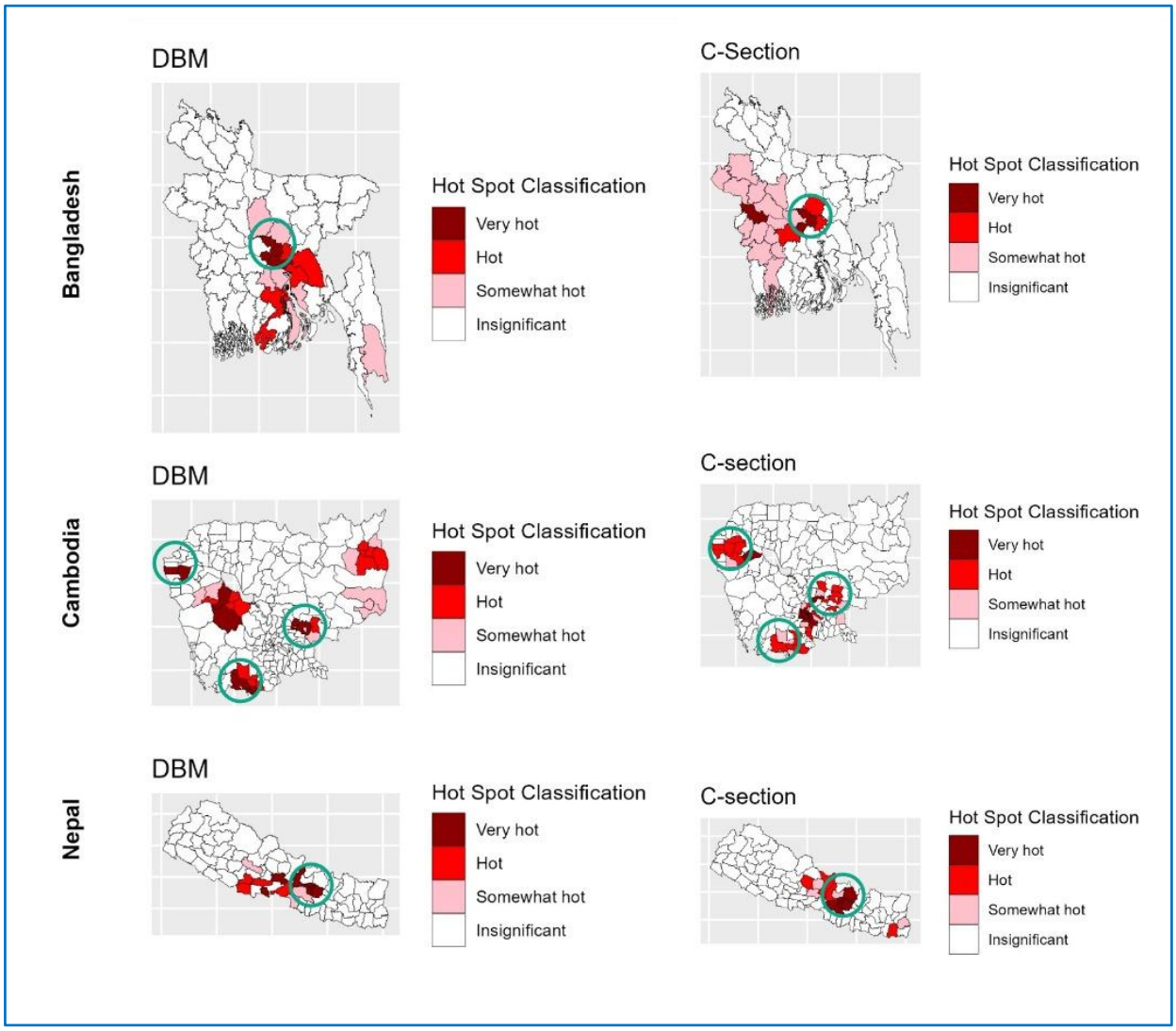

Figure 2: Hot spot analysis for DBM (response variable) and C-section (exposure variable) of Bangladesh, Cambodia, and Nepal.

Note: Circles represent common regions for both DBM and C-section. Note: Very hot: hot spot (99% confidence); hot: hot spot (95% confidence); somewhat hot: hot spot (90% confidence).

Table 2 presents adjusted odds ratios (AORs) from a two-level logistic regression of factors associated with DBM. In Nepal, children born via C-section were 72% more likely to live in a household experiencing DBM (AOR = 1.72, 95% CI: 1.09–2.70), and in Bangladesh, the likelihood was more than double (AOR = 2.60, 95% CI: 1.55–4.37). This suggests that surgical births may influence early feeding patterns or maternal recovery, with downstream nutritional consequences. Delayed initiation of breastfeeding independently elevated the odds of DBM in all three countries, emphasising the nutritional importance of early breastfeeding. Shorter

breastfeeding duration also showed a negative association with DBM, reinforcing the protective role of breastfeeding. At contextual level, urban households were more prone to DBM, likely reflecting shifts in diet and lifestyle. The effect of C-sections in urban areas in Nepal and Bangladesh indicate that urbanization and C-section births may together increase DBM vulnerability. Lastly, high community ANC coverage served as a protective factor in Nepal, indicating the potential of community-level interventions in mitigating DBM risks. The Hosmer & Lemeshow test, with insignificant p-values, confirms that the multilevel regression models appropriately capture the relationship between exposure variable DBM, supporting the reliability of the findings.

Figure 2 displays the hotspot analysis results for the prevalence of DBM and C-section deliveries across Bangladesh, Cambodia, and Nepal. The analysis revealed notable geographic overlaps between DBM and C-section hot spots. We identified one region each in Bangladesh and Nepal as a common hotspot where DBM and C-section intersected (Figure 2). In Cambodia, this overlap was more pronounced, with three regions exhibiting concurrent hot spots. These findings point to a possible spatial relationship between DBM and C-section deliveries in certain areas of the selected countries.

Discussion

What is Already Known on this Topic

While some studies suggest that children born via C-section are more likely to live in households experiencing DBM [12,49], a comprehensive regional analysis remains lacking. C-section deliveries can disrupt the infant's microbiota, increasing susceptibility to obesity and metabolic disorders later in life [47,48], and potentially contributing to maternal obesity through altered energy metabolism and fat storage [47]. In resource-limited settings, the higher cost of C-sections can strain household finances, reducing access to nutritious food and healthcare [50-52], leading to child undernutrition and prompting reliance on cheaper, energy-dense, low-nutrient foods that promote maternal overweight [53,54]. Longer recovery times after C-sections may also affect subsequent pregnancies and overall health [12], creating a cycle of poor maternal nutrition. Overweight or obese mothers may, in turn, be more likely to give birth to undernourished children [55], perpetuating DBM within households.

Main Findings of this Study

C-section deliveries were strongly associated with an increased likelihood of DBM, particularly in Bangladesh and Nepal, where the risk was compounded when breastfeeding was delayed. Urban households across all three countries were more likely to experience DBM, indicating that urbanisation can be a contributing factor to increase the prevalence of this condition. Furthermore, longer breastfeeding durations appeared to reduce the likelihood of DBM, emphasising the protective role of extended breastfeeding in mitigating malnutrition. Our analysis also highlighted geographic areas in each country where both high rates of DBM and C-section deliveries were concentrated, suggesting that local factors may be driving these overlapping trends.

What this Study Adds

To our knowledge, this is the first regionwide study across Bangladesh, Cambodia, and Nepal to examine the association between C-section delivery and household-level DBM using the most recent nationally representative DHS data. Although findings may not be fully generalisable to all of South and Southeast Asia due to cultural, dietary, and health system differences, they offer valuable case studies to guide future research in similar contexts. We found that delayed initiation of breastfeeding significantly increased DBM risk across all countries, particularly when combined with C-section deliveries, consistent with previous studies [12,49]. One explanation is that C-section births are more likely to delay breastfeeding initiation [56,57], depriving infants of essential early nutrition and immune protection [58], while disrupted maternal hormonal and metabolic processes may further raise obesity risk [59-61].

Although Bangladesh reports a higher rate of C-section deliveries, the prevalence of DBM remains comparable to that in Cambodia and Nepal. One possible explanation is that C-sections in Bangladesh are predominantly concentrated among urban and wealthier households [62,63], where child undernutrition tends to be lower due to better access to healthcare, improved maternal education, and better infant feeding practices [64]. While maternal overweight is more common in these groups, the relatively better nutritional status of children may reduce the overall likelihood of DBM. This pattern may help explain why rising C-section rates in Bangladesh have not yet translated into higher DBM prevalence, although continued monitoring is warranted as nutrition transitions progress. We also emphasise that households with a history of C-sections are more likely to experience DBM, which is a key message for guiding public health responses.

We found that extended breastfeeding plays an important role in reducing DBM risk. Households where mothers breastfed longer were significantly less likely to experience DBM, consistent with prior research on benefits for both mothers and children [65-67]. Longer breastfeeding supplies essential micronutrients for child growth and supports postpartum weight loss in mothers [68,69]. Evidence also shows that exclusive breastfeeding for up to six months improves child health and nutrition while reducing maternal weight retention [70]. Promoting optimal breastfeeding is therefore crucial to healthy growth, preventing maternal obesity, and breaking the DBM cycle in vulnerable households.

Urban households were more likely to experience DBM than rural households, consistent with previous studies [71]. Higher obesity rates among urban women stem from unhealthy diets, sedentary lifestyles, and limited physical activity [72,73]. Although urban children generally face lower undernutrition rates, factors such as food insecurity and inadequate services in low-income urban areas still contribute to malnutrition [74]. We also found that high community-level ANC coverage significantly reduced DBM risk in Nepal but not in Bangladesh or Cambodia, likely reflecting differences in service quality and content. In Nepal, strong healthcare infrastructure and effective nutrition education through ANC may play a protective role [75,76].

Our spatial analysis identified overlapping hotspots of DBM and C-section deliveries, particularly in Cambodia, with distinct clusters in Bangladesh and Nepal as well. These patterns may reflect disparities in healthcare access, socio-economic conditions, and maternal and child health practices [77,78]. Identifying these geographic patterns underscores the need for localized interventions to address both malnutrition and the overuse of C-section deliveries.

This study has several strengths. Using nationally representative DHS data from Bangladesh, Cambodia, and Nepal ensures robust, generalizable findings across diverse settings. Standardized methods and high response rates enhance reliability and comparability. Focusing on countries in rapid nutrition transition provides valuable regional insights into household-level DBM. Multilevel modelling strengthens the analysis by accounting for clustering and contextual factors. Overall, the study addresses a substantial evidence gap on the intersection between C-section deliveries and DBM, offering novel insights with direct implications for maternal and child health programs and policy development in transitioning economies.

Limitations of this Study

This study has some limitations. The cross-sectional design limits causal interpretations. Additionally, we were unable to account for other potentially important factors influencing DBM, such as daily dietary patterns for under-five children (0–59 months), physical activity, caregiving practices, cultural factors, and detailed pregnancy and birth data, which are not included in the DHS dataset. The absence of confounders like household income and healthcare access may also influence the findings. Moreover, using data from only three countries restricts the generalisability of results across South and Southeast Asia, given diverse socio-economic and health system contexts. Therefore, caution is advised when applying these findings beyond the countries studied.

Conclusion

This study identifies a significant association between C-section deliveries and rising prevalence of DBM in Bangladesh and Nepal, highlighting the need to limit unnecessary surgical births through stricter clinical guidelines and health system oversight. Promoting early initiation of breastfeeding after C-sections, alongside postpartum weight management, are crucial preventive measures. Strengthening community-based ANC services with nutritional counselling can effectively address DBM at the local level. Addressing urban–rural disparities require improving access to nutritious foods and promoting healthier lifestyles in urban areas. Importantly, policy responses and interventions must be context-specific, accounting for regional health infrastructure, cultural norms, and geographic differences. Supporting locally driven research and fostering multisectoral collaboration will be key to developing and implementing effective strategies to reduce DBM and unnecessary C-sections in South and Southeast Asia.

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Section IV: Policy Insights

Chapter 9: National Policies and DBM in Bangladesh

9.1 Chapter Context

This chapter addresses **Objective 4.1,** which aimed to examine how DBM is addressed within Bangladesh's national nutrition policy architecture. The study conducted a documentary analysis of five major national policies covering nutrition, food security, health, and agriculture. By assessing the extent to which these policies recognise and address the coexistence of undernutrition and overnutrition, the study provides the policy evidence base for the stakeholder perspectives examined in the following chapter. This chapter comprises one publication, which has been published in ***Global Epidemiology*** journal.

9.2 Article on Policy Responses to DBM in Bangladesh

The following published article forms the foundation of this chapter:

Talukder A, Kelly M, Gray D, Sarma H. Addressing the double burden of malnutrition in Bangladesh: Evidence from national policy documents and gaps in policy integration. ***Glob Epidemiol.*** 2026;11:100258. https://doi.org/10.1016/j.gloepi.2026.100258

Addressing the Double Burden of Malnutrition in Bangladesh: Evidence from National Policy Documents and Gaps in Policy Integration

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Statement of Contribution

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I declare that the research presented in this Thesis represents original work that I carried out during my candidature at the Australian National University, except for contributions to multi-author papers incorporated in the Thesis where my contributions are specified in this Statement of Contribution.

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Abstract

Background

Bangladesh faces a growing double burden of malnutrition (DBM), where persistent undernutrition coexists alongside rapidly rising overweight and obesity. Despite numerous national policies addressing malnutrition, the extent to which these policies explicitly recognise and integrate DBM remains unclear.

Objective

This study critically analyses major national policies on nutrition, food security, health, and agriculture in Bangladesh to assess the integration of DBM and identify gaps requiring urgent policy attention.

Methods

We conducted a narrative policy analysis of five purposively selected national nutrition policy documents implemented between 2015 and 2030. Policies were evaluated using a structured analytical framework informed by Hawkes et al.'s double-duty actions framework, the Essential Nutrition Actions framework of the World Health Organization, and the policy principles of the Global Nutrition Report. The analysis examined three dimensions: (i) recognition and framing of DBM, (ii) intervention design and content, and (iii) implementation systems. Data were extracted using a pre-specified template, verified by a second reviewer, and compared against framework components to identify gaps. Recommendations were then classified into immediate, medium-term, and long-term priorities based on feasibility and urgency.

Results

All five policies demonstrated comprehensive undernutrition programming, with measurable targets. However, overnutrition has received minimal attention in all the policies. Only the National Nutrition Policy (2015) explicitly acknowledged DBM, but this fell short of an integrated operational framework. The remaining four policies continued to treat malnutrition as synonymous with undernutrition, leaving overnutrition largely invisible as a policy concern. No policy has provided integrated service delivery models, household-level DBM strategies, life-

course surveillance systems, or food environment regulations. Seven critical gap categories were identified: service delivery, monitoring and evaluation, human resources, dietary guidelines, food environment regulation, equity and targeting, and multi-sectoral coordination.

Conclusions

Bangladesh's nutrition policies remain structurally misaligned with its evolving DBM burden. Urgent policy actions are needed to explicitly recognize DBM as a distinct policy problem, establish integrated operational frameworks, develop household-level strategies, strengthen food environment regulations, and build multisectoral governance capacity. Phased recommendations spanning immediate, medium-term, and long-term timeframes are proposed to guide the systematic integration of DBM policies and support progress towards Sustainable Development Goal targets.

Keywords: Double burden of malnutrition; nutrition policy; undernutrition; overweight; obesity; Bangladesh; policy integration; health systems.

Introduction

The double burden of malnutrition (DBM) represents one of the most complex public health challenges faced by low- and middle-income countries (LMICs) in the 21st century [1]. DBM is characterized by the coexistence of undernutrition (stunting, wasting, and micronutrient deficiencies) along with overweight, obesity, and diet-related non-communicable diseases (NCDs) within the same population, household, or individual across the life course [2, 3]. This phenomenon reflects the nutritional transition occurring in many LMICs, driven by rapid urbanization, dietary shifts towards processed foods, sedentary lifestyles, and persistent poverty [4, 5].

Bangladesh has exemplified this transition. While the country has made remarkable progress in reducing childhood undernutrition over the past two decades, with stunting declining from 51% in 2004 to 23.6% in 2022, the rising rates of overweight and obesity present new challenges [6, 7]. The Bangladesh Demographic and Health Survey (BDHS) 2022 reported that 36.5% of women aged 15–49 were overweight/obese, an increase from 9% in 2004 [7]. Moreover, DBM occurs at the household level, with studies indicating that the proportion of Bangladeshi

households with members experiencing both undernutrition and overnutrition simultaneously has increased from 4% in 2004 to 14.2% in 2022 [8, 9].

The aetiology of DBM is multifaceted, involving complex biological, behavioral, and environmental pathways [10]. Maternal and early childhood undernutrition can program metabolic changes that increase susceptibility to obesity and NCDs in later life, a phenomenon known as "developmental programming" [11, 12]. Additionally, the nutrition transition, characterized by increased consumption of energy-dense, nutrient-poor processed foods and reduced physical activity, contributes to rapid weight gain among populations previously experiencing food insecurity [5, 13]. In Bangladesh, rapid urbanization, increased household incomes, aggressive marketing of ultra-processed fast foods, and changing food systems have accelerated this transition [14, 15].

Addressing DBM requires fundamentally different policy approaches from those used to address undernutrition or overnutrition in isolation [16]. Effective DBM management demands integrated interventions that simultaneously prevent and treat both forms of malnutrition across the life course; household-level strategies that recognize the coexistence of multiple forms within families; food systems approaches that ensure the availability and affordability of diverse, nutritious foods; regulatory frameworks that create healthier food environments by limiting unhealthy food marketing and promoting healthy options; and multisectoral coordination linking health, agriculture, education, social protection, and urban planning [3, 17, 18].

Despite growing recognition of DBM as a critical public health issue, many countries' nutrition policies remain siloed, addressing undernutrition and overnutrition through separate programmes and platforms [19]. The World Health Organization (WHO) and UNICEF have called for integrated approaches to DBM, emphasizing the need for policy coherence, service integration, and life-course perspectives [20, 21]. However, limited evidence exists on how national policies in DBM-affected countries have adapted to this challenge, particularly in South Asia, where the burden is substantial [8].

This study aims to critically analyze the integration of DBM considerations within Bangladesh's national nutrition, food security, health, and agriculture policies. Although DBM is increasingly recognized as a policy priority, no previous study, to our knowledge, has systematically assessed Bangladesh's nutrition policy landscape using a structured, multidimensional framework aligned with international DBM guidance. As a result, policy gaps remain insufficiently identified, and

their relevance to established best practices and implications for policy action are unclear. This study addresses this gap by applying an integrated analytical framework to evaluate national policy documents across multiple dimensions. This approach enables benchmark-based identification of policy gaps and provides clear, actionable, and time-bound recommendations. It also offers useful insights for other South Asian countries experiencing similar nutrition transitions.

Methods

Study Design and Conceptual Framework

This study employed a purposive review of policy documents to critically examine how Bangladesh's national nutrition policies address DBM. Our analysis was guided by an integrated framework drawing on three established approaches to addressing DBM. First, Hawkes et al.'s (2020) [16] double-duty actions framework, published in 'The Lancet ', identifies interventions that can simultaneously address both undernutrition and overnutrition. This framework emphasizes the explicit recognition of coexisting forms, integrated service delivery, and life-course approaches that link childhood undernutrition to the risk of adult obesity. Second, WHO's Essential Nutrition Actions (2019) [20] provides operational guidance for integrating nutrition interventions across health service platforms and the life course. Third, the Global Nutrition Report (GNR, 2020) [17] identifies policy integration principles, including cross-sectoral coherence, food environment regulation, multisectoral coordination with accountability, and equity-focused targeting.

We operationalized core principles from these three sources into a structured assessment tool organized around three analytical dimensions (Figure 1). First, dimension 1: Recognition and Framing, examines how policies conceptualize DBM, including whether both forms are explicitly acknowledged, how each is defined, recognition of nutrition transition dynamics, adoption of life-course perspectives, and policy goals and targets. Then, dimension 2: Intervention Content, assesses what policies propose, including the comprehensiveness of interventions for each form, whether delivery platforms are integrated or separate, the presence of household-level strategies, food-environment regulations, and operational guidance. Finally, dimension 3: Implementation Systems, evaluates how policies enable implementation, including monitoring frameworks with indicators for both forms; surveillance systems; multisectoral coordination mechanisms; governance structures; human resource provisions; financing; and equity considerations.

This framework is particularly appropriate for assessing DBM policy integration in Bangladesh for several interconnected reasons. First, it provides an evidence-based foundation by anchoring assessment criteria in the most authoritative international guidance on DBM rather than relying on arbitrary or subjective standards. Second, the framework provides comprehensive coverage of the full policy cycle from problem definition through implementation. Third, the framework is methodologically appropriate for narrative policy analysis. Finally, the framework is specifically designed for gap identification, directly serving this study's aim of assessing policy integration and identifying areas requiring attention.

Policy Document Selection

We purposively identified national policy documents governing nutrition and related sectors in Bangladesh through review of government and development partner websites. Documents were selected if they were (1) national-level policies or strategic plans issued by Government of Bangladesh ministries, (2) primarily focused on nutrition, food security, or agriculture with substantial nutrition content, (3) publicly available, and (4) officially endorsed with authority over nutrition programming.

Five documents met criteria: National Nutrition Policy (NNP, 2015), Second National Plan of Action for Nutrition (NPAN2, 2016-2025), Bangladesh National Food and Nutrition Security Policy (BNFNSP, 2021-2030), National Agricultural Policy (NAP, 2018), and 8th Five-Year Plan (8th FYP, 2020-2025). These represent the core national policy architecture spanning the health, food, agriculture, and planning sectors, with overlapping implementation timeframes that enable assessment of cross-sectoral coherence.

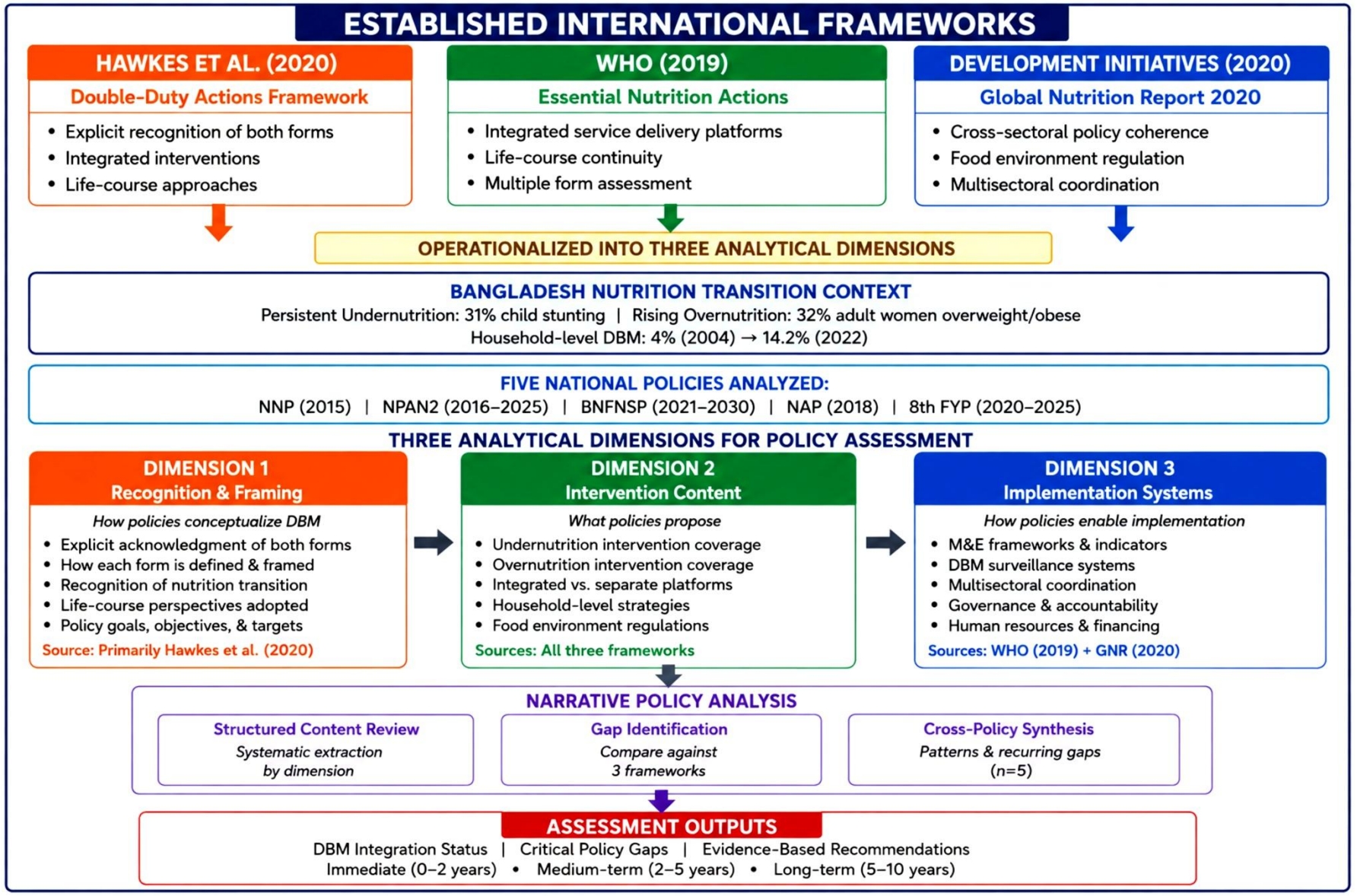

Figure 1: Conceptual framework for assessing DBM policy integration in Bangladesh

Table 1: Summary Findings of National Policies with Framework-Referenced Gaps for DBM Policy Integration

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
National Nutrition Policy[23]	**2015**	• **Goal:** To improve nutritional well-being across the population, with particular attention to women, children, and other vulnerable groups • **Objective:** To implement comprehensive nutrition interventions that prevent and address all forms of malnutrition	• Exclusive breastfeeding promotion (0-6 months) • Complementary feeding from 6 months • Vitamin A supplementation every 6 months • Iron-folic acid for pregnant women • Treatment of moderate/severe acute malnutrition • Growth monitoring and promotion • Zinc supplementation for diarrhea • Micronutrient powder (MNP) supplementation • Food fortification (salt, edible oil) • Reduction targets: stunting, wasting, underweight	• Regulation of processed food marketing • BCC to avoid excess salt, saturated fat, trans fat • Promotion of physical activity and exercise • Encourage healthy lifestyle and food habits • Target to reduce maternal overweight (BMI >23) • Prevention of overweight/obesity in educational institutions • Control of unabated marketing of commercial foods • Awareness of avoiding processed foods	• Explicit DBM recognition in policy text • Acknowledgement of coexistence of under and over-nutrition • Addresses both forms but as separate issues • Life-cycle approach covering all age groups • Mentions need to control both malnutrition and overweight • Includes indicators for both undernutrition and overweight reduction	• **No integrated service delivery model:** Policy specifies separate interventions for undernutrition and overnutrition without integration at service delivery points. Gap relative to WHO (2019) Essential Nutrition Actions principle of "integrated service delivery platforms" where multiple forms of malnutrition should be addressed through common health contact points rather than parallel systems. • **Lack of household-level DBM strategies:** No operational guidance provided for health workers or families on how to simultaneously manage both forms within households where they coexist. Gap relative to Hawkes et al. (2020) emphasis on household-level strategies recognizing coexistence of multiple forms within families, and supported by evidence that 8-15% of Bangladeshi households experience DBM simultaneously (Kosaka & Umezaki, 2017). • **No DBM-specific targets:** Policy sets separate targets for undernutrition reduction and overweight reduction without integrated DBM targets at household or population level. Gap relative to Hawkes et al. (2020) double-duty actions framework requiring explicit dual recognition with integrated targets, not merely parallel targets for each form separately. • **Limited operational guidelines:** Policy does not specify how service providers should manage DBM simultaneously or how to design "double-duty" interventions with impact on both forms. Gap relative to Hawkes et al. (2020) operational guidance on implementing integrated interventions and WHO (2019) principle that health workers should be trained to assess and manage multiple forms simultaneously.

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
						• **Insufficient monitoring systems:** No DBM-specific surveillance system to track coexistence of both forms at household level or to monitor developmental pathways from childhood undernutrition to adult obesity. Gap relative to WHO (2019) life-course continuity principle requiring surveillance across life stages, and Development Initiatives (2020) recommendation for monitoring systems with indicators for all malnutrition forms.
Second National Plan of Action for Nutrition (NPAN2)[24]	**2016-2025**	• **Goal:** To enhance the nutritional status of mothers and children and accelerate progress in reducing malnutrition • **Objective:** To strengthen nutrition interventions across the health, education, agriculture, and social protection sectors	• **Stunting reduction:** 36% to 25% by 2025 • **Wasting reduction:** 14% to 8% by 2025 • **Exclusive breastfeeding:** increase to 55% to 70% by 2025 • Focus on increasing rate of early initiation breastfeeding within 1 hour • CMAM services scale-up • Increasing focus on Vitamin A supplementation program • Provide iron-folic acid for adolescent girls • Nutrition counseling at ANC contacts	• Very limited explicit focus on overnutrition prevention • Physical activity promotion in schools • Healthy diet promotion through BCC • General dietary diversification messaging • School health programs (minimal focus on overweight/obesity prevention)	• Minimal DBM integration • Policy predominantly frames malnutrition as undernutrition • No explicit DBM conceptual framework • Overweight mentioned but not operationalized • No strategies for preventing stunted children from becoming overweight adults	• **No overweight/obesity reduction targets:** Indicator framework completely omits targets for reducing overweight or obesity despite rising prevalence. Gap relative to Hawkes et al. (2020) requirement for explicit recognition of both forms with measurable targets, and Development Initiatives (2020) emphasis that policies must include indicators for all malnutrition forms. • **No DBM-specific indicators:** Monitoring framework focused exclusively on undernutrition indicators without household-level DBM indicators or life-course tracking. Gap relative to WHO (2019) life-course continuity principle requiring monitoring across the continuum, and Development Initiatives (2020) recommendation for surveillance systems tracking DBM at household and population levels. • **Lack of life-course DBM prevention strategies:** No strategies linking childhood undernutrition prevention to adult obesity prevention, missing critical developmental programming pathways. Gap relative to Hawkes et al. (2020) life-course approaches and substantial evidence that early-life undernutrition increases adult obesity risk (Barker, 2007; Victora et al., 2008).

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
			• Promoting Deworming programs • Growth monitoring at community clinics • Homestead food production programs • Food fortification (iodized salt, fortified oil)			• **No ultra-processed food monitoring:** Consumption patterns of ultra-processed foods not tracked despite evidence of rapid proliferation and contribution to obesity. Gap relative to Development Initiatives (2020) food environment monitoring recommendations and evidence on ultra-processed food consumption driving obesity transition (Monteiro et al., 2013). • **Weak school nutrition standards:** No regulations on foods sold in schools or marketed to children, leaving obesogenic environment unaddressed. Gap relative to Development Initiatives (2020) food environment regulation principles requiring marketing restrictions and school food standards, demonstrated effective in other contexts (Taillie et al., 2020). • **Limited urban-slum focus:** Minimal attention to urban slums where DBM prevalence is highest due to coexistence of food insecurity and obesogenic environments. Gap relative to Development Initiatives (2020) equity principle requiring explicit targeting of populations and areas with highest DBM burden.
Bangladesh National Food and Nutrition Security Policy [25]	**2021-2030**	• **Goal:** To enhance food and nutrition security and support the achievement of the Sustainable Development Goals (SDGs) and related national and international	• Promote nutrition-sensitive agriculture • Diversified food production (pulses, vegetables, fruits) • Micronutrient supplementation programs • Food fortification initiatives	• Promotion of balanced nutrition • Food system approach addressing dietary quality • Dietary diversification beyond cereals • Awareness of food choices	Implicit DBM consideration through addresses "all forms of malnutrition" conceptually	• **No DBM-specific governance structure:** Coordination mechanisms don't explicitly address DBM; sectoral coordination lacks integrated DBM mandate. Gap relative to Development Initiatives (2020) multisectoral coordination principle requiring governance mechanisms with clear authority and accountability for addressing all malnutrition forms, and WHO (2019) emphasis on coordinated platforms. • **Missing fiscal policies for nutrition:** No taxation of unhealthy foods or subsidies for healthy foods despite food system mandate. Gap relative to Development Initiatives

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
		commitments by 2030 • **Objective:** To strengthen multisectoral governance and expand access to nutrition-sensitive social protection interventions	• Social safety nets for vulnerable groups • Maternal and child nutrition programs • WASH interventions for reducing infection • Homestead food production • Nutrition education and BCC	• Healthy eating promotion		(2020) food environment regulation requiring fiscal measures, with evidence from Mexico and Chile showing sugar-sweetened beverage taxes reduce consumption (Colchero et al., 2017; Taillie et al., 2020). • **Insufficient food labeling requirements:** Consumers lack information to make informed choices; no front-of-package warning labels. Gap relative to Development Initiatives (2020) food environment regulation requiring labeling, with evidence that warning labels improve consumer choices (Taillie et al., 2020). • **No agricultural incentives for nutrition-dense crops:** Continued emphasis on calorie production without explicit incentives for nutrient-dense foods over calorie-dense foods. Gap relative to Hawkes et al. (2020) food systems action area requiring agricultural policies aligned with nutrition goals, and Development Initiatives (2020) cross-sectoral policy coherence principle.
National Agricultural Policy [26]	**2018**	• **Goal:** To ensure safe, affordable, and sustainable food systems that promote food and nutrition security • **Objective:** To enhance agricultural productivity through research, innovation, and the adoption of	• Production of micronutrient-rich crops • Biofortification research (zinc-enriched rice, Vitamin A crops) • Homestead vegetable gardening • Small fish cultivation for animal protein • Poultry and livestock for dietary diversity • Pulse production for protein	• Minimal direct focus • General food production for adequate nutrition • No explicit obesity/NCD prevention strategies in agricultural policy	• No DBM integration • Policy focuses on increasing food production • Nutrition framed only as undernutrition/food insecurity • No consideration of over-nutrition risks from agricultural policies	• **No link to healthy eating patterns:** Agricultural production outputs not explicitly connected to dietary recommendations for DBM prevention; focus remains on production volume rather than nutrition quality. Gap relative to Hawkes et al. (2020) food systems action area requiring agriculture-nutrition linkages, and Development Initiatives (2020) cross-sectoral policy coherence requiring agricultural policies aligned with health nutrition goals. • **Missing nutrition education integration:** Agricultural extension workers not trained in nutrition despite their direct contact with farming households; missed opportunity for nutrition counseling. Gap relative to WHO (2019) principle that multiple sectors should contribute to nutrition service delivery, and Development Initiatives (2020)

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
		improved technologies	• Fruit and vegetable production • Nutrition-rich crop varieties development			multisectoral coordination requiring capacity building across sectors. • **Insufficient promotion of nutrient-dense foods:** Continued policy emphasis on rice production without commensurate emphasis on fruits, vegetables, and pulses for dietary diversity. Gap relative to Hawkes et al. (2020) double-duty actions requiring promotion of dietary diversity benefiting both forms, and evidence that dietary diversity prevents both undernutrition and obesity. • **No consideration of ultra-processed food supply chains:** Agricultural policies don't address food processing industry despite its role in obesity transition; no regulations or guidance on processing that maintains nutritional quality. Gap relative to Development Initiatives (2020) food environment focus on ultra-processed foods, and evidence linking ultra-processed food consumption to obesity (Monteiro et al., 2013). • **Lack of urban agriculture strategies:** No specific provisions for urban and peri-urban agriculture despite highest DBM burden in urban areas and potential for urban food production to improve dietary diversity. Gap relative to Development Initiatives (2020) equity principle requiring targeting of high-burden areas.
8th Five-Year Plan (FYP) [27]	**2020-2025**	• **Goal:** To strengthen the quality of programmes aimed at preventing and managing child wasting while improving the	• Vitamin A supplementation and deworming at vaccination • Dietary fortification (Vitamin A, iron, iodine)	• Very limited focus • Mentioned as emerging issue • Linked to NCDs	• No DBM integration • Nutrition section predominantly focused on undernutrition • NCDs mentioned separately without integration with nutrition	• **Nutritional framing limited to undernutrition:** National planning document frames nutrition exclusively as undernutrition despite rising overweight/obesity; missed opportunity to position DBM as national development priority. Gap relative to Hawkes et al. (2020) explicit recognition principle that effective responses require acknowledging both forms coexist, and Development

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
		delivery of nutrition services at health facilities • **Objective:** To strengthen essential nutrition services and improve strategies for addressing child wasting	• IYCF counseling for mothers • Micronutrient supplementation • CMAM program expansion • Community clinic nutrition services • Growth monitoring • Management of wasting at facility and community levels			Initiatives (2020) emphasis on policy framing addressing all forms. • **Weak linkage between nutrition and NCD sections:** Nutrition and NCDs discussed as separate development challenges without recognizing their interconnection through DBM and shared food system determinants. Gap relative to Hawkes et al. (2020) integrated interventions principle and WHO (2019) life-course continuity requiring linkages between maternal-child health and adult NCD prevention. • **Lack of innovation in service delivery**: Traditional undernutrition-focused approaches maintained without piloting integrated platforms or new models appropriate for DBM context. Gap relative to WHO (2019) integrated service delivery platform principle recommending innovation in service models, and evidence that integrated approaches are more cost-effective (Shekar et al., 2017). • **No urban nutrition strategy:** Despite highest urban DBM burden and rapid urbanization, no urban-specific nutrition strategy addressing unique urban challenges of food insecurity amid obesogenic environments. Gap relative to Development Initiatives (2020) equity principle requiring geographic targeting of high-burden areas, and evidence of concentrated urban DBM burden (Kimani-Murage et al., 2015).

Analytical Approach

Narrative Policy Analysis

We employed narrative policy analysis, an interpretive approach examining policy content through systematic reading and structured synthesis [22]. Policy content was systematically extracted using a structured data extraction template organized around the three analytical dimensions and their component criteria (see Appendix F: Supplementary Table 1). For each policy document, the first author read the full text and identified all sections relevant to each criterion, recording both direct textual evidence and interpretive notes in the template.

The coding process followed a deductive analytical approach: all coding categories were defined a priori from the integrated analytical framework rather than emerging inductively from the policy texts. This choice was deliberate, as the study aim was to assess the degree to which existing policies aligned with established international standards for DBM integration, necessitating benchmark-defined categories against which policy content could be systematically compared. Nevertheless, where policy texts raised issues not anticipated by the framework (for example, references to emerging NCD-nutrition linkages), these were recorded as supplementary observations and considered during synthesis.

Coding categories within each dimension were operationalized as follows. Within Dimension 1 (Recognition and Framing), categories included (i) explicit acknowledgement of DBM coexistence; (ii) definition of undernutrition and overnutrition; (iii) recognition of nutrition transition dynamics; (iv) adoption of a life-course perspective linking childhood undernutrition to adult obesity risk; and (v) policy goals and targets for both forms. Within Dimension 2 (Intervention Content), categories included (i) comprehensiveness of undernutrition interventions; (ii) comprehensiveness of overnutrition interventions; (iii) service delivery platform integration; (iv) household-level DBM strategies; (v) food environment regulation; and (vi) dietary guidelines. Within Dimension 3 (Implementation Systems), categories included (i) monitoring indicators for both forms of malnutrition; (ii) life-course surveillance systems; (iii) multisectoral coordination mechanisms; (iv) governance and accountability frameworks; (v) human resource capacity provisions; (vi) financing arrangements; and (vii) equity and targeting considerations. A full description of these categories with illustrative coding examples is provided in Supplementary Table 1.

To ensure consistency and transparency, the senior author independently reviewed all extracted content and verified that the evidence had been accurately identified and appropriately categorized according to the pre-specified criteria. In instances of divergent interpretations, for example, when determining whether a policy provision represented explicit acknowledgement of a criterion or only a conceptual mention, discrepancies were discussed and resolved through consensus. If consensus was not immediately achieved, the relevant policy text was re-examined, and a final classification was made based on the definitional criteria established within the analytical framework prior to data extraction. Each criterion was coded using a three-level classification: (1) explicitly addressed with operational detail, (2) conceptually mentioned without operationalization, or (3) absent. Items classified under categories (2) and (3) were subsequently treated as policy gaps.

Gap Identification

Building on the coding process described above, we systematically compared extracted content against the assessment criteria within each analytical dimension. Elements coded as category (2) or (3) were identified as gaps where policies fall short of international evidence-based guidance.

Within Dimension 1 (Recognition and Framing), we assessed whether policies explicitly acknowledged DBM, defined both forms of malnutrition, recognized nutrition transition dynamics, and adopted life-course perspectives linking childhood undernutrition to adult obesity risk. Within Dimension 2 (Intervention Content), we evaluated the comprehensiveness of interventions for each form, whether service delivery platforms were integrated or separate, the presence of household-level strategies and food environment regulations, and the availability of operational guidance. Within Dimension 3 (Implementation Systems), we examined monitoring frameworks and surveillance capacities, multisectoral coordination mechanisms, human resource provisions, financing arrangements, and equity and targeting considerations.

Finally, we synthesized findings across all three analytical dimensions and five policies through iterative comparison to identify consistent patterns in problem framing, variations in approach across sectors, and cross-cutting gaps appearing in multiple policies.

Development of Recommendations

Recommendations were developed by synthesizing identified gaps, reviewing international evidence on effective DBM interventions, and considering the Bangladeshi context, including

health system capacity, resource constraints, and socio-cultural factors. Recommendations were organized into immediate (0-2 years), medium-term (2-5 years), and long-term (5-10 years) timeframes based on feasibility, resource requirements, and urgency.

Ethical Considerations

This study analyzed publicly available policy documents and did not require ethical approval. No primary data collection involving human subjects was conducted.

Results

Overview of Policy Landscape

Five national policy documents implemented between 2015 and 2030 form the foundation of Bangladesh's nutrition governance architecture (Table 1). These documents outline the country's strategic approach to addressing nutrition across multiple sectors. Analysis using the three framework dimensions—recognition and framing, intervention content, and implementation systems—showed how DBM is currently addressed in national policies and identified key gaps relative to international evidence-based guidance.

Dimension 1: Recognition and Framing of DBM

Across all five policies, malnutrition was predominantly framed as undernutrition, with overnutrition receiving minimal recognition. Only the NNP (2015) [23] explicitly acknowledged DBM, stating that Bangladesh faces "the coexistence of undernutrition and overnutrition" and recognizing the need to "control both malnutrition and overweight". This policy adopted a life-cycle approach, covering all age groups, and included separate targets for reducing stunting and maternal overweight. However, even this strongest recognition addressed the two forms as separate issues rather than as part of an integrated DBM framework.

The remaining four policies showed limited to no recognition of overnutrition as a policy problem. NPAN2 (2016-2025) [24] framed malnutrition almost exclusively as undernutrition, with its goal explicitly stating "to improve maternal and child nutrition and to accelerate the reduction of malnutrition"—operationalized entirely through undernutrition indicators. Overweight was mentioned briefly but not operationalized into targets or programmes. The

BNFNSP (2021-2030) [25] referenced "all forms of malnutrition" conceptually but without operational definition or differentiation. The NAP (2018) [26] and the 8th FYP (2020-2025) [27] framed nutrition entirely in terms of undernutrition and food insecurity, with no acknowledgement of rising rates of overweight and obesity.

None of the policies explicitly recognized the dynamics of the nutrition transition—the epidemiological shift from predominant undernutrition towards coexisting forms that Bangladesh is experiencing. Life-course perspectives linking childhood undernutrition to adult obesity risk, central to Hawkes et al.'s (2020) [16] framework and developmental programming evidence [24, 25], were absent from all policies.

Gap Summary for Dimension 1

Comparison with Hawkes et al. (2020) [16], who emphasize that an effective DBM response begins with the explicit recognition that both forms coexist, reveals fundamental framing gaps. Only one of five policies explicitly acknowledged DBM, and none operationalized this recognition into integrated targets or frameworks. The absence of recognition of the nutrition transition and of life-course perspectives linking early undernutrition to later obesity represents a critical missed opportunity for prevention-oriented policy approaches.

Dimension 2: Intervention Content and Design

Undernutrition Intervention Coverage

All five policies demonstrated comprehensive, well-specified interventions for undernutrition (Table 1). The NNP and NPAN2 included detailed maternal and child nutrition programmes: exclusive breastfeeding promotion (0-6 months), complementary feeding guidance from 6 months, vitamin A supplementation every 6 months, iron-folic acid supplementation for pregnant women and adolescent girls, management of moderate and severe acute malnutrition, growth monitoring and promotion, zinc supplementation for diarrhea, micronutrient powder supplementation, and food fortification of salt and edible oil. NPAN2 set ambitious, time-bound targets: reduce stunting from 36% to 25%, reduce wasting from 14% to 8%, and increase exclusive breastfeeding from 55% to 70% by 2025 [26].

The BNFNSP emphasized nutrition-sensitive agriculture, including diversified production of pulses, vegetables, and fruits alongside continued micronutrient supplementation and fortification

programmes. The NAP focused on micronutrient-rich crop production, biofortification research, homestead vegetable gardening, and promoting small fish, poultry, and livestock to enhance dietary diversity. The 8th FYP prioritized scaling Community-based Management of Acute Malnutrition (CMAM) services and enhancing facility- and community-level nutrition services.

Overnutrition Intervention Coverage

In stark contrast, overnutrition interventions were minimal or absent across all policies. Only the NNP explicitly addressed overweight and obesity prevention, including regulation of processed food marketing, behavior change communication to reduce excess salt, saturated fat, and trans-fat consumption, promotion of physical activity and exercise, targets to reduce maternal overweight (BMI >23), and prevention of overweight/obesity in educational institutions. However, operational guidance on implementing these interventions was limited.

NPAN2 mentioned promoting physical activity in schools and general messaging on dietary diversification but provided no specific overnutrition-prevention targets, programs, or resource allocation. School health programs included minimal focus on overweight prevention. The BNFNSP addressed overnutrition only implicitly through "promotion of balanced nutrition" and "dietary diversification beyond cereals," with no specific targets or implementation guidance. The NAP and 8th FYP provided no direct focus on obesity or NCD prevention through nutrition, mentioning NCDs only as emerging issues separate from nutrition programming. It is worth noting, however, that certain NAP provisions—notably homestead vegetable gardening and diversified smallholder farming to promote dietary variety—could arguably function as double-duty actions in the sense described by Hawkes et al. (2020) [16], since promoting dietary diversity can simultaneously address micronutrient deficiencies and reduce reliance on energy-dense processed foods. These provisions were not, however, explicitly framed or operationalized as DBM interventions in the policy, thereby missing an opportunity to leverage existing agricultural programming to achieve integrated DBM outcomes.

Service Platform Integration

A critical gap emerged regarding service delivery platform integration. WHO's Essential Nutrition Actions (2019) recommends that nutrition interventions be delivered through common health contact points, with health workers trained to assess and manage multiple forms of malnutrition simultaneously. None of the five policies specified integrated service platforms. Instead, all

maintained separation: undernutrition interventions were delivered through maternal-child health services (ANC, immunization, and growth monitoring), and overnutrition/NCD interventions were delivered through separate adult NCD services. This creates parallel rather than integrated systems.

None of the policies included household-level strategies that recognise the coexistence of undernutrition and overweight or obesity within the same family. This is a critical gap, given that 14.2% of Bangladeshi households experienced household-level DBM in 2022. [9]. Policies designed interventions at the individual level without guidance for managing families where, for example, a stunted child and overweight mother require simultaneous but different nutritional support.

Food Environment Regulations and Dietary Guidelines

Food environment regulation, emphasized by the GNR (2020) as essential for addressing both forms of malnutrition, was largely absent. Only the NNP mentioned "regulation of processed food marketing" and "control of unabated marketing of commercial foods" but provided no operational details or enforcement mechanisms. None of the policies included front-of-package labelling requirements, fiscal measures such as sugar-sweetened beverage taxation, or comprehensive school food standards—all evidence-based approaches identified in the Global Nutrition Report. The existing Breastmilk Substitutes Act was not referenced in any policy, nor was its enforcement addressed.

Gap Summary of Dimension 2

Comparison against all three frameworks reveals profound asymmetry. While undernutrition interventions are comprehensive and well-operationalized, overnutrition interventions remain limited. Hawkes et al. (2020) emphasize "double-duty" interventions addressing both forms simultaneously; no such interventions were identified. WHO (2019) calls for integrated platforms; policies maintain separation. GNR (2020) highlights food environment regulation; policies lack operational approaches. The absence of household-level strategies represents a critical gap, given the prevalence of household-level DBM.

Dimension 3: Implementation Systems and Enablers

Monitoring and Evaluation Frameworks

Monitoring frameworks demonstrated the same asymmetry observed in interventions. All policies included detailed indicators of undernutrition: stunting, wasting, underweight, exclusive breastfeeding rates, and coverage of vitamin A and iron-folic acid supplementation. The NNP included maternal overweight (BMI >23) as an indicator, making it the only policy with any overnutrition monitoring provision.

However, no policy included household-level DBM indicators to track the coexistence of both forms within families, a critical monitoring gap, given that household DBM is the most policy-relevant manifestation of the double burden. Adult obesity surveillance beyond pregnant women was not specified in any policy. Diet quality indicators that assess nutrient adequacy and dietary patterns, rather than simple food security or dietary diversity measures, were absent. Ultra-processed food consumption, despite rapid increases in Bangladesh, was not included in any monitoring framework.

None of the policies specified surveillance systems capable of tracking nutritional status across the life course, following individuals from childhood through adulthood to monitor the obesity risk of stunted children, as developmental programming evidence suggests is necessary [24, 25].

Multisectoral Coordination Mechanisms

All policies acknowledged the importance of multisectoral coordination, with NPAN2 involving more than 17 ministries and establishing the Bangladesh National Nutrition Council (BNNC) as the apex body for coordination. However, structural weaknesses in coordination mechanisms were evident. The BNNC, while established as a coordination body, lacks binding authority to enforce coordination across ministries. Policies specified coordination structures but not accountability mechanisms, shared budgeting frameworks, or performance indicators—elements the GNR (2020) identifies as essential for effective multisectoral governance.

Joint planning and budgeting for DBM were absent. Ministries received separate allocations for nutrition activities without integrated DBM programming. Linkages between the agriculture and health sectors were weak, with agricultural policies focusing on production without connecting to nutrition and consumption goals and health policies focusing on supplementation without

addressing food systems. Engagement in the education sector was minimal, despite schools being critical platforms for adolescent nutrition. Private sector roles in both creating obesogenic environments and potentially supporting solutions remained unaddressed.

Human Resource Capacity

Human resource provisions focused entirely on managing undernutrition. Shortages of trained nutritionists at all levels were acknowledged, but capacity-building provisions emphasized undernutrition-related topics. No policy specified training for health workers in simultaneous DBM assessment and management or integrated counselling approaches. Medical and nursing pre-service curricula, where mentioned, focused on undernutrition. Agricultural extension workers, teachers, and social workers—all potentially important for nutrition education—were not included in nutrition training provisions.

Equity and Targeting

While all policies mentioned "vulnerable groups", specific populations bearing high DBM burden remained underserved. Urban slum populations, where DBM prevalence is highest due to simultaneous food insecurity and obesogenic environments, received limited attention despite rapid urbanization. Adolescents, navigating critical growth and lifestyle transitions, were insufficiently targeted beyond school feeding programmes. Elderly populations facing both undernutrition and NCD comorbidities were not addressed. Working women with limited time and access to nutritious foods were not specifically targeted despite their dual roles as primary carers and income earners.

Gap Summary of Dimension 3

Comparison with WHO (2019) and GNR (2020) reveals fundamental gaps in implementation systems. Monitoring frameworks lack DBM-specific indicators and life-course tracking capabilities, as emphasized in WHO guidance. Governance mechanisms lack the binding authority and shared accountability frameworks that the Global Nutrition Report specifies as necessary. Human resources are trained only in managing undernutrition, creating capacity gaps for integrated service delivery. Targeting approaches do not address populations and geographies where DBM is concentrated.

Discussion

This study provides a structured, framework-referenced assessment of how Bangladesh's five national nutrition policy documents address DBM. Organized across three analytical dimensions—recognition and framing, intervention content and design, and implementation systems—the analysis reveals a persistent gap between the country's evolving nutrition landscape and its policy responses. The following discussion contextualizes these findings within international literature and examines the political-economy forces that sustain this misalignment.

The most fundamental finding of this study is that only one of five major national policies, the NNP 2015, explicitly acknowledges DBM, and even that recognition does not extend to an integrated operational framework. The remaining four policies continue to conflate malnutrition with undernutrition, effectively rendering overnutrition invisible as a policy problem. This pattern reflects a well-documented tendency among policymakers in LMIC countries to focus on undernutrition even as the burden of overnutrition grows alongside it [28]. Addressing this policy-evidence gap requires nutrition frameworks that treat both forms of malnutrition as shared priorities rather than separate problems [16, 28, 29]. Broad commitments to address “all forms of malnutrition", such as those outlined in the BNFNSP (2021–2030), are insufficient without explicit recognition of their coexistence. Effective policy responses require clear, targeted strategies that explicitly identify undernutrition and overnutrition as interconnected conditions within the same households and address them through coordinated, integrated interventions [16].

Notably, none of the policies acknowledges nutrition-transition dynamics or adopts life-course perspectives linking childhood undernutrition to adult obesity risk through developmental programming, a pathway well established in the literature [11,25]. This absence is particularly consequential. Evidence suggests that stunted children exposed to increasingly obesogenic environments face disproportionate risks of overweight and NCDs in adulthood [11, 12]. The failure to operationalize this understanding into prevention-oriented policy represents a missed window for upstream intervention.

The persistence of undernutrition-centric framing is not simply a knowledge gap. Undernutrition programming has well-established institutional champions, dedicated financing streams, and strong international support through multilateral agencies. Overnutrition prevention, by contrast, requires confronting commercially powerful food industry actors who benefit from weak

regulatory environments [27]. Reframing national nutrition policy around DBM therefore demands deliberate political strategies alongside technical evidence.

Bangladesh's experience reflects a broader pattern across South Asia. India's POSHAN Abhiyan (2018) primarily focuses on undernutrition, including stunting, wasting, anemia, and low birth weight [30], with limited integration of overnutrition prevention despite rising obesity, particularly in urban areas [31, 32]. Nepal's Multi-Sector Nutrition Plan III (2023 to 2030) takes a more advanced approach by outlining objectives such as reducing salt and sugar intake, promoting healthy food production, regulating marketing of unhealthy foods, and improving food labelling and dietary guidelines [33]. However, these remain largely aspirational and are not yet fully operationalized. Overall, all three countries continue to prioritize undernutrition, while food environment regulation and overnutrition prevention remain secondary, highlighting a shared regional challenge in adapting nutrition policies to the ongoing nutrition transition.

All five policies include well-specified, operationally detailed undernutrition interventions with measurable targets, whereas overnutrition interventions are limited to general health-promotion messaging without programmatic detail or resource commitments. Comparison against the double-duty actions framework [16] reveals a complete absence of interventions explicitly designed to address both forms simultaneously, such as dietary diversity promotion structured to ensure both micronutrient adequacy and energy balance. No such integrated intervention logic appears in any of the reviewed policies.

Food environment regulation represents the most critical gap. The WHO Essential Nutrition Actions framework [20] and the GNR (2020) [17] both identify food environment policy as foundational to addressing the full spectrum of malnutrition. Evidence from Chile demonstrates that mandatory front-of-package warning labels, combined with marketing restrictions and school food standards, meaningfully reduce purchases of high-sugar and high-fat products [28]. Mexico's sugar-sweetened beverage tax reduced consumption by approximately 7.6% overall and substantially more among low-income households [29]. A recent South Asian consensus statement on front-of-pack warning labels specifically highlights their relevance for contexts where diet-related NCDs and micronutrient deficiencies coexist [34]. Bangladesh's food policy architecture lacks all such instruments: no front-of-package labelling requirements, no fiscal measures on unhealthy foods, and no enforceable school food standards appear in any reviewed policy.

Multisectoral coordination represents an equally important structural weakness. Although the BNNC nominally coordinates across more than 17 ministries [24], it lacks binding authority, shared budgeting, and DBM-specific accountability frameworks. In practice, ministries often operate within institutional silos. For example, the health sector primarily focuses on supplementation and treatment, agriculture emphasizes production targets, and planning prioritizes economic growth, with limited coordination across sectors to address the common food system drivers of DBM. The GNR [17] identifies high-level governance with binding authority and shared accountability frameworks as essential for effective multisectoral nutrition coordination. However, current mechanisms do not meet this standard. Additionally, human resource capacity is similarly constrained, with training provisions across all policies focused exclusively on undernutrition management, leaving frontline workers without the skills to screen for or counsel on co-existing overnutrition. Agricultural extension workers, teachers, and social workers are entirely excluded from nutrition training frameworks.

Evidence-Based Conclusions and Priority Recommendations

Three evidence-based conclusions emerge from this analysis. First, Bangladesh's policies are structurally misaligned with the DBM burden, comprehensively addressing undernutrition while providing negligible guidance for overnutrition prevention or integrated DBM management. Second, the food environment regulatory gap is a primary driver of accelerating overnutrition, and evidence from multiple settings confirms that fiscal measures, warning labels, and marketing restrictions can reduce unhealthy food consumption. Third, effective DBM management requires household-level strategies, life-course surveillance, and governance mechanisms with binding multisectoral authority—all of which are absent from current policies.

On this basis, we propose a prioritized set of policy actions directly linked to the identified gaps. In the immediate term (0–2 years):

- DBM indicators should be included in routine monitoring. This would provide a baseline to track DBM and support recommendations to expand nutrition surveillance [1].
- DBM screening should be included in antenatal care services. This would use Bangladesh’s community clinics, which reach about 98% of the population but are currently underused for comprehensive nutrition services [35].
- A high-level DBM task force with cross-ministerial representation should be established to develop a national strategy with clearly assigned responsibilities. Evidence shows that

strong political commitment and executive champions are essential for effective multisectoral nutrition coordination [18,36].

In the medium term (2–5 years):

- NPAN2 should be revised to include explicit DBM goals, targets, and dedicated resources. This ensures integrated programming is properly financed and can improve service delivery practices [16,27].
- Food labeling laws, including mandatory front-of-package warning labels, and fiscal measures on sugar-sweetened beverages should be introduced. Evidence shows these policies reduce unhealthy food purchases, especially among lower-income households [36-39].
- DBM topics should be included in pre-service medical, nursing, and public health education. Training a workforce across the full spectrum of malnutrition is critical to respond to the nutrition transition [40].

Over the next 5–10 years:

- Bangladesh should aim to achieve universal coverage of integrated DBM services, implement comprehensive food environment regulations, and establish sustainable financing linked to DBM performance indicators. These actions are essential to achieve SDG 2.2 (ending all forms of malnutrition) and SDG 3.4 (reducing premature NCD mortality) by 2030.

Bangladesh's strong record in health system innovation, including successful scaling of community-based nutrition programs, provides a solid foundation to lead effective DBM responses in South Asia [41,42]. Realizing this potential will require sustained political commitment and institutional reforms to integrate DBM across sectors [41,43,44].

Strengths and Limitations

This study is strengthened by its consideration of major national policies across multiple sectors, use of an analytical framework grounded in three established international sources, and development of actionable recommendations aligned with feasibility timeframes. However, several limitations should be noted. Our analysis focused on policy intent as stated in documents rather than implementation fidelity or outcomes. Actual practice may differ substantially from written policies due to resource constraints, capacity limitations, or political factors. The national-level focus may not capture sub-national variations, local innovations, or implementation realities

at district and community levels. We analyzed policy content through narrative interpretation structured by our analytical framework. However, different analysts might emphasize different aspects. Although our analysis was limited to publicly available documents, we did not access confidential government materials or unpublished draft policies. Finally, formal engagement with implementing agencies, frontline workers, communities, and private-sector actors was not undertaken, which may limit our understanding of on-the-ground implementation challenges and contextual factors that influence the translation of policy into practice.

Conclusion

Bangladesh is at a critical stage of its nutrition transition, with persistent undernutrition coexisting alongside rapidly increasing overweight and obesity. Our analysis indicates that while national policies effectively address undernutrition, they remain inadequate for managing DBM due to gaps in integrated service delivery, monitoring and surveillance, human resource capacity, dietary guidance, food environment regulation, and multisectoral coordination. Addressing DBM requires a shift from siloed, undernutrition-focused approaches to integrated, life-course strategies that simultaneously prevent and manage both forms of malnutrition. The phased recommendations outlined in this analysis provide a practical roadmap for strengthening policy integration. Urgent action is needed to establish coherent DBM frameworks, strengthen health systems, regulate unhealthy food environments, and operationalize multisectoral coordination. Without timely intervention, DBM will continue to drive preventable morbidity, rising non-communicable disease costs, and missed Sustainable Development Goal targets; however, Bangladesh's strong track record in health system innovation positions it well to lead effective DBM responses in the region.

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Chapter 10: DBM Policy and Practice in Bangladesh

10.1 Chapter Context

This chapter addresses **Objective 4.2**, which aimed to explore stakeholder perspectives on the policy architecture and implementation of DBM in Bangladesh. The study conducted key informant interviews with national-level stakeholders, with the data analysed using reflexive thematic analysis. By examining stakeholder perspectives on the gaps and challenges in current policy and its implementation, the study provides insight into why these gaps persist and identifies priorities for strengthening the policy response to DBM. This complements the documentary findings presented in the preceding chapter. This chapter comprises one publication, which has been published in ***Current Developments in Nutrition*** journal.

10.2 Article on DBM Policy Implementation in Bangladesh

The following published article forms the foundation of this chapter:

Talukder A, Kelly M, Chanda SK, Gray D, Sarma H. The double burden of malnutrition in Bangladesh: Policy architecture, implementation realities, and future directions. ***Curr Dev Nutr.*** 2026. 109433. https://doi.org/10.1016/j.cdnut.2026.109433

The Double Burden of Malnutrition in Bangladesh: Policy Architecture, Implementation Realities, and Future Directions

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Statement of Contribution

This thesis is submitted as a Thesis by Compilation in accordance with
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I declare that the research presented in this Thesis represents original work that I carried out during my candidature at the Australian National University, except for contributions to multi-author papers incorporated in the Thesis where my contributions are specified in this Statement of Contribution.

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Authors: Ashis Talukder, Matthew Kelly, Sanjoy Kumar Chanda, Darren Gray, Haribondhu Sarma

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Abstract

Background

Bangladesh faces a growing double burden of malnutrition (DBM), where persistent undernutrition coexists with rapidly rising overweight and obesity. Although the country has a comprehensive national nutrition policy architecture, it remains unclear whether current policies address DBM as an integrated challenge.

Objectives

This study aimed to explore stakeholders' perspectives on the DBM in Bangladesh by examining how DBM is understood and framed, assessing the responsiveness of the current national nutrition policy architecture, identifying implementation challenges, and exploring policy and governance priorities for strengthening future nutrition outcomes.

Methods

This study employed a qualitative design conducted in Bangladesh between June and August 2025. A total of 12 purposively selected senior-level nutrition stakeholders participated in semi-structured key informant interviews (KII), including representatives from government, international and national non-governmental organisations, and research institutions. Participants were selected based on their expertise and direct involvement in nutrition policy development and implementation. Interview data were analysed using reflexive thematic analysis following Braun and Clarke, with themes generated inductively from participants' accounts. The integrated Health Policy Triangle–CDC Policy Process Framework (HPT–CDC) was used as an interpretive lens to contextualise and organise the emergent themes within established health policy frameworks.

Results

Key informant interviews generated four themes that extend beyond policy description to illuminate implementation realities, causal explanations, and reform priorities: (1) growing recognition of DBM among senior stakeholders that has not yet translated to frontline or community levels; (2) stakeholder-confirmed undernutrition-focused policy architecture, with explanatory accounts of the cognitive and institutional barriers preventing DBM integration; (3) implementation challenges characterised by symbolic multisectoral coordination, weak accountability systems without DBM-specific indicators, and limited subnational workforce

capacity; and (4) stakeholder-identified priorities including stronger multisectoral governance, food system regulatory reform, DBM-focused capacity building, and adaptation of existing programmes as double-duty actions.

Conclusions

Recognition of DBM in policy is necessary but insufficient without broader reforms in governance, programme design, and resource allocation. The ongoing revision of Bangladesh's National Plan of Action for Nutrition (NPAN-3) provides a timely opportunity to incorporate operational DBM indicators, adapt existing programmes as double-duty actions, and strengthen accountability systems to track progress across multiple forms of malnutrition. These findings may also inform policy responses in other low- and middle-income countries undergoing similar nutrition transitions.

Keywords: Double burden of malnutrition; nutrition policy; double-duty actions; Bangladesh; qualitative research.

Introduction

In recent decades, low- and middle-income countries (LMICs) have confronted an increasingly complex nutrition challenge: the simultaneous coexistence of undernutrition and overnutrition within the same populations, households, and even individuals across the life course, a phenomenon known as the double burden of malnutrition (DBM) [1, 2]. Driven by rapid economic development, urbanisation, and shifts in dietary patterns, this transition has progressed rapidly in many countries across Asia and Africa, placing mounting pressure on policy systems designed primarily for single-burden responses [3, 4]. Traditional policy approaches that address undernutrition and overnutrition separately are increasingly inadequate because both forms of malnutrition share common upstream determinants, including poverty, food insecurity, poor dietary quality, and inequitable food environments [5]. Moreover, the consequences of early-life undernutrition can increase the risk of obesity and diet-related non-communicable diseases (NCDs) later in life, highlighting the need for coordinated, life-course policy responses [6]. Fragmented policy frameworks may therefore generate unintended consequences, such as nutrition programmes that increase caloric intake without improving diet quality, potentially accelerating the transition towards overnutrition [7–9].

The presence of DBM is particularly evident across LMICs. Globally, over 45 countries experience both high levels of child stunting (>20%) and adult overweight (>35%), illustrating

the extensive and simultaneous presence of undernutrition and overnutrition within populations [10]. In South Asia, the proportion of households affected by both forms of malnutrition ranges from 6% to 20%, demonstrating that DBM occurs not only at the population level but also within households [11]. In response to this growing challenge, global health agencies increasingly advocate for integrated actions that address the shared determinants of undernutrition and overnutrition simultaneously. These include promoting breastfeeding, improving maternal and child nutrition during the first 1,000 days of life, creating healthier school food environments, and regulating the marketing of unhealthy foods to children. Such interventions have the potential to reduce undernutrition while also preventing overweight, obesity, and diet related noncommunicable diseases [1, 12, 13].

Bangladesh provides a compelling example of DBM during a rapid nutrition transition. Despite substantial progress in reducing child undernutrition over the past two decades, undernutrition remains a major public health challenge. According to the most recent Bangladesh Demographic and Health Survey (BDHS) 2022, 22.5% of children under five years of age were stunted and 9.7% were wasted, with the prevalence of wasting remaining nearly double the global target of less than 5% [14–16]. Micronutrient deficiencies also remain widespread, with anaemia affecting children, adolescent girls, and women of reproductive age, and deficiencies in vitamin A, iron, iodine, zinc, vitamin B12, and folate reported among young children, pregnant women, and lactating mothers [17]. These forms of undernutrition are concentrated among young children, adolescent girls, and poorer rural populations [18, 19]. At the same time, overweight and obesity have risen sharply, with 36.5% of women aged 15–49 years classified as overweight or obese in 2022, compared with only 9% in 2004 [14, 20]. This increase has been most pronounced among older, wealthier, and urban women, contributing to growing socioeconomic and rural–urban inequalities in nutritional outcomes [21]. The simultaneous presence of persistent undernutrition and micronutrient deficiencies alongside rapidly increasing overweight and obesity illustrates the complex nature of malnutrition in Bangladesh and highlights the need for integrated policy responses that address all forms of malnutrition simultaneously [22].

Bangladesh's nutrition policy architecture is guided by several key policy instruments. The National Nutrition Policy (2015) [23] provides the overarching strategic framework, while the Second National Plan of Action for Nutrition (NPAN-2) [17] translates this framework into action through a multisectoral implementation strategy involving 17 ministries across areas such as life-course nutrition, agriculture and dietary diversification, and social protection. The Bangladesh National Nutrition Council (BNNC) is responsible for coordinating nutrition-related activities

across 22 ministries [17, 22]. NPAN-2 established specific targets for reducing undernutrition and overnutrition, including reducing stunting among children under five years of age to 25% and limiting overweight and obesity among women of reproductive age to 30% by 2025 [17]. While the stunting target has been achieved, the target for overweight and obesity has not been met. Complementing these efforts, the National Food and Nutrition Security Policy (NFNSP, 2020) and its associated Plan of Action (2021–2030) [24] adopt a broader food systems approach aimed at improving dietary quality and promoting dietary diversification. As part of this strategy, the policy seeks to reduce the contribution of cereals to total dietary energy intake to below 60% by 2030 [24].

Despite this comprehensive policy architecture, implementation priorities have historically remained focused on reducing undernutrition, particularly among children and women, with comparatively limited operational attention to overnutrition [22]. Although global evidence increasingly promotes integrated "double duty" actions that simultaneously address undernutrition and overnutrition [5], it remains unclear to what extent such approaches are operationalised within national implementation in Bangladesh. In addition, there is limited empirical evidence on how key stakeholders interpret and translate these policies in practice. To the best of our knowledge, no previous study has systematically examined how policymakers, programme implementers, and technical experts understand DBM, assess existing policy responses, identify implementation barriers, and propose future policy directions in Bangladesh. Addressing this gap is essential for developing more coherent and effective strategies to strengthen nutrition policy implementation and tackle the growing prevalence of DBM.

This study addresses these gaps by investigating the perspectives of senior-level key stakeholders on DBM policy in Bangladesh. This study specifically explores: (1) how stakeholders understand and frame DBM within Bangladesh's nutrition transition context; (2) how stakeholders perceive and assess current national nutrition policy architecture in relation to DBM; (3) what implementation challenges constrain the translation of policy commitments into effective action; and (4) which policy and governance strategies stakeholders consider most important for improving future nutrition outcomes. By answering these questions, we aim to complement the existing policy analysis with stakeholder-grounded evidence to support the strengthening of Bangladesh's nutrition governance.

Methods

Study Setting

This study was conducted in Bangladesh between June and August 2025, coinciding with the final implementation phase of NPAN-2 and the preparatory period for its successor (NPAN-3). As a LMIC experiencing DBM and undertaking a revision of its national nutrition plan, Bangladesh provided a timely context for capturing stakeholder perspectives on current nutrition policy challenges and priorities for future reform.

Conceptual Framework

This study adopted an integrated conceptual framework combining Walt and Gilson's (1994) Health Policy Triangle (HPT) [25] with the CDC Policy Process Framework [26] (Figure 1). The HPT examines how context (Bangladesh's nutrition transition, governance structures, institutional environment), actors (government agencies, UN organisations, NGOs, researchers, community stakeholders), policy content, and policy processes interact to shape national DBM responses. The CDC Policy Process Framework operationalises the HPT's 'process' component through five core domains: (1) problem identification, (2) policy analysis, (3) strategy and policy development, (4) policy enactment, and (5) policy implementation, with two overarching domains, such as stakeholder engagement and education, and evaluation, operating continuously throughout the process.

This integration addresses each framework's limitations. The HPT provides contextual depth but lacks detailed process guidance, while the CDC framework offers clear process delineation but limited attention to contextual and actor-related factors [26, 27]. Together, the frameworks enable systematic examination of both structural determinants (context, actors, content) and dynamic processes (from problem identification to implementation) that shape DBM policy responses. This integrated approach is particularly relevant for DBM, which requires coordinated multisectoral action, engagement of diverse stakeholders with competing priorities, and navigation of complex contextual factors, including nutrition transition, institutional legacies, and resource constraints.

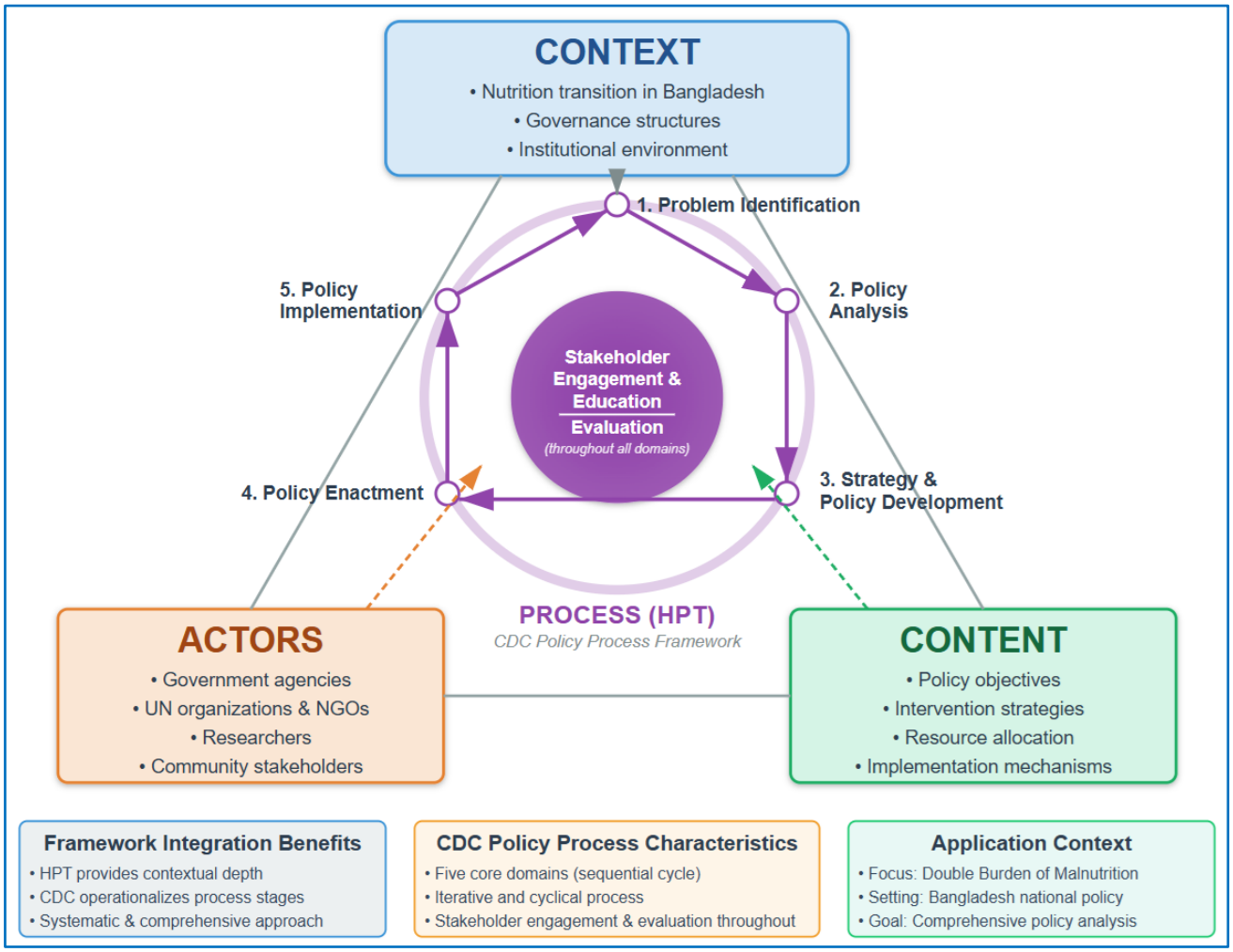

Figure 1: Integrated Conceptual Framework Combining the Health Policy Triangle and CDC Policy Process Framework for DBM Policy Analysis in Bangladesh.

Note: *The triangle represents the three HPT dimensions (Context, Actors, and Content) that interact with the central Process component, operationalised through five CDC framework core domains. Arrows indicate dynamic interactions between components. The framework acknowledges that policy processes are iterative and cyclical, continuously shaped by contextual factors, actor dynamics, and policy content. Abbreviations: HPT, Health Policy Triangle; CDC, Centres for Disease Control and Prevention; DBM, Double Burden of Malnutrition.*

Participant Selection and Recruitment for KII

Participants were selected using purposive sampling to obtain a range of perspectives from stakeholders involved in nutrition policy and programming in Bangladesh. Although effective responses to DBM require coordinated action across multiple sectors, this study focused specifically on stakeholders working within the nutrition sector because its primary aim was to examine how DBM is understood, prioritised, and addressed within Bangladesh's nutrition policy and programme architecture. The implications of not including stakeholders from other sectors are discussed in the 'study limitations' section.

Eligible participants had: (1) current or recent involvement in nutrition policy development, programme implementation, or technical advisory roles; (2) at least five years of experience working on nutrition issues in Bangladesh; and (3) the ability to provide informed perspectives on policy responses to malnutrition. To ensure variation across key stakeholder groups within the nutrition sector, participants were recruited from four categories: government nutrition authorities, international non-governmental organisations, national research and academic institutions, and subnational health and nutrition service providers. This approach enabled the inclusion of perspectives from individuals involved in policy development, technical advice, programme coordination, and frontline implementation at both national and subnational levels. Initial participants were identified through a review of nutrition policy documents, national coordination meeting records, and relevant literature, with additional participants recruited through snowball sampling [28, 29]. Potential participants were contacted by email and provided with study information before providing informed consent. Individuals who were approached but declined to participate or did not respond were not formally logged. All individuals who agreed to participate completed an interview.

Data Collection

A semi-structured interview guide was developed to explore participants' perceptions and experiences of DBM policy in Bangladesh. The guide was initially developed by the first author (A.T.) following a review of relevant literature and informed by the integrated HPT–CDC conceptual framework (Figure 1). It was further refined through iterative discussions within the research team to ensure conceptual alignment with study objectives, clarity of wording, and logical sequencing of questions. Attention was given to ensuring that questions were clearly structured and that probes were appropriate to elicit detailed and in-depth responses from participants. The final version of the interview guide is provided in supplementary file 1 (Appendix G).

The interview guide included open-ended questions organised into four main domains: (1) participants' awareness and perceptions of DBM within the context of Bangladesh's nutrition transition; (2) perspectives on existing national nutrition policies, including their scope in addressing undernutrition and overnutrition, and perceived policy gaps; (3) stakeholder roles, coordination mechanisms, and multisectoral governance arrangements; and (4) experiences of policy implementation, monitoring and evaluation processes, and views on future policy directions. The use of open-ended questions allowed participants to introduce additional issues

not anticipated a priori, in line with the flexible and exploratory nature of semi-structured interviews. The guide was designed to ensure comprehensive coverage of relevant policy domains while maintaining consistency across interviews.

Face-to-face interviews were conducted by the first author (A.T.) between June and August 2025. A.T. had prior experience conducting research on nutrition and health related topics in Bangladesh. Before data collection commenced, A.T. received training and mentorship in qualitative interviewing techniques, including probing, active listening, reflexive note-taking, and management of interviewer bias, from the senior author (H.S.), who has extensive experience in qualitative health policy research in low- and middle-income settings. H.S. also provided ongoing methodological oversight throughout the study. A.T. was not affiliated with any of the participating institutions and had no prior professional, supervisory, or working relationships with the participants. This independent position helped minimise the potential influence of existing organisational relationships, professional hierarchies, or perceived conflicts of interest on participant responses. After the first two interviews, H.S. reviewed the transcripts and field notes and provided structured feedback on question framing and probing depth, which informed minor refinements to the interviewing approach for subsequent interviews. Reporting of the qualitative methods follows the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [30], provided in supplementary file 2 (Appendix G). All participants, including those representing international organisations, were Bangladeshi nationals based in Dhaka and fluent in Bangla. Consequently, all interviews were conducted in Bangla. Only the participant and the interviewer (A.T.) were present during each interview. Interviews were audio recorded with participant consent and lasted approximately 40–60 minutes. A.T. used flexible probing throughout the interviews to encourage participants to elaborate on issues they considered important and to explore emerging topics in greater depth [29]. Field notes were maintained to document contextual observations, interview dynamics, and preliminary analytical reflections. All interviews were transcribed verbatim in Bangla and subsequently translated into English by A.T., a native Bangla speaker with professional proficiency in English. After each interview, A.T. reviewed the findings and tracked their alignment with the research questions and objectives.

Data collection concluded after 12 interviews. This decision was informed by the principle of information power [31], which suggests that the sample size required in qualitative research depends on factors such as the specificity of the study aim, the richness and relevance of information provided by participants, and the analytical approach employed. In this study, participants occupied senior policy, programme, and technical roles within Bangladesh's nutrition

sector and were selected for their direct experience with nutrition policy and implementation. Given the focused research objectives and the use of reflexive thematic analysis, the interviews generated sufficient depth and richness of information to address the study aims. Data collection concluded when successive interviews yielded no substantively new insights. Nevertheless, the relatively small sample size should be considered when interpreting the findings and is discussed further in the 'study limitations' section.

Data Analysis

Data were analysed using reflexive thematic analysis following the approach described by Braun and Clarke [32]. Analysis proceeded inductively, allowing themes to be generated from the data. The process followed six phases: familiarisation with the data through repeated reading of transcripts; generation of initial codes; development of themes; review and refinement of themes; definition and naming of themes; and production of the final analytic narrative.

The integrated HPT–CDC conceptual framework served as an interpretive lens during analysis. While themes were generated inductively from participants' accounts, the framework guided their interpretation with respect to the policy context, actors, content, and process. This approach allowed themes to emerge from participants' accounts while ensuring that findings were systematically connected to the established health policy framework. The first author (A.T.) conducted the coding, while the senior author (H.S.) reviewed the coding framework and thematic interpretations to ensure consistency and credibility. Emerging themes were discussed iteratively with all co-authors to refine interpretations and strengthen the trustworthiness of the analysis. The themes were mapped onto the HPT–CDC domains. All analysis was performed using NVivo 15 (QSR International Pty Ltd., 2023)

Results

Overview of Study Participants

A total of 12 participants were included, representing four stakeholder groups (Table 1): international non-governmental organisations working on nutrition (n=4), national research and academic institutions (n=3), government nutrition authorities (n=3), and subnational health and nutrition service providers (n=2). Ten participants worked primarily at the national level in policy

formulation, technical advisory, and programme coordination roles, while two provided subnational perspectives from district-level implementation contexts.

Table 1: Study participant distribution by stakeholder group and engagement level

Stakeholder Group	Number of Participants	Level of Engagement
International NGOs	4	National
National Research & Academic Institutions	3	National
Government Nutrition Authorities	3	National
Subnational Health and Nutrition Services	2	Subnational

Thematic Structure

The analysis generated four major themes that capture participants' accounts of Bangladesh's policy response to DBM (Table 2). Theme 1 examines how DBM is understood and framed at the policy level. Theme 2 explores the current nutrition policy landscape and its responsiveness to DBM. Theme 3 identifies implementation challenges constraining effective policy response. Theme 4 captures stakeholder perspectives on policy strengthening and future directions. Table 2 maps each theme and its sub-themes to the corresponding dimensions of the integrated HPT–CDC conceptual framework, illustrating how identified themes connect to the framework's domains and CDC policy stages.

Table 2: Thematic structure mapped to integrated HPT-CDC framework

Theme	Sub-themes	Framework Dimension(s)	CDC Policy Stage(s)
Theme 1: Understanding and Framing DBM	1.1 Shifting the meaning of malnutrition from undernutrition to dual burden 1.2 Ongoing challenges in defining and conceptualising DBM	• Context (nutrition transition, historical focus) • Actors (expert vs. community understanding)	• Problem Identification
Theme 2: Current Nutrition Policy Landscape and Responsiveness to DBM	2.1 Comprehensive multisectoral nutrition policies with a persistent focus on undernutrition 2.2 Absence of integrated DBM-specific frameworks and double-duty action approaches	• Content (policy substance) • Actors (multisectoral engagement) • Context (institutional arrangements)	• Policy Analysis • Strategy & Policy Development

Theme 3: Policy Implementation Challenges	3.1 Weak multisectoral coordination and policy implementation gaps 3.2 Weak monitoring, evaluation, and accountability systems 3.3 Insufficient human and institutional capacity for implementation	• Process (implementation mechanisms) • Actors (capacity, coordination) • Context (resource environment)	• Policy Implementation • Evaluation
Theme 4: Policy Strengthening and Future Directions	4.1 Enhancing multisectoral governance, food system transformation, and regulatory interventions 4.2 Strengthening implementation capacity, monitoring systems, and institutional mechanisms 4.3 Behaviour change communication and awareness programmes	• All dimensions (comprehensive strengthening) • Context (governance reform) • Actors (capacity building) • Content (policy revision) • Process (implementation systems)	• Strategy & Policy Development • Stakeholder Engagement & Education • All stages (iterative improvement)

Theme 1: Understanding and Framing DBM

Sub-theme 1.1: Shifting the Meaning of Malnutrition from Undernutrition to Dual Burden

Participants consistently described a fundamental shift in how malnutrition is conceptualised in Bangladesh, moving from a historically dominant focus on undernutrition to a growing recognition of a dual burden encompassing both undernutrition and overnutrition. This shift was linked to broader socioeconomic changes, including improvements in food security, reductions in poverty, and rising purchasing power, which have altered dietary patterns and nutritional risk profiles. As one government nutrition official explained:

"As food security has improved, poverty has declined, and purchasing power has increased, undernutrition has gradually fallen. However, this progress has been accompanied by a rise in overnutrition due to shifts in dietary patterns" (P1, Government nutrition authority).

Several participants noted malnutrition was previously understood almost exclusively as undernutrition, with limited overnutrition recognition as public health concern. Reflecting this evolving perspective, another government official stated:

"Previously, our general understanding of malnutrition was limited to undernutrition only. However, both undernutrition and overnutrition fall under the category of malnutrition" (P7, Government nutrition authority).

Participants further emphasised that this transition is evident at both population and household levels. They described declines in stunting and undernutrition alongside a rapid increase in overweight and obesity, particularly in urban areas (P12; Appendix G: Supplementary Table 1). Participants also highlighted that the dual burden of malnutrition is increasingly observed both within and across households. Within households, undernutrition and overnutrition may coexist simultaneously, for example where an overweight mother and an undernourished child live together. Across households in the same community, food-secure households were reported to experience overweight, while economically disadvantaged neighbouring households continued to face undernutrition (P9; Appendix G: Supplementary Table 1).

Despite growing recognition of the dual burden among policy-level and technical actors, participants identified persistent gaps in community-level understanding. A senior researcher highlighted the disconnect between expert discourse and public awareness:

"The concept of double burden of malnutrition does not actually exist in Bangladesh. It is neither recognised nor understood at the individual or household level" (P4, National research institution).

Sub-theme 1.2: Ongoing Challenges in Defining and Conceptualising DBM

Participants reported persistent conceptual ambiguities that complicate problem identification and policy formulation for DBM in Bangladesh. Absence of a universally accepted definition creates uncertainty among policy actors about what constitutes DBM and what should be prioritised in interventions. As one government official explained:

"To be honest, there is still no globally accepted definition. There is only a working definition provided by WHO, which we generally follow" (P7, Government nutrition authority).

Participants also attributed definitional ambiguity to both historical context and evolving scientific understanding. Malnutrition discourse in Bangladesh has long been dominated by undernutrition, dating back to a time when overnutrition was viewed as a problem confined to

Western countries. This historical framing creates enduring path dependencies continuing to shape how DBM is defined and understood (P3; Supplementary Table 2).

Although participants acknowledged that DBM understanding has expanded, they emphasised that prevailing definitions remain limited in scope. An International NGO representative highlighted that micronutrient deficiencies are often excluded from the conceptualisation of DBM:

"By double burden of malnutrition, we generally mean two things: overnutrition and undernutrition. One is malnutrition and the other is overnutrition—that is what we understand. But along with this double burden, there is another thing that is very important, and that is micronutrient deficiency" (P8, International NGO representative).

Participants also reported persistent uncertainty regarding DBM conceptualisation across age groups and life stages, highlighting importance of life-course perspective noting individuals may experience underweight and overweight at different life stages (P7; Appendix G: Supplementary Table 2).

The two sub-themes above indicate persistent challenges in DBM understanding and framing. Recognition remains largely limited to expert levels, with limited community awareness. Conceptual ambiguities, including roles of micronutrient deficiencies and life-course considerations, leave policy actors working with incomplete frameworks. Historical undernutrition-focused policies further constrain the adoption of a dual-burden perspective. These problem-identification gaps extend throughout the policy process, contributing to content gaps and implementation challenges described in Themes 2 and 3.

Theme 2: Current Nutrition Policy Landscape and Responsiveness to DBM

Sub-theme 2.1: Comprehensive Multisectoral Nutrition Policies with Persistent Focus on Undernutrition

Bangladesh's national nutrition policy architecture formally acknowledges both malnutrition forms but with markedly different emphasis: undernutrition receives considerably more attention and detailed intervention guidance, while overnutrition is addressed only through generic behaviour change communication and without programmatic specificity. Stakeholders confirmed

this structural pattern and, critically, offered explanatory accounts of why it has persisted despite growing epidemiological awareness of overnutrition.

Participants observed that while DBM is increasingly recognised in principle, policy guidance remains uneven in depth and specificity. As one government official explained:

"In the process of formulating the new policy, there is an initiative to address DBM, although the work has not yet begun" (P6, Government nutrition authority).

Despite comprehensive multisectoral frameworks, participants reported that historical undernutrition focus continues to shape policy priorities and implementation. Undernutrition dominates across ministries, influencing programme design and operational practices. As one government official summarised:

"Unfortunately, everything is still undernutrition-centric. Whether we talk about programs or policies, the main focus remains undernutrition" (P7, Government nutrition authority).

Although policies acknowledge rising overweight and obesity, interventions, training, technical guidance, and communication materials remain largely undernutrition-focused, leaving frontline workers less equipped to response to overnutrition across population groups (P2, P7, P8; Appendix G: Supplementary Table 3).

Sub-theme 2.2: Absence of Integrated DBM-Specific Frameworks and Double-Duty Action Approaches

Participants reported that Bangladesh lacks a formal, integrated policy framework specifically designed to address DBM. This gap was attributed not only to structural limitations but also to prevailing mindsets among policymakers. A government nutrition official reflected on this evolving policy awareness, stating:

"The main reason it has not been included in the policy is that our mindset has not yet fully evolved. I have been emphasising this for the past two to three years. Our discourse has focused heavily on stunting—an issue we have been addressing for the last 20 years" (P7, Government nutrition authority).

Participants described this as a lag between epidemiological reality and policy cognition. Representatives from International NGO and the government noted:

"Effective interventions, links, or strong separate policies for overnutrition are not there. That part is missing" (P8, International NGO representative).

"If you go to programmatic level… whether there is anything that specifically addresses the double burden of malnutrition with a double duty action approach, the answer is no" (P7, Government nutrition authority).

Theme 3: Policy Implementation Challenges

Sub-theme 3.1: Weak Multisectoral Coordination and Policy Implementation Gaps

Participants identified a critical disconnect between formal structures and functional operationalisation. While comprehensive frameworks exist with explicit coordination mandates, on-the-ground translation was described as weak. An international NGO representative noted:

"Bangladesh performs well in policy adoption, comparable to many countries. But when it comes to implementation, we face significant challenges" (P9, international NGO representative).

This assessment was echoed across stakeholder groups. A UN agency representative and academic institution participants emphasised that while policies are well-developed, implementation falls short of original intent, with implementation challenges rather than policy design identified as the primary constraint (P2, P5; Appendix G: Supplementary Table 5). Nutrition is inherently multisectoral, yet sectors operate largely in silos with limited functional coordination despite formal structures. As a UN agency representative explained:

"Nutrition is a multisectoral issue, not the responsibility of a single ministry. The Bangladesh National Nutrition Council (BNNC) under the Ministry of Health is supposed to coordinate across 22 ministries, but it lacks the mechanisms to regularly monitor or review progress" (P2, UN agency representative).

Weak coordination challenges extend beyond organisational structures to accountability gaps. Participants noted the absence of effective mechanisms to ensure that non-health sectors fulfil their nutrition-related responsibilities, limiting accountability and cross-sectoral commitment to nutrition objectives (P8; Appendix G: Supplementary Table 5).

Sub-theme 3.2: Weak Monitoring, Evaluation, and Accountability Systems

Despite formal provisions, participants identified persistent weaknesses in the functioning of monitoring, evaluation, and accountability mechanisms. Although monitoring policies formally exist, they lack rigorous mechanisms for effective oversight. As a government nutrition authority explained:

"The monitoring mechanism is very weak" (P6, Government nutrition authority).

Government monitoring lacks adequate strength because routine activity tracking fails to capture service quality or verify information accuracy provided to beneficiaries (P8; Appendix G: Supplementary Table 6). Participants reported gaps between formal monitoring systems outlined in policies and practical application. A researcher highlighted this deficit:

"There is a monitoring policy, but in practice, it is not fully implemented" (P3, National research institution).

Participants identified critical gaps related to routine data collection and systematic evaluation. Key nutrition indicators, particularly anthropometric measurements, are not consistently tracked across service delivery points (P1, P3; Appendix G: Supplementary Table 6). Systematic weaknesses in evaluation compound this data gap, with agencies often lacking basic information on policy outcomes and unable to demonstrate implementation progress or impact (P10; Appendix G: Supplementary Table 6).

Sub-theme 3.3: Insufficient Human and Institutional Capacity for Implementation

Interviewed participants identified critical shortages of trained, dedicated personnel as major constraints affecting policy implementation and scale-up. Workforce limitations extend from national coordination bodies to frontline service delivery. At the national level, institutional capacity constraints are particularly evident in coordinating bodies. Despite formal mandates, BNNC was described as under-resourced and lacking authority. A UN agency representative explained:

"BNNC is expected to coordinate across 22 ministries, but it has limited manpower and authority. Even though the government has given them a mandate, a small and weak

directorate-level institution cannot effectively supervise so many ministries" (P2, UN agency representative).

Capacity constraints within technical institutions compound these challenges. Institutions like IPHN lack the manpower required even for limited geographical implementation (P6; Appendix G: Supplementary Table 7). These institutional capacity deficits restrict the system's ability to provide oversight, technical guidance, and quality assurance for nutrition programming.

At the frontline level, participants described substantial human resource gaps limiting nutrition service delivery. No specific nutrition workers exist at the field level, and family planning workers already carrying multiple priorities leave nutrition competing for attention (P8; Appendix G: Supplementary Table 7). Nutrition activities are often carried out by workers whose primary responsibility is not nutrition. A government nutrition authority explained:

"The primary problem is human resources. Nutrition has no dedicated human resources and depends on proxies who do not consider it their main task" (P7, Government nutrition authority).

Beyond workforce numbers, available personnel often lack the skills and training needed to implement nutrition interventions effectively. This skills gap reflects inadequate training, leaving workers unable to operationalise policies, even when they are explained. A UN agency representative highlighted:

"They have not been trained... even if you explain the policy, they cannot implement it because they are unaware" (P10, UN agency representative).

Theme 4: Policy Strengthening and Future Directions

Sub-theme 4.1: Enhancing Multisectoral Governance, Food System Transformation, and Regulatory Interventions

Participants highlighted the need to strengthen multisectoral governance mechanisms and to expand policy responses beyond the health sector. Current coordination bodies face persistent institutional weaknesses, particularly regarding the capacity to fulfil coordination mandates effectively (P11; Appendix G: Supplementary Table 8). Stronger governance requires clearer role

definitions, improved accountability, and broader stakeholder engagement. As an international NGO representative stated:

"It must clearly state the responsibilities of each stakeholder… otherwise there will be a big gap" (P8, International NGO representative).

Participants also highlighted the need to engage private-sector actors in nutrition governance as a critical strategy addressing emerging nutrition challenges (P10; Appendix G: Supplementary Table 8).

Stakeholders recognised healthy diets as a central component of efforts to address DBM and emphasised the need to move beyond a traditional focus on food security towards improving dietary quality. As an international NGO representative noted:

"Food security alone is not enough; attention must be given to food quality" (P9, International NGO representative).

A prominent regulatory concern raised was the sale of unregulated, unhealthy food near schools. Participants described widespread availability of highly processed, energy-dense snacks within school vicinities, emphasising the need for enforceable restrictions. As one subnational health and nutrition service provider noted:

"In front of every school… there's always a fast-food shop. If they could be fined or restricted, it would help" (P11, Subnational health and nutrition services).

Sub-theme 4.2: Strengthening Implementation Capacity, Monitoring Systems, and Institutional Mechanisms

Building on implementation and monitoring gaps identified in Theme 3, participants identified strategies enhancing Bangladesh's ability to operationalise nutrition policies and respond effectively to DBM. Strengthening implementation was repeatedly highlighted as a priority, with participants noting policies are strong but lack proper follow-through (P2; Appendix G: Supplementary Table 9). Systematic project assessment is essential for learning and improvement. As a district health education officer stated:

"If a three-month pilot is done but not evaluated, nothing improves" (P11, Subnational health and nutrition services).

Strengthening monitoring and verification systems is essential for accountability. Participants identified need for functional surveillance systems enabling evidence-based decision-making. Proper record-keeping allows early problem identification and rapid response (P8; Appendix G: Supplementary Table 9).

Building human and institutional capacity emerged as a key priority to directly address workforce constraints. Frontline workers often lack specific skills in implementing nutrition policies effectively (P10; Supplementary Table 9). Strengthening coordination structures and ensuring adequate local-level resources were also recommended:

"The District Nutrition Coordination Committee needs to be made functional with proper support" (P11, Subnational health and nutrition services).

Participants highlighted emerging positive developments, such as research partnerships and digitised reporting systems that have the potential to be scaled up. Research on trans-fat was reported to have already contributed to the establishment of new national laboratory capacity (P9; Appendix G: Supplementary Table 9).

Sub-theme 4.3: Behaviour Change Communication and Awareness Programmes

Behavioural Change Communication (BCC) is widely recognised as a fundamental strategy for addressing both undernutrition and overnutrition in Bangladesh. Interviewed participants emphasised the central role of systematic communication and knowledge dissemination across stakeholder groups. A government nutrition official noting:

"The main strategy is counselling and communication aimed at changing behaviour" (P1, Government nutrition authority).

Participants highlighted mass media campaigns as key mechanisms for reaching wide audiences, drawing lessons from successful initiatives, such as oral rehydration solution (ORS) awareness programmes (P2; Appendix G: Supplementary Table 10). This example demonstrated how consistent public education translates into widespread knowledge and behaviour change at the community level, providing a potential model for DBM-related nutrition messaging.

Health professionals play a critical role in initiating and sustaining BCC, even in the absence of formal policies or programmes (P10; Appendix G: Supplementary Table 10). The absence of

comprehensive overnutrition policies limits the development of structured BCC programmes. A senior researcher explained:

"First, we don't have a comprehensive policy on overweight and obesity. Without it, awareness campaigns and training cannot be properly implemented" (P3, National research institution).

Discussion

This study identified a range of conceptual, policy, and implementation challenges that stakeholders perceived as constraining effective responses to DBM in Bangladesh. Findings suggest that limitations in how DBM is understood, prioritised, and translated into policy and practice continue to hinder effective responses. Stakeholders highlighted challenges related to conceptual clarity, competing policy priorities, multisectoral coordination, and implementation capacity, which may impede the translation of growing awareness of DBM into coherent and sustained action. Addressing these challenges will require stronger alignment between policy objectives and implementation realities, as well as greater attention to how DBM is incorporated into policy planning, programme design, and service delivery. Drawing on the perspectives of 12 senior nutrition stakeholders, this study contributes empirical evidence on perceived gaps in current policy responses and identifies stakeholder priorities for strengthening future efforts to address DBM in Bangladesh.

Themes 1 and 2 help explain why Bangladesh's nutrition policies remain undernutrition-centric despite growing recognition of overnutrition. Stakeholders described a persistent 'path dependency' [33], in which priorities established during decades of undernutrition programming continue to shape policy cognition, funding flows, and institutional culture. In this 'adding on' dynamic, overnutrition concerns are appended to existing frameworks without meaningful reorientation, reflecting a lag between epidemiological reality and policy understanding [33, 34]. The lack of a widely operationalised DBM definition further compounds this challenge, with ongoing ambiguity around what constitutes DBM, which age groups should be prioritised, and how micronutrient deficiencies fit within the dual burden framework. These conceptual gaps help explain the structural policy limitations identified in Theme 2. Overnutrition remains insufficiently integrated into policy, highlighting that the absence of double-duty actions stems from institutional and cognitive factors that require engagement at the actor level, rather than simple policy revision [5].

Findings from Theme 3 highlight implementation gaps as a central challenge in Bangladesh's nutrition policy, reflecting a broader disconnect between policy intentions and practical realities in global nutrition governance [35, 36]. Three interrelated barriers were identified: weak multisectoral coordination, insufficient monitoring and accountability systems, and persistent resource and workforce constraints. Although formal structures such as the BNNC exist, stakeholders described multisectoral coordination as largely symbolic, with nutrition often viewed by non-health sectors as outside their remit. This underscores the absence of a truly operational multisectoral approach, which is essential for effectively addressing DBM [37]. Coordination challenges were also apparent at subnational levels, where platforms suffered from irregular meetings and limited logistical support, indicating that gaps extend beyond national structures to the frontline settings where interventions are delivered. These findings align with prior evidence that effective multisectoral nutrition action requires functional coordination at district and community levels, supported by adequate resources, clear mandates, and robust accountability frameworks [35, 37, 38].

Monitoring and accountability gaps were identified as a major constraint in Sub-theme 3.2. Although policy documents outline monitoring mechanisms, participants reported that their implementation remains weak. Existing data systems do not adequately capture service quality or provide timely information to guide decision-making. In particular, the lack of routine anthropometric measurements and the absence of DBM-specific indicators were highlighted as critical shortcomings. The 2020 Global Nutrition Report notes that when monitoring systems focus primarily on undernutrition while neglecting overweight, obesity, and diet-quality indicators, implementation tends to default to traditional undernutrition-focused interventions [10]. Accountability for nutrition outcomes is also limited, with few consequences for poor performance, reducing incentives for implementers to maintain high-quality service delivery [10, 39, 40].

Sub-theme 3.3 highlighted human resource constraints as one of the most critical barriers to effective policy implementation. Participants described the absence of a dedicated nutrition workforce at the frontline, with existing staff already overburdened and nutrition responsibilities often treated as secondary tasks. Capacity is further constrained by a lack of DBM-specific skills, as most personnel are trained primarily in undernutrition-focused approaches. These findings align with previous evidence showing that inadequate workforce capacity undermines the effectiveness of nutrition programmes across LMICs [41–44]. Limited budget allocations for

nutrition-specific interventions further exacerbate the challenge, indicating that fiscal commitments have not kept pace with policy rhetoric on DBM [10, 45].

Reflecting the reform priorities highlighted in Theme 4, participants identified several key areas for strengthening nutrition policy, including enhancing multisectoral governance, advancing food system reforms through regulatory measures, improving implementation capacity and monitoring, and expanding BCC initiatives. They emphasised the importance of functional, rather than symbolic, coordination mechanisms, echoing previous evidence that successful nutrition action requires clearly defined roles, robust accountability structures, and active engagement across sectors beyond health [46]. The call to strengthen subnational coordination is consistent with experiences from the 'Nutrition Officers in Tanzania' initiative, where effective implementation relied on empowered district-level platforms and clearly defined authority [47].

Emphasis on food system approaches—including trans-fat regulation, sodium reduction, nutrient profiling, and restrictions on unhealthy foods near schools—reflects alignment with global evidence on obesity prevention [48, 49]. However, participants noted that while such regulations exist, enforcement remains weak, highlighting the need for implementation infrastructure, including laboratory capacity, inspection systems, and clear enforcement authority. Expanding the definition of food safety to encompass nutritional harm represents an important conceptual shift, with the potential to strengthen regulatory action [49, 50].

The emphasis on implementation capacity and monitoring reflects recognition that Bangladesh's primary challenge lies in execution rather than policy formulation. Participants stressed the importance of evaluation and learning, noting that "if a pilot is done but not evaluated, nothing improves," underscoring the role of learning systems in adapting policies. Emerging research partnerships and digitised reporting systems provide a foundation for continuous quality improvement, but these mechanisms require further scaling and institutionalisation. Participants also highlighted BCC as a critical component of effective nutrition policy, as it shapes dietary knowledge, attitudes, and practices that influence nutritional outcomes. However, they noted that BCC efforts in Bangladesh remain heavily focused on undernutrition, with comparatively limited and less developed initiatives targeting overnutrition and unhealthy diets [51,52].

Taken together, the four themes of this study highlight that a DBM-responsive policy architecture is not simply a matter of appending overnutrition programmes to existing undernutrition frameworks. Instead, it requires what Hawkes and colleagues describe as "double-duty actions":

interventions, programmes, and policies deliberately designed or adapted to address the shared drivers of undernutrition, overweight, obesity, and diet-related NCDs within the same populations or households [5]. The Lancet series on DBM further identifies such actions with strong evidence potential, categorised around four key domains: early-life nutrition, diet diversity, food environments, and socioeconomic factors [5].

Bangladesh has existing platforms that could be adapted for double-duty purposes. Breastfeeding promotion already features in the NNP [23] and NPAN-2; enhancing enforcement of the International Code of Marketing of Breast-milk Substitutes and expanding community lactation support could strengthen both undernutrition and obesity prevention [5]. The National School Feeding Policy [53, 54], could be adapted to emphasise dietary diversity, locally sourced foods, and limits on added sugar, salt, and saturated fat, simultaneously addressing micronutrient deficiencies and unhealthy dietary exposure [55, 56]. Social protection programmes such as the Mother and Child Benefit Programme (MCBP) can act as double-duty interventions if paired with BCC focusing on diet quality [57]. Finally, food environment interventions such as front-of-pack labelling [58, 59] and marketing restrictions on unhealthy foods would reduce exposure to ultra-processed foods, benefiting both undernourished and overweight populations [54]. These examples highlight that Bangladesh does not need to develop DBM policy from scratch; rather, existing programmes can be systematically adapted, monitored, and integrated through a double-duty lens, using combined indicators to capture co-benefits and manage potential trade-offs.

Implications for Policy and Practice

Our findings have several important implications for nutrition policy in Bangladesh and similar contexts. First, while existing programmes provide opportunities for double-duty interventions, addressing DBM ultimately requires moving beyond “policy add-ons” towards a broader reorientation of nutrition governance, including integrated policy frameworks, stronger multisectoral coordination, and balanced resource allocation. Second, strengthening implementation must be prioritised alongside policy formulation, with particular emphasis on improving multisectoral coordination, establishing functional monitoring and accountability systems, and building adequate workforce capacity. Third, conceptual clarity around DBM definitions and operationalisation is essential for translating recognition into action. Fourth, greater emphasis is needed on food system approaches, including regulatory measures and environmental modifications, to complement individual-level interventions.

For policymakers, ongoing revisions such as NPAN-3 provide an opportunity to integrate DBM into national frameworks, clarify implementation processes, strengthen monitoring indicators for both forms of malnutrition, and align resource allocation with current nutrition trends. For program implementers, the findings highlight the need for workforce training on integrated approaches, strengthened supervision systems, and adaptation of intervention packages to address risk factors associated with both forms of malnutrition.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, although DBM is inherently a multisectoral issue and participants frequently emphasised the importance of engagement beyond the nutrition sector, all participants were recruited from nutrition-sector organizations. Consequently, perspectives from stakeholders in other sectors relevant to DBM, such as agriculture, education, food systems, trade, and urban planning, were not captured. Future research could extend this work by examining how actors across these sectors understand and respond to DBM. Second, the sample size was relatively small. Although participants were purposively selected for their direct involvement in nutrition policy and implementation, and the sample size was guided by the principle of information power, the findings may not reflect the full range of perspectives present within Bangladesh's broader nutrition and policy landscape. Relatedly, data collection was conducted over a three-month period (June–August 2025), which limited the time available for more participants recruitment. A longer recruitment period may have facilitated engagement with additional senior stakeholders, particularly from academic and research institutions.

Third, the cross-sectional design captured stakeholder perspectives at a single point in time during ongoing policy review and implementation processes. As nutrition policies, governance arrangements, and programmatic priorities continue to evolve, stakeholder perspectives may also change over time. Longitudinal research could provide further insights into how understandings of DBM and policy responses develop in response to evolving policy contexts. Fourth, transcripts were not returned to participants for comment or correction, and member checking of emergent themes was not conducted due to time and scheduling constraints that limited the feasibility of a second round of stakeholder consultation. Finally, participant responses may have been influenced by social desirability bias, particularly when discussing politically sensitive issues such as policy implementation challenges, institutional constraints, and resource allocation.

Efforts were made to minimise this risk by assuring participants of confidentiality and encouraging open discussion during interviews.

Conclusion

Drawing on the perspectives of 12 senior stakeholders within Bangladesh's nutrition sector, this study provides timely, stakeholder-informed evidence to inform nutrition governance during a critical policy revision period. We recommend three priority actions for policymakers: (1) operationalise DBM definitions within NPAN-3 with clear indicators and resource allocations; (2) establish effective multisectoral coordination mechanisms with dedicated budgets and robust accountability systems at both national and subnational levels; and (3) invest in workforce capacity to support integrated approaches that address both undernutrition and overnutrition. Development partners can reinforce these efforts by aligning technical assistance with double-duty action frameworks, improving monitoring systems that capture the full spectrum of malnutrition, and facilitating evidence exchange with countries navigating similar transitions. It is evident that recognising DBM in policy is necessary but insufficient without deeper reforms in governance, implementation, and resource allocation—an emerging challenge for many LMICs undergoing rapid nutrition transitions.

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Section V: Knowledge Integration

Chapter 11: Discussion and Conclusion

11.1 Chapter Overview

This chapter synthesises the findings from the seven papers comprising this thesis and interprets them within the broader context of the nutrition transition and double burden of malnutrition (DBM) in South and Southeast Asia. It brings together evidence on the conceptualisation and measurement of household-level DBM, its prevalence and trends, associated factors, and policy responses to the changing nutrition landscape. The discussion is structured around four interrelated objectives: (1) defining and measuring DBM across individual-level, household-level, and population-level assessment (Paper 1); (2) examining its prevalence and trends across South and Southeast Asia (Paper 2); (3) investigating its determinants through a systematic synthesis and subsequent examination of specific interactions and risk factors (Papers 3 to 5); and (4) analysing nutrition policy responses through a Bangladesh case study combining document analysis and stakeholder interviews (Papers 6 and 7). Together, these studies provide an integrated account of household-level DBM, from its conceptualisation and epidemiology to its determinants and policy responses.

Sections 11.2–11.5 interpret the findings in relation to the four objectives of the thesis. Section 11.6 then integrates these findings, followed by a discussion of the methodological contributions, limitations, and implications for policy, practice, and future research.

11.2 Definitional Heterogeneity and Conceptual Foundation of DBM Research

A foundational contribution of this thesis is the systematic examination of how DBM has been operationalised in the literature. The review found substantial heterogeneity in the definition and measurement of DBM across individual, household, and population levels. Studies varied considerably in the indicators used to define undernutrition and overnutrition, the anthropometric thresholds applied, and the combinations of nutritional outcomes used to classify DBM. Consequently, prevalence estimates differed markedly across studies and settings, limiting comparability and complicating the synthesis of evidence, and creating challenges for identifying shared policy priorities and monitoring progress across countries.

These findings extend earlier work by Davis et al. (2020) [1], whose systematic review identified similar diversity in DBM definitions and proposed a classification framework built around three dimensions: level of assessment, target population, and form of malnutrition. Their framework offered a flexible approach for selecting indicators fit for purpose, but deliberately avoided recommending a single standardised operational definition at each level. Paper 1 extends this work in two respects. First, rather than providing only a flexible framework, it synthesises the available evidence to propose a recommended operational definition for DBM at the household, individual, and population levels, providing a more consistent basis for measurement and comparison across studies. Second, at the population level, Paper 1 introduces prevalence thresholds informed directly by evidence, addressing a gap where standardised population-level criteria had not previously been established. Paper 1 also diverges from Davis et al. on one substantive point. Since their framework retains cardiometabolic risk factors such as hypertension and diabetes as a valid component of the overnutrition dimension, Paper 1 excludes these conditions from its individual-level definition, treating them as consequences of chronic disease rather than direct indicators of nutritional imbalance. This distinction helps conceptually separate the double burden of malnutrition from the broader double burden of disease.

This heterogeneity has implications beyond measurement. At the household level, the widespread reliance on the pairing of a mother with overweight or obesity and a child with stunting largely reflects the structure and availability of DHS-type survey data, rather than the full range of possible combinations of undernutrition and overnutrition within households. Other combinations, such as children with overweight or obesity and mothers who are underweight, or those involving fathers and older household members, remain largely unexplored. Consequently, existing estimates may underestimate the overall burden of household-level DBM. At the population level, only three previous studies had proposed prevalence thresholds, developed independently and not directly comparable, limiting monitoring across countries. Importantly, this lack of conceptual clarity is not confined to academic research: stakeholder interviews in Paper 7 showed that policymakers in Bangladesh also lacked a shared definition of DBM and often relied on provisional WHO working definitions [2]. Together, Papers 1 and 7 indicate that definitional inconsistency is not simply a methodological issue but also a practical challenge for policy formulation, monitoring, and intersectoral coordination. The standardised definitions and measurement criteria proposed in Paper 1, spanning individual, household, and population levels and aligned with WHO benchmarks [3-5], provide a more consistent foundation for DBM research and strengthen the empirical analyses that follow in this thesis.

11.3 Epidemiological Landscape of DBM in South and Southeast Asia

Paper 2 analysed two decades of DHS data from Bangladesh, Cambodia, Nepal, and Timor-Leste and identified a consistent increase in household-level DBM across all four countries (Figure 1). This trend reflects an uneven nutrition transition, characterised by a rapid increase in the prevalence of overweight and obesity among mothers alongside slower declines in child undernutrition, which remains prevalent. These findings are consistent with the broader nutrition transition literature, which links economic growth, urbanisation, and changes in dietary patterns and lifestyles to an increasing prevalence of overweight and obesity among adults [6–12]. However, the nutrition transition does not affect all household members equally. In many low- and middle-income countries, mothers may have greater access to inexpensive, energy-dense but nutrient-poor foods, contributing to excess weight gain, while children continue to experience inadequate dietary diversity, micronutrient deficiencies, recurrent infections, and suboptimal feeding practices that contribute to undernutrition [13–16]. Consequently, the coexistence of mothers with overweight or obesity and children with undernutrition within the same household may become increasingly common, reinforcing previous evidence that the nutrition transition contributes to household-level DBM in low- and middle-income countries [6, 7, 17].

These findings also provide a more up-to-date picture of household-level DBM in the region. Biswas et al. (2021) analysed DHS data from eight South and Southeast Asian countries between 2007 and 2016, reporting a pooled prevalence of household-level DBM of approximately 12%, based on the coexistence of mothers with overweight or obesity and children with undernutrition [18]. In contrast, the present analysis shows that household-level DBM has continued to increase in more recent survey rounds across the four countries included in this study, indicating a higher and rising burden than earlier pooled estimates suggested [13]. This suggests that the burden of household-level DBM has not stabilised, reinforcing concerns about the ongoing nutrition transition and its uneven effects within households.

Importantly, the epidemiological pattern observed in Paper 2 indicates that the increasing burden of DBM is not driven solely by changes in maternal nutritional status. Rather, it reflects the coexistence of an increasing prevalence of overweight and obesity among mothers and persistent undernutrition among children within the same households. Understanding why these conditions continue to coexist requires consideration of the socioeconomic, maternal, behavioural, and health service factors examined in the subsequent papers.

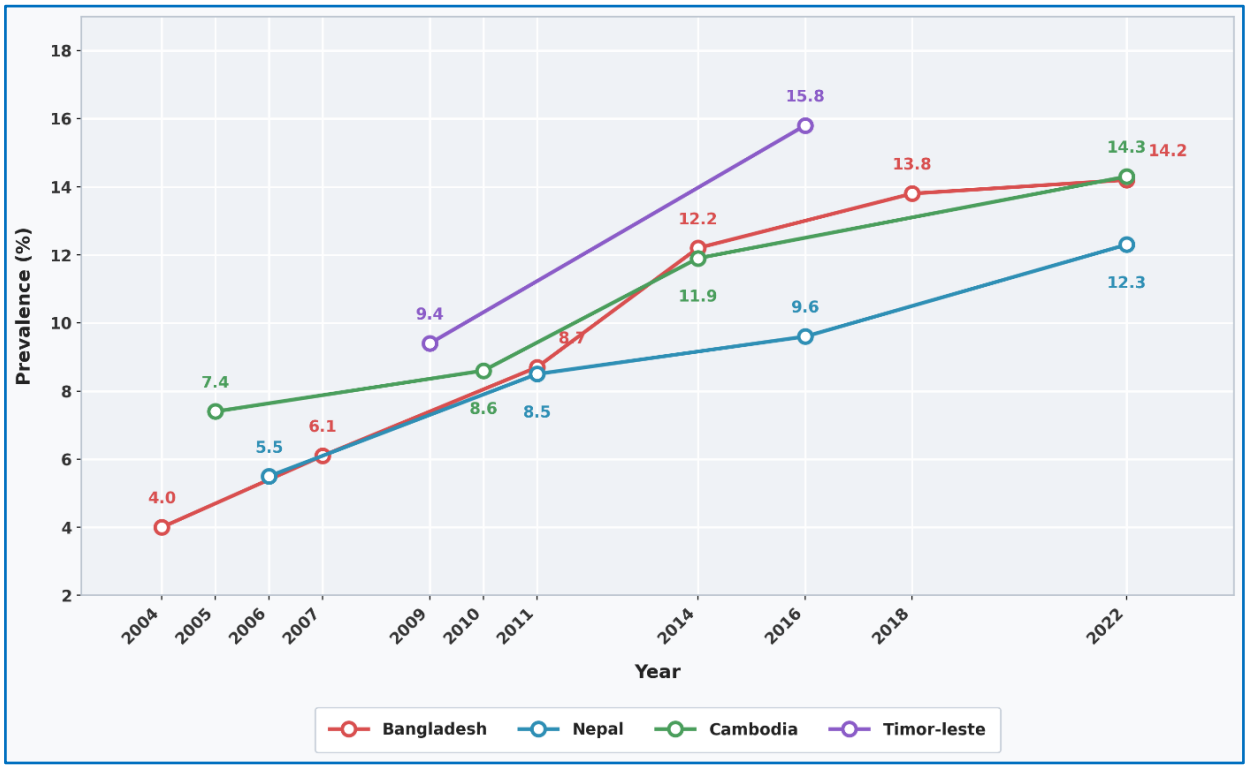

Figure 1: Country-wise trends in the prevalence of household-level DBM in selected countries in South and Southeast Asia

Note: The figure was adapted from Paper 2 and Paper 4 (for the 2022 Bangladesh estimates) of this thesis. Here should be mentioned that the time points are not uniform across countries, as the analysis was based on the availability of Demographic and Health Survey (DHS) data for each respective country.

11.3.1 Religious and Cultural Context

The four study countries differ considerably in their religious and cultural contexts. Bangladesh is predominantly Muslim, Nepal predominantly Hindu, Cambodia predominantly Buddhist, and Timor-Leste predominantly Christian [19]. Religious beliefs and cultural traditions may influence maternal and child nutrition through breastfeeding, complementary feeding, food choices and household dietary practices. For example, Islamic teachings encourage mothers to breastfeed their children for up to two years [20,21], promote moderation in food consumption, and provide dietary guidelines through halal requirements that distinguish permissible from prohibited foods [20,21]. Hindu and Buddhist traditions may involve vegetarianism, fasting, dietary restrictions and culturally specific child-feeding practices [20]. However, these religious and cultural practices vary within and between communities, and their influence on nutritional behaviours may depend on maternal education, household wealth, food availability and access to healthcare [22,23]. Although these contextual differences may be relevant to understanding household-level DBM, religious and cultural factors were not directly examined in this thesis. Therefore,

differences in DBM prevalence and trends across the four countries should be interpreted in relation to broader socioeconomic conditions, food environments and healthcare access, rather than attributed to religious or cultural differences.

11.4 Multilevel Determinants of Household-Level DBM

The findings across Papers 2 to 5 indicate that household-level DBM is shaped by the interplay of socioeconomic, maternal, behavioural, and health service factors rather than by any single determinant. Household wealth, maternal characteristics and education, breastfeeding practices, antenatal care, and caesarean delivery each influence different aspects of the coexistence of undernutrition and overweight. Taken together, these findings suggest that household-level DBM is a manifestation of the broader nutrition transition, but its occurrence is shaped by inequalities in household resources, knowledge, maternal health and behaviours, and access to preventive and supportive health services.

11.4.1 Household Wealth and Urban Patterning

Household wealth was consistently associated with a higher odds of DBM across the studies. Rather than indicating that DBM is concentrated exclusively among poorer households, this finding suggests that the socioeconomic patterning of malnutrition changes as countries undergo nutritional and economic transition [24-26]. Increasing household resources may improve access to food and other necessities, but these benefits may not be distributed equally across household members or translate into improved child nutritional outcomes [27-29]. Thus, economic advancement at the household level does not necessarily protect against the coexistence of maternal overweight and child undernutrition.

Urban residence showed a similar association with DBM. Although urban households may have greater access to health, food, and economic opportunities, urban environments are also characterised by substantial socioeconomic inequalities [13, 22, 30, 31]. These inequalities may result in markedly different nutritional circumstances within the same urban setting, with some households benefiting from improved resources while others continue to face constraints affecting child nutrition. The higher odds of DBM among urban households therefore highlights the importance of considering within-setting inequalities, rather than viewing urbanisation simply as a marker of improved socioeconomic conditions.

11.4.2 Maternal Characteristics and the Intergenerational Dimension

Region-specific evidence on the determinants of household-level DBM showed that maternal characteristics had stronger and consistent associations with DBM than household structural or child-level factors. This highlights the central role of maternal nutritional and biological factors in the coexistence of undernutrition and overnutrition within households.

Older maternal age emerged as one of the strongest risk factors for DBM. This association reflects two concurrent processes within the same household. Older mothers face higher cumulative risk of being overweight due to weight retention from multiple pregnancies, metabolic changes associated with ageing and reduced physical activity. Their children, often from earlier pregnancies, may have experienced persistent stunting due to suboptimal nutrition during critical growth windows [32, 33].

Maternal short stature, a marker of chronic undernutrition during the mother's own childhood and adolescence, was strongly associated with DBM. This finding points to an intergenerational dimension of DBM not captured by cross-sectional analyses of current household composition. Short maternal stature is associated with restricted fetal growth and a higher risk of low birth weight, which can increase the risk of growth faltering and stunting in early childhood [34-38]. At the same time, mothers with short stature may be more vulnerable to overweight and obesity later in life [36, 38], potentially due to metabolic adaptations to early-life undernutrition and lower lean body mass [39, 40]. Thus, maternal short stature can contribute to the coexistence of maternal overweight and child undernutrition within the same household. This pattern can extend into the next generation when a stunted female child carries the effects of early-life undernutrition into adulthood and remains short-statured. When she becomes a mother, her own short stature can place her child at increased risk of undernutrition, while she remains vulnerable to overweight. In this way, early-life undernutrition can contribute to short maternal stature in one generation, which is then linked to child undernutrition and maternal overweight in the next, creating a cycle that sustains household-level DBM across generations. Figure 2 shows the possible intergenerational pathways linking maternal short stature with household-level DBM.

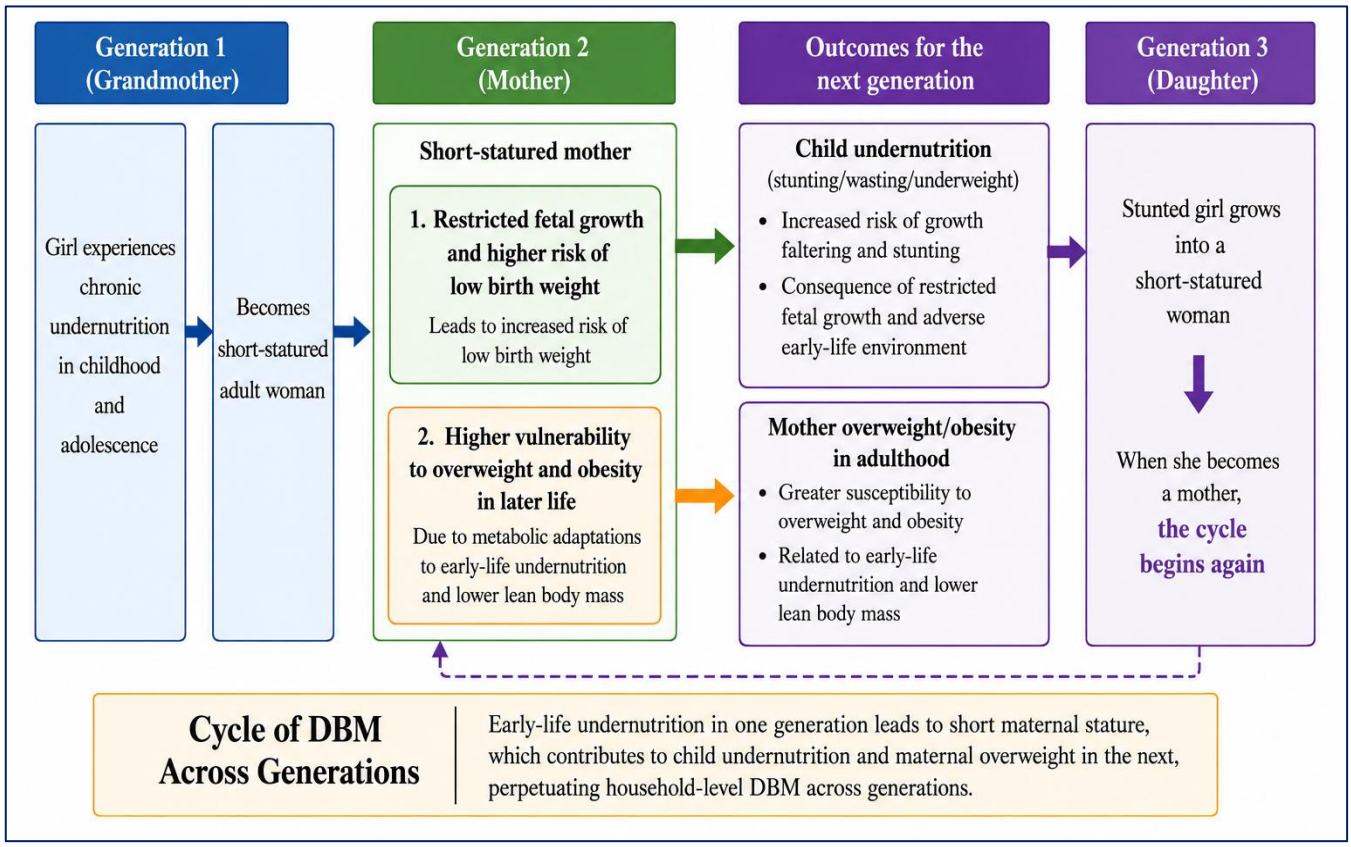

Figure 2: Possible intergenerational pathways linking maternal short stature with household-level DBM

Note: *The framework was developed based on the study findings and supporting literature. The figure illustrates potential intergenerational pathways and does not imply causal relationships.*

11.4.3 Maternal Education as a Key Modifiable Driver of DBM

Maternal education provides an important counterpoint to the positive association between wealth and DBM. Higher maternal education was associated with a lower odds of DBM, and Paper 4 showed that this protective association was particularly evident among wealthier households. Specifically, households with highly educated mothers in the wealthiest socioeconomic groups appeared to have lower odds of DBM than would be expected from the separate associations of maternal education and household wealth. This suggests that the association between maternal education and DBM may vary according to household wealth, rather than remaining constant across socioeconomic groups. The interaction therefore provides additional insight beyond the individual associations, indicating that maternal education may help mitigate the higher odds of DBM associated with greater household wealth. These findings suggest that economic improvement alone may not be sufficient to prevent DBM when households lack the knowledge and capacity to make healthy dietary and lifestyle choices [41]. Educated mothers may be better able to promote balanced diets and appropriate child feeding practices, make informed use of

healthcare services, and recognise the longer-term risks associated with unhealthy foods and sedentary lifestyles [41, 42]. They may also be better equipped to navigate the increasing availability and marketing of energy-dense processed foods that accompany the nutrition transition [41, 43]. Through these pathways, maternal education may help reduce child undernutrition while also limiting the risk of maternal overweight and obesity within the same household.

The interaction between education and wealth therefore suggests that the nutritional benefits of socioeconomic development depend partly on how effectively households can translate greater economic resources into healthier practices. Maternal education may provide an important opportunity for preventing DBM, particularly as countries progress further through the nutrition transition. This highlights the importance of viewing women not only as caregivers but also as key actors who influence household dietary choices, health behaviours, and the nutritional wellbeing of family members [44-48].

11.4.4 Breastfeeding and Antenatal Care as Protective Pathways

Breastfeeding emerged as one of the most robust and key protective factors against household-level DBM. The protective role of breastfeeding operates through complementary pathways affecting both child and maternal nutrition. For children, breastfeeding provides optimal nutrition during the critical first months of life, reduces susceptibility to infectious diseases that contribute to stunting, and promotes a healthy gut microbiota associated with better growth outcomes [49, 50]. For mothers, breastfeeding supports postpartum weight management by increasing energy expenditure and may help prevent excessive postpartum weight retention that contributes to overweight [51, 52]. These dual benefits position breastfeeding promotion as a key “double-duty” practice that simultaneously supports child growth and maternal weight regulation [53].

Adequate ANC also emerged as a protective factor against DBM. The role of ANC as an early, repeated point of contact between mothers and healthcare providers likely explains its protective effect [54, 55]. ANC visits provide opportunities for nutrition counselling, dietary guidance, and early identification of health and nutritional risks [54]. They also facilitate supplementation with iron and folic acid, which improves maternal nutritional status and can influence both pregnancy outcomes and longer-term household nutrition patterns [55]. In this way, ANC functions not only as an obstetric service but also as a preventive platform that can influence both maternal and child nutritional health.

11.4.5 Caesarean Delivery as an Emerging Factor Associated with DBM

The association between caesarean delivery and household-level DBM adds an underexplored dimension to its determinants. Caesarean delivery may delay breastfeeding initiation, disrupt breastfeeding establishment, and shorten breastfeeding duration [56, 57]. Paper 5 supported this pathway, showing that the combination of caesarean delivery and delayed breastfeeding initiation were associated with substantially higher odds of DBM beyond either factor alone [58]. Caesarean birth may also influence longer-term maternal and child outcomes through changes in infant gut microbiota, maternal postpartum recovery, mobility, and weight retention [59, 60]. These pathways may increase maternal overweight while adversely affecting child growth, contributing to the coexistence of undernutrition and overweight within the same household.

The rising use of caesarean delivery across South and Southeast Asia therefore has important implications for DBM prevention [61, 62]. In many settings, caesarean rates exceed levels considered medically necessary [61], raising concerns about the over-medicalisation of childbirth. Reducing unnecessary caesarean deliveries, alongside timely breastfeeding support and appropriate postpartum care, may therefore help address nutrition risks for both mothers and children.

11.4.6 Child Level Factors and Developmental Vulnerability

The association between older child age and household-level DBM highlights the importance of timing in nutritional risk. After six months of age, breast milk alone is no longer sufficient, and the quality of complementary feeding becomes critical [63]. Inadequate dietary diversity, recurrent infections, and poor sanitation during this period can progressively contribute to growth faltering [64, 65]. At the same time, maternal overweight may continue to increase during the postpartum period due to sustained lifestyle changes and challenges in weight management. The combination of these processes helps explain why DBM becomes more evident as children grow older within the same household.

This age-related pattern highlights the importance of timing in intervention strategies. Prevention of household-level DBM should begin early, well before the 24–59 month period when risk becomes more apparent. Interventions during pregnancy, the immediate postnatal period, and the transition to complementary feeding are particularly critical, as they can simultaneously influence the maternal nutritional situation and child growth outcomes before adverse patterns become established.

11.5 Policy Evidence Gap: DBM in Bangladesh's National Nutrition Architecture

Papers 6 and 7 together help explain why the epidemiological and determinant evidence presented above has not yet translated into a coherent policy response in Bangladesh. Paper 6 shows that DBM remains largely absent from national nutrition policy. Only the National Nutrition Policy (2015) explicitly refers to DBM, and even this policy largely treats undernutrition and overnutrition as separate problems rather than as interacting forms of malnutrition. It also lacks a clear life-course perspective linking early-life undernutrition with later obesity risk, despite growing evidence of these intergenerational and life-course pathways [66-69]. The limited regulation of the food environment, including the absence of comprehensive front-of-pack labelling, restrictions on unhealthy food marketing, and enforceable school food standards, represents another important policy gap, particularly given evidence of the potential effectiveness of such measures in countries such as Chile and Mexico [70, 71].

Paper 7 adds an important explanation for these policy gaps by showing how DBM is understood and addressed by key stakeholders. Although technical and policy actors increasingly recognise DBM as an emerging concern, this recognition has not yet been translated into institutional action. DBM remains insufficiently reflected in funding priorities, programme design, monitoring indicators, and community-level awareness. The evidence therefore suggests that the policy gap is not simply a lack of awareness but also a challenge of governance and implementation. Although multisectoral coordination mechanisms exist, implementation remains fragmented, accountability is limited, and monitoring systems are not designed to capture DBM-specific outcomes. Importantly, stakeholders identified existing platforms such as breastfeeding promotion, school feeding, and social protection as potential entry points for double-duty action. These platforms provide an existing foundation for an integrated response. The key challenge is to strengthen governance and accountability so that this existing infrastructure can be deliberately directed towards preventing and addressing DBM.

11.6 Integrated Synthesis of Study Findings

Taken together, the findings from seven papers provide a broader understanding of household-level DBM that is not evident when each finding is considered separately.

First, the socioeconomic and maternal findings pointed out in Section 11.4 challenge a simple poverty-based explanation of DBM. Wealth and urban residence are associated with a higher odds

of DBM, whereas maternal education appears to reduce this odds. This suggests that DBM is increasingly concentrated among wealthier and urban households where mothers have lower levels of education. DBM may therefore be less a problem of limited resources and more a problem of how households use the resources available to them during the nutrition transition. Having greater purchasing power does not necessarily lead to healthier diets and outcomes for all household members, particularly when mothers have limited access to nutrition knowledge and decision-making power.

Second, the maternal biological and behavioural factors mentioned in Section 11.4, including older maternal age, shorter maternal stature, breastfeeding, antenatal care, and caesarean delivery, can be understood as interconnected components of a maternal life course pathway rather than as separate risk factors. A mother's nutritional history can influence both her own risk of overweight and her child's risk of undernutrition. At the same time, contact with health services through antenatal care, breastfeeding support, and childbirth care provides opportunities to interrupt this intergenerational pathway. This perspective suggests that household-level DBM is partly shaped by maternal experiences across the life-course, rather than representing the independent coexistence of maternal overweight and child undernutrition.

Third, the policy findings presented in Section 11.5 reflect a similar divide at the institutional level. Just as nutritional outcomes within households can differ between mothers and children, national nutrition policies have largely developed separate areas of attention for child undernutrition and adult overweight and obesity, with limited integration between the two. The absence of DBM as an explicit policy concern is therefore unlikely to be an isolated oversight. Rather, it reflects a broader fragmentation that is also evident within households.

Together, these patterns support a broader interpretation of household-level DBM in South and Southeast Asia. DBM is not simply the coexistence of undernutrition and overnutrition within the same household. Rather, it reflects the interaction of maternal factors, household resources, health behaviours, and policy systems that currently distribute attention unevenly between mothers and children. Effective responses therefore need to address these factors together rather than treating undernutrition and overnutrition as separate problems. Figure 3 summarises how the contextual factors, determinants, and system gaps identified across this thesis are interconnected and how they point towards the need for integrated double-duty actions.

International experience provides some examples of the type of cross-sectoral response that may

be relevant. Brazil's Bolsa Familia Programme, embedded within the National Food and Nutrition Security System (SISAN), links social protection with nutrition through a multisectoral framework [72]. Nonetheless, governance mechanisms that explicitly tackle both undernutrition and overweight and obesity are still underdeveloped on a global scale. Evidence from France similarly highlights coordination challenges and the importance of strong leadership at the local government level [67]. Bangladesh currently lacks an equivalent governance structure with clear and shared responsibilities across sectors. This gap was also identified in the policy analysis and is consistent with the broader fragmentation described throughout this section.

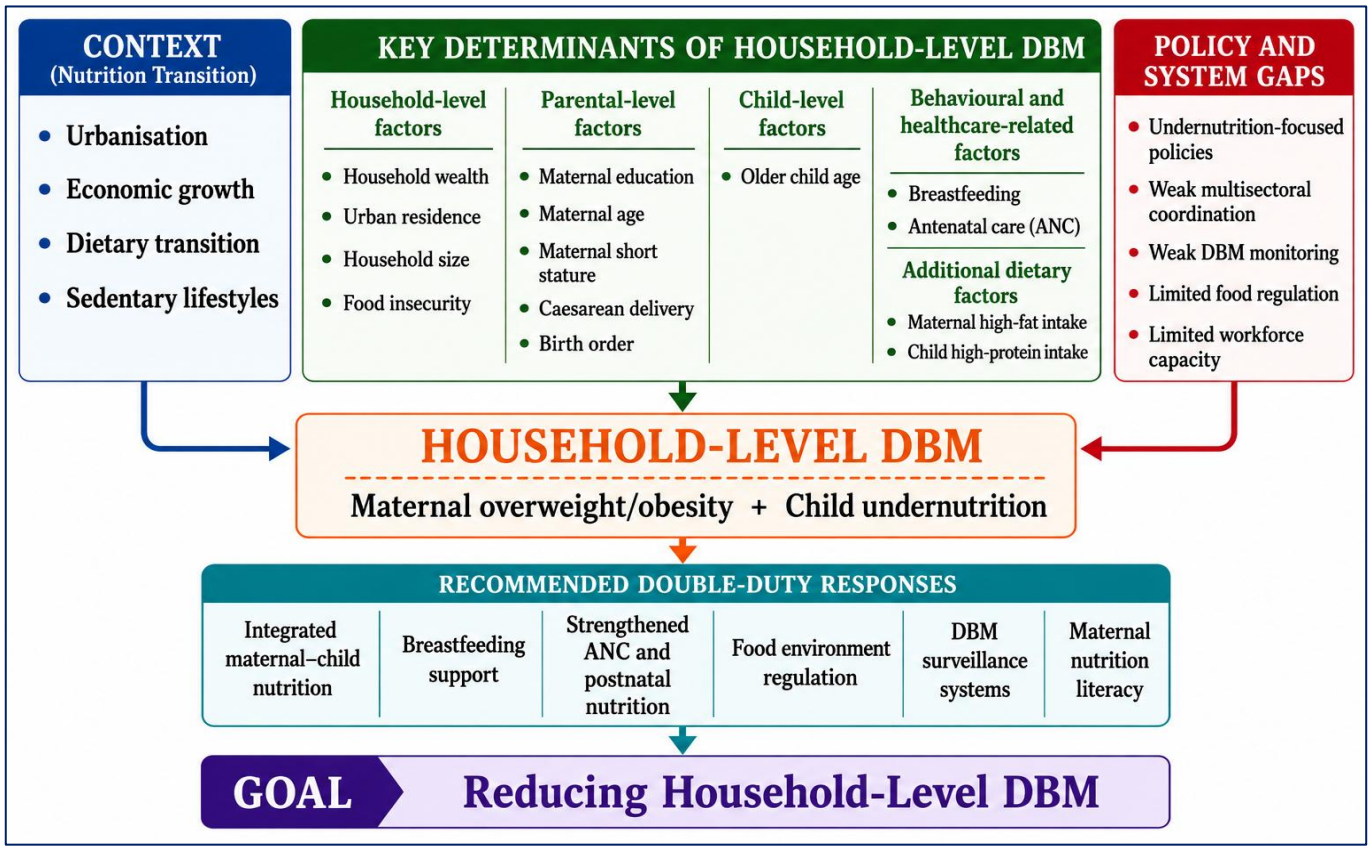

Figure 3: Diagram showing contextual factors, identified key determinants, and policy and system gaps contributing to household-level DBM, alongside recommended double-duty responses for its reduction.

Note: *The diagram is developed based on the findings of this thesis.*

11.7 Methodological Contributions and Strengths

This thesis makes several methodological and substantive contributions. First, the thesis adopts a range of complementary methodologies, including a structured narrative review (Paper 1), a multi-country cross-sectional trend analysis (Paper 2), a systematic review and meta-analysis (Paper 3), interaction analysis using multivariable logistic regression (Paper 4), multilevel logistic

regression with spatial analysis (Paper 5), documentary policy analysis (Paper 6), and a qualitative key informant interview study (Paper 7). This methodological diversity provides a more comprehensive understanding of DBM than any single approach could offer.

Second, all empirical papers draw on nationally representative DHS data with large sample sizes and standardised measurement protocols. The DHS uses probabilistic multistage cluster sampling and trained personnel to conduct standardised anthropometric measurements, thereby strengthening the reliability and comparability of nutritional status data. Third, the multi-country perspective in Papers 2, 4 and 5 extends beyond the single-country focus that dominates much of the existing DBM literature. The analysis of four countries provides a regional perspective that identifies consistent patterns while also highlighting contextual differences.

Fourth, the systematic review and meta-analysis in Paper 3 addresses a key gap by providing the first region-specific pooled estimates of major DBM determinants in South and Southeast Asia. It applies a transparent PRISMA-guided approach, with independent duplicate screening and data extraction; quality assessment using an adapted Newcastle-Ottawa Scale for cross-sectional studies; and comprehensive sensitivity and publication bias assessments. Fifth, the qualitative study in Paper 7 addresses a gap that documentary policy analysis alone cannot fill. It provides stakeholder-informed evidence on why policy gaps persist and identifies practitioner perspectives on priorities for policy reform.

11.8 Limitations

Several limitations must be acknowledged. First, all empirical studies are based on cross-sectional DHS data, which precludes causal inference. The associations documented between factors such as maternal education, household wealth, breastfeeding, caesarean delivery, and DBM are consistent with plausible causal pathways, but temporal ordering and residual confounding cannot be definitively ruled out. Longitudinal designs are needed to establish temporal relationships and identify critical windows for intervention.

Second, the DHS datasets do not include detailed dietary intake data, physical activity measures, caregiving practices, or information on food environments at the community or neighbourhood level. These are important mediating and moderating factors in the pathways between sociodemographic determinants and DBM outcomes, and their absence means that underlying mechanisms can only be inferred rather than directly tested. Furthermore, the four-visit threshold used to categorise ANC does not reflect the current WHO recommendation of eight contacts and

may not adequately distinguish differences in ANC utilisation. Future studies should consider the eight-contact threshold where data availability and sample sizes permit.

Third, the selection of countries in the empirical analyses was constrained by the availability of nationally representative DHS data across multiple time points. As a result, several countries in South and Southeast Asia were not included in the trend analyses, which limits the regional coverage of the findings. Furthermore, the analyses were restricted to mother–child pairs with valid anthropometric measurements. Excluding mothers with missing or invalid BMI measurements may have introduced selection bias if these women differed systematically from those with complete measurements in their demographic, socioeconomic or nutritional characteristics. Although DHS sampling weights were applied, they may not fully account for potential bias arising from missing anthropometric data. In addition, the meta-analysis showed substantial heterogeneity across studies for several determinants of DBM. Although subgroup analyses helped partially explain this variation, considerable unexplained heterogeneity remains, suggesting that pooled estimates should be interpreted with caution and not directly generalised to all national contexts. Moreover, religious and cultural beliefs and practices related to child feeding may influence dietary choices and parental decisions regarding nutrition. However, these factors were not directly examined in this thesis. Although DHS data include information on religious affiliation in some countries and survey rounds, they do not adequately capture religious practices or observance. Therefore, the findings should be interpreted with this contextual limitation in mind.

Fourth, pooling data across countries in the regional interaction models may have masked country-specific differences in associations. For example, the association between higher maternal education and household-level DBM among wealthier households differed between Bangladesh and Nepal. Therefore, the pooled regional estimates should be interpreted cautiously and should not be generalised beyond the countries included in the analysis.

Fifth, the policy analyses in Papers 6 and 7 were conducted solely in Bangladesh due to resource and time constraints. While Bangladesh provides a relevant and informative case study due to its nutrition transition and policy landscape, the findings related to policy architecture and implementation challenges may not be fully generalisable to other countries in South and Southeast Asia. Countries such as India, Nepal, and others in the region have distinct governance structures, policy priorities, and implementation capacities that were not captured in this analysis.

Sixth, the qualitative component in Paper 7 was limited by a relatively small sample size and its focus on senior national-level stakeholders. It did not include perspectives from frontline health workers or beneficiary populations. In addition, responses may have been influenced by social desirability bias, particularly in discussions related to policy implementation gaps and institutional performance.

Seventh, the analyses of DHS data have limitations related to the survey design. DHS sampling weights were applied in all analyses so that estimates represent the population of mother–child pairs in each country, but the cluster and strata information of the survey design was not used. The weights are reflected in the point estimates. However, the standard errors and confidence intervals do not fully incorporate the clustering and stratification of the DHS sample and may be narrower than design-based estimates. Therefore, some associations may appear more precise than they are. In Paper 5, clustering was addressed with cluster-level random intercepts, but the sampling weight was applied through the weights argument of glmer, which does not rescale weights across levels. As a result, these weighted estimates are approximate. The AIC and the Hosmer–Lemeshow test were calculated from the weighted models and were used only to compare candidate models and to describe calibration. Therefore, they are interpreted as approximate. The comparison of mean breastfeeding duration used ANOVA with weights but without the cluster information, so independence of observations within clusters may not be fully met. Findings with confidence interval limits close to the null value should therefore be interpreted cautiously. The large national samples, the consistency of associations across countries and survey rounds, and the cluster-level random effects in Paper 5 help to limit the influence of this limitation on the overall conclusions. Future analyses should apply design-based estimation using the cluster, strata and weight variables.

11.9 Policy Implications

The findings of this thesis collectively call for a fundamental reorientation of nutrition policy frameworks in South and Southeast Asia. Current nutrition programmes, especially in Bangladesh, primarily focus on undernutrition, which hinders their capacity to address DBM in an integrated way. The evidence from across the studies suggests that nutrition policies need to move towards more coordinated and comprehensive approaches that address both undernutrition and overnutrition together. Several key policy priorities emerge from the cross-study evidence.

National nutrition strategies need to explicitly recognise DBM as a distinct policy challenge, in

which undernutrition and overnutrition are understood as interconnected conditions that can coexist and reinforce one another within the same population and household. This requires moving beyond broad commitments to addressing "all forms of malnutrition" towards the explicit operationalisation of DBM within policy and monitoring frameworks. A key priority in this regard is the development and adoption of consistent, standardised operational definitions of DBM, such as those proposed in Paper 1, and their integration into national surveys, DHS programmes, and routine nutrition surveillance systems. Embedding DBM-specific indicators within these systems would improve cross-country comparability, strengthen trend analysis, and support more evidence-informed policy development, programme planning, and resource allocation.

Building on these efforts, national monitoring systems should be further strengthened to capture the full spectrum of DBM by incorporating household-level DBM indicators, measures of diet quality, and routine surveillance of adult overweight and obesity. In addition, establishing nutritional surveillance systems that collect information on key nutrition indicators for the population from early childhood through to adulthood would provide a stronger evidence base for understanding how early-life undernutrition may translate into later-life obesity risk. These improvements complement the need for standardised DBM definitions and indicators, as highlighted in national surveys and DHS-based monitoring systems.

Breastfeeding promotion and support should be positioned as a central pillar of DBM prevention due to its dual benefits for both child growth and maternal weight regulation [68]. Programmes should prioritise continuous breastfeeding support through both facility-based and community-based services. Attention is needed for mothers experiencing delayed breastfeeding initiation following caesarean delivery [58]. Expanding counselling and practical lactation support during the immediate postpartum period may improve breastfeeding continuation and contribute to healthier maternal and child nutritional outcomes [53].

Food environment regulation should be strengthened and fully integrated into national nutrition policy frameworks as a core strategy for addressing DBM. This includes fiscal measures such as taxes on sugar-sweetened beverages, the introduction of front-of-package warning labels, restrictions on the marketing of unhealthy foods to children, and the implementation of mandatory school food standards [70, 71].

In addition, maternal education should be considered one of the most important modifiable

protective factors against DBM and, therefore, recognised as a key upstream policy priority [54]. Investments in girls' education, nutrition literacy, and women's empowerment should therefore be positioned as long-term DBM prevention strategies within national development planning.

11.10 Implications for Practice

While the policy implications above highlight changes needed at the national and systems level, the findings also have important implications for how nutrition programmes and services are delivered. At the programmatic level, the findings of this thesis support the design and implementation of double-duty interventions that simultaneously address undernutrition and overnutrition within the same households and communities [53]. Existing maternal and child health platforms offer key opportunities for integration, as many of the determinants identified across the studies operate through interconnected maternal, child, and household pathways [74]. Rather than maintaining separate intervention models for undernutrition and obesity, programmes should adopt integrated approaches that address shared risk factors across the life course.

ANC platforms represent a particularly important entry point for DBM prevention because they provide repeated contact with women during critical developmental periods. The increase in both the quality and frequency of ANC may contribute to improved maternal and child nutritional outcomes. ANC services should therefore integrate screening for maternal undernutrition, overweight, and obesity alongside counselling on breastfeeding, complementary feeding, dietary diversity, a healthy maternal diet, and physical activity [75]. Nutrition counselling should also be extended into the postnatal period, particularly for women who deliver by caesarean section. Post-caesarean nutrition support, including dietary counselling, supplementation, breastfeeding assistance, and maternal recovery guidance, may help reduce some of the pathways linking caesarean delivery to household-level DBM identified in Paper 5.

Frontline health workers also need greater capacity to deliver integrated nutrition services [76, 77]. As community health workers are central to maternal and child nutrition programmes across the region [78, 79], their training should extend beyond undernutrition management to include healthy diets, overweight prevention, physical activity, and the identification of DBM risks [48, 80, 81]. This could strengthen household-level counselling and support the earlier identification of households at risk of DBM [82].

Finally, addressing DBM requires engagement beyond the health sector [83]. Schools, women's

groups, and social protection programmes can extend nutrition and healthy lifestyle interventions to communities [84, 85]. Private-sector participation may also support multisectoral action, but should operate within clear regulatory and accountability frameworks to ensure alignment with public health goals [86].

11.11 Future Research Priorities

This thesis identifies several priority areas for future research. First, longitudinal cohort studies are needed to establish causal pathways and to identify critical windows for intervention. Following children from birth through adolescence in settings undergoing rapid nutritional transition would help clarify when DBM risk emerges within households and which early-life exposures are most strongly associated with later dual burden. Studies focusing on the developmental programming pathway, through which early undernutrition increases the risk of later obesity within individuals and households, are especially important.

Second, future research should extend the analysis of DBM determinants beyond the commonly studied mother–child dyad. Examining other intra-household configurations, such as father–child pairs, sibling relationships, and older-adult–younger-adult combinations, would provide a more complete understanding of household-level DBM as defined in Paper 1. This would also help determine whether the determinants identified in this thesis are specific to mother–child households or are generalisable across different household structures.

Third, the associations between caesarean delivery and household-level DBM observed in Papers 3 and 5 require further investigation to better understand the underlying mechanisms. Future studies should incorporate information on breastfeeding initiation and duration, complementary feeding practices, maternal postnatal physical activity, and infant gut microbiome composition to explore potential biological and behavioural pathways. Furthermore, future analyses should examine the association between caesarean delivery and household-level DBM using comprehensive models that simultaneously adjust for maternal education, household wealth, antenatal care attendance, and other relevant confounders, while assessing the potential mediating role of breastfeeding practices. Longitudinal studies following mothers and their children from birth through early childhood would provide stronger evidence on temporal relationships, nutritional trajectories, and the mechanisms linking caesarean delivery to household-level DBM.

Fourth, qualitative research is needed to deepen understanding of how DBM is experienced and

managed within households. This includes exploring the lived experiences of households affected by DBM, mothers' dietary decision-making processes across different levels of wealth and education, and the barriers and facilitators to adopting healthy dietary practices in diverse cultural and economic settings. Such evidence would complement the quantitative findings of this thesis by providing contextual insight into how household nutrition decisions are shaped in practice and would help inform the design of more contextually appropriate and acceptable interventions. Additionally, future research should investigate whether and how religious beliefs and practices are associated with child-feeding behaviours and nutritional outcomes, including household-level DBM. Suitable approaches include within-country analyses where religious diversity permits (e.g. Bangladesh and Nepal) and qualitative or mixed-methods studies with communities of different faiths.

Fifth, there is a need for rigorous evaluation of specific double-duty interventions to generate stronger evidence regarding their implementation. This includes interventions such as enhanced antenatal care–based nutrition counselling, community-based breastfeeding support, food environment regulatory measures, and school food standards. Robust evaluation of these approaches is essential to determine their effectiveness, feasibility, and scalability in real-world settings. Enhancing the evidence base in this domain would facilitate translating the theoretical and empirical results of this thesis into actionable, scalable programmatic frameworks to address DBM.

11.12 Conclusion

This thesis shows that DBM is increasing across South and Southeast Asia. This trend reflects an uneven nutrition transition, in which maternal overweight is increasing faster than child undernutrition is declining. The persistence of DBM is not simply a result of limited knowledge or information. It is also shaped by structural and institutional factors. In Bangladesh, national policies and programmes have not fully adapted to the changing nutrition landscape. Maternal and child nutrition are often addressed through separate policy and programme structures, despite the close relationship between these forms of malnutrition within households.

Addressing this gap requires more than incremental changes to existing programmes. Undernutrition and overnutrition need to be recognised as interconnected outcomes of the same broader nutrition system. This requires stronger coordination across nutrition, health, education, and food policies. It also requires adequate monitoring, regulatory mechanisms, and workforce

capacity to support action on both forms of malnutrition. These changes are possible, but they will require sustained political commitment and continued research. South and Southeast Asia are at a critical stage in their nutrition transition. The evidence generated across the seven papers of this thesis provides a foundation for policies that address undernutrition and overnutrition together, rather than treating them as separate and sequential problems.

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Appendix A

Supplementary Materials for Chapter 4

Supplementary table 1: Search Strategy

PubMed ((("double burden" OR "dual burden" OR simultaneous OR co-occurrence OR co-existing OR concurrent) OR malnutrition OR DBM OR SCOWT OR SCOM) AND (stunt* OR undernutrition OR underweight OR thinness OR wasting OR malnutrition)) AND (individual* OR house* OR population OR "overweight mother*" OR "underweight child*" OR "overweight child*")
Scopus ((("double burden" OR "dual burden" OR simultaneous OR co-occurrence OR co-existing OR concurrent) OR malnutrition OR DBM OR SCOWT OR SCOM) AND (stunt* OR undernutrition OR underweight OR thinness OR wasting OR malnutrition)) AND (individual* OR house* OR population OR "overweight mother*" OR "underweight child*" OR "overweight child*")
Web of Science ((("double burden" OR "dual burden" OR simultaneous OR co-occurrence OR co-existing OR concurrent) OR malnutrition OR DBM OR SCOWT OR SCOM) AND (stunt* OR undernutrition OR underweight OR thinness OR wasting OR malnutrition)) AND (individual* OR house* OR population OR "overweight mother*" OR "underweight child*" OR "overweight child*")

Supplementary table 2: Summary table of the review

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
1.	Double Burden of Malnutrition and Its Associated Factors in Urbanized Indigenous Peoples (Orang Asli) of Peninsular Malaysia	Shariff et al. (2024)	Household	451 households	Malaysia (specifically, the state of Selangor)	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
2.	Prevalence and socio-demographic factors associated with double and triple burden of malnutrition among mother-child pairs in India: Findings from a nationally representative survey (NFHS-5)	Ramasubramani *et al.* (2024)	Household	167,380 mother-child pairs	India	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
3.	Magnitude, trends and drivers of the coexistence of maternal overweight/obesity and childhood undernutrition in Ethiopia: Evidence from Demographic and Health Surveys (2005-2016)	Pradeilles *et al.* (2024)	Household	13,107 households	Ethiopia	• Stunting: <-2SD height-for-age • Anaemia: haemoglobin level <11.0 g/dl	- Household-level DBM: coexistence of maternal overweight/obesity and child undernutrition - Type 1: Maternal overweight/obesity and under-five stunting - Type 2: Maternal overweight/obesity and under-five anaemia - Type 3: Maternal overweight/obesity and under-five anaemia and/or stunting
4.	Dynamics of the double burden of malnutrition in Guatemala: a secondary data analysis of the demographic and health surveys from 1998-2015	Sagastume et al. (2024)	Household	Total: 39,749 households	Guatemala	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
5.	Comparison of household double burden of malnutrition among mother-child dyads in different settings in Maharashtra	Jeyakumar et al. (2024)	Household	Total: 295 mother-child dyads	Maharashtra, India	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
6.	Double burden of malnutrition and associated factors among mother-child pairs at household level in Bahir Dar City, Northwest Ethiopia: community based cross-sectional study design	Mekonnen et al. (2024)	Household	Total: 702 mother-child pairs (initially), with 661 participating in the study.	Ethiopia	Undernutrition for children: • Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age Overweight for children • Overweight: >+2SD height-for-age Overnutrition for adults: • Overweight/obese: BMI ≥25 kg/m² Undernutrition for adults: • Underweight: BMI <18.5	Participants were categorised as experiencing DBM if either the mother was overweight/obese and the child was undernourished (with stunting, wasting, or underweight), or if the mother was underweight and the child was overweight
7.	Socioeconomic determinants of the double burden of malnutrition among women of reproductive age in sub-Saharan Africa: A cross-sectional study	Okyera et al. (2024)	Household	Total: 97,529 women	sub-Saharan Africa	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM in households, defined as the coexistence of an overweight/obese mother and a stunted child
8.	Association Between Parental Education and Simultaneous Malnutrition Among Parents and Children in 45 Low-and Middle-Income Countries	Chen et al. (2023)	Household	Total: 480,060 - Mother-child pairs: 423,340 - Father-child pairs: 56,720	multinational (45 LMICs for mother-child pairs and 16 LMICs for father-child pairs)	Undernutrition for children: • Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Anaemia: haemoglobin level <11.0 g/dl Overweight for children • Overweight: >+2SD height-for-age Overnutrition for adults: • Overweight/obese: BMI ≥25 kg/m² Undernutrition for adults: • Underweight: BMI <18.5 • Short stature (mother's height <145 cm; father's height <155 cm) Anaemia: haemoglobin level <12 g/dL	DBM is classified into four subtypes: (1) maternal (or paternal) overnutrition with child undernutrition, (2) maternal (or paternal) undernutrition with child overnutrition, (3) maternal (or paternal) overnutrition with child overnutrition, and (4) maternal (or paternal) undernutrition with child undernutrition.
9.	Association between maternal stature and household-level double burden of malnutrition: findings from a comprehensive analysis of Ethiopian	Sahiledengle et al. (2023)	Household	33,454 mother-child pairs	Ethiopia	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
	Demographic and Health Survey						
10.	Malnutrition in mother-child dyads in the Brazilian National Survey on Child Nutrition (ENANI-2019)	Farias et al. (2023)	Household	13,659 mother-child dyads	Brazil	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
11.	Global inequalities in the double burden of malnutrition and associations with globalisation: a multilevel analysis of Demographic and Health Surveys from 55 low-income and middle-income countries, 1992-2018	Seferidi et al. (2022)	Household	1,132,069 child-mother pairs	Multinational (55 low-income and middle-income countries)	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as a stunted child with an overweight mother living in the same household
12.	Drivers and distribution of the household-level double burden of malnutrition in Bangladesh: analysis of mother-child dyads from a national household survey	Sarker et al. (2022)	Household	Total: 8697 mothers-child pair	Bangladesh	Undernutrition for children: • Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age Overweight for children • Overweight: >+2SD height-for-age Overnutrition for adults: • Overweight/obese: BMI ≥25 kg/m² Undernutrition for adults: • Underweight: BMI <18.5	DBM at the household level, defined as: - Coexistence of mothers' underweight condition and children's overweight condition - Coexistence of mothers' overweight and children's stunting, wasting, or underweight condition
13.	Patterns and Determinants of Double Burden Malnutrition at Household Level in Babylon	Zahraa et al. (2022)	Households	205 households	Iraq, Babylon governorate	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
14.	Transition and persistence in the double burden of malnutrition and overweight or obesity: Evidence from South Africa	Azomahou et al. (2022)	Household	2,711 households	South Africa	Undernutrition for children: • Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age Overweight for children • Overweight: >+2SD height-for-age Overnutrition for adults: • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
						Undernutrition for adults: • Underweight: BMI <18.5	
15.	How does mode of delivery associate with double burden of malnutrition among mother-child dyads?: a trend analysis using Bangladesh demographic health surveys	Sutopa et al. (2022)	Household	14,975 mother-child pairs	Bangladesh	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
16.	Prevalence and associated factors of double and triple burden of malnutrition among child-mother pairs in Ethiopia: Spatial and survey regression analysis	Tarekegn et al. (2022)	Household	Total: 7,624 child-mother pairs	Ethiopia	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
17.	Prevalence and socioeconomic determinants of the double burden of malnutrition in mother-child pairs in Latin America and the Caribbean	Otten et al. (2022)	Household	Total: 48,807 mother-child pairs	Latin America and the Caribbean (LAC) region: Bolivia, Colombia, Haiti, Honduras, Dominican Republic, Guyana, Guatemala, Peru	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m² • Anaemia: haemoglobin <12 g/dL for females • Anaemia: haemoglobin <11 g/dL for children • Overweight for child: >+2SD height-for-age	DBM is defined as the following way: overweight mother with at least one stunted child) - overweight mother with at least one wasted child - overweight mother with at least one anaemic child - anaemic mother with at least one overweight child
18.	The double burden of malnutrition and dietary patterns in rural Central Java, Indonesia	Lowe et al. (2021)	Household	Total: 1,521 households	Central Java, Indonesia	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM at the household level is typically defined as the presence of an overweight mother and a stunted child
19.	Food insecurity and the double burden of malnutrition in Colombian rural households	Rosas et al. (2021)	Household	2,350 mother-child pairs	Colombia	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m² •	DBM is the coexistence of a stunted child under 5 years of age and an overweight or obese mother
20.	Predictor of Obese Mothers and Stunted Children in the Same Roof: A Population-Based Study in the	Berawi et al. (2021)	Household	Total: 428 households	Indonesia	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM in households, defined as the coexistence of an overweight/obese mother and a stunted child

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
	Urban Poor Setting Indonesia						
21.	Urbanisation in Peru is inversely associated with double burden of malnutrition: Pooled analysis of 92,841 mother-child pairs	Daniel et al. (2021)	Household	92,841 mother-child pairs	Peru	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
22.	Trends and patterns of the double burden of malnutrition (DBM) in Peru: a pooled analysis of 129,159 mother-child dyads	Pomati et al. (2021)	Household	129,159 mother-child dyads	Peru	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
23.	Household-level double burden of malnutrition in Ethiopia: a comparison of Addis Ababa and the rural district of Kersa	Bliznashka et al. (2021)	Household	Total: 1454 households - Addis Ababa: 592 households - Kersa: 862 households	Ethiopia	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM in households, defined as the coexistence of an overweight/obese adult and a stunted child
24.	Maternal height and double-burden of malnutrition households in Mexico: stunted children with overweight or obese mothers	Lucia et al. (2021)	Household	Total: 4706 mother-child dyads	Mexico (South, North, Centre, Mexico City)	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as the simultaneous presence of maternal overweight and child short stature.
25.	Prevalence and regional variations of coexistence of child stunting and maternal overweight or obesity in Myanmar	Hong et al. (2020)	Household	3954 mother-child pairs	Myanmar	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥23 kg/m²	DBM is defined as a stunted child with an overweight mother living in the same household
26.	Factors associated with double burden of malnutrition among mother-child pairs in India: A study based on National Family Health Survey 2015-16	Patel et al. (2020)	Household	Total: 184,680 mother-child pairs	India	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
27.	Prevalence of double burden on malnutrition at household level in four Latin America countries	Melendez et al. (2020)	Household	Total: 26,506 households - Brazil: 2,664 mother-child pairs - Bolivia: 5,363 mother-child pairs	Brazil, Bolivia, Colombia, Peru	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as the simultaneous presence of maternal overweight and child short stature.

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
				- Colombia: 11,467 mother-child pairs - Peru: 7,012 mother-child pairs			
28.	Patterns and determinants of the double burden of malnutrition at the household level in South and Southeast Asia	Biswas et al. (2020)	Household	Total: 798,961 households	South and Southeast Asia: Bangladesh, India, Nepal, Pakistan, Myanmar, Timor, Maldives, Cambodia	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
29.	Double burden of malnutrition at household level: A comparative study among Bangladesh, Nepal, Pakistan, and Myanmar	Anik et al. (2019)	Household	Households: 18,459 - Bangladesh: 6,478 - Nepal: 2,670 - Pakistan: 5,770 - Myanmar: 3,541	Bangladesh, Nepal, Pakistan, Myanmar	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM in households, defined as the coexistence of an overweight/obese adult and a stunted child
30.	The double burden of malnutrition: an assessment of 'stunted child and overweight/obese mother (SCOWT) pairs' in Kerala households	Jayalakshmi et al. (2019)	Household	344 mother and child pairs	Kerala, India	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as the simultaneous presence of maternal overweight and child short stature.
31.	Prevalence and sociodemographic determinants of household level double burden of malnutrition in Bangladesh	Das et al. (2019)	Household	5951 households	Bangladesh	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
32.	Intra-household double burden of malnutrition in a North African nutrition transition context: magnitude and associated factors of child anaemia with mother excess adiposity	Sassi et al. (2019)	Household	437 child-mother pairs	Middle East and North Africa region, specifically Tunisia	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m² • Anaemia: haemoglobin <12 g/dL for females • Anaemia: haemoglobin <11 g/dL for children • Overweight for child: >+2SD height-for-age	DBM is defined as following way: - Anaemic child and overweight mother - Anaemic child and obese mother - Overweight child and anaemic mother - Stunted child and overweight mother - Stunted child and obese mother - Wasted child and overweight mother - Wasted child and obese mother

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
33.	Understanding the double burden of malnutrition in food insecure households in Brazil	Gubret et al. (2017)	Household	4299 mother/child pairs	Brazil	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as maternal overweight and child stunting
34.	Double-burden of malnutrition among the indigenous peoples (Orang Asli) of Peninsular Malaysia	Wong et al. (2015)	Household	Total: 1,285 households	Peninsular Malaysia	• Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as overweight mother and child having any form of undernutrition (stunting, wasting or underweight).
35.	Prevalence and determinants of the dual burden of malnutrition at the household level in Puna and Quebrada of Humahuaca, Jujuy, Argentina	Prevalencia *et al.* (2014)	Household	403 households	Argentina	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM at the household level refers to households with an overweight or obese mother and a stunted child.
36.	Predictors of maternal and child double burden of malnutrition in rural Indonesia and Bangladesh 1-3	Oddo et al. (2012)	Household	Total: 415,443 households - Indonesia: 247,126 households - Bangladesh: 168,317 households	Indonesia, Bangladesh	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as the simultaneous presence of maternal overweight and child short stature.
37.	Socioeconomic disparities and the familial coexistence of child stunting and maternal overweight in guatemala	Lee et al. (2012)	Household	Total: 2492 households	Guatemala	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as coexistence of child stunting and maternal overweight
38.	Peri-Urban, but Not Urban, Residence in Bolivia Is Associated with Higher Odds of Co-Occurrence of Overweight and Anaemiaamong Young Children, and of Households with an Overweight Woman and Stunted Child	Jones et al. (2018)	Household & Individual	3946 households	Bolivia	Undernutrition for children: • Stunting: <-2SD height-for-age • Anaemia: haemoglobin level <11.0 g/dl Overweight for children • Overweight: >+2SD height-for-age Overnutrition for adults: • Overweight/obese: BMI ≥25 kg/m² Undernutrition for adults: • Underweight: BMI <18.5	DBM is defined as following way: Individual level - Concurrent overweight and anaemia among women aged 15-49 years - Concurrent overweight and anaemia among children aged 6-59 months - Concurrent overweight and stunting among children Household level

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
						• Anaemia: haemoglobin level <12 g/dL	- Households with an overweight woman and anaemic child - Households with an overweight woman and stunted child
39.	Deforestation and Household-and Individual-Level Double Burden of Malnutrition in Sub-saharan Africa	Shankar et al. (2020)	Household & Individual	Total: 73,941 PSC 25,285 WCBA, 69,082 mother-child pairs	Sub-Saharan Africa: Benin, Cote d'Ivoire, Ghana, Guinea, Liberia, Mali, Nigeria, Senegal, Sierra Leone, Togo, Democratic Republic of Congo, Gabon, Zambia, Kenya, Rwanda	• Stunting: <-2SD height-for-age • Anaemia: haemoglobin level <12.0 g/dl • Overweight/obese: BMI ≥25 kg/m²	Household-level: Co-occurrence of an overweight woman of childbearing age (WCBA) and a stunted pre-school child (PSC) within the same household. Individual level: Co-occurrence of overweight and anaemia within an individual WCBA. Individual level: Co-occurrence of overweight and stunting within a PSC.
40.	The dual burden of malnutrition in Colombia	Sarmiento et al. (2014)	Household & Individual	Total individuals: 160,696 - Children <5 years: 17,696 - School-aged children: 25,508 - Adolescents: 28,328 - Adults: 89,164 Total households: 10,487	Colombia	• Among children 6–59 month, anaemia was defined as haemoglobin <11 g/dL. For children 5–12 y old and female adolescents, anaemia was defined as haemoglobin <12 g/dL. For male adolescents, anaemia was defined as haemoglobin <13 g/dL, for adult women as haemoglobin <12 g/dL, and for pregnant women as haemoglobin <11 g/dL. • Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m² Stunting for child: >+2SD height-for-age	The dual burden of malnutrition was defined as the coexistence of overweight and stunting or anaemia in the same person or household.
41.	Various forms of double burden of malnutrition problems exist in rural Kenya	Fongar et al. (2019)	Household & Individual	Total individuals: 1058 - Female adults: 558 - Male adults: 316 - Children: 184 Total households: 835	Nyanza region, Western Kenya (Kisii and Nyamira Counties)	• Overweight/obese for adult: BMI ≥25 kg/m² For child under nutrition: • Stunting: <-2SD height-for-age • Wasting: <-2SD weight-for-height • Underweight: <-2SD weight-for-age • body-mass-index-for-age Z-scores (BAZ)<-2 SD Micronutrient deficiency: To identify micronutrient deficiency, estimated average requirements (EAR) were used for each	DBM is defined as different way: - DB 1: Adult overweight/obese and micronutrient-deficient - DB 2: Child overweight (BAZ > + 2 SD) and micronutrient-deficient - DB 2.1: Child overweight (WHZ > + 2 SD) and micronutrient-deficient - DB 3: Child overweight (BAZ > + 2 SD) and stunted (HAZ < -2 SD)

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
						nutrient, taking individual gender and age into account. EAR thresholds used to define micronutrient deficiency. EAR thresholds values are available in the "Additional file 2" of the original article. Note that, it is a very large table, so, we are not able to show here.	- DB 3.1: Child overweight (WHZ > + 2 SD) and stunted (HAZ < -2 SD) - DB 4: Adult overweight/obese and child underweight (BAZ < -2 SD) - DB 5: Adult overweight/obese and child underweight (WAZ < -2 SD) - DB 6: Adult overweight/obese and child stunted (HAZ < -2 SD) - DB 7: Adult overweight/obese and child wasted (WHZ < -2 SD) - DB 8: Adult overweight/obese and child micronutrient-deficient
42.	The double burden of malnutrition in indigenous and nonindigenous Guatemalan populations 1-4	Manuet et al. (2014)	Household & Individual	Households: 22,990 (2008) - Women of Reproductive Age: 16,819 (2008) - Children aged 0-59 months: 10,775 (2008)	Guatemala	Undernutrition and overnutrition for women: • Underweight: <18.5 • Overweight/obese: BMI ≥25 kg/m² • Short stature: height <145 cm • Anaemia: haemoglobin <12 g/dL Undernutrition for children • Stunting: <-2SD height-for-age	- Household level DBM (stunted child and overweight mother) - Individual level DBM (stunting/short stature and overweight or anaemia and overweight)
43.	The Nutritional Dual-Burden in Developing Countries -How is it Assessed and What Are the Health Implications?	Silva et al. (2012)	Household & Individual	Total: 116 (58 mother-child pairs)	Mexico	These articles used anthropometric indicators and nutritional status cut-off points based on guidelines from the WHO, CDC, and the International Obesity Task Force (IOTF). Detailed measurements are provided within the articles. Please note that due to the large size of the table, it is not included here.	DBM is defined as the coexistence of stunting and overweight/obesity in individuals or within mother-child pairs.
44.	Double malnutrition and associated factors in a middle-aged and older, rural South African population	Seedat et al. (2024)	Individual	Total: 250	South Africa	• Overweight: BMI ≥25.0 kg/m² • Iodine deficiency: a median UIC of <100 µg/L • Anaemia: haemoglobin <13 g/dL for males or <12 g/dL for females	Individual level DBM is defined as: - Overweight/obesity and anaemia - Overweight/obesity and iodine insufficiency - Overweight/obesity and any micronutrient deficiency (anaemia and/or iodine insufficiency)
45.	The Double Burden of Malnutrition is Associated with Continued Breastfeeding and	Gonzaga et al.(2024)	Individual	Total: 561	Northeast Brazil	• Short stature: <-2SD height-for-age • Overweight: >+2SD height-for-age	DBM at individual level is the coexistence of short stature and overweight in the same child.

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
	Early Consumption of Ultra-Processed Drinks in Socially Vulnerable Brazilian Children						
46.	Prevalence of the Double Burden of Malnutrition among Adolescents: Associations with Lifestyle Behaviours and Clusters of Social Determinants	Manuet el al. (2024)	Individual	Total: 1152	Brazil	BMI-z-score: The adopted cutoff points were as follows: Z-score < −3 (very low weight); Z-score ≥ −3 and <−2 (low weight); Z-score ≥ −2 and ≤1 (normal weight); Z-score > 1 and ≤2 (overweight); and Z-score > 2 (obesity) • Vitamin D deficiency or hypovitaminosis is characterised by 25(OH)D levels below 20 ng/mL, while vitamin D insufficiency is defined by 25(OH)D levels	DBM is defined as the coexistence of obesity and vitamin D deficiency
47.	Double burden of malnutrition among women of reproductive age: Trends and determinants over the last 15 years in India	Prithishkumar et al. (2024)	Individual	NFHS-3: 117,956; NFHS-4: 668,563; NFHS-5: 696,990	India	• Anaemia: haemoglobin <12 g/dL for females • Overweight/obese: BMI ≥25 kg/m²	Presence of both (i) underweight and anaemia, and (ii) overweight/ obesity and anaemia, within the same individual group was categorised as having DBM.
48.	Double burden of malnutrition in Afghanistan: Secondary analysis of a national survey	Fahim et al. (2023)	Individual	Total: 126,890 individuals	Afghanistan	• Stunting: <3rd percentile of height-for-age based on WHO criteria in 0-19y • Wasting: <3rd percentile (WHO cut-off points) age- and sex-specific weight-for-length for children aged <2 y and <3rd percentile (WHO cut-off points) age- and sex-specific BMI-for-age for children and adolescents aged 2-19y • Underweight: <3rd percentile (WHO cut-off points) age- and sex-specific weight-for-age for children aged 0-10y, <3rd percentile (WHO cut-off points) age- and sex-specific BMI-for-age for adolescents aged >10–19 y and BMI<18.5 kg/m2 for those aged >19 y • Vitamin D deficiency: <20ng/ml • Anaemia: haemoglobin concentrations of less than 11 g/dL among children aged <5.0 years, and less than 11.5 g/dL among those aged ≥5.0, <12.0 years. These cut-off points was less than 12.0 g/dL among those aged≥12.0 and <15.0 years. In non-	Individual DBM was defined as the co-existence of "overweight" along with "stunting or micronutrient deficiencies" (including anaemia, vitamin A deficiency, vitamin D deficiency and iodine deficiency)

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
						pregnant females aged ≥ 15.0 years, this cut-off point was 12.0 g/dL • Vitamin A deficiency: serum retinol concentrations below a cut-off of 0.70 µmol/L (or 20 µg/dL) • Iodine deficiency: a median UIC of <100 µg/L • Overweight/obese was defined as >85th percentile (WHO cut-off points) age- and sex-specific weight-for-length for children aged <2 y and >85th percentile (WHO cut-off points) age- and sex-specific BMI-for-age for those aged 2–19 y and BMI ≥25 kg/m2 for those aged >19 y	
49.	Dual burden of individual malnutrition in children 1-4 years: Findings from the Colombian nutritional health survey ENSIN 2015	Castillo et al. (2023)	Individual	Total: 6807	Colombia (Atlantic, Central, Pacific, Eastern, Bogotá)	• Iron deficiency was defined as serum ferritin values below 12 µg/L • Zinc deficiency by serum zinc values below 65 µg/L • Vitamin A deficiency by serum retinol values below 20 µg/dL • Vitamin D deficiency by serum 25-OH-D values below a concentration of 30 nanomoles per litre (nmol/L) • Stunting: <-2SD height-for-age • Overweight for child: >+2SD height-for-age	DBM is defined by the presence of overweight and stunting and/or micronutrient deficiency (vitamin A, D, zinc, or iron)
50.	Trends in the Intraindividual Double Burden of Overweight/Obesity and Anaemia among Adult Women Living in 33 Low-and Middle-Income Countries: A Secondary Analysis of Demographic and Health Surveys from 2000-2019	Irache *et al.* (2023)	Individual	1,648,308 nonpregnant adult women	African region, Eastern Mediterranean region, European region, Americas region, Southeast Asian region, Western Pacific region	• Overweight/obese: BMI ≥25 kg/m² • Anaemia: haemoglobin concentrations <12.0 g/dL	DBM is defined as the coexistence of overweight or obesity and anaemia
51.	The double burden of overweight or obesity and anaemia among women married as children in India: A	Datta et al. (2022)	Individual	Total: 473,052	India	• Anaemia: haemoglobin level <12.0 g/dl • Overweight/obese: BMI ≥25 kg/m²	DBM is defined as the coexistence of overweight or obesity and anaemia.

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
	case of the Simpson's paradox						
52.	Sex Differences in Dietary Patterns of Adults and Their Associations with the Double Burden of Malnutrition: A Population-Based National Survey in the Philippines	Kaliora et al. (2022)	Individual	Total: 8957 - Male: 4465 - Female: 4492	Philippines	• Anaemia: haemoglobin <13 g/dL for males or <12 g/dL for females • Vitamin A deficiency: serum retinol of <10 µg/dL indicated • Hyperglycemia was characterised as a fasting blood glucose ≥110 mg/dL • dyslipidemia was characterised as having an HDL cholesterol <40 mg/dL for males or <50 mg/dL for females, or triglyceride ≥150 mg/dL • Hypertension was denoted by a blood pressure measurement of ≥140/≥90 mmHg • Overweight/obese: BMI ≥25 kg/m² • Waist circumference was obtained with a calibrated tape measure midway between the lowest rib and tip of the hip bone while the participant was standing and breathing normally, and expressed to the nearest 0.1 cm. Abdominal obesity was defined as waist circumference ≥102 cm for males or ≥88 cm for females • A blood pressure measurement of ≥140/≥90 mmHg indicated hypertension •	DBM is defined as the co-existence of underweight or anaemia or vitamin A deficiency or iodine insufficiency and at least one cardiometabolic risk factor.
53.	Prevalence and Determinants of the Co-Occurrence of Overweight or Obesity and Micronutrient Deficiencies among Adults in the Philippines: Results from a National Representative Survey	Juras et al. (2021)	Individual	Total: 17,010 - Male: 8,536 - Female: 8,474	Philippines	• Overweight/obese: BMI ≥25 kg/m² • Anaemia: haemoglobin < 13 g/dL for males and <12 g/dL for females • vitamin A deficiency: serum retinol with a cut-off of <10 µg/dL	Individual level DBM is defined as: - Overweight/obesity and anaemia - Overweight/obesity and anaemia or vitamin A deficiency - Overweight/obesity and anaemia or vitamin A deficiency or iodine insufficiency
54.	Intraindividual Double Burden of Malnutrition in Chinese Children and Adolescents Aged 6-17 Years: Evidence from the China Health	Xiao Hu et al. (2021)	Individual	Total: 1555 - Boys: 806 - Girls: 749	China	Children and adolescents' obesity were defined as BAZ > +2 SD, overweight was defined as (BAZ > +1 SD), and underweight was defined as BAZ < −2 SD. • Micronutrient Deficiency: Cut-offs are not clearly defined. Just mention that	Individual DBM is defined as the coexistence of overweight/obesity and dietary micronutrient intake insufficiency.

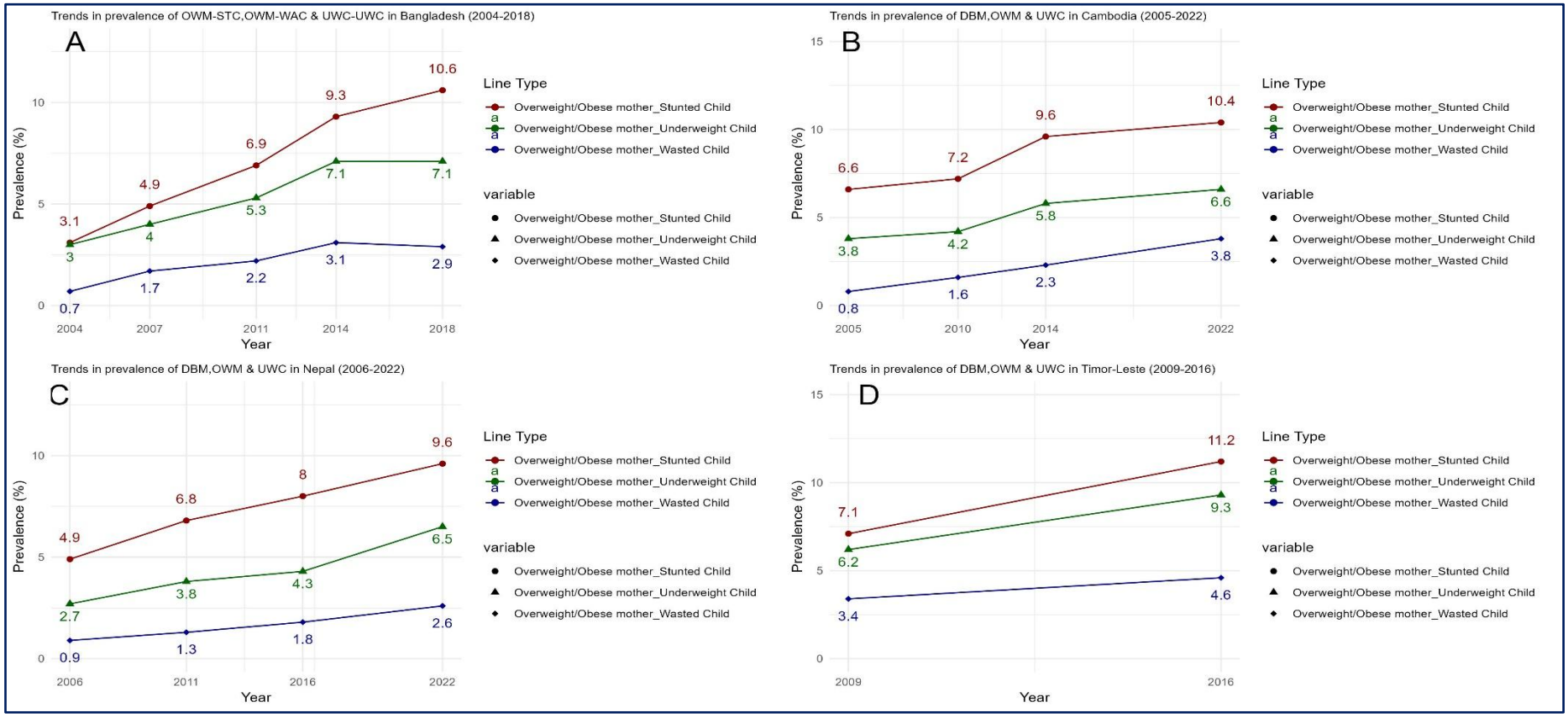
No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
	and Nutrition Survey 2015					"We applied estimated average requirement (EAR) as the cut-offs to assess dietary intake of the micronutrients in present study." However, not provide any references for EAR values.	
55.	The Double Burden of Malnutrition at the Individual Level Among Adults: A Nationwide Survey in the Philippines	Susan et al. (2021)	Individual	Total: 17,157 - Male: 8,596 - Female: 8,561	Philippines	• Anaemia: haemoglobin <13 g/dL for males or <12 g/dL for females • Vitamin A deficiency: serum retinol of <10 μg/dL indicated • Iodine insufficiency: The acid digestion/colorimetric method was employed to evaluate the UIE levels with a cut-off of <50 μg/dL • Overweight/obese: BMI ≥25 kg/m² • Waist circumference was obtained with a calibrated tape measure midway between the lowest rib and tip of the hip bone while the participant was standing and breathing normally, and expressed to the nearest 0.1 cm. Abdominal obesity was defined as waist circumference ≥102 cm for males or ≥88 cm for females • A blood pressure measurement of ≥140/≥90 mmHg indicated hypertension • Hyperglycemia was defined as fasting glucose ≥110 mg/dL; low HDL cholesterol as <40 mg/dL for males and <50 mg/dL for females; and hypertriglyceridemia as triglycerides ≥150 mg/dL. Participants were classified as having cardiometabolic risk factors (CMRF) if they had any of the following: overweight/obesity or abdominal obesity, hypertension, hyperglycemia, or dyslipidemia (low HDL or high triglycerides)	DBM at individual level is defined as following way: - Co-occurrence of underweight and at least one cardiometabolic risk factor (Uw + ≥1 CMRF) - Co-occurrence of anaemia and at least one cardiometabolic risk factor (An + ≥1 CMRF) - Co-occurrence of vitamin A deficiency or iodine insufficiency and at least one cardiometabolic risk factor (Other MND + ≥1 CMRF) CMRF measurements included the following: overweight/obesity or abdominal obesity, hypertension, hyperglycemia, and dyslipidemia (low HDL cholesterol or hypertriacylglycerolemia)
56.	Intra-Individual Double Burden of Malnutrition among	Huang et al. (2020)	Individual	Total: 6602 - Men: 3699 - Women: 2903	China	• Overweight/obese: BMI ≥25 kg/m²	DBM is defined as the coexistence of overweight/obesity and micronutrient deficiency.

No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
	Adults in China: Evidence from the China Health and Nutrition Survey 2015					• Micronutrient deficiency Using the China Food Composition Table, the authors calculated the average three-day intake of: • Total energy • Micronutrients (e.g., vitamins and minerals) • Retinol intake was estimated using a conversion formula: μgRAE = μg retinol + μg carotenes/12	
57.	The prevalence and correlates of the double burden of malnutrition among women in Ghana	Kushitor et al. (2020)	Individual	Total: 4,337 women	Ghana	• Anaemia: haemoglobin <12 g/dL for females • Overweight/obese: BMI ≥25 kg/m²	Women who suffered simultaneously from underweight or overweight/obesity and anaemia were considered as having the DBM.
58.	National income and macro-economic correlates of the double burden of malnutrition: an ecological study of adult populations in 188 countries over 42 years	Talukdar et al. (2023)	Population	Not mentioned	North America and Europe, East Asia, South Asia, Latin America, Middle East and North Africa, Sub-Saharan Africa	• Overweight: BMI ≥25.0 kg/m² • Underweight: BMI <18.5 kg/m²	A country was considered to have the DBM in a year when adult overweight and underweight prevalence was each 10% or more in that year.
59.	The double burden of malnutrition in under-five children at national and individual levels: observed and expected prevalence in ninety-three low-and middle-income countries	Lerm et al. (2020)	Population	Total: 825,633 children	West and Central Africa, Eastern and Southern Africa, Middle East and North Africa, Europe and Central Asia, South Asia, East Asia and the Pacific, Latin America and the Caribbean	• Stunting: <-2SD height-for-age • Overweight/obese: BMI ≥25 kg/m²	At the population level, DBM is measured by the prevalence of stunting and overweight, using thresholds of 20% for stunting and 10% for overweight.
60.	Dynamics of the double burden of malnutrition and the changing nutrition reality	Popkin *et al.* (2019)	Population	Not mentioned	sub-Saharan Africa, south Asia, east Asia, Pacific, Latin America	In low- and middle-income countries (LMICs), DBM is identified when there is a prevalence of: • Wasting > 15% • Stunting > 30%	DBM at the country level is defined by the coexistence of high levels of both undernutrition and overweight/obesity within a population.

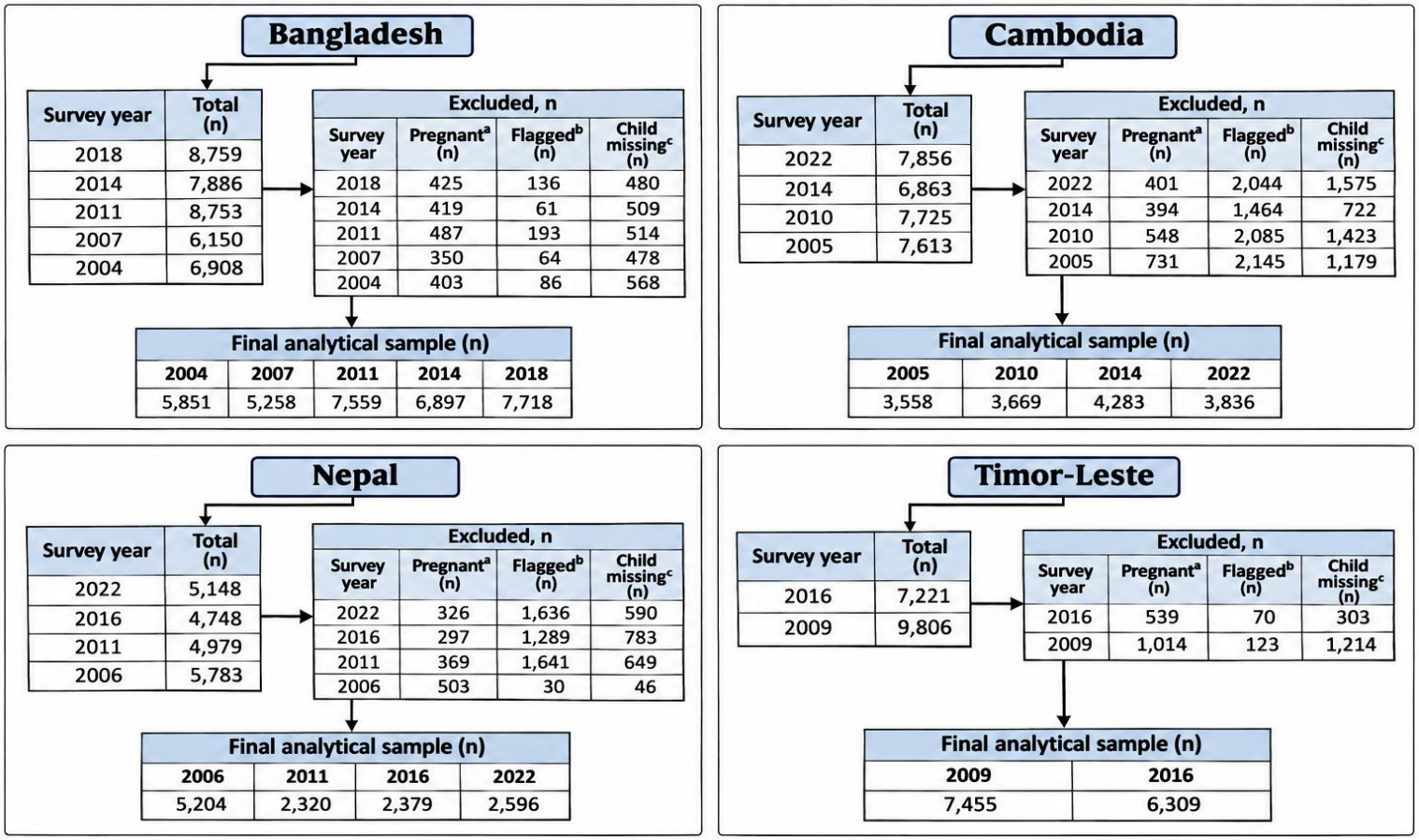
No.	Title	Reference ID	Level of measurement	Total participants	Region	Indicators with cut off	Definition of DBM
					and the Caribbean, eastern Europe, central Asia	• Thinness in women > 20% • Overweight in children or adults > 20% The specific cutoffs include: • Wasting: Weight-for-height Z score < -2 • Stunting: Height-for-age Z score < -2 (for children aged 0-4 years) • Thinness in women: BMI < 18.5 kg/m² • Overweight: BMI Z score > 2 in children; BMI > 25 kg/m² in adults.	

Appendix B

Supplementary Materials for Chapter 5

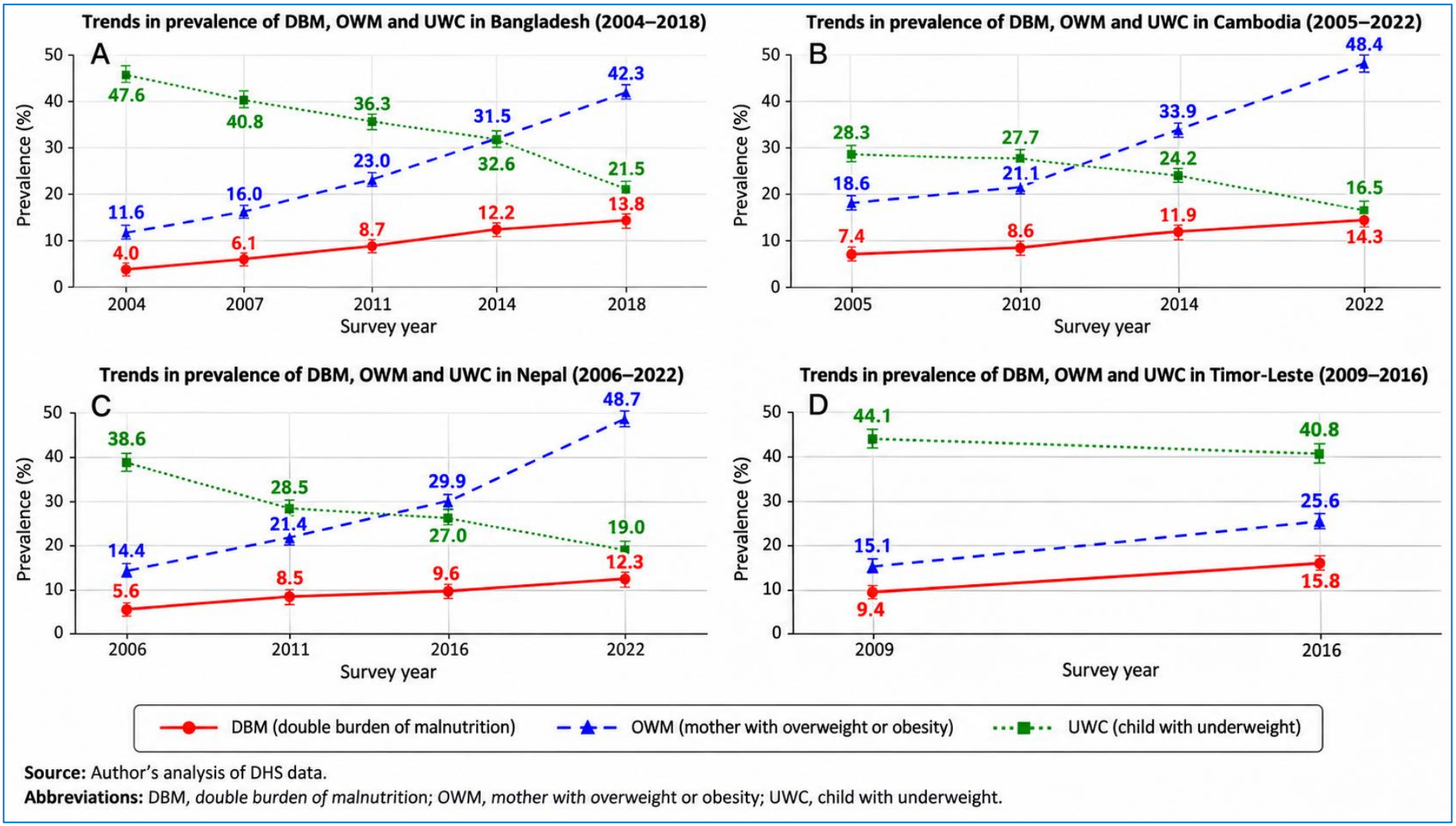


Supplementary Figure 1: Trends in prevalence of OWM-STC, OWM-WAC, & UWM-UWC in Bangladesh (**A**), Cambodia (**B**), Nepal (**C**) & Timor-Leste (**D**)



Supplementary Figure 2: Flow chart showing detailed analytical samples.

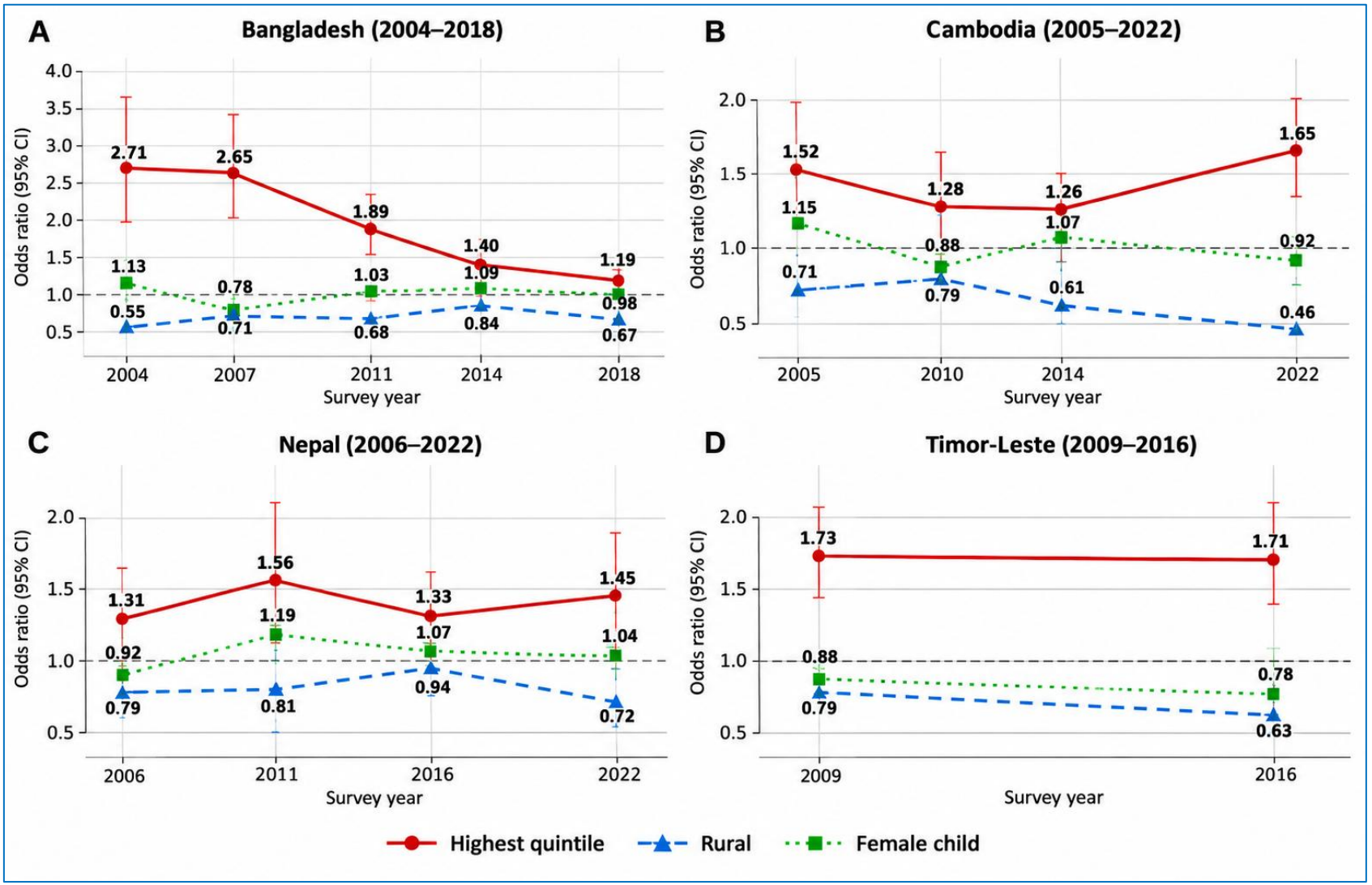
Note: Differences in exclusions due to unavailable maternal anthropometric measurements across countries and survey rounds partly reflect variations in DHS anthropometric sampling procedures. In Cambodia, maternal height and weight were measured in a subsample of households, while subsampling was also used in later Nepal surveys. Consequently, this exclusion category may include women who were not selected for anthropometric measurements, in addition to those with missing or flagged measurements. The larger analytical sample in Nepal 2006 is consistent with broader anthropometric measurement coverage compared with later survey rounds. (**Source:** Author's analysis of DHS data).



Source: Author's analysis of DHS data.

Abbreviations: DBM, *double burden of malnutrition*; OWM, *mother with overweight or obesity*; UWC, child with underweight.

Supplementary Figure 3: Changes in the prevalence of household-level double burden of malnutrition (DBM) among mother–child pairs in Bangladesh (A), Cambodia (B), Nepal (C), and Timor-Leste (D).



Supplementary Figure 4: Trends in disparities for household level DBM among mother–child pairs in Bangladesh (A), Cambodia (B), Nepal (C) & Timor-Leste (D) based on wealth index, place of residence, and child sex.

Appendix C

Supplementary Materials for Chapter 6

Supplementary table S1: Search strategy

Source	Search strategy
PubMed (Total search: 237)	("double burden"[all] OR double burden[all] OR "dual burden"[all] OR coexist*[all] OR concurrent[all] OR (overweight[all] AND (undernutri*[all] OR underweight[all] OR stunt*[all] OR wast*[all]) AND (double[all] OR dual[all] OR coexist*[all] OR concurrent[all]))) AND (Mother [Mesh] OR Child [Mesh] OR Parents [Mesh] OR household [all] OR households [all] OR mother[all] OR maternal[all] OR mother-child[all] OR "mother and child"[all] OR dyad[all] OR pair[all] OR parent*[all] OR caregiver[all]) AND (Malnutrition [Mesh] OR Overweight [Mesh] OR Obesity [Mesh] OR Underweight [Mesh] OR "Protein-Energy Malnutrition"[Mesh] OR "Growth Disorders"[Mesh]) AND (factor*[all] OR determinant*[all] OR associated[all] OR association[all] OR predictor*[all] OR correlate*[all] OR "risk factor*"[all]) AND (Afghanistan[all] OR Bangladesh[all] OR Bhutan[all] OR India[all] OR Maldives[all] OR Nepal[all] OR Pakistan[all] OR "Sri Lanka"[all] OR Brunei[all] OR Cambodia[all] OR Indonesia[all] OR Laos[all] OR "Lao PDR"[all] OR Malaysia[all] OR Myanmar[all] OR Philippines[all] OR Singapore[all] OR Thailand[all] OR Timor[all] OR "East Timor"[all] OR Timor-Leste[all] OR Vietnam[all])
Scopus (Total search: 367)	TITLE-ABS-KEY (("double burden" OR double-burden OR "dual burden" OR coexist* OR concurrent OR (overweight AND (undernutri* OR underweight OR stunt* OR wast*) AND (double OR dual OR coexist* OR concurrent))) AND (Mother OR Child OR Parents OR household OR households OR mother OR maternal OR mother-child OR "mother and child" OR dyad OR pair OR parent* OR caregiver) AND (Malnutrition OR Overweight OR Obesity OR Underweight OR "Protein-Energy Malnutrition" OR "Growth Disorders") AND (factor* OR determinant* OR associated OR association OR predictor* OR correlate* OR "risk factor*") AND

Source	Search strategy
	(Afghanistan OR Bangladesh OR Bhutan OR India OR Maldives OR Nepal OR Pakistan OR "Sri Lanka" OR Brunei OR Cambodia OR Indonesia OR Laos OR "Lao PDR" OR Malaysia OR Myanmar OR Philippines OR Singapore OR Thailand OR Timor OR "East Timor" OR "Timor-Leste" OR Vietnam))
Web of science (Total search: 417)	("double burden" OR "double burden" OR "dual burden" OR coexist* OR concurrent OR (overweight AND (undernutri* OR underweight OR stunt* OR wast*) AND (double OR dual OR coexist* OR concurrent))) AND (Mother OR Child OR Parents OR household OR households OR mother OR maternal OR mother-child OR "mother and child" OR dyad OR pair OR parent* OR caregiver) AND (Malnutrition OR Overweight OR Obesity OR Underweight OR "Protein-Energy Malnutrition" OR "Growth Disorders") AND (factor* OR determinant* OR associated OR association OR predictor* OR correlate* OR "risk factor*") AND (Afghanistan OR Bangladesh OR Bhutan OR India OR Maldives OR Nepal OR Pakistan OR "Sri Lanka" OR Brunei OR Cambodia OR Indonesia OR Laos OR "Lao PDR" OR Malaysia OR Myanmar OR Philippines OR Singapore OR Thailand OR Timor OR "East Timor" OR Timor-Leste OR Vietnam)

Supplementary Table S2. Characteristics of studies included in the systematic review on household-level DBM in South and Southeast Asia

Author	Country	Sample Size	DBM definition	Effect Measures	Study design	Suitable for meta	NOS-xs Score
Anik et al. (2019) [26]	Bangladesh, Nepal, Pakistan, Mayanmar	Bangladesh: 6,478 Nepal: 2,670 Pakistan: 5,770 Myanmar: 3,541	OWM+SC	AOR	Cross sectional	Yes	9
Agdeppa et al. (2003) [31]	Philippines	376 mother-child pairs	OWM+UW	Descriptive Statistics only	Cross sectional	No	7
Biswas et al. (2020) [24]	8 South and Southeast Asian Countries	798,961 households	OWM+SC, OWM+WC, OWM+UWC, OWM+SC/WC/UW	OR	Cross sectional	No	9
Das et al. (2018) [32]	Bangladesh	5951 households	OWM+SC, OWM+WC, OWM+UWC, OWM+SC/WC/UW	OR	Cross sectional	Yes	9
Fooken et al (2021)[33]	11 Asian Countries	134,283 households	OWM+SC	Descriptive Statistics only	Cross sectional	No	9
Gaupholm et al. (2023) [34]	Philippines	5837 households	OWM+SC/WC/UW	AOR	Cross sectional	Yes	9
Hauqe et al. (2017) [35]	Bangladesh	5697 mother-child pairs	OWM+SC/WC/UW	RR	Cross sectional	Yes	9
Hong et al. (2020) [23]	Myanmar	5687 mother-child pairs	OWM+SC	AOR	Cross sectional	Yes	9
Ihab et al. (2013) [36]	Malaysia	223 households	OWM+SC/WC/UW	AOR	Cross sectional	Yes	8
Jayalakshmi et al. (2019) [37]	India	344 mother and child pairs	OWM+SC	Descriptive Statistics only	Cross sectional	Yes	8
Khaliq et al. (2025) [38]	Pakistan	6198 mother-child pairs	OWM+SC	AOR	Cross sectional	Yes	9
Khor et al. (2003) [39]	Malaysia	140 households	OWM+UW	Descriptive Statistics only	Cross sectional	No	7
Krismanita et al. (2022) [40]	Indonesia	274 households	OWM+SC	OR	Cross sectional	Yes	8
Limon et al. (2021) [41]	Bangladesh	3772 mother-child pairs	OWM+SC/WC/UW	AOR	Cross sectional	Yes	8
Mahmudiono et al. (2018) [54]	Indonesia	685 households	OWM+SC	OR	Cross sectional	Yes	9
Nakphong et al. (2021) [42]	Cambodia	14,988 mother-child pairs	OWM+SC	AOR	Cross sectional	Yes	8

Author	Country	Sample Size	DBM definition	Effect Measures	Study design	Suitable for meta	NOS-xs Score
Oddo et al. (2012) [43]	Indonesia, Bangladesh	Indonesia: 247126 Bangladesh: 168317	OWM+SC	AOR	Cross sectional	Yes	8
Patel et al. (2020) [25]	India	184,680 mother-child pairs	OWM+SC/WC/UW	AOR	Cross sectional	Yes	9
Rachmah et al. (2021) [44]	Indonesia	436 (households)	OWM+SC	OR	Cross sectional	Yes	8
Rahman et al. (2021) [45]	Bangladesh	7,662 mother-child pairs	OWM+SC, OWM+WC, OWM+UWC, OWM+SC/WC/UW	AOR	Cross sectional	Yes	9
Ramasubramani et al. (2024)[10]	India	167,380 mother-child pairs	OWM+SC/WC	AOR	Cross sectional	Yes	9
Saibul et al. (2009) [46]	Malaysia	227 households	OWM+SC/WC/UW	AOR	Cross sectional	Yes	7
Sarker et al. (2022) [47]	Bangladesh	8,697 mother-child pairs	OWM+SC/WC/UW	AOR	Cross sectional	Yes	9
Sekiyama et al. (2015) [48]	Indonesia	242 mother-child pairs	OWM+SC	OR	Cross sectional	Yes	8
Sengupta et al. (2025) [49]	India	360 households	OWM+SC/WC/UW	AOR	Cross sectional	Yes	8
Shariff et al. (2024) [50]	Malaysia	451 households	OWM+SC/UW	AOR	Cross sectional	Yes	9
Singh et al. (2023)[52]	India	122,922 mother-child pairs	OWM+SC/WC/UW	AOR	Cross sectional	Yes	9
Sunuwar et al. (2020) [51]	Nepal	2261 mother-child pairs	OWM+SC, OWM+WC, OWM+UWC	AOR	Cross sectional	Yes	9
Sutopa et al. (2022) [53]	Bangladesh	14,975 mother-child pairs	OWM+SC/WC/UW	AOR	Cross sectional	Yes	9
Talukder et al. (2024) [13]	Bangladesh, Cambodia, Nepal, Timor-Leste	Total: 18,459 Bangladesh: 7,718 Cambodia: 3,836 Nepal: 2,596 Timor-Leste: 6,309	OWM+SC/WC/UW	AOR	Cross sectional	Yes	9

Supplementary Table S3: Newcastle–Ottawa Scale adapted for cross-sectional studies (NOS-xs) quality assessment of included studies

		Domain 1: Study Sample Selection (Max: 2 ★)		Domain 2: Assessment of Exposure and Outcome (Max: 4 ★)				Domain 3: Confounding Factors (Max: 3 ★)				
Author	**Country**	**Representativeness of Sample**	**Adequacy of Sample Size**	**Validity of Exposure Measurement**	**Reliability of Exposure Measurement**	**Validity of Outcome Measurement**	**Reliability of Outcome Measurement**	**Appropriate Control of Confounders**	**Measurement of Confounders**	**Reporting of Confounders**	**Total Score (Max: 9)**	**Quality Rating**
Anik et al. (2019)	Bangladesh, Nepal, Pakistan, Myanmar	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Agdeppa et al. (2003)	Philippines	★	—	★	★	★	★	★	—	★	**7/9**	Low Risk (Good)
Biswas et al. (2020)	8 South & Southeast Asian Countries	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Das et al. (2018)	Bangladesh	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Fooken et al. (2021)	11 Asian Countries	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Gaupholm et al. (2023)	Philippines	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Hauqe et al. (2018)	Bangladesh	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Hong et al. (2020)	Myanmar	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Ihab et al. (2013)	Malaysia	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Jayalakshmi et al. (2019)	India	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Khaliq et al. (2025)	Pakistan	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Khor et al. (2003)	Malaysia	★	—	★	★	—	★	★	★	★	**7/9**	Low Risk (Good)
Krismanita et al. (2022)	Indonesia	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Limon et al. (2021)	Bangladesh	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Mahmudiono et al. (2018)	Indonesia	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)

		Domain 1: Study Sample Selection (Max: 2 ★)		Domain 2: Assessment of Exposure and Outcome (Max: 4 ★)				Domain 3: Confounding Factors (Max: 3 ★)				
Author	**Country**	**Representativeness of Sample**	**Adequacy of Sample Size**	**Validity of Exposure Measurement**	**Reliability of Exposure Measurement**	**Validity of Outcome Measurement**	**Reliability of Outcome Measurement**	**Appropriate Control of Confounders**	**Measurement of Confounders**	**Reporting of Confounders**	**Total Score (Max: 9)**	**Quality Rating**
Nakphong et al. (2021)	Cambodia	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Oddo et al. (2012)	Indonesia, Bangladesh	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Patel et al. (2020)	India	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Rachmah et al. (2021)	Indonesia	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Rahman et al. (2021)	Bangladesh	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Ramasubramani et al. (2024)	India	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Saibul et al. (2009)	Malaysia	★	—	★	★	★	★	—	★	★	**7/9**	Low Risk (Good)
Sarker et al. 2022	Bangladesh	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Sekiyama et al. (2015)	Indonesia	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Sengupta et al. (2025)	India	★	★	★	★	★	★	★	—	★	**8/9**	Low Risk (Good)
Shariff et al. (2024)	Malaysia	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Singh et al. (2023)	India	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Sunuwar et al. (2020)	Nepal	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Sutopa et al. (2022)	Bangladesh	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)
Talukder et al. (2024)	Bangladesh, Cambodia, Nepal, Timor-Leste	★	★	★	★	★	★	★	★	★	**9/9**	Low Risk (Good)

Notes: ★ = Criterion met (1 star) | — = Criterion not met (0 stars)

Quality Rating: Low Risk / Good Quality: 7–9 stars | Moderate Risk: 5–6 stars | High Risk: 0–4 stars

Scale: Newcastle–Ottawa Scale adapted for cross-sectional studies (NOS-xs). Carra et al., J Periodontal Res, 2025.

Figures: SF1-SF12: Forrest plots of factors associated with double burden of malnutrition in South and Southeast Asia

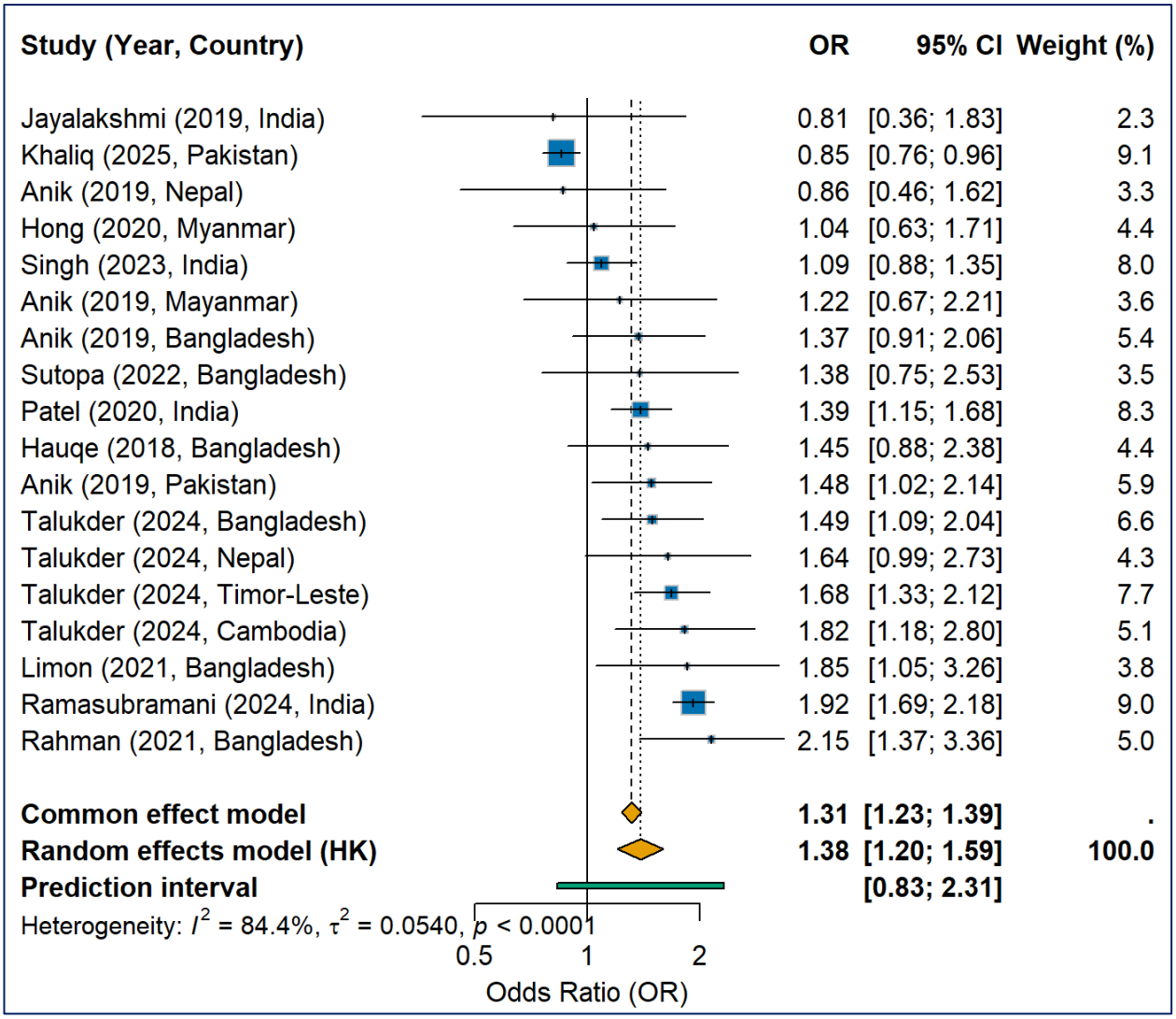


Figure: SF1: Forest plot for factor: Residence (Urban vs Rural)

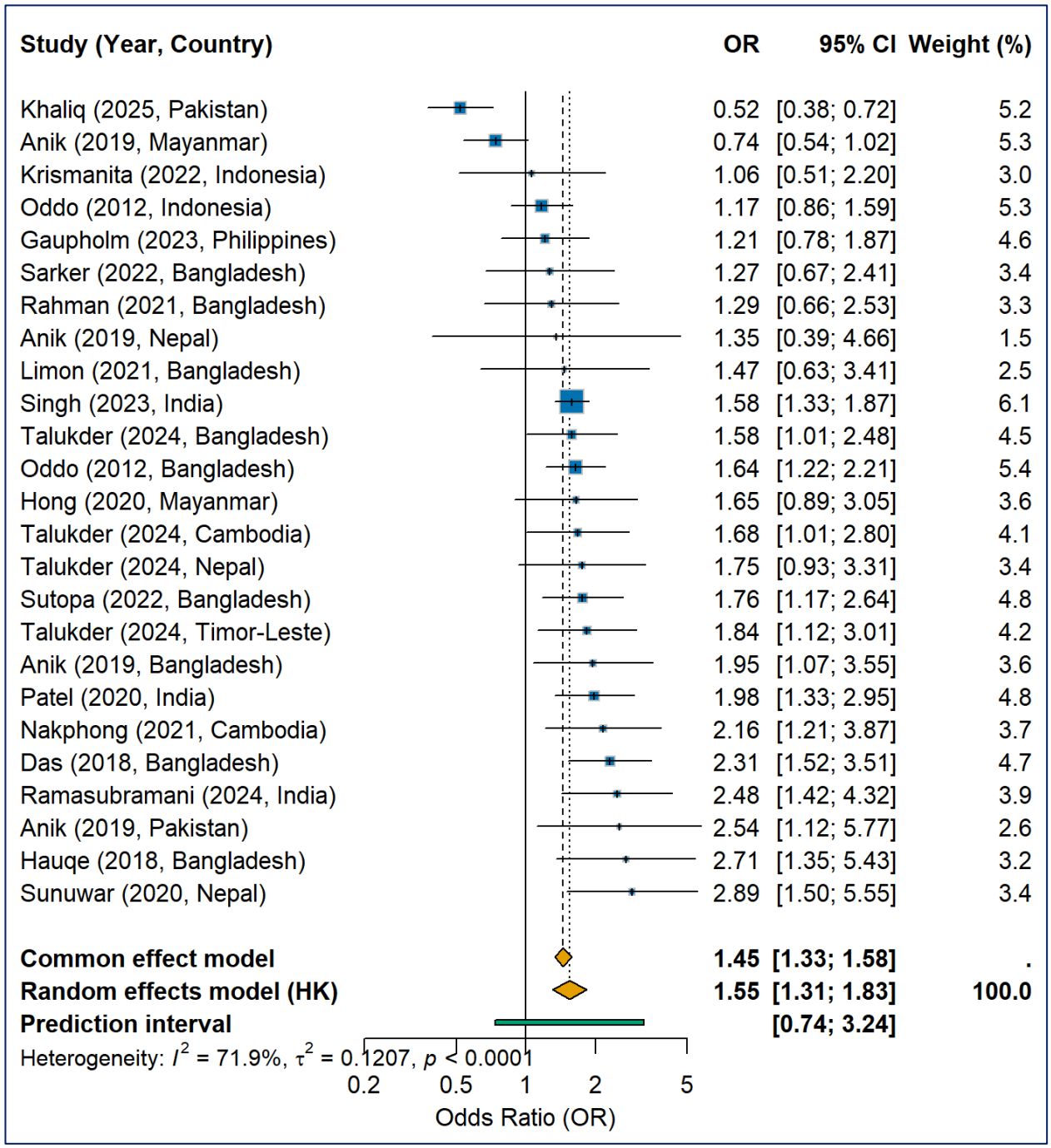


Figure: SF2: Forest plot for factor: Wealth Index (Rich vs Poor)

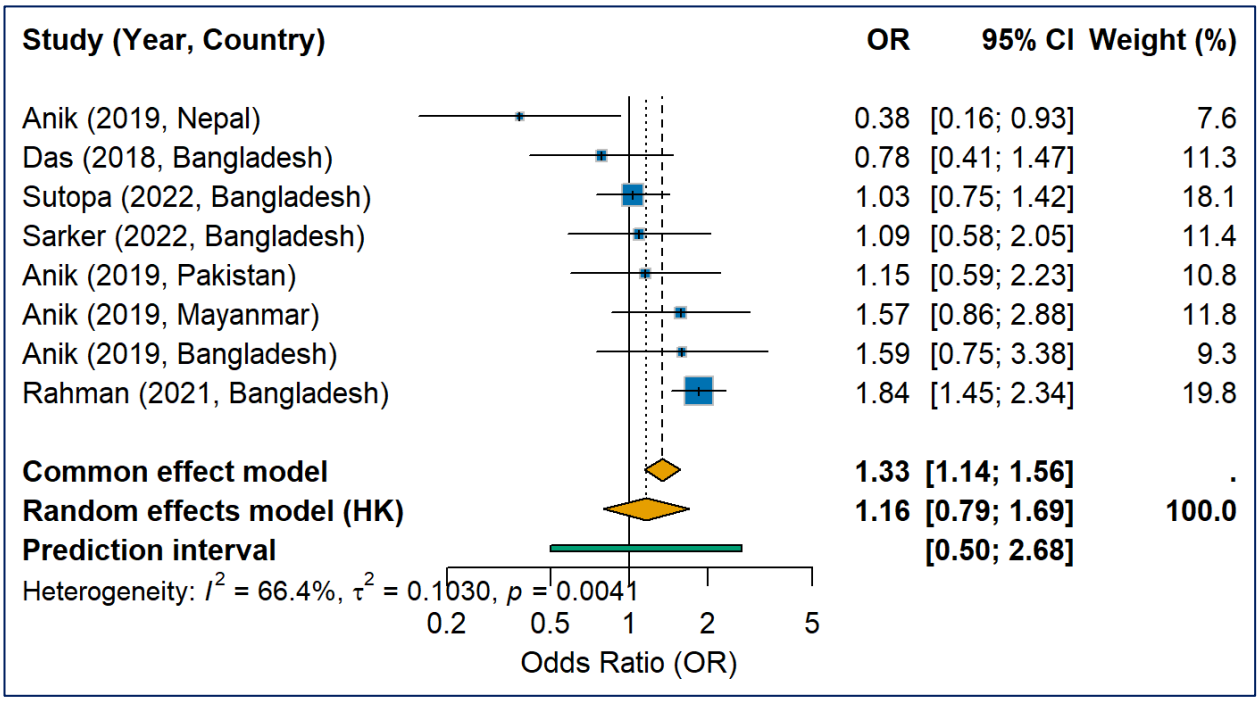


Figure: SF3: Forest plot for factor: Media Exposure (Yes vs No)

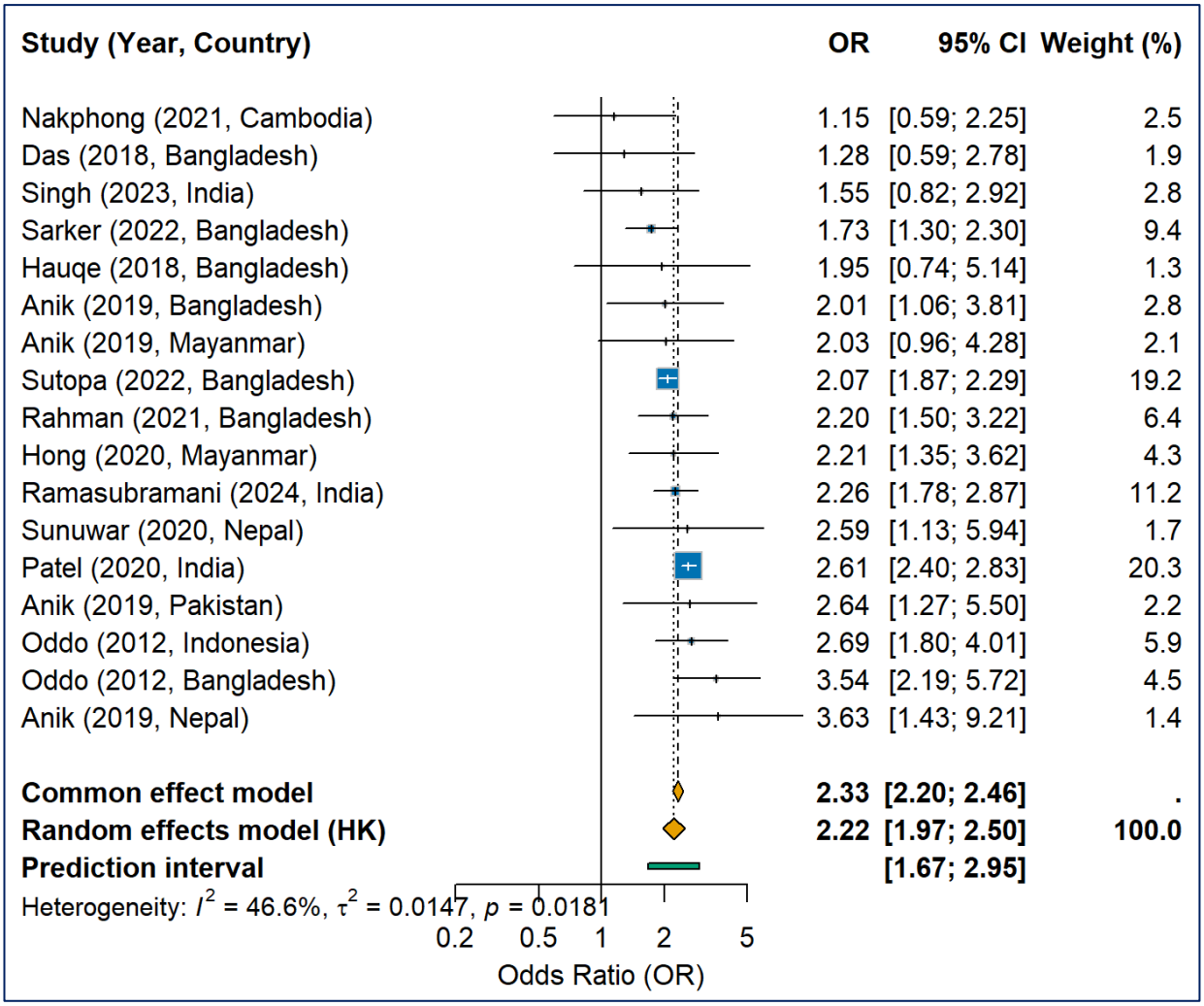


Figure: SF4: Forest plot for factor: Maternal Age (≥25 vs vs 15-24 years)

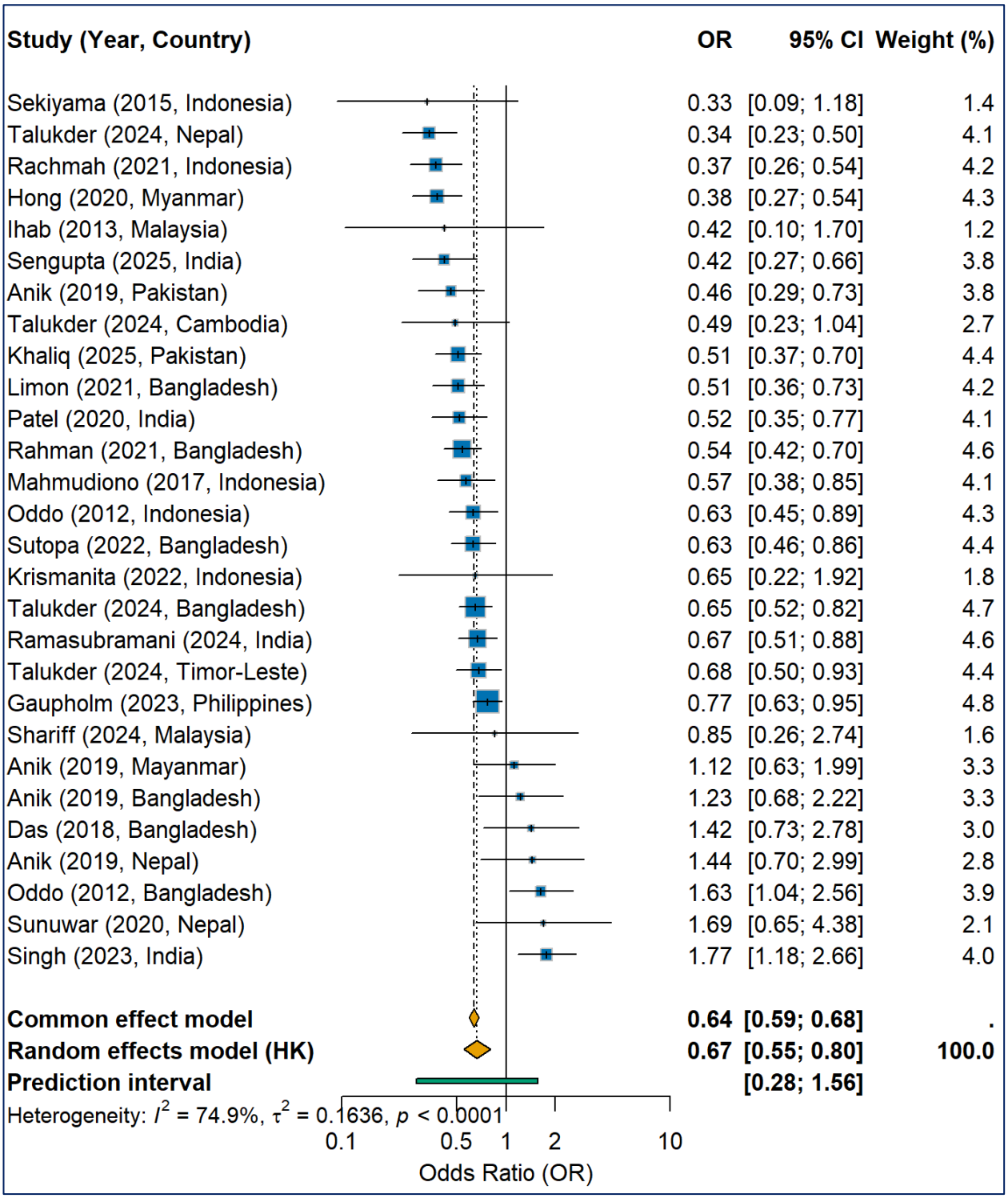


Figure: SF5: Forest plot for factor: Maternal Education (High vs Low)

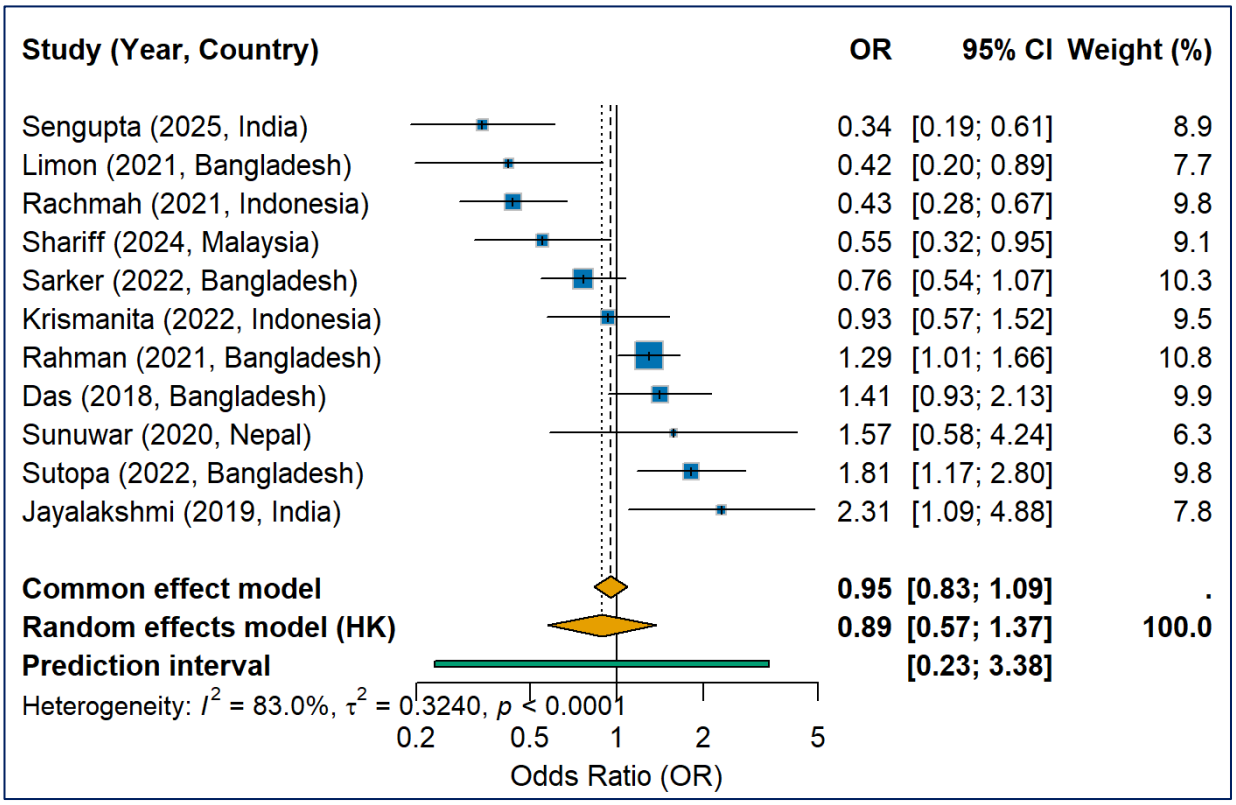


Figure: SF6: Forest plot for factor: Father's Education (High vs Low)

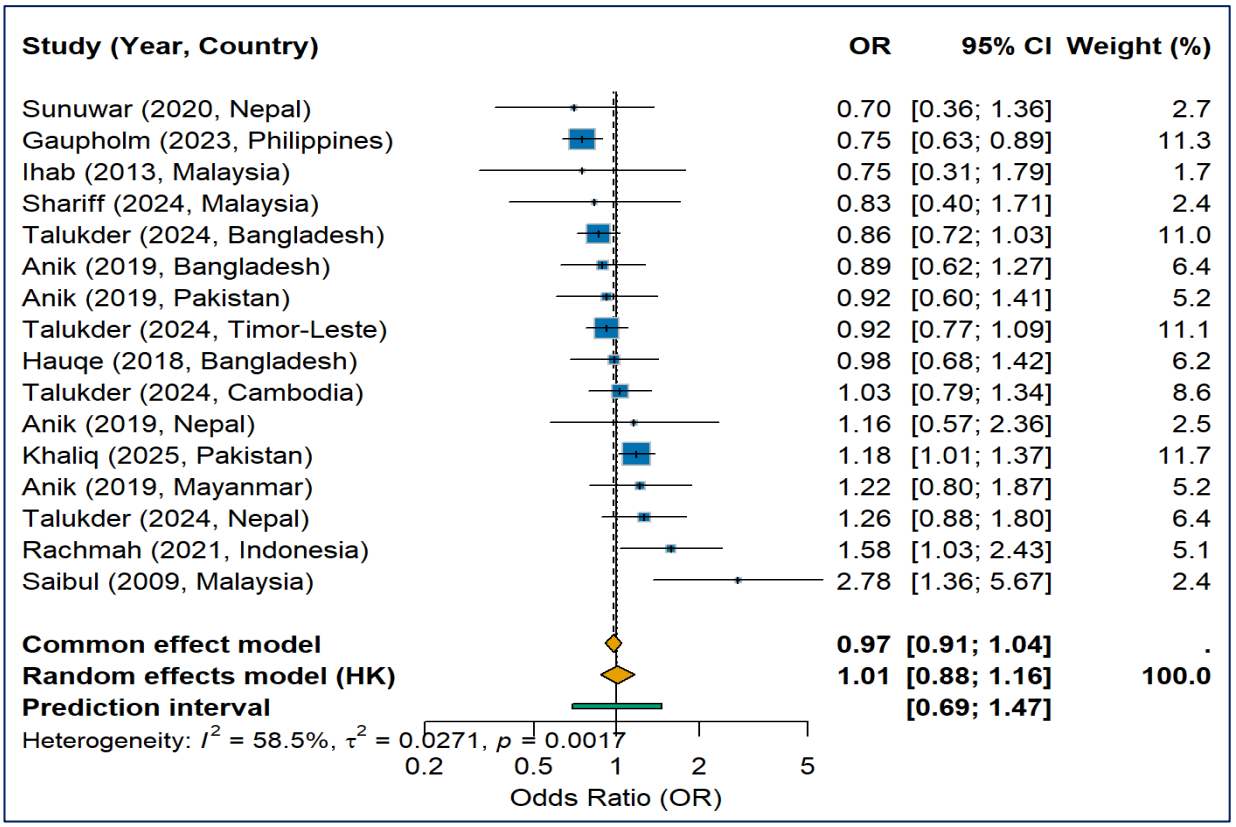


Figure: SF7: Forest plot for factor: Maternal Working Status (Yes vs No)

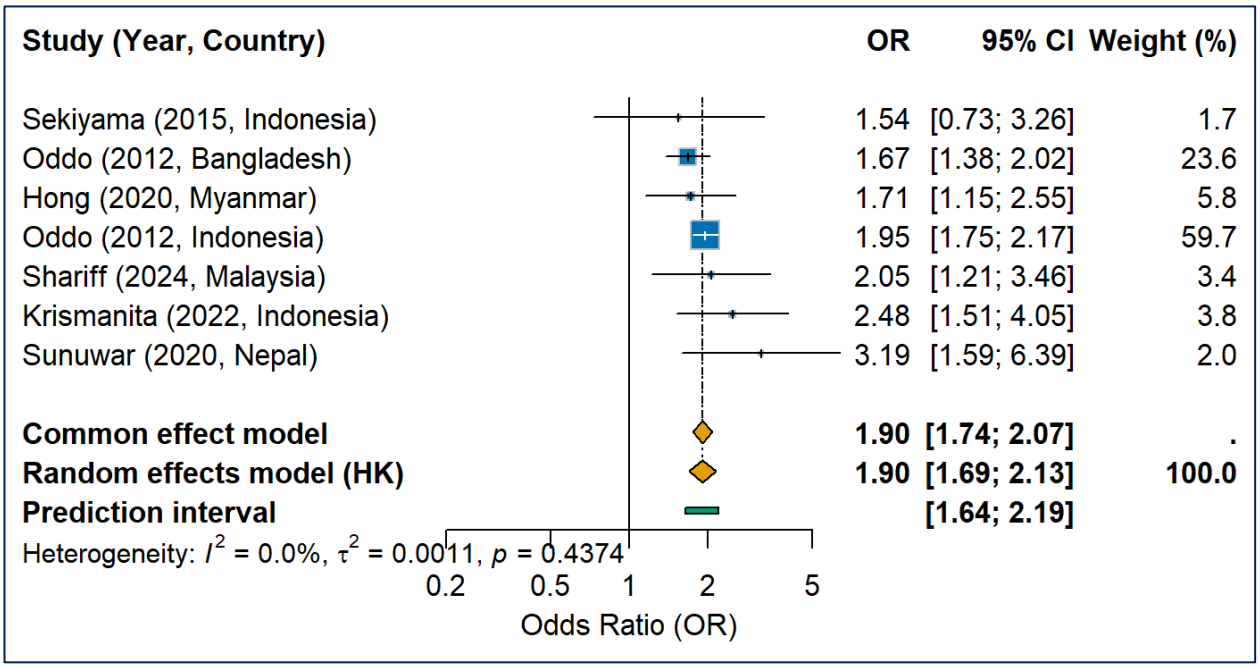


Figure: SF8: Forest plot for factor: Maternal Stature (<150 vs≥150 cm)

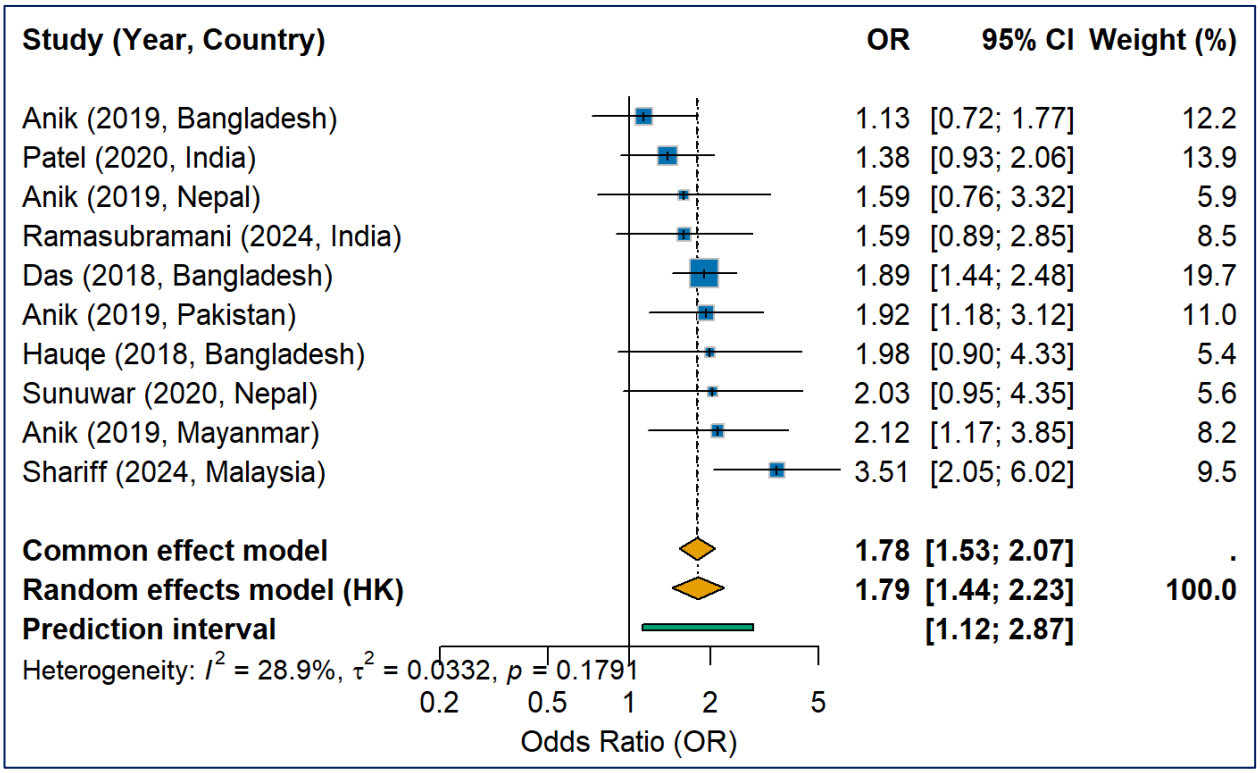


Figure: SF9: Forest plot for factor: Child Age (24-59 vs 0-23 months)

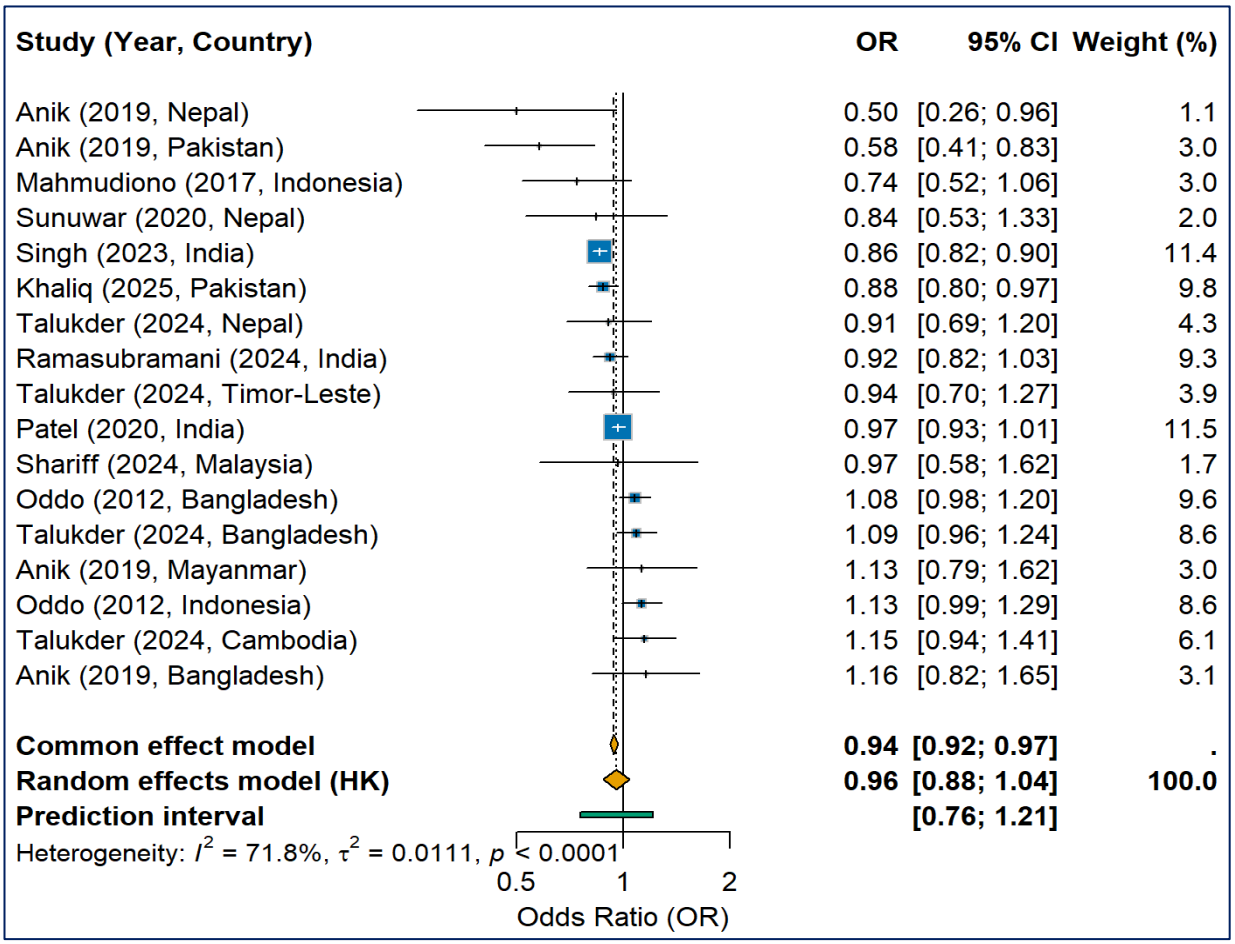


Figure: SF10: Forest plot for factor: Child Sex (Female vs Male)

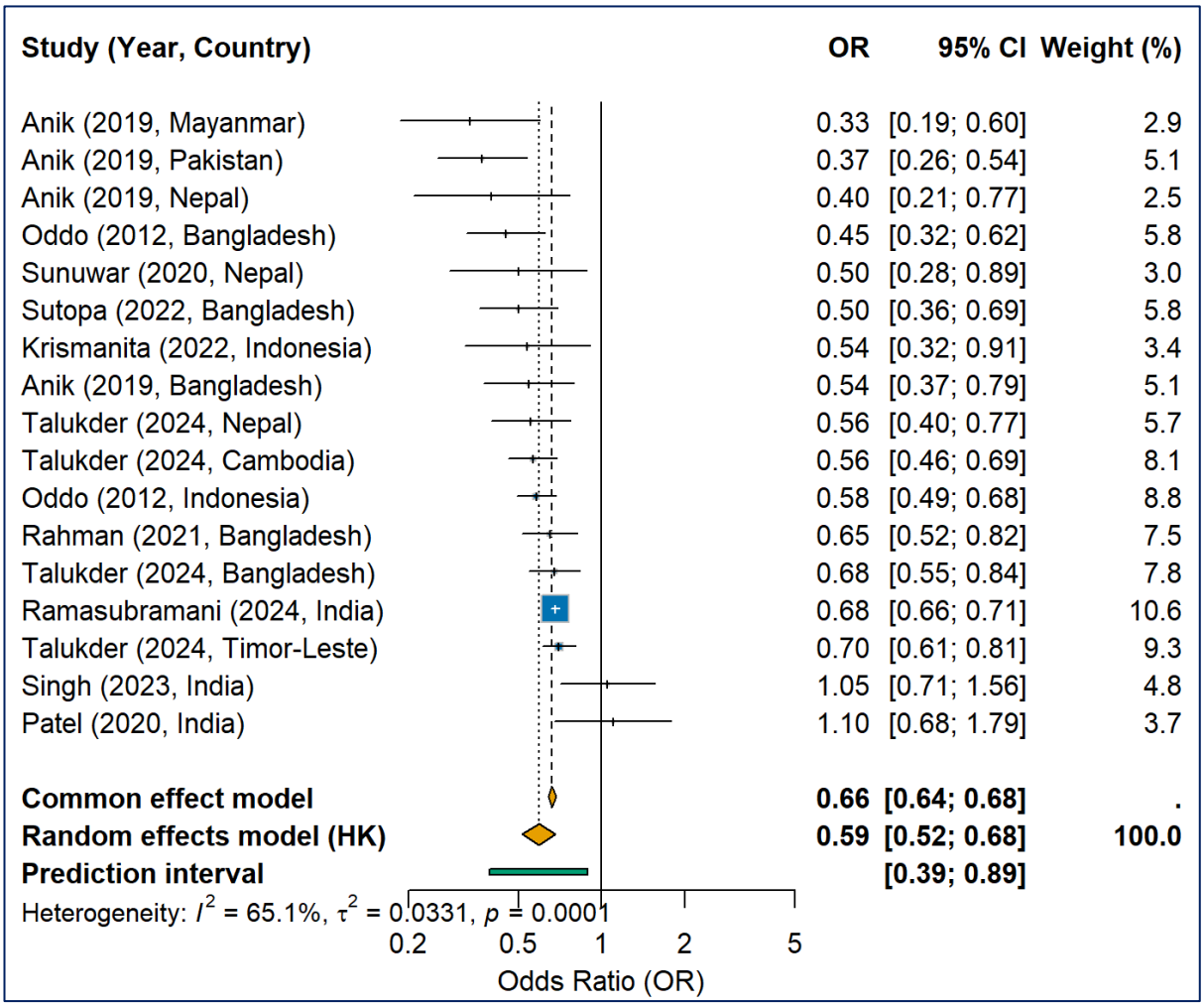


Figure: SF11: Forest plot for factor: Breastfeeding (Yes vs No)

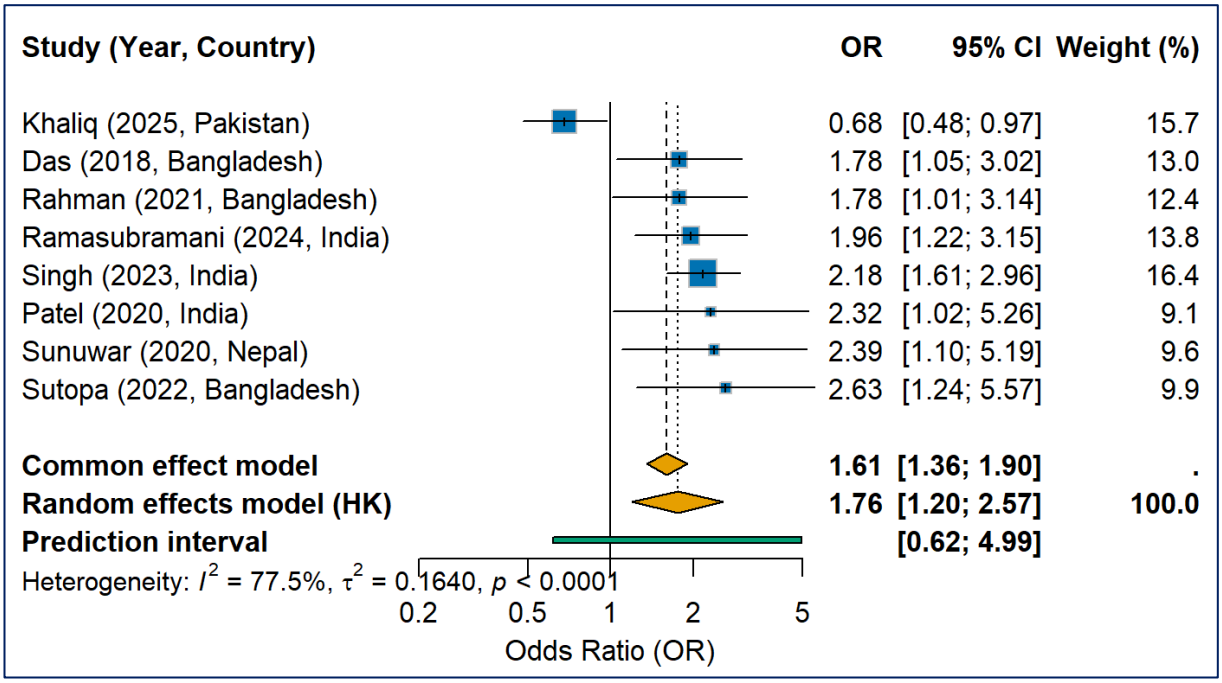


Figure: SF12: Forest plot for factor: C-section (Yes vs No)

PRISMA 2020 Main Checklist

Topic	No.	Item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1, Lines 1–2 (Title)
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist	Page 2, Lines 29–53 (Abstract section)
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Pages 5–6, Lines 147–197 (Introduction section)
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 6, Lines 179–197 (Introduction, last paragraph)
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 6, Lines 204–216 (Methods: Study selection and eligibility criteria; Exclusion Criteria)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Pages 6–7, Lines 217–225 (Methods: Search Strategy)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Pages 6–7, Lines 217–225 (Methods: Search Strategy); Page 9, Line 290 (Results: Overview of literature screening)
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 7, Lines 226–241 (Methods: Study Screening and Data Extraction)
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 7, Lines 226–241 (Methods: Study Screening and Data Extraction)

Topic	No.	Item	Location where item is reported
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 8, Lines 255–288 (Methods: Statistical Methods)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Pages 7–8, Lines 226–254 (Methods: Study Screening and Data Extraction)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Pages 7–8, Lines 242–254 (Methods: Risk of Bias Assessment)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 8, Lines 255–288 (Methods: Statistical Methods)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item 5)).	Page 8, Lines 255–288 (Methods: Statistical Methods)
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 8, Lines 255–288 (Methods: Statistical Methods)
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 8, Lines 255–288 (Methods: Statistical Methods)
	13d	Describe any methods used to synthesise results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 8, Lines 255–288 (Methods: Statistical Methods)
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Pages 8–11, Lines 255–393 (Methods: Statistical Methods; Results: Subgroup analysis, Lines 370–393)

Topic	No.	Item	Location where item is reported
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesised results.	Pages 8–12, Lines 255–407 (Methods: Statistical Methods; Results: Sensitivity Analysis, Lines 394–407)
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Pages 7–8, Lines 242–254 (Methods: Risk of Bias Assessment); Page 8, Lines 283–286 (Methods: Statistical Methods)
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 17, Lines 601–605 (Discussion: Strengths and Limitations — formal GRADE certainty assessment not undertaken for observational etiological evidence)
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Pages 8–9, Lines 290–303 (Results: Overview of the literature screening process)
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 9, Lines 295–303 (Results: Overview of the literature screening process)
Study characteristics	17	Cite each included study and present its characteristics.	Pages 9–10, Lines 304–319 (Results: Characteristics of Included Studies); Table 3
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Pages 9–10, Lines 304–319 (Results: Characteristics of Included Studies; NOS-xs ratings in Supplementary Table S3)
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Table 3 (pages 32–35)
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Pages 9–10, Lines 304–319 (Results: Characteristics of Included Studies)

Topic	No.	Item	Location where item is reported
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Pages 9–12, Lines 320–412 (Results: Meta-analysis results of factors associated with DBM)
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Page 11, Lines 370–393 (Results: Subgroup analysis)
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesised results.	Pages 11–12, Lines 394–407 (Results: Sensitivity Analysis)
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Page 12, Lines 408–412 (Results: Publication bias)
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Page 17, Lines 601–605 (Discussion: Strengths and Limitations)
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 12, Lines 413–458 (Discussion, 1st paragraph)
	23b	Discuss any limitations of the evidence included in the review.	Pages 16–17, Lines 576–605 (Discussion: Strengths and Limitations)
	23c	Discuss any limitations of the review processes used.	Pages 16–17, Lines 576–605 (Discussion: Strengths and Limitations)
	23d	Discuss implications of the results for practice, policy, and future research.	Pages 15–16, Lines 543–575 (Discussion: Implications for policy and practice)
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 2, Line 54 (Abstract); Page 6, Lines 199–203 (Methods, 1st paragraph)
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 6, Lines 199–203 (Methods, 1st paragraph)
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Page 6, Lines 199–203 (Methods, 1st paragraph)

Topic	No.	Item	Location where item is reported
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 18, Line 642 (Funding statement)
Competing interests	26	Declare any competing interests of review authors.	Page 18, Line 643 (Conflict of interest statement)
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 18, Lines 636–640 (Data availability)

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. MetaArXiv. 2020, September 14. DOI: 10.31222/osf.io/v7gm2. For more information, visit: www.prisma-statement.org

Appendix D

Supplementary Materials for Chapter 7

Supplementary Table 1: Regression model estimates of household-level DBM in South Asia (Bangladesh & Nepal) and Southeast Asia (Cambodia & Timor-Leste) along with Hosmer & Lemeshow goodness of fit test

Covariates	South Asia ($N = 10314$) (Bangladesh & Nepal)	Southeast Asia ($N = 10145$) (Cambodia & Timor-Leste)
	AOR (95% CI)	AOR (95% CI)
Main effect		
Country		
Bangladesh	**Reference**	-
Nepal	0.88 (0.72, 1.08)	-
Cambodia	-	**Reference**
Timor-Leste	-	1.19 (1.01, 1.39) **
Place of residence		
Rural	**Reference**	**Reference**
Urban	1.18 (1.01, 1.40) **	1.33 (1.12, 1.58) ***
Wealth index		
Poor	**Reference**	**Reference**
Middle	1.32 (1.06, 1.65) **	1.43 (1.18, 1.74) ***
Rich	1.69 (1.39, 2.07) ***	1.56 (1.28, 1.89) ***
Mother's education		
No/ Primary	1.34 (1.05, 1.70) **	1.55 (1.17, 2.05) ***
Secondary	1.31 (1.06, 1.62) **	1.23 (0.95, 1.61)
Higher	**Reference**	**Reference**
Household member		
<4	**Reference**	**Reference**
>4	1.05 (0.89, 1.24)	1.21 (1.01, 1.44) **
Working Status of Mother		
No	**Reference**	**Reference**
Yes	0.86 (0.73, 1.01) *	1.11 (0.96, 1.28)
Breastfeeding status		
No	**Reference**	**Reference**
Yes	0.58 (0.48, 0.71) ***	0.72 (0.63, 0.83) ***
ANC visits		
<4	**Reference**	**Reference**
>4	0.71 (0.59, 0.83) ***	0.96 (0.82, 1.11)
Goodness of fit		
Hosmer & Lemeshow Test	$\chi^2 = 7.21; df = 8,;$ $P\text{-}value = 0.51$	$\chi^2 = 11.24; df = 8;$ $P\text{-}value = 0.19$

Appendix E

Supplementary Materials for Chapter 8

Methods

Statistical Analysis

In our analysis, we applied the sampling weights provided in the DHS dataset to account for the complex survey design, which includes stratification and clustering. This approach ensured that the findings were nationally representative and adjusted for design effects, thereby reducing potential biases associated with unequal probabilities of selection. By incorporating these weights, we improved the reliability and generalizability of our estimates, ensuring that they accurately reflected the true distribution of the population across different demographic and socioeconomic groups.

We conducted descriptive analyses to summarise the characteristics of the study population. To explore associations between predictor variables and DBM, we first performed bivariate chi-square tests for categorical variables and analysis of variance (ANOVA) for continuous variables. To account for potential clustering effects, we applied a two-level logistic regression model, defined as:

$$logit(P_{ij}) = \beta_{00} + \beta_{10}x_{ij} + \beta_{01}X_j + V_{0j}$$

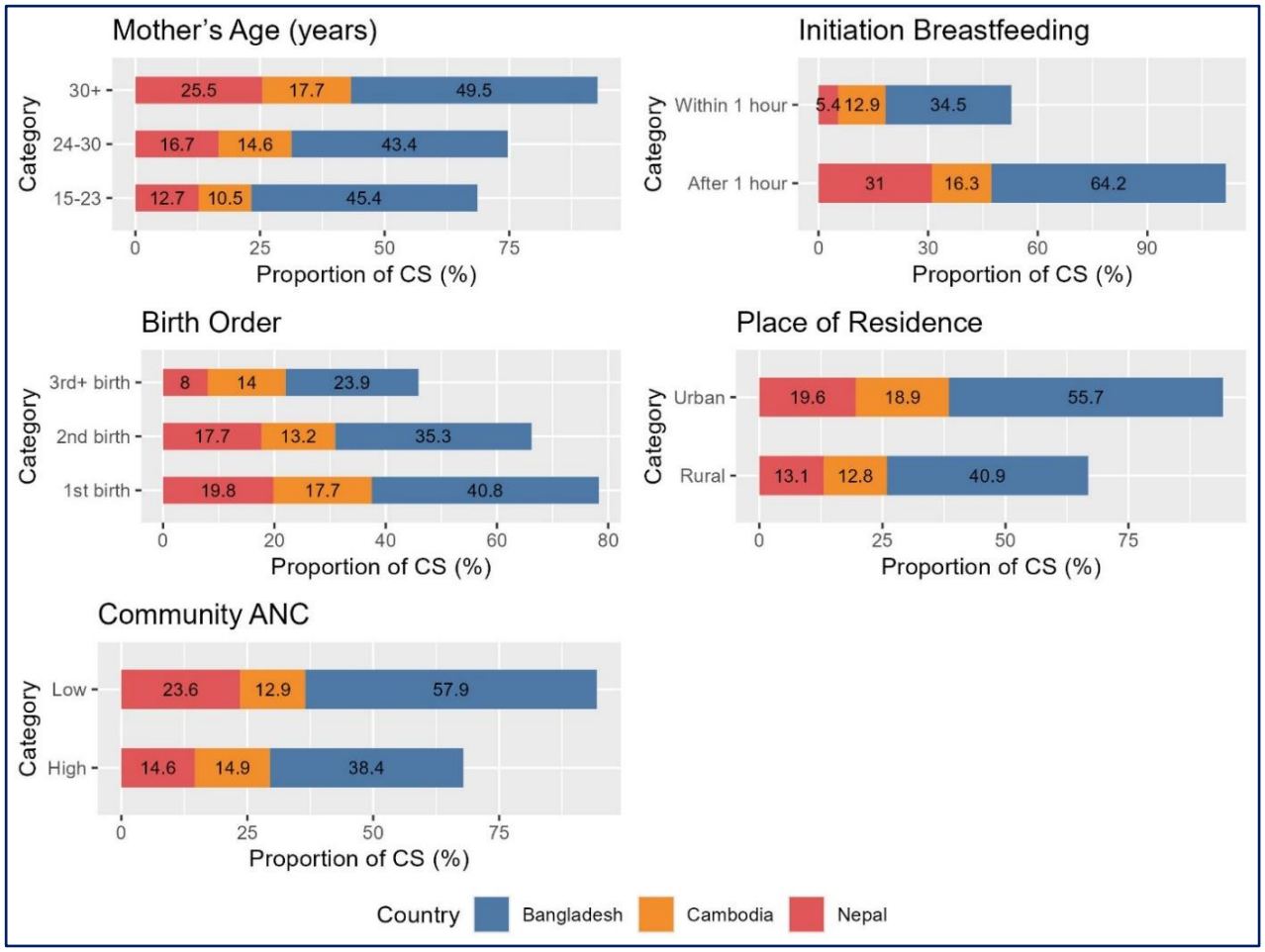
Where, $logit(P_{ij}) = \log(\frac{P(Y_{ij}=1)}{1-P(Y_{ij}=1)})$, β_{00} is the fixed effect intercept and V_{0j} is the level-2 residual. The variables x_{ij} and X_j correspond to level-1 (individual-level) and level-2 (cluster-level) variables, respectively, with β_{10} and β_{01} denoting their fixed effects. In this study, covariates were classified as individual-level variables (C-section delivery, mother's Age, initiation breastfeeding, months of breastfeeding and interaction between C-section delivery and initiation of breastfeeding and interaction between C-section delivery and place of residence) and cluster-level variables (place of residence and community ANC coverage). To construct the interaction between C-section delivery and initiation of breastfeeding, we multiplying these two binary variables. This new variable captures whether the effect of C-section delivery on the outcome varies based on whether breastfeeding was initiated timely or delayed. Similarly, to

assess the interaction between C-section delivery and place of residence, we generated another interaction term by multiplying these two binary variables. This term allows us to evaluate whether the association between C-section delivery and the outcome differs between urban and rural settings. Both interaction terms were included in the regression models alongside their main effects and relevant covariates to assess their influence on the outcome variable.

The intra-class correlation coefficient (ICC) was calculated using an empty multilevel model to assess the degree of clustering. A multilevel logistic regression model was deemed appropriate as the ICC exceeded zero. To ensure that the predictors in our models were not highly correlated, we assessed multicollinearity by checking that the variance inflation factor (VIF) was less than 5. We evaluated the fit of the regression model using the Hosmer & Lemeshow test, which compares the predicted probabilities with the observed outcomes across various risk groups. A non-significant result ($p > 0.05$) suggests no significant difference between the observed and expected values, indicating that the model fits the data well. This implies that the model's predictions are reliable and accurately reflect the relationship between the predictor variables and the outcome. All data analyses were conducted using SPSS and R (R Foundation for Statistical Computing, Vienna, Austria) software.

Hot-spot analysis

We used the Getis-Ord (Gi*) statistic to assess spatial autocorrelation and identify clusters of DBM and C-section deliveries at the district level in the selected countries. We applied the local Gi* statistic to quantify the intensity and stability of hotspot clusters. This method compares the local mean rate (i.e., the rates for a specific location and its neighbors) to the global mean rate (i.e., the rates across all locations in the study). The Gi* statistic calculates a Z-score and p-value for each location, which allows us to assess whether the local mean differs significantly from the global mean. Locations with significantly high Z-scores are classified as hotspots, indicating areas where high values are spatially concentrated, and such patterns are unlikely to occur by chance.



Supplementary Fig. 1: Proportion of C-Section delivery by background characteristics

Proportion of C-Section Deliveries by Background Characteristics

Supplementary Figure 1 reveals that C-section deliveries are disproportionately concentrated among specific sociodemographic groups across the three countries. The highest proportions were observed among women aged 30 and above, 49.5% in Bangladesh, 17.7% in Cambodia, and 25.5% in Nepal, suggesting that older maternal age may be associated with increased obstetric complications or a preference for medicalised births. First-time mothers consistently showed higher C-section rates, likely reflecting clinical caution during primiparous deliveries. A strong association was evident between delayed breastfeeding initiation and C-sections, particularly in Bangladesh (64.2%) and Nepal (31.0%), possibly reflecting recovery delays that hinder immediate postnatal care. Urban residence was also linked with higher C-section rates, highlighting healthcare system differences or rising demand for surgical procedures in cities. Interestingly, in both Bangladesh and Nepal, women in areas with lower community ANC

coverage had higher C-section rates (57.9% in Bangladesh & 23.6% in Nepal), which may reflect either insufficient prenatal risk detection or overuse of surgical delivery in poorly monitored settings. In contrast, Cambodia showed a slightly different pattern, where C-sections were more common in high ANC coverage areas (14.9%), possibly due to better access to surgical services.

Appendix F

Supplementary Materials for Chapter 9

Supplementary Table 1: Analytical Coding Framework and Illustrative Examples

Dimension	Analytical Category	Assessment Criterion	Coding Classification	Illustrative Example
1. Recognition & Framing	Explicit DBM acknowledgment	Does the policy explicitly state that undernutrition and overnutrition coexist?	(1) Explicit (2) Conceptual (3) Absent	NNP 2015 states Bangladesh faces "coexistence of undernutrition and overnutrition" → coded (1)
	Definition of both forms	Are both undernutrition and overnutrition defined or described?	(1) Both defined (2) One defined (3) Neither	NPAN2 defines only undernutrition → coded (2)
	Nutrition transition recognition	Does the policy acknowledge the shift towards coexisting forms?	(1) Explicit (2) Conceptual (3) Absent	No policy acknowledged transition dynamics → coded (3)
	Life-course perspective	Does the policy link childhood undernutrition to adult obesity risk?	(1) Explicit (2) Conceptual (3) Absent	No policy included this linkage → coded (3)
	Goals and targets for both forms	Are measurable targets set for both undernutrition and overnutrition?	(1) Both targeted (2) One targeted (3) Neither	NNP includes stunting and maternal overweight targets → coded (1)
2. Intervention Content	Undernutrition interventions	Are undernutrition interventions comprehensive and operationally specified?	(1) Comprehensive (2) Partial (3) Absent	All five policies include detailed maternal-child nutrition programmes → coded (1)
	Overnutrition interventions	Are overnutrition prevention interventions specified with targets?	(1) Comprehensive (2) Partial (3) Absent	NNP includes general messaging, no targets → coded (2); NAP and 8th FYP → coded (3)
	Service platform integration	Are integrated delivery platforms	(1) Integrated (2) Partial (3) Separate	All policies maintain separate

Dimension	Analytical Category	Assessment Criterion	Coding Classification	Illustrative Example
		specified for both forms?		platforms → coded (3)
	Household-level DBM strategies	Are strategies designed for households experiencing both forms simultaneously?	(1) Explicit (2) Conceptual (3) Absent	No policy addresses household-level DBM → coded (3)
	Food environment regulation	Are regulatory instruments (labeling, taxation, marketing restrictions) specified?	(1) Operational (2) Mentioned (3) Absent	NNP mentions marketing regulation without operational detail → coded (2)
	Dietary guidelines	Are integrated dietary guidelines for both forms provided?	(1) Integrated (2) Partial (3) Absent	No integrated guidelines in any policy → coded (3)
3. Implementation Systems	Monitoring indicators (both forms)	Are indicators for both undernutrition and overnutrition included?	(1) Both forms (2) One form (3) Neither	NNP includes maternal overweight indicator → coded (2); others → coded (2) or (3)
	Life-course surveillance	Are surveillance systems designed to track individuals across the life course?	(1) Specified (2) Mentioned (3) Absent	No life-course surveillance system in any policy → coded (3)
	Multisectoral coordination	Are coordination mechanisms with binding authority and accountability specified?	(1) Binding + accountable (2) Structural only (3) Absent	NPAN2 specifies BNNC but no binding authority → coded (2)
	Human resource capacity	Does training address both forms of malnutrition?	(1) Both forms (2) Undernutrition only (3) Absent	All policies focus training on undernutrition only → coded (2)
	Equity and targeting	Are high-DBM-burden populations (urban poor, adolescents) specifically targeted?	(1) Targeted (2) Mentioned (3) Absent	General mention of vulnerable groups without DBM specificity → coded (2)

Note: The above table presents the coding categories used in data extraction organised by analytical dimension, the assessment criterion applied, and illustrative examples of how policy content was classified.

Appendix G

Supplementary Materials for Chapter 10

Supplementary File 1

Key Informant Interview Guide

Project Title: Policy approaches to tackling the double burden of malnutrition at the household level in South and South-east Asia

Study Overview

This interview guide was developed to explore the perspectives of senior-level nutrition stakeholders on the double burden of malnutrition (DBM) and related policy responses in Bangladesh. The guide was informed by a review of relevant literature and structured around the integrated Health Policy Triangle–CDC Policy Process Framework (HPT–CDC), which examines the context, actors, content, and process dimensions of nutrition policy.

The guide is organised into four thematic domains corresponding to the study objectives: (1) awareness and understanding of DBM; (2) assessment of current national nutrition policy architecture; (3) multisectoral coordination, stakeholder roles, and implementation experiences; and (4) future policy directions and priorities. Open-ended questions are used throughout to encourage participants to introduce issues beyond those explicitly listed.

This guide was used for semi-structured key informant interviews (KIIs) conducted face-to-face interviews.

Instructions for the Interviewer

Before beginning each interview, please ensure the following:

- Confirm that informed consent has been obtained and the participant understands their right to withdraw at any time.
- Remind the participant that the interview will be audio-recorded (with consent) and that all information will be kept confidential.
- Assign the participant an alphanumeric code (P1–P12) and record it on the interview log.
- Note the date, time, location, and participant category in the field notes.

During the interview:

- Use the questions as a flexible guide, not a rigid script. Follow the participant's lead where relevant new issues emerge.
- Use probing questions (listed in italics below each main question) to encourage depth and

elaboration.
- Avoid leading questions; allow silences and avoid interrupting participants mid-response.
- Record field notes on contextual observations, interview dynamics, and preliminary analytical reflections immediately after each interview.

Opening and Introduction

Thank you for agreeing to participate in this study. My name is **Ashis Talukder**, and I am a researcher at the Australian National University conducting a study on nutrition policy in Bangladesh, with a particular focus on the double burden of malnutrition. The interview will take approximately 40–60 minutes. There are no right or wrong answers—I am interested in your experiences and perspectives.

With your permission, I will audio-record this interview to ensure accuracy. Your name will not be used in any publication; you will be referred to by a code. You are free to skip any question or stop the interview at any time.

Do you have any questions before we begin? [Obtain verbal consent and commence recording.]

Domain 1: Awareness and Understanding of the Double Burden of Malnutrition

This section explores how participants understand and frame the concept of DBM in the context of Bangladesh's nutrition transition.

1.1. In your view, how would you describe the current nutrition situation in Bangladesh? How has it changed over the past decade or so?
- ✓ What types of malnutrition are you most concerned about in your work?
- ✓ Have you observed any changes in the prevalence of overweight or obesity alongside undernutrition?

1.2. How do you understand the term 'double burden of malnutrition'? Could you explain what it means in the Bangladeshi context?
- ✓ Do you think there is a shared or consistent understanding of DBM among nutrition stakeholders in Bangladesh?
- ✓ Are there aspects of DBM—such as micronutrient deficiencies or life-course considerations—that you feel are not adequately captured in current definitions?

1.3. To what extent do you think the coexistence of undernutrition and overnutrition is recognised at different levels among policymakers, programme staff, and communities?
- ✓ Have you noticed differences in awareness between national, subnational, and community levels?
- ✓ What do you think are the main reasons for any gaps in recognition or understanding?

1.4. How do you think Bangladesh's broader development changes, such as urbanisation, economic growth, and dietary shifts, have influenced the nutritional landscape?

- ✓ Have you observed differences between rural and urban areas, or between different socioeconomic groups?
- ✓ To what extent do you think food system changes have contributed to rising overnutrition?

Domain 2: National Nutrition Policy Architecture and Responsiveness to DBM

This section explores stakeholders' perceptions of existing national nutrition policies and their adequacy in addressing DBM.

2.1. How would you assess the current national nutrition policy architecture in Bangladesh—for example, the National Nutrition Policy (2015), NPAN-2, and related frameworks?

- ✓ In your view, how well do these policies address undernutrition? Overnutrition? Both simultaneously?
- ✓ Are there specific areas or population groups that you feel are not adequately addressed?

2.2. Do you think current policies adequately reflect the double burden of malnutrition as an integrated challenge, or do they tend to address undernutrition and overnutrition separately?

- ✓ Can you give examples of policies or programme that you see as responsive—or not responsive—to DBM?
- ✓ Is there a policy or framework you are aware of that specifically addresses DBM in an integrated way?

2.3. Are you familiar with the concept of 'double-duty actions'—interventions designed to address both undernutrition and overnutrition simultaneously? If so, how do you think they are reflected in current policy or programming?

- ✓ Can you identify any existing programme in Bangladesh that could serve as double-duty actions if adapted?
- ✓ What do you think would be needed to incorporate double-duty approaches into the policy framework?

2.4. What factors do you think explain why policy responses to overnutrition remain less developed than those targeting undernutrition in Bangladesh?

- ✓ Do you think institutional culture, cognitive factors, or historical priorities play a role?
- ✓ How do you think funding flows and donor priorities influence the focus of nutrition policies?

2.5. How do you see the National Food and Nutrition Security Policy (2020) and its Plan of Action (2021–2030) contributing to addressing DBM? Are there gaps?

- ✓ Does the food systems approach embedded in this policy provide opportunities to address both forms of malnutrition?
- ✓ Are overnutrition-related targets—such as limiting overweight prevalence—reflected in programme planning and monitoring?

Domain 3: Stakeholder Roles, Coordination, Implementation, and Accountability

This section examines stakeholders' experiences of multisectoral coordination, implementation challenges, and accountability mechanisms in nutrition policy.

3.1. What is your organisation's role in nutrition policy development and/or programme implementation in Bangladesh?

- ✓ How does your organisation engage with DBM-related issues in its day-to-day work?
- ✓ Have your organisation's priorities shifted in recent years in response to rising overnutrition?

3.2. How would you describe the current mechanisms for multisectoral coordination in nutrition, such as the Bangladesh National Nutrition Council (BNNC)?

- ✓ In your experience, how functional are these coordination platforms in practice?
- ✓ What are the main strengths and weaknesses of existing coordination mechanisms?
- ✓ Are there sectors beyond health, such as agriculture, education, or trade, that you think should be more actively engaged in nutrition governance?

3.3. In your experience, what are the most significant barriers to translating nutrition policies into effective implementation at the national level? At the subnational or frontline level?

- ✓ How do resource constraints—including budgetary and human resources—affect implementation?
- ✓ Are there differences in implementation capacity between national and subnational levels?
- ✓ What role does political will or institutional leadership play in enabling or constraining implementation?

3.4. How would you assess existing monitoring and evaluation systems for nutrition programme in Bangladesh?

- ✓ Are there specific indicators used to track DBM outcomes—covering both undernutrition and overnutrition?
- ✓ How effectively is monitoring data used to inform policy and programme decision-making?
- ✓ What accountability mechanisms exist to ensure that stakeholders fulfil their nutrition-related responsibilities?

3.5. How would you characterise the current workforce capacity to implement nutrition interventions, particularly at the district and community levels?

- ✓ Are frontline workers adequately trained to respond to both undernutrition and overnutrition?
- ✓ What skills or training do you think are most lacking in the current nutrition workforce?
- ✓ Are there dedicated nutrition staff at the field level, or is nutrition integrated into other roles?

3.6. In your view, how effectively do stakeholders from different sectors and organisations communicate and collaborate on nutrition issues?

- ✓ Are there examples of coordination that has worked well? What made it successful?

- ✓ What have been the main obstacles to effective inter-agency or multisectoral collaboration?

Domain 4: Future Policy Directions and Priorities

This section explores stakeholders' recommendations for strengthening nutrition policy to address DBM more effectively.

4.1. In your opinion, what are the most urgent policy priorities to address the double burden of malnutrition in Bangladesh?

- ✓ Are there specific regulatory or legislative measures you would prioritise, for example, food labelling, marketing restrictions, or food safety standards?
- ✓ How should existing programme be adapted to become more responsive to DBM?

4.2. With NPAN-3 currently in development, what recommendations would you make to ensure it more effectively addresses DBM compared to its predecessors?

- ✓ What specific targets, indicators, or accountability mechanisms would you recommend including?
- ✓ How should the balance between undernutrition and overnutrition be reflected in NPAN-3?
- ✓ What role should civil society, academic institutions, and the private sector play in the development and implementation of NPAN-3?

4.3. How do you think multisectoral governance for nutrition can be strengthened in Bangladesh?

- ✓ What changes to existing coordination structures, such as BNNC, would make them more functional?
- ✓ How can accountability for nutrition outcomes be strengthened across sectors?
- ✓ Are there models from other countries or sectors that Bangladesh could learn from?

4.4. What strategies do you think are most important for improving workforce capacity to address DBM at both national and subnational levels?

- ✓ What training or capacity-building initiatives would you recommend?
- ✓ How can nutrition roles and responsibilities be better integrated into existing health and social service systems?

4.5. What role do you think behaviour change communication (BCC) should play in addressing DBM in Bangladesh? How does current BCC compare to what is needed?

- ✓ How can BCC strategies be expanded beyond undernutrition to include overnutrition and unhealthy dietary practices?
- ✓ What channels or approaches do you think would be most effective for reaching different population groups?

4.6. Are there any policy responses or governance models from other countries experiencing similar nutrition transitions that you think Bangladesh could usefully adapt?

- ✓ What aspects of the international experience do you think are most relevant to

Bangladesh's context?

4.7. Is there anything else you would like to add about the double burden of malnutrition, existing policies, or future directions that we have not yet covered?

Closing

Thank you very much for your time and for sharing your perspectives. Your insights are very valuable to this research. As a reminder, all information you have shared will be kept strictly confidential and used only for research purposes. You will be identified only by an alphanumeric code in any publications arising from this study.

If you think of anything further after this interview, or have any questions about the study, please feel free to contact the research team using the contact details provided in your participant information sheet.

[Stop audio recording. Document field notes. Complete interview log.]

Supplementary Information

Participant Categories

Participants were recruited from four stakeholder groups:

- Government nutrition authorities (national and subnational)
- International non-governmental organisations working on nutrition
- National research and academic institutions
- Subnational health and nutrition service providers

Conceptual Framework Alignment

Interview domains were aligned with the integrated Health Policy Triangle–CDC Policy Process Framework (HPT–CDC) as follows:

Interview Domain	HPT Dimension	CDC Policy Stage(s)
Domain 1: DBM Awareness and Understanding	Context; Actors	Problem Identification
Domain 2: National Policy Architecture	Policy Content; Context	Policy Analysis; Strategy & Policy Development
Domain 3: Coordination,	Actors; Process	Policy Enactment; Policy Implementation

Interview Domain	HPT Dimension	CDC Policy Stage(s)
Implementation, Accountability		
Domain 4: Future Policy Directions	All dimensions	Evaluation; Stakeholder Engagement

Ethical Note

All interviews were conducted after obtaining informed oral consent. Participants were assured of confidentiality and assigned alphanumeric codes in all records. Audio recordings and identifying information were stored separately in password-protected files accessible only to the first author.

Ethical approval was obtained from the Human Research Ethics Committee, Australian National University, Australia (Project H/2025/0278), and the Research and Innovation Centre, Khulna University, Bangladesh (KUECC-2025-04-32).

End of Interview Guide

Supplementary File 2

Consolidated Criteria for Reporting Qualitative Research (COREQ)

32-Item Checklist for Interviews and Focus Groups

Title: The Double Burden of Malnutrition in Bangladesh: Policy Architecture, Implementation Realities, and Future Directions

No.	Item	Guide Question	Response from This Study
Domain 1: Research Team and Reflexivity			
Personal Characteristics			
1	**Interviewer/facilitator**	Which author/s conducted the interview or focus group?	The first author (A.T.) conducted all 12 key informant interviews face-to-face.
2	**Credentials**	What were the researcher's credentials, e.g., PhD, MD?	A.T. is a PhD candidate at the Australian National University, National Centre for Epidemiology and Population Health. H.S. (senior author) holds a PhD and has extensive experience in qualitative health policy research in LMICs.
3	**Occupation**	What was their occupation at the time of the study?	A.T. was a PhD candidate conducting this study as part of doctoral research. H.S. was an academic researcher and supervisor at the Australian National University.
4	**Gender**	Was the researcher male or female?	Male
5	**Experience and training**	What experience or training did the researcher have?	A.T. had prior experience conducting research on nutrition and health-related topics in Bangladesh. Before data collection, A.T. received training and mentorship in qualitative interviewing techniques—including probing, active listening, reflexive note-taking, and management of interviewer bias—from H.S. H.S. provided ongoing methodological oversight throughout the study. After the first two interviews, H.S. reviewed transcripts and field notes and provided structured feedback, which informed minor refinements to the interviewing approach.
Relationship with Participants			
6	**Relationship established**	Was a relationship established prior to study commencement?	No. A.T. was not affiliated with any of the participating institutions and had no prior professional, supervisory, or working relationships with the participants.
7	**Participant knowledge of the interviewer**	What did participants know about the researcher, e.g., personal goals, reasons for doing the research?	Participants were provided with study information before consenting, including the study aims and the institutional affiliation of the research team (Australian National University). They were informed that A.T. was conducting the study as part of doctoral research on nutrition policy in Bangladesh.
8	**Interviewer characteristics**	What characteristics were reported about the interviewer/facilitator?	A.T. is a Bangladeshi national, a native Bangla speaker with professional proficiency in English, and was independent of all participating

No.	Item	Guide Question	Response from This Study
			organisations. This position minimised potential influence from organisational relationships, professional hierarchies, or conflicts of interest on participant responses.
Domain 2: Study Design			
Theoretical Framework			
9	**Methodological orientation and theory**	What methodological orientation was stated to underpin the study, e.g., grounded theory, discourse analysis, ethnography, phenomenology, content analysis?	The study employed a qualitative design using semi-structured key informant interviews (KIIs). Data were analysed using reflexive thematic analysis following Braun and Clarke (2006), with themes generated inductively from participants' accounts. The integrated Health Policy Triangle–CDC Policy Process Framework (HPT–CDC) served as an interpretive lens to contextualise and organise emergent themes within established health policy frameworks.
Participant Selection			
10	**Sampling**	How were participants selected, e.g., purposive, convenience, consecutive, snowball?	Participants were selected using purposive sampling to obtain a range of perspectives from stakeholders involved in nutrition policy and programming in Bangladesh. Initial participants were identified through a review of nutrition policy documents, national coordination meeting records, and relevant literature. Additional participants were recruited through snowball sampling.
11	**Method of approach**	How were participants approached, e.g., face-to-face, telephone, mail, email?	Potential participants were contacted by email and provided with study information before providing informed consent.
12	**Sample size**	How many participants were in the study?	12 participants.
13	**Non-participation**	How many people refused to participate or dropped out? Reasons?	Exact numbers of individuals who were approached but declined to participate or did not respond were not formally tracked, given the purposively selected pool of stakeholders and reliance on snowball referrals. All individuals who agreed to participate completed interviews; no participant withdrew after consenting.
Setting			
14	**Setting of data collection**	Where was the data collected, e.g., home, clinic, workplace?	Face-to-face interviews were conducted in Bangladesh between June and August 2025. The specific interview locations (e.g., participants' workplaces) are not described in detail in the manuscript.
15	**Presence of non-participants**	Was anyone else present besides the participants and researchers?	No other individuals were present during the interviews aside from the participant and the interviewer (A.T.).
16	**Description of sample**	What are the important characteristics of the sample, e.g., demographic data, date?	12 senior-level nutrition stakeholders participated, representing four groups: international NGOs working on nutrition (n=4), national research and academic institutions (n=3), government nutrition

No.	Item	Guide Question	Response from This Study
			authorities (n=3), and subnational health and nutrition service providers (n=2). Ten participants worked at the national level in policy formulation, technical advisory, and programme coordination roles; two provided subnational perspectives from district-level implementation contexts. All participants were Bangladeshi nationals based in Dhaka and fluent in Bangla.
Data Collection			
17	**Interview guide**	Were questions, prompts, guides provided by the authors? Was it pilot tested?	A semi-structured interview guide was developed by A.T. following a review of relevant literature and informed by the integrated HPT–CDC conceptual framework. It was refined through iterative discussions within the research team to ensure conceptual alignment with study objectives, clarity of wording, and logical sequencing of questions. The final version is provided in Supplementary File 1.
18	**Repeat interviews**	Were repeat interviews carried out? If yes, how many?	No repeat interviews were conducted. Each participant was interviewed once.
19	**Audio/visual recording**	Did the research use audio or visual recording to collect the data?	Yes. All interviews were audio-recorded with participant consent.
20	**Field notes**	Were field notes made during and/or after the interview or focus group?	Yes. Field notes were maintained to document contextual observations, interview dynamics, and preliminary analytical reflections after each interview.
21	**Duration**	What was the duration of the interviews or focus group?	Approximately 40–60 minutes per interview.
22	**Data saturation**	Was data saturation discussed?	Data collection was guided by the principle of information power rather than saturation per se. Collection concluded after 12 interviews, when successive interviews yielded no substantively new insights, given the focused research objectives, seniority of participants, and use of reflexive thematic analysis.
23	**Transcripts returned**	Were transcripts returned to participants for comment and/or correction?	Transcripts were not returned to participants for comment or correction, due to time and scheduling constraints that limited the feasibility of a second round of stakeholder consultation. This is acknowledged as a limitation of the study (see 'Study Limitations').
Domain 3: Analysis and Findings			
Data Analysis			
24	**Number of data coders**	How many data coders coded the data?	The first author (A.T.) conducted the coding, while the senior author (H.S.) reviewed the coding framework and thematic interpretations to ensure consistency and credibility. Emerging themes were discussed iteratively with all co-authors to refine interpretations and strengthen the trustworthiness of the analysis.

No.	Item	Guide Question	Response from This Study
25	**Description of the coding tree**	Did authors provide a description of the coding tree?	Yes. Four major themes and associated sub-themes are described in detail in the Results section, and Table 2 maps each theme and sub-theme to the corresponding HPT–CDC framework dimensions and CDC policy stages.
26	**Derivation of themes**	Were themes identified in advance or derived from the data?	Themes were derived inductively from the data. The HPT–CDC conceptual framework served as an interpretive lens during analysis but did not predetermine themes; it guided the interpretation of inductively generated themes with respect to policy context, actors, content, and process.
27	**Software**	What software, if applicable, was used to manage the data?	NVivo 15 (QSR International Pty Ltd., 2023) was used for data management and analysis.
28	**Participant checking**	Did participants provide feedback on the findings?	Participants did not provide feedback on the emergent themes or findings, due to the same time and scheduling constraints noted in item 23. This is also acknowledged as a limitation of the study (see 'Study Limitations').
Reporting			
29	**Quotations presented**	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified, e.g., participant number?	Yes. Representative verbatim quotations are presented throughout the Results section to illustrate each theme and sub-theme. Each quotation is attributed to a participant code (e.g., P1–P12) and stakeholder category (e.g., Government nutrition authority, International NGO representative).
30	**Data and findings consistent**	Was there consistency between the data presented and the findings?	Yes. Findings are supported by direct quotations from participants and cross-referenced with supplementary tables (Supplementary Tables 1–10) containing additional supporting excerpts. The thematic structure maps systematically to the interview domains and the HPT–CDC framework.
31	**Clarity of major themes**	Were major themes clearly presented in the findings?	Yes. Four major themes with nine sub-themes are presented, each with a descriptive heading, explanatory narrative, supporting participant quotations, and cross-references to the HPT–CDC framework dimensions and CDC policy stages (Table 2).
32	**Clarity of minor themes**	Is there a description of diverse cases or discussion of minor themes?	Divergent and less prominent perspectives are noted within themes where relevant (e.g., variation between national and subnational levels, differences in stakeholder group perspectives). The limitations section acknowledges that the relatively small sample may not reflect the full range of perspectives in Bangladesh's nutrition sector.

Note: KII = Key Informant Interview; HPT-CDC = Health Policy Triangle-CDC Policy Process Framework; DBM = Double Burden of Malnutrition; NVivo = qualitative data analysis software. NA: Not Available/Not Reported

Ref: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care. 2007 Dec;19(6):349-57. doi: 10.1093/intqhc/mzm042. Epub 2007 Sep 14. PMID: 17872937.

Supplementary Tables

Title: The Double Burden of Malnutrition in Bangladesh: Policy Architecture, Implementation Realities, and Future Directions

Supplementary Table 1: Additional quotes supporting Theme 1, Sub-theme 1.1	
Participant	**Quote**
P12, Subnational health and nutrition services	*"Previously, undernutrition and stunting were highly prevalent, but those have decreased markedly. At the same time, overnutrition or obesity in urban areas has increased significantly. I would say obesity has increased more than undernutrition"*
P9, International NGO representative	*"Both forms of malnutrition, undernutrition and overnutrition, can coexist simultaneously within the same household"*

Supplementary Table 2: Additional quotes supporting Theme 1, Sub-theme 1.2	
Participant	**Quote**
P3, National research institution	*"Earlier, when we started our careers back in the late 1990s, our understanding of malnutrition in Bangladesh and in low- and middle-income countries was mainly about undernutrition: a child becoming stunted or wasted, with overnutrition either ignored or considered a problem confined to Western countries"*
P7, Government nutrition authority	*"We must ask which age group we are referring to… we should consider the individual-level phenomenon: the same person may experience both problems at different life stages—underweight at one stage and becoming overweight later"*

Supplementary Table 3: Additional quotes supporting Theme 2, Sub-theme 2.1	
Participant	**Quote**
P9, International NGO representative	*"Operational planning documents, particularly NPAN-2, were described as adopting multisectoral framing by addressing undernutrition, overnutrition, anaemia, and related health concerns"*
P9, International NGO representative	*"This policy was described as emphasising food quality, dietary diversity, and the structural determinants of malnutrition affecting both rural and urban households"*
P1, Government nutrition authority	*"Earlier in our country, malnutrition was understood almost entirely as undernutrition, and our primary focus was on addressing that"*
P2, UN agency representative	*"The National Nutrition Policy strongly covers undernutrition, while overnutrition is included but not prominently"*
P8, International NGO representative	*"For underweight mothers, what message to give is there, but for overweight, no one really knows what message to give"*

P7, Government nutrition authority	*"All existing training, orientation, and skill development initiatives have been undernutrition centric… all communication materials, orientation programmes, and trainings focus exclusively on undernutrition"*

Supplementary Table 4: Additional quotes supporting Theme 2, Sub-theme 2.2	
Participant	**Quote**
P6, Government nutrition authority	*"Although undernutrition policies have also covered overnutrition, there is no extensive framework on it"*

Supplementary Table 5: Additional quotes supporting Theme 3, Sub-theme 3.1	
Participant	**Quote**
P5, Academic institution	*"The main challenge remains implementation, which is not progressing as effectively as policy design"*
P8, International NGO representative	*"Since nutrition is multisectoral, we must keep in mind whether other sectors are acting responsibly"*
P2, UN agency representative	*"Implementation remains a major gap. Bangladesh performs well in policy adoption, comparable to many countries. But when it comes to implementation, we face significant challenges"*

Supplementary Table 6: Additional quotes supporting Theme 3, Sub-theme 3.2	
Participant	**Quote**
P8, International NGO representative	*"The government does some monitoring… they do not fully follow accountability"*
P1, Government nutrition authority	*"Anthropometric measurements—such as height and weight—are not routinely collected"*
P3, National research institution	*"What struck me most is that anthropometric measurements for malnutrition patients, which need to be done regularly, are often not carried out"*
P10, UN agency representative	*"If you ask them whether they have data showing how this policy has been implemented or its impact over the last two years to five years, they do not know"*

Supplementary Table 7: Additional quotes supporting Theme 3, Sub-theme 3.3	
Participant	**Quote**
P8, International NGO representative	*"Beyond community clinics, there is very little communication at the grassroots level. There are no specific nutrition workers at the field level, and family planning workers already have so many priorities that nutrition often falls behind"*

P6, Government nutrition authority	*"The Institute of Public Health Nutrition is supposed to carry out this work. But even if it tried to implement activities in just one area of Dhaka, it does not have the manpower required"*

Supplementary Table 8: Additional quotes supporting Theme 4, Sub-theme 4.1	
Participant	**Quote**
P11, Subnational health and nutrition services	*"Meetings are supposed to be held every two months, but these meetings don't happen… they lack the logistical support or resources needed"*
P10, UN agency representative	*"If private sector actors do not focus on health or nutrition, nutrition outcomes will be compromised"*
P5, Academic institution	*"The National Food and Nutrition Security Policy (2020) were developed along with CIP-3…. a healthy diet as a key strategy to tackle both under- and overnutrition"*
P5, Academic institution	*"We are developing a Nutrient Profile Model and sodium benchmarks to regulate unhealthy diets"*

Supplementary Table 9: Additional quotes supporting Theme 4, Sub-theme 4.2	
Participant	**Quote**
P2, UN agency representative	*"Implementation needs to be our main focus. Policies are strong, but without proper follow-through, we cannot expect improvements"*
P8, International NGO representative	*"If proper record-keeping exists, then we can identify problems early and act quickly"*
P10, UN agency representative	*"They have not been trained… even if you explain the policy, they cannot implement it because they are unaware"*
P9, International NGO representative	*"Research on trans-fat has already led to new national laboratory capacity"*

Supplementary Table 10: Additional quotes supporting Theme 4, Sub-theme 4.3	
Participant	**Quote**
P2, UN agency representative	*"Now you can find ORS even in small grocery stores, and people generally know how much to take, when to take it"*
P10, UN agency representative	*"We must not just sit and wait. From our side, we should also actively raise public awareness about which factors cause obesity and overweight"*

Appendix H

Ethical Approval Documents



Australian National University

HREA Project Description

Protocol Number: 2025/0278

Background

1. **Short literature review:** The double burden of malnutrition (DBM), defined as the coexistence of undernutrition and overnutrition within the same population, individual or household, is a growing public health concern in South and South-east Asia. Economic growth, urbanisation, and changing food systems have led to diets that fuel both nutrient deficiencies and rising obesity. Literature highlights the need for integrated, multisectoral policies that address both forms of malnutrition. While nutrition-sensitive strategies like improving food security and fiscal measures are promising, many current policies overlook key socioecological factors such as urbanisation, gender norms, and cultural practices, indicating the need for more context-specific and inclusive approaches.
2. **Rationale/Justification**: Despite increased attention to DBM, little is known about how policy frameworks in South and South-east Asia address it at the household level. We aim to apply the Centers for Disease Control and Prevention (CDC) policy process framework—focusing on problem identification, policy analysis, and strategy development—to examine DBM-related policies in selected countries. It will Identify implementation gaps, evaluate stakeholder engagement, and propose integrated, context-sensitive recommendations for diverse socio-economic settings.
3. **Research questions/aims/objectives/hypothesis: Research Questions**
   Guided by the CDC's policy framework, this study aims to explore the following questions:
   - What are the key policies addressing household-level DBM in South and Southeast Asia?
   - How effective have these policies been in reducing DBM at the household level?
   - What are the challenges and gaps in current policies?
   - What policy recommendations can be made to address DBM more effectively?

Project Design

4. **Methodological approach**: We will use a qualitative research approach guided by the CDC policy framework to explore how policymakers address the double burden of malnutrition (DBM) at the household level in South and South-east Asia, with a particular focus on Bangladesh. This approach is well suited to the goals of the study because it allows for an in-depth understanding of the real-world experiences, challenges, and perspectives of those directly involved in the design and implementation of nutrition policies. The primary method of data collection will be key-informant interviews with stakeholders who play significant roles in the development, implementation, or monitoring of nutrition policy. These interviews will provide rich, contextual insights that are often

missed in quantitative research and are essential for generating practical, evidence-based recommendations. This methodology supports the project's aim to produce context-specific findings that can inform more effective and actionable nutrition policies across the region.

5. **Research Activities**: We will recruit key stakeholders such as officials from the Directorate of Nutrition, public health nutritionists, and representatives from UN agencies and NGOs working on DBM in Bangladesh. Participants will be identified based on their involvement in developing, implementing, or monitoring nutrition-related policies. Inclusion criteria include individuals with demonstrated experience in DBM-related policy work at the national or sub-national level and those with relevant policy-making, advisory, technical, or implementation roles. Individuals not engaged in such work or unwilling to provide informed consent will be excluded. Screening will be done before recruitment using publicly available information (e.g., organisational websites, reports, networks). Initial contact will be made via formal email with attached study information and consent materials, followed by phone calls if needed. Participants will have at least one week to consider the invitation. Semi-structured key-informant interviews will be conducted using a structured questionnaire for consistency. Interviews will be scheduled flexibly, either in person or online, and participation is voluntary, with the right to skip questions or withdraw at any time. Informed consent will be obtained, and confidentiality will be ensured. With consent, interviews will be recorded, transcribed, and participants can review and revise transcripts before analysis. While no major risks are anticipated and no financial compensation will be provided, participants' contributions will enhance understanding of DBM-related policy challenges and inform the development of more effective and equitable strategies. All research activities will be conducted in close consultation with our PhD supervisors, and any ethical issues will be promptly addressed.
6. **Data Collection/Gathering**: We will collect data through key-informant interviews with individuals involved in the development, implementation, or monitoring of nutrition policies in Bangladesh. The interviews will explore participants' professional roles and experiences, challenges in policy implementation, effective strategies, and suggestions for improvement. With participant consent, all interviews will be audio-recorded, transcribed, and analysed using thematic and comparative approaches. To ensure privacy, all transcripts will be de-identified by removing names, job titles, and organisational affiliations, and replacing them with unique codes. The data will be securely stored in a password-protected, ANU-approved database, accessible only through secured personal laptops, and retained for a minimum of five years following the final publication before being permanently deleted. The study involves minimal risk, although discussions about policy challenges may involve some professional sensitivity. Participation is voluntary, and participants may skip questions or withdraw at any time without consequence. While there are no direct personal benefits, the insights gained will contribute to a better understanding of how to strengthen nutrition policies targeting the double burden of malnutrition. Once the study is complete, a plain-language summary of the de-identified findings will be shared with participants via email upon request.
7. **Expected outcome:** We expect that our study will provide context-specific, actionable policy recommendations for addressing DBM at the household level in South and South-east Asia. We expect to highlight common challenges faced by policymakers, such as the need for integrated strategies, the importance of community engagement, and the influence of socio-economic and cultural factors. We believe our findings will provide important insights on how policies can be refined to reduce both undernutrition and overnutrition in these regions.



Australian National University

Participant Information Sheet

Researcher

I am Ashis Talukder, a PhD candidate at the National Centre for Epidemiology and Population Health, Australian National University (ANU), Canberra, Australia. I am pursuing my PhD with a study leave from Khulna University, Bangladesh, where I worked as a faculty member. This research is a part of my PhD study and is not connected with any other organisation or employer.

Project Title

Policy approaches to tackling the double burden of malnutrition at the household level in South and South-east Asia

Outline of the project

Description and Methodology: The double burden of malnutrition (DBM), which refers to the coexistence of undernutrition and overnutrition within individuals, households, or populations, is a growing public health challenge in many parts of South and South-east Asia. In this study, I aim to explore how current policy frameworks are addressing this issue at the household level, with a particular focus on Bangladesh. To achieve this, I will conduct interviews with key informants to better understand policy priorities, existing gaps, and potential strategies for improving household-level nutrition outcomes.

Participants: I will collect data through interviews with key informants selected for their professional expertise in policy development or implementation related to malnutrition. I plan to interview approximately 15–20 individuals, including officials from the Directorate of Nutrition under the Ministry of Health, public health nutritionists, representatives from United Nations agencies, and national as well as international non-governmental organisations working on DBM-related issues in Bangladesh. The interviews will focus exclusively on participants' professional roles and experiences. I will not collect any personal or sensitive information from the participants.

Use of data and Feedback: The data collected through this research will be used in my PhD thesis and may also be included in peer-reviewed journal articles or conference presentations. Upon request, I will share a summary of the research findings with participants via email.

Project Funding: I have not received any additional funds to conduct this study, and I declare that there are no conflicts of interest.

Participant Involvement

Voluntary Participation and Withdrawal: Your participation in this study is entirely voluntary. You can opt out of the study at any time without giving a reason. If you choose to withdraw before your interview is completed or before your data has been de-identified, your information will be removed from the study. De-identification involves removing all personal identifiers, such as your name, organisation, or role, from the interview transcript and replacing them with a unique participant

code to protect your privacy. You may also choose to allow me to retain and use the data collected up to the point of withdrawal; however, this will be entirely your decision. Once your data is de-identified and analysed, it may not be possible to withdraw.

What does participation involve: You will be invited to participate in a one-on-one interview, either in person or via a secure online platform such as Zoom. The interview will explore your knowledge and experiences with nutrition policies and programmes and include some questions about nutrition governance, programme implementation, or policy challenges. Participation is entirely voluntary, and you may decline to answer any question. With your consent, the interview will be audio recorded to ensure accurate capture of your responses. The recordings will be securely stored and accessed only by me and my academic supervisors. You can review your transcript and request changes before the data is included in the final analysis. All transcripts will be de-identified to protect your privacy, and the original recordings will be permanently deleted after transcription is complete. No identifying information will appear in any publications or presentations resulting from this study.

Location and duration: Each interview is expected to last approximately 45 to 60 minutes. In most cases, there will be only one interview per participant. However, if a follow-up is necessary to clarify or expand on certain points, it may be scheduled with your consent. In that case, the total time commitment for your participation in this research would not exceed two hours.

Remuneration: There is no payment or financial incentive for participation in this study.

Risks: There are no major risks involved in this study. However, if discussing policy matters creates any discomfort or distress, you can skip questions or stop the interview.

Benefits: Although you may not gain any immediate personal benefits from participating in this study, your input will play an important role in enhancing the understanding of how policy frameworks address the DBM at the household level. The knowledge generated from this research may help guide the development of more effective strategies and policies aimed at improving nutrition outcomes at both national and regional levels.

Confidentiality

Although I will not collect any personal data, it is possible that initial interview content—such as voice recordings or contextual details—could potentially lead to the identification of individuals. To mitigate this risk, all audio recordings will be securely stored, and the transcripts will be carefully coded to remove any direct identifiers, including names, locations, and organisational affiliations. A separate, password-protected file linking pseudonyms to participant identities will be stored on a secure device and accessible only to the research team. I promise that your data will only be used for this study and not shared with anyone outside the research team.

Privacy Notice

In collecting your personal information within this research, the ANU must comply with the Privacy Act 1988. The ANU Privacy Policy is available at https://policies.anu.edu.au/ppl/document/ANUP010007. It contains information about how a person can:

- Access or seek correction to their personal information;
- Complain about a breach of an Australian Privacy Principle by ANU, and how ANU will handle the complaint

Data Storage

Where: All data collected for this study will be securely stored in a password-protected ANU-approved database, accessible only through my secured personal laptops to maintain confidentiality and ensure data security.

How long: I will keep the data for at least five years after the final publication of the research.

Handling of data following the required storage period: At the end of the storage period, all data will be permanently deleted without leaving any trace, either by me or my academic supervisors.

Queries and Concerns

If you have any questions about the study, please contact:

Principal Investigator	Primary Supervisor & chair of panel	Local contact
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Ethics Committee Clearance

The ethical aspects of this research have been approved by the ANU Human Research Ethics Committee (Protocol 2025/xxx).

If you have any concerns or complaints about how this research has been conducted, please contact:

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The ANU Human Research Ethics Committee
The Australian National University
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Australian National University

অংশগ্রহণকারী তথ্য শীট

গবেষক

আমি আশিস তালুকদার, ন্যাশনাল সেন্টার ফর এপিডেমিওলজি অ্যান্ড পপুলেশন হেলথ, অস্ট্রেলিয়ান ন্যাশনাল ইউনিভার্সিটি (এএনইউ), ক্যানবেরা, অস্ট্রেলিয়ার পিএইচডি প্রার্থী। আমি বাংলাদেশের খুলনা বিশ্ববিদ্যালয় থেকে একটি অধ্যয়ন ছুটি নিয়ে পিএইচডি করছি, যেখানে আমি একজন শিক্ষক হিসেবে কাজ করেছি। এই গবেষণাটি আমার পিএইচডি অধ্যয়নের একটি অংশ এবং অন্য কোন সংস্থা বা নিয়োগকর্তার সাথে সংযুক্ত নয়।

প্রকল্পের শিরোনাম

দক্ষিণ ও দক্ষিণ-পূর্ব এশিয়ায় পরিবার পর্যায়ে অপুষ্টির দ্বিগুণ বোঝা মোকাবেলায় নীতিগত পন্থা

প্রকল্পের রূপরেখা

প্রকল্পের বিবরণ ও পদ্ধতি: অপুষ্টির দ্বিগুণ বোঝা (DBM)—যা একক ব্যক্তি, পরিবার বা জনগোষ্ঠীর মধ্যে অপুষ্টি ও অতিপুষ্টি একসাথে বিরাজমান থাকাকে বোঝায়—এটি দক্ষিণ ও দক্ষিণ-পূর্ব এশিয়ার অনেক দেশে একটি ক্রমবর্ধমান জনস্বাস্থ্য সমস্যা। এই গবেষণায়, আমি বিশেষ করে বাংলাদেশের প্রেক্ষাপটে, পারিবারিক পর্যায়ে দ্বৈত অপুষ্টি মোকাবেলায় বর্তমান নীতিমালার কার্যকারিতা বিশ্লেষণ করবো। এ উদ্দেশ্যে, আমি মূল নীতিনির্ধারকদের সাক্ষাৎকার নিয়ে তাদের অভিজ্ঞতা, চ্যালেঞ্জ এবং প্রস্তাবিত কৌশলসমূহ সম্পর্কে জানার চেষ্টা করবো।

অংশগ্রহণকারী: আমি অপুষ্টি সম্পর্কিত নীতি উন্নয়ন বা বাস্তবায়নে সংশ্লিষ্ট বিশেষজ্ঞদের সাক্ষাৎকারের মাধ্যমে তথ্য সংগ্রহ করবো। আমি প্রায় ১৫-২০ জন নীতিনির্ধারকের সাক্ষাৎকার গ্রহণের পরিকল্পনা করছি, যার মধ্যে স্বাস্থ্য মন্ত্রণালয়ের পুষ্টি অধিদপ্তরের কর্মকর্তাগণ, জনস্বাস্থ্য পুষ্টিবিদগণ, জাতিসংঘের বিভিন্ন সংস্থার প্রতিনিধি, এবং জাতীয় ও আন্তর্জাতিক এনজিওগুলোর প্রতিনিধিগণ অন্তর্ভুক্ত থাকবেন। সাক্ষাৎকারে শুধুমাত্র তাদের পেশাগত ভূমিকা ও অভিজ্ঞতার উপর আলোচনা হবে, কোনো ব্যক্তিগত বা সংবেদনশীল তথ্য সংগ্রহ করা হবে না।

তথ্য ব্যবহার ও প্রতিক্রিয়া: এই গবেষণা থেকে সংগৃহীত তথ্য আমার পিএইচডি থিসিসে ব্যবহৃত হবে এবং কিছু তথ্য পিয়ার-রিভিউড জার্নাল ও সম্মেলনে উপস্থাপিত হতে পারে। অনুরোধ করলে, অংশগ্রহণকারীদের ইমেইলের মাধ্যমে গবেষণার সারাংশ প্রদান করা হবে।

প্রকল্পের অর্থায়ন: আমি এই অধ্যয়নটি পরিচালনা করার জন্য কোন অতিরিক্ত তহবিল পাইনি, এবং আমি ঘোষণা করছি যে স্বার্থের কোন দ্বন্দ্ব নেই।

অংশগ্রহণকারীদের সম্পৃক্ততা

স্বেচ্ছায় অংশগ্রহণ এবং প্রত্যাহার: এই গবেষণায় আপনার অংশগ্রহণ সম্পূর্ণ স্বেচ্ছামূলক। আপনি যেকোনো সময়, কোনো কারণ না দেখিয়ে, অংশগ্রহণ না করার সিদ্ধান্ত নিতে পারেন। যদি আপনি সাক্ষাৎকার শেষ হওয়ার আগে বা আপনার তথ্য সনাক্ত-মুক্ত (de-identified) হওয়ার আগে প্রত্যাহার করেন, তাহলে আপনার সব তথ্য গবেষণা থেকে মুছে ফেলা হবে। সনাক্ত-মুক্তকরণে আপনার নাম, প্রতিষ্ঠান বা পদবির মতো পরিচয় প্রকাশকারী তথ্য মুছে ফেলা হবেএবং তার পরিবর্তে একটি ইউনিক

কোড ব্যবহার করা হবে। আপনি চাইলে আগ পর্যন্ত সংগৃহীত তথ্য সংরক্ষণের অনুমতি দিতে পারেন, তবে এটি সম্পূর্ণ আপনার সিদ্ধান্ত। একবার ডেটা বিশ্লেষণে অন্তর্ভুক্ত হলে এবং সনাক্ত-মুক্ত হয়ে গেলে, তা মুছে ফেলা সম্ভব নাও হতে পারে।

অংশগ্রহণের ধরণ: আপনাকে একজন অংশগ্রহণকারী হিসেবে সরাসরি বা Zoom-এর মতো নিরাপদ অনলাইন প্ল্যাটফর্মে একটি সাক্ষাৎকারে আমন্ত্রণ জানানো হবে। সাক্ষাৎকারে পুষ্টি নীতিমালা ও কর্মসূচি সংক্রান্ত আপনার অভিজ্ঞতা ও জ্ঞান নিয়ে আলোচনা হবে। আপনার সম্মতিতে সাক্ষাৎকার রেকর্ড করা হবে এবং রেকর্ডিং শুধুমাত্র আমি ও আমার গবেষণা তত্ত্বাবধায়কদের জন্য উপলব্ধ থাকবে। আপনি আপনার ট্রান্সক্রিপ্ট পর্যালোচনা করে সংশোধনের অনুরোধ করতে পারবেন। সকল ট্রান্সক্রিপ্ট সনাক্ত-মুক্ত করা হবে এবং রেকর্ডিং ট্রান্সক্রিপশনের পরে স্থায়ীভাবে মুছে ফেলা হবে। কোনো প্রকাশনা বা উপস্থাপনায় পরিচয়-সংশ্লিষ্ট তথ্য ব্যবহার করা হবে না।

স্থান ও সময়কাল: প্রতিটি সাক্ষাৎকার প্রায় ৪৫ থেকে ৬০ মিনিট স্থায়ী হবে। অধিকাংশ ক্ষেত্রে, একজন অংশগ্রহণকারীর সাথে একটি সাক্ষাৎকারই যথেষ্ট হবে। যদি কোনো তথ্য স্পষ্ট করার জন্য ফলো-আপ প্রয়োজন হয়, আপনার সম্মতিতে তা করা হবে এবং সর্বোচ্চ ২ ঘণ্টার বেশি সময় নেয়া হবে না।

পারিশ্রমিক: এই গবেষণায় অংশগ্রহণের জন্য কোনো আর্থিক সম্মানী প্রদান করা হবে না।

ঝুঁকি: এই গবেষণায় কোনো গুরুতর ঝুঁকি নেই। তবে, যদি নীতিমালার আলোচনা আপনার জন্য অস্বস্তিকর হয়, আপনি যে কোনো প্রশ্ন এড়িয়ে যেতে বা সাক্ষাৎকার বন্ধ করতে পারেন।

উপকারিতা: যদিও আপনি সরাসরি কোনো ব্যক্তিগত উপকার নাও পেতে পারেন, আপনার মতামত এই বিষয়টি নিয়ে অধিকতর বোঝাপড়া তৈরিতে গুরুত্বপূর্ণ ভূমিকা রাখবে। গবেষণার ফলাফল জাতীয় ও আঞ্চলিক পর্যায়ে আরও কার্যকর পুষ্টি নীতি ও কৌশল তৈরিতে সহায়ক হতে পারে।

গোপনীয়তা:

যদিও আমি কোনো ব্যক্তিগত তথ্য সংগ্রহ করবো না, তথাপি রেকর্ডিং বা প্রাসঙ্গিক বিশ্লেষণের মাধ্যমে কারো পরিচয় প্রকাশ পাওয়ার সম্ভাবনা থাকতে পারে। এ কারণে, সব রেকর্ডিং সুরক্ষিতভাবে সংরক্ষণ করা হবে এবং ট্রান্সক্রিপ্টে সব পরিচয় চিহ্নিত তথ্য মুছে ফেলা হবে। একটি আলাদা পাসওয়ার্ড-সুরক্ষিত ফাইলে অংশগ্রহণকারীদের কোড সংরক্ষণ করা হবে, যা শুধুমাত্র গবেষণা দলের জন্যই উন্মুক্ত থাকবে।

গোপনীয়তা সংক্রান্ত নোটিশ:

এই গবেষণায় ব্যক্তিগত তথ্য সংগ্রহ করার ক্ষেত্রে ANU 'Privacy Act 1988' অনুসরণ করে। ANU গোপনীয়তা নীতিমালা পাওয়া যাবে: https://policies.anu.edu.au/ppl/document/ANUP 010007.

একজন ব্যক্তি কীভাবে ব্যক্তিগত তথ্য সংগ্রহ করতে পারে সে সম্পর্কে এতে তথ্য রয়েছে:

- তাদের ব্যক্তিগত তথ্য অ্যাক্সেস করা বা সংশোধন করা;
- ANU দ্বারা একটি অস্ট্রেলিয়ান গোপনীয়তা নীতি লঙ্ঘন সম্পর্কে অভিযোগ করুন এবং ANU কীভাবে অভিযোগটি পরিচালনা করবে

তথ্য সংরক্ষণ

কোথায়: সব তথ্য পাসওয়ার্ড-সুরক্ষিত এবং ANU অনুমোদিত ডেটাবেজে সংরক্ষিত থাকবে।

সময়কাল: গবেষণা প্রকাশের পর কমপক্ষে পাঁচ বছর তথ্য সংরক্ষিত থাকবে।

পরবর্তী ব্যবস্থা: সংরক্ষণকাল শেষে সব তথ্য চূড়ান্তভাবে মুছে ফেলা হবে।

প্রশ্ন বা যোগাযোগ

গবেষণা সম্পর্কে আপনার কোন প্রশ্ন থাকলে, অনুগ্রহ করে যোগাযোগ করুন:

প্রধান গবেষক	**প্রধান তত্ত্বাবধায়ক ও প্যানেল প্রধান**	**স্থানীয় যোগাযোগ ব্যক্তি**
আশিস তালুকদার PhD ক্যান্ডিডেট ন্যাশনাল সেন্টার ফর এপিডেমিওলজি অ্যান্ড পপুলেশন হেলথ, অস্ট্রেলিয়ান ন্যাশনাল ইউনিভার্সিটি ইমেইল: ashis.talukder@anu.edu.au মোবাইল: +৬১ ০৪৮ ০৪১৯৫৯০; +৮৮ ০১৭৭২-০৬৩-৫০৭	ড. হরিবন্ধু শর্মা সিনিয়র লেকচারার, ন্যাশনাল সেন্টার ফর এপিডেমিওলজি অ্যান্ড পপুলেশন হেলথ, অস্ট্রেলিয়ান ন্যাশনাল ইউনিভার্সিটি ইমেইল: haribondhu.sarma@anu.edu.au মোবাইল: +৬১ ৪২৬ ৪০১৭২৫	ড. মো. মেনহাজুল আবেদিন সহযোগী অধ্যাপক, পরিসংখ্যান বিভাগ, খুলনা বিশ্ববিদ্যালয় খুলনা- ৯২০৮, বাংলাদেশ ইমেইল: menhaz70@gmail.com মোবাইল: +৮৮০ ১৭৭৩-৩৯৫ ৪৭৩

এথিক্স কমিটি ক্লিয়ারেন্স

এই গবেষণার নৈতিক দিকগুলি ANU হিউম্যান রিসার্চ এথিক্স কমিটি (প্রটোকল 2025/xxx) দ্বারা অনুমোদিত হয়েছে।

এই গবেষণাটি কীভাবে পরিচালিত হয়েছে সে সম্পর্কে আপনার যদি কোনো উদ্বেগ বা অভিযোগ থাকে, অনুগ্রহ করে যোগাযোগ করুন:

এথিক্স ম্যানেজার
এএনইউ হিউম্যান রিসার্চ এথিক্স কমিটি
অস্ট্রেলিয়ান ন্যাশনাল ইউনিভার্সিটি
টেলিফোন: +৬১ ২ ৬১২৫ ৩৪২৭
ইমেল: Human.Ethics.Officer@anu.edu.au

Australian National University

ORAL CONSENT SCRIPT for research participants

Policy approaches to tackling the double burden of malnutrition at the household level in South and South-east Asia

I am Ashis Talukder, a PhD candidate at the National Centre for Epidemiology and Population Health, Australian National University (ANU), Canberra, Australia. I am conducting this interview as a part of my PhD research. I ensure that your data will only be used for this study and not shared with anyone outside the research team. I have read to you the Information Sheet about the research project.

Was this information clear? Do you have any questions about the project?

Do you agree to participate in this project? (Record the answer as Yes/No)

- Do you agree for this interview to be audio-recorded? (Record the answer as Yes/No)

When I prepare the research outputs, I can attribute information to you in three ways: full name, pseudonym, or I can use NO attribution and hold your information confidentially.

- Would you like information attributed using your full name? (Record Yes/No)
- Would you like to be referred to using a pseudonym (false name)? (Record Yes/No)
- Would you prefer that your information be not attributed to anyone at all? (Record Yes/No)

May we start the interview now?

Date of script being read:.....

Australian National University

মৌখিক সম্মতি পত্র

দক্ষিণ ও দক্ষিণ-পূর্ব এশিয়ায় পরিবার পর্যায়ে অপুষ্টির দ্বিগুণ বোঝা মোকাবেলায় নীতিগত পন্থা

আমি আশিস তালুকদার, অস্ট্রেলিয়ান ন্যাশনাল ইউনিভার্সিটি (ANU), ক্যানবেরা, অস্ট্রেলিয়া-র ন্যাশনাল সেন্টার ফর এপিডেমিওলজি অ্যান্ড পপুলেশন হেলথ-এর একজন পিএইচডি গবেষক। আমি এই সাক্ষাৎকারটি আমার পিএইচডি গবেষণার অংশ হিসেবে নিচ্ছি। আপনার অংশগ্রহণ সম্পূর্ণ স্বেচ্ছাসেবী এবং আপনি যেকোনো সময় সাক্ষাৎকার বাতিল করতে বা কোনো প্রশ্নের উত্তর না দিতে পারেন। আপনার ব্যক্তিগত তথ্য গোপন রাখা হবে এবং গবেষণা দলের বাইরে কারও সাথে তা শেয়ার করা হবে না। আমি আপনাকে গবেষণা সম্পর্কিত তথ্যপত্রটি পড়ে শুনিয়েছি।

এই তথ্যগুলো কি আপনার কাছে পরিষ্কার ছিল? এই প্রকল্প সম্পর্কে আপনার কি কোনো প্রশ্ন আছে?

আপনি কি এই গবেষণায় অংশগ্রহণে সম্মত? (উত্তর রেকর্ড করুন: হ্যাঁ/না)

- আপনি কি সম্মত যে, এই সাক্ষাৎকারটি অডিও রেকর্ড করা হোক? **(উত্তর রেকর্ড করুন: হ্যাঁ/না)**

গবেষণা প্রতিবেদন প্রস্তুতের সময়, আপনার তথ্য আমি তিনভাবে উপস্থাপন করতে পারি: আপনার পূর্ণ নামসহ, একটি ছদ্মনাম ব্যবহার করে, অথবা কোনো নাম ছাড়াই সম্পূর্ণ গোপনীয়ভাবে।

- আপনি কি চান যে, আপনার তথ্য আপনার পূর্ণ নামসহ উপস্থাপন করা হোক? **(উত্তর রেকর্ড করুন: হ্যাঁ/না)**
- আপনি কি চান যে, আপনার নামের পরিবর্তে একটি ছদ্মনাম ব্যবহার করা হোক? **(উত্তর রেকর্ড করুন: হ্যাঁ/না)**
- আপনি কি চান যে, আপনার তথ্য কোনো নাম বা পরিচয় ছাড়াই উপস্থাপন করা হোক? **(উত্তর রেকর্ড করুন: হ্যাঁ/না)**

আমরা কি এখন সাক্ষাৎকার শুরু করতে পারি?

স্ক্রিপ্ট পড়ার তারিখ:.....

Information on Ethical Issue

Working Title of Research : Policy approaches to tackling the double burden of malnutrition at the Household-level in South and Southeast Asia

Supervisor/ Principal Investigator's details

Name : Ashis Talukder

Designation : Assistant Professor (on Study leave) & PhD Researcher

Affiliation : Statistics Discipline, Khulna University, Bangladesh
&
National Centre for Epidemiology and Population Health, Australian National University, Canberra, Australia

Email : ashistalukder3168@stat.ku.ac.bd

Phone Number : +610480519590; +8801772063507

Target Population : Stakeholders who play key roles in nutrition policy development in Bangladesh

Place of Research : Bangladesh

Research ethics checklist

Sl. No.	Statements	Yes	No
1.	The study will be involved among the participants who are unable to give informed consent.		✓
2.	Only those who will show interest to participate voluntarily will be involved.	✓	
3.	The study will fully maintain anonymity of the participants.	✓	
4.	Full confidentiality of the obtained data will be maintained.	✓	
5.	The study will involve discussion of sensitive topics.	✓	
6.	There will no possibility of compromise for the safety of the participants.	✓	
7.	The participants will have the choice to leave any question of the questionnaire unanswered.	✓	
8.	The research will not share the data/ confidential information beyond the academic purpose.	✓	
9.	Participants will have all freedom to withdraw themselves at any time from the research.	✓	
10.	Participants will not be offered any incentives for taking part in the study.	✓	

I do hereby declare that the above mentioned statements are true.



Signature of Applicant

Date: 27/04/2025

General Instructions for Application:

1. The Principal Investigator (PI) of a research project submitting for "Ethical Clearance Certificate" must be affiliated with Khulna University. The faculty members and research scientists of the University are eligible to apply.

2. Please fill out the application form mentioned above, and do mention the tick mark (✓) in the "Research Ethics Checklist section", where necessary.

3. Please attach the "Research Questionnaire" and the "Proposal of the Research Project" with a detailed description of the methods and procedures intended to be carried out during your research so that the review committee can understand the extent and impact of your research for evaluation.

4. Please attach the consent form for the participants before the questionnaire to ensure the participant's rights.

5. Please apply with a cover letter admiring the director of the Research and Innovation Centre (RIC) which must be forwarded by the Head of the Discipline/Director of the institutes/Cells/Centres, and signed by the PI, while applying.

6. Please also submit a soft copy of your application to office@ric.ku.ac.bd and director@rc.ku.ac.bd by e-mail.

7. Please note that it generally takes 3 to 4 weeks to complete the review process of the application. Henceforth, honorable applicants are strongly suggested to apply well in advance.

গবেষণা ও উদ্ভাবনী কেন্দ্র
Research and Innovation Centre
Khulna University

24 May 2025

Ethical Clearance Certificate

Reference Number	:	KUECC-2025-04-32
Date of Application	:	27 April 2025
Title	:	Policy approaches to tackling the double burden of malnutrition at the household level in South and South-east Asia
Applicant	:	Ashis Talukder Assistant Professor Statistics Discipline Khulna University, Bangladesh

Based on the statement regarding the ethical issues which have been considered by the applicant (as per the declaration letter of Ashis Talukder), I, hereby, am issuing the ethical clearance of the research work on the aforementioned title.

The Ethical Clearance is valid for Bangladesh only. The applicant is requested to submit the Ethical Clearance Certificate obtained from Australian National University to the Research and Innovation Centre of Khulna University.

Regards

24.05.2025

(Prof. Dr. Kazi Mohammed Didarul Islam)
Chairman
Ethical Clearance Committee, and
Director, Research and Innovation Centre
Khulna University, Khulna-9208
Bangladesh

Research and Innovation Centre, Khulna University, Khulna-9208, Bangladesh.
Tel: +88-02-477734139, Ext: 5120, Fax: + 88-02-477734138, E-mail: director@ric.ku.ac.bd, office@ric.ku.ac.bd

Appendix I

Conference Publications

Journal of Public Health and Emergency, 2026

AB082. Nutritional consequences of cesarean births: exploring the link to the double burden of malnutrition in South and Southeast Asia

Ashis Talukder[1,2], Matthew Kelly[1], Darren Gray[1,3], Haribondhu Sarma[1]

[1]National Centre for Epidemiology and Population Health, Australian National University, Canberra, ACT, Australia; [2]Statistics Discipline, Science Engineering and Technology School, Khulna University, Khulna, Bangladesh; [3]Population Health Department, QIMR Berghofer Medical Research Institute, Brisbane, QLD, Australia

Background: The rising prevalence of caesarean section (C-section) deliveries in South and Southeast Asia may be an emerging driver of the double burden of malnutrition (DBM), defined as the coexistence of maternal overweight/obesity and child undernutrition within the same household. Although concerns about this potential link are growing, empirical evidence on the association between C-section births and DBM in this region remains limited. The aim of this study is to examine the association between C-section births and DBM in selected South and Southeast Asian countries.

Methods: We used nationally representative data from the 2022 Demographic and Health Surveys of Bangladesh, Cambodia, and Nepal. The analysis included mother-child pairs involving women aged 15–49 years with at least one child, both having valid anthropometric measurements and reported delivery methods. We used Chi-squared tests and analysis of variance (ANOVA) for initial analysis and then applied a two-level logistic regression to account for household-level clustering.

Results: Our sample consisted of 4,132 pairs from Bangladesh, 3,836 from Cambodia, and 2,596 from Nepal. The results showed that C-section deliveries were associated with higher likelihood of DBM in Bangladesh [adjusted odds ratio (AOR) =2.60; 95% confidence interval (CI): 1.55, 4.37] and Nepal (AOR =1.72; 95% CI: 1.09, 2.70). This relationship was particularly evident when breastfeeding was delayed, whereas longer breastfeeding durations appeared to have a protective effect. Additionally, DBM was more prevalent in urban areas across all three countries.

Conclusions: Our study found that C-section deliveries increase the risk of DBM, especially when breastfeeding was delayed. This evidence suggests that C-sections can influence long-term nutritional outcomes for both mothers and children, potentially worsening malnutrition in South and Southeast Asian countries. Addressing this issue requires reducing unnecessary C-sections, encouraging early breastfeeding, and supporting postpartum weight management. Strengthening integrated maternal and nutrition care, particularly in urban areas, is vital to advancing global nutrition goals and promoting intergenerational health equity. Further country-specific research is needed to inform culturally appropriate, evidence-based interventions.

Keywords: Cesarean section (C-section); South and Southeast Asia; double burden of malnutrition (DBM); maternal obesity; multilevel logistic regression

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

doi: 10.21037/jphe-26-ab082

Cite this abstract as: Talukder A, Kelly M, Gray D, Sarma H. AB082. Nutritional consequences of cesarean births: exploring the link to the double burden of malnutrition in South and Southeast Asia. J Public Health Emerg 2026;10:AB082.

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Journal of Public Health and Emergency, 2026

AB133. Urbanization and double burden of malnutrition at the household level in South and Southeast Asia: insights from night-time lights data

Ashis Talukder[1,2], Matthew Kelly[1], Darren Gray[1,3], Haribondhu Sarma[1]

[1]National Centre for Epidemiology and Population Health, Australian National University, Canberra, ACT, Australia; [2]Statistics Discipline, Science, Engineering, and Technology Science School, Khulna University, Khulna, Bangladesh; [3]Population Health Department, QIMR Berghofer Medical Research Institute, Brisbane, QLD, Australia

Background: Urbanization is rapidly reshaping the socio-economic and health landscapes of South and Southeast Asia, presenting both opportunities and significant public health challenges. Among the most pressing is the double burden of malnutrition (DBM), the co-existence of undernutrition and overnutrition within the same households or populations. This phenomenon underscores that urban growth, while associated with improved infrastructure and economic development, does not uniformly translate into better nutritional outcomes. This perspective aims to explore spatial patterns of DBM using night-time light (NTL) satellite data as a proxy for urbanization in Bangladesh, Cambodia, and Nepal.

Methods: We conducted a spatial analysis of DBM in relation to urbanization by integrating demographic and nutrition survey data with NTL satellite imagery. NTL intensity served as a proxy for urban growth and economic activity, allowing us to identify areas of high urbanization and assess their overlap with DBM prevalence at the population and household levels.

Results: DBM affects approximately 12–14% of households in Nepal, Bangladesh, and Cambodia. Areas with high NTL intensity are associated with higher rates of household-level DBM. Urban centers such as Dhaka in Bangladesh and Kathmandu in Nepal emerge as prominent DBM hotspots, demonstrating a clear spatial overlap between urbanization and malnutrition.

Conclusions: Integrating NTL data into public health planning can enhance the identification of high-risk areas and guide targeted, context-specific interventions. Addressing DBM in urbanizing regions requires cross-sectoral policies that combine nutrition-sensitive urban planning with inclusive food systems and social protection strategies.

Keywords: Urbanization; double burden; night-time lights (NLTs); South Asia; Southeast Asia

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

doi: 10.21037/jphe-26-ab133

Cite this abstract as: Talukder A, Kelly M, Gray D, Sarma H. AB133. Urbanization and double burden of malnutrition at the household level in South and Southeast Asia: insights from night-time lights data. J Public Health Emerg 2026;10:AB133.

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Urbanisation and Double Burden of Malnutrition at the Household Level in South and Southeast Asia: Insights from Night-Time Lights Data

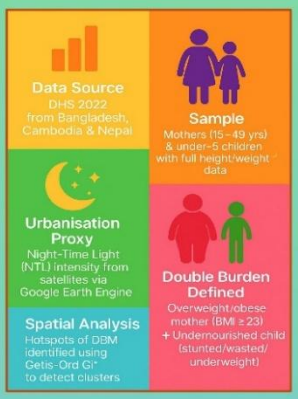
Ashis Talukder[1,2], Matthew Kelly[1], Darren Gray[1,3], Haribondhu Sarma[1]
[1]National Centre for Epidemiology and Population Health, Australian National University, Canberra, ACT 2600, Australia
[2]Statistics Discipline, Khulna University, Khulna-9208, Bangladesh
[3]QIMR Berghofer Medical Research Institute, Australia

Background

- Urbanisation in South and Southeast Asia is reshaping economic, social, and health systems—offering improved services and opportunities, yet also introducing complex health risks [1-3].
- One critical challenge is the Double Burden of Malnutrition (DBM)—the coexistence of undernutrition (e.g., stunting, wasting) and overnutrition (e.g., overweight, obesity)—reflecting the paradox where urban growth fails to deliver uniform improvements in nutrition and health outcomes [2,4].

Objective
Explore how urban growth patterns contribute to DBM through spatial analysis.

Methods



- **Total Sample:**
  - Bangladesh: 4132 pairs
  - Cambodia: 3836 pairs
  - Nepal: 2596 pairs
- **Analysis:**
  - Mapped NTL using georeferenced DHS clusters
  - Identified DBM hotspots using spatial autocorrelation (Getis-Ord Gi*) [5]

Results

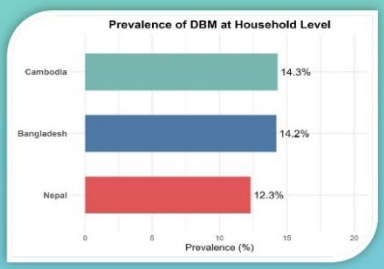


Figure1: Prevalence of DBM at household level in Bangladesh, Cambodia & Nepal

- DBM affects 12–14% of households in Nepal, Bangladesh, and Cambodia
- High NTL areas are associated with higher rates of household-level DBM.
- Urban centers such as Dhaka (Bangladesh) and Kathmandu (Nepal) are prominent DBM hotspots, indicating a spatial overlap between urbanisation and malnutrition.

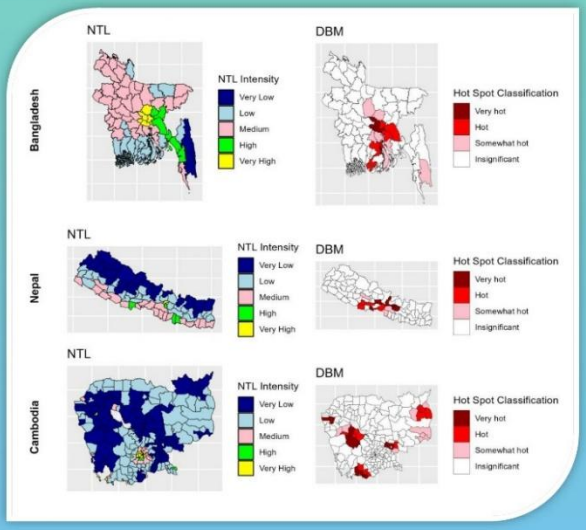
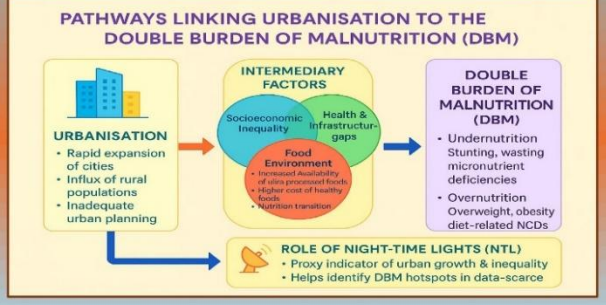


Figure 2: Night-time-light intensity (NTL) and DBM hotspots for Bangladesh, Cambodia & Nepal

Key message

Urbanisation, reflected by NTL, is a strong predictor of household-level DBM, highlighting the need for integrated health and nutrition policies in rapidly expanding peri-urban areas.

Conclusion



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Australian National University

CONTRIBUTED ORAL PAPERS

[P-067]

Double Burden of Malnutrition Among Urban Women of Reproductive Age: A Multicounty Analysis in South and Southeast Asia

Ashis Talukder* (Australian National University)

Abstract

Background The double burden of malnutrition (DBM)—the coexistence of undernutrition and overnutrition—is a rising public health concern among urban women of reproductive age (WRA) in South and Southeast Asia. It poses serious health risks for women and contributes to intergenerational transmission of malnutrition. This study aims to explore the prevalence and determinants of the components (overweight and underweight) of DBM among urban WRA in selected countries of this region.

Methods We analysed nationally representative cross-sectional data from the 2022 Demographic and Health Surveys conducted in three South and Southeast Asian countries: Bangladesh, Nepal, and Cambodia. We focused on urban women aged 15–49 years. DBM was considered present if both underweight (BMI < 18.5 kg/m^2) and overweight (BMI 23 kg/m^2) prevalence reached 10% or more. We used multinomial regression to explore the socioeconomic and behavioural correlates of being underweight and overweight.

Results The pooled sample included 11,977 urban WRA. In Bangladesh, high overweight prevalence (64.1%) and low underweight (7.3%) indicated no DBM. In contrast, both Nepal (12.9% underweight; 44.1% overweight) and Cambodia (10.4% underweight; 45.8% overweight) met the DBM threshold. Regionally, 10.3% were underweight and 51.0% overweight. Regression findings showed underweight declined and overweight increased with age. Higher education was protective against both. Women from wealthier households had a lower risk of being underweight but a higher risk of being overweight. Physical activity was linked with lower overweight risk. In all three selected countries, unhealthy food and sweetened beverage intake raised overweight risk.

Conclusion DBM exists among urban women in Nepal and Cambodia, while Bangladesh faces a dominant overweight burden. To address this challenge, age- and wealth-specific nutrition interventions are needed, including promoting physical activity and discouraging sugary and unhealthy beverages. Policymakers should implement awareness campaigns, strengthen nutrition education, and regulate the marketing and availability of nutrient-poor foods in urban areas.

Key words: DBM, urban women, South and Southeast Asia.

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Determinants of Double Burden of Malnutrition in South and Southeast Asian Households: A Systematic Review and Meta-Analysis

Ashis Talukder[1,2], Matthew Kelly[1], Md Abu Sayeed[1], Darren Gray[3], Haribondhu Sarma[1]*

[1] National Centre for Epidemiology & Population Health, Australian National University, Australia | [2] Statistics Discipline, Khulna University, Bangladesh | [3] QIMR Berghofer Medical Research Institute, Brisbane, Australia

Contact: Haribondhu.Sarma@anu.edu.au

NUTRITION 2026 — Where the Best in Science & Health Meet — July 25-28, 2026 • Washington, D.C.

Background

Double burden of malnutrition (DBM) refers to the coexistence of **undernutrition in children** and **overnutrition in mothers** within the same household.

South and Southeast Asia account for **54%** of the global burden of **child stunting** in 2024, while adult **overweight and obesity** are increasing at the fastest rates.

These overlapping forms of malnutrition threaten the **health and future of women and children** across the life course.

Evidence on the **determinants** of household-level DBM in South and Southeast Asia remains **fragmented** and **inconsistent**.

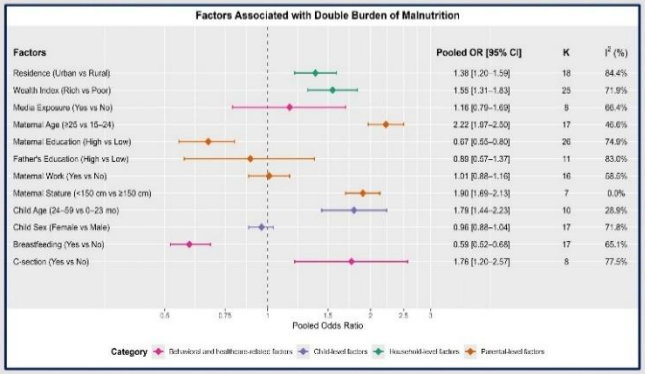
Study Objectives

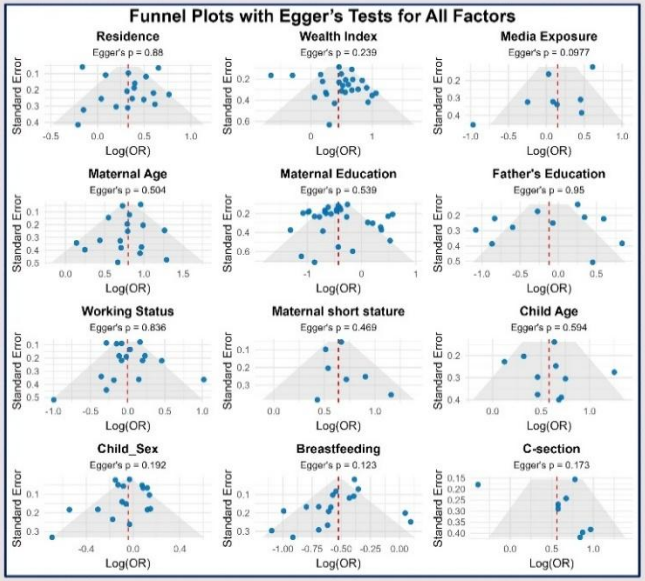
To synthesize evidence on factors associated with **household-level DBM** in South and Southeast Asia through a **systematic review and meta-analysis.**

Methods

STUDY DESIGN	Systematic Review and Meta-analysis
DATA SOURCES	PubMed, Scopus, Web of Science
SEARCH PERIOD	January 2000 to 15 September 2025
STUDY SELECTION AND INCLUSION	30 studies identified 26 studies included in meta-analysis
ELIGIBILITY CRITERIA	• Observational studies • Reported household-level DBM outcomes • Reported effect estimates (OR) with sufficient data • South and Southeast Asia
QUALITY ASSESSMENT	Newcastle–Ottawa Scale (NOS) adapted for cross-sectional studies.
DATA ANALYSIS	✓ Random-Effect Meta-Analysis (DerSimonian–Laird method) ✓ Pooled Odds Ratios (OR) with 95% CI ✓ Subgroup Analyses by DBM definition and region ✓ Heterogeneity Assessment using I^2 statistic ✓ Publication Bias Assessment with Egger's Test Software: R (Version 4.4.2)

Figures





Key Findings

KEY FACTORS ASSOCIATED WITH DBM *(Meta-analysis: 12 factors)*

HOUSEHOLD-LEVEL FACTORS	PARENTAL-LEVEL FACTORS	CHILD-LEVEL FACTORS	BEHAVIORAL & HEALTHCARE FACTORS
Wealth index (Rich vs Poor) OR 1.55 (1.31–1.83)	Maternal age (≥25 vs 15–24) OR 2.22 (1.97–2.50)	Child age (24–59 vs 0–23 mo) OR 1.79 (1.44–2.23)	Caesarean section (Yes vs No) OR 1.76 (1.20–2.57)
Residence (Urban vs Rural) OR 1.38 (1.20–1.59)	Maternal stature (<150 vs ≥150 cm) OR 1.90 (1.69–2.13)	Child sex (Female vs Male) OR 0.96 (0.88–1.04)	Media exposure (Yes vs No) OR 1.16 (0.79–1.69)
Higher wealth and urban residence increase DBM risk.	Older age and short stature increase risk; higher maternal education is protective.	Older children have higher DBM risk; no significant difference by sex.	Breastfeeding (Yes vs No) OR 0.59 (0.52–0.68)
	Maternal education (High vs Low) OR 0.67 (0.55–0.80)		Caesarean section increases risk; breastfeeding is protective; media exposure not significant.

ADDITIONAL FACTORS ASSOCIATED WITH DBM

Later-born child (birth order ≥2)	Larger household size	Antenatal care (ANC) visits	Household food insecurity	Dietary factors
Higher risk	Higher risk	Lower risk	Higher risk	Higher protein intake in children and higher fat intake in mothers increase DBM risk

Study Strength

- Comprehensive search across multiple databases
- Good quality studies (NOS-xs)
- Meta-analysis of 12 key factors with pooled estimates
- Subgroup and sensitivity analysis confirms robustness

Take-Home Message

Household-level factors significantly influence double burden of malnutrition (DBM) in South and Southeast Asia.

Integrated, context-specific interventions
Address both undernutrition and overnutrition across the life course.

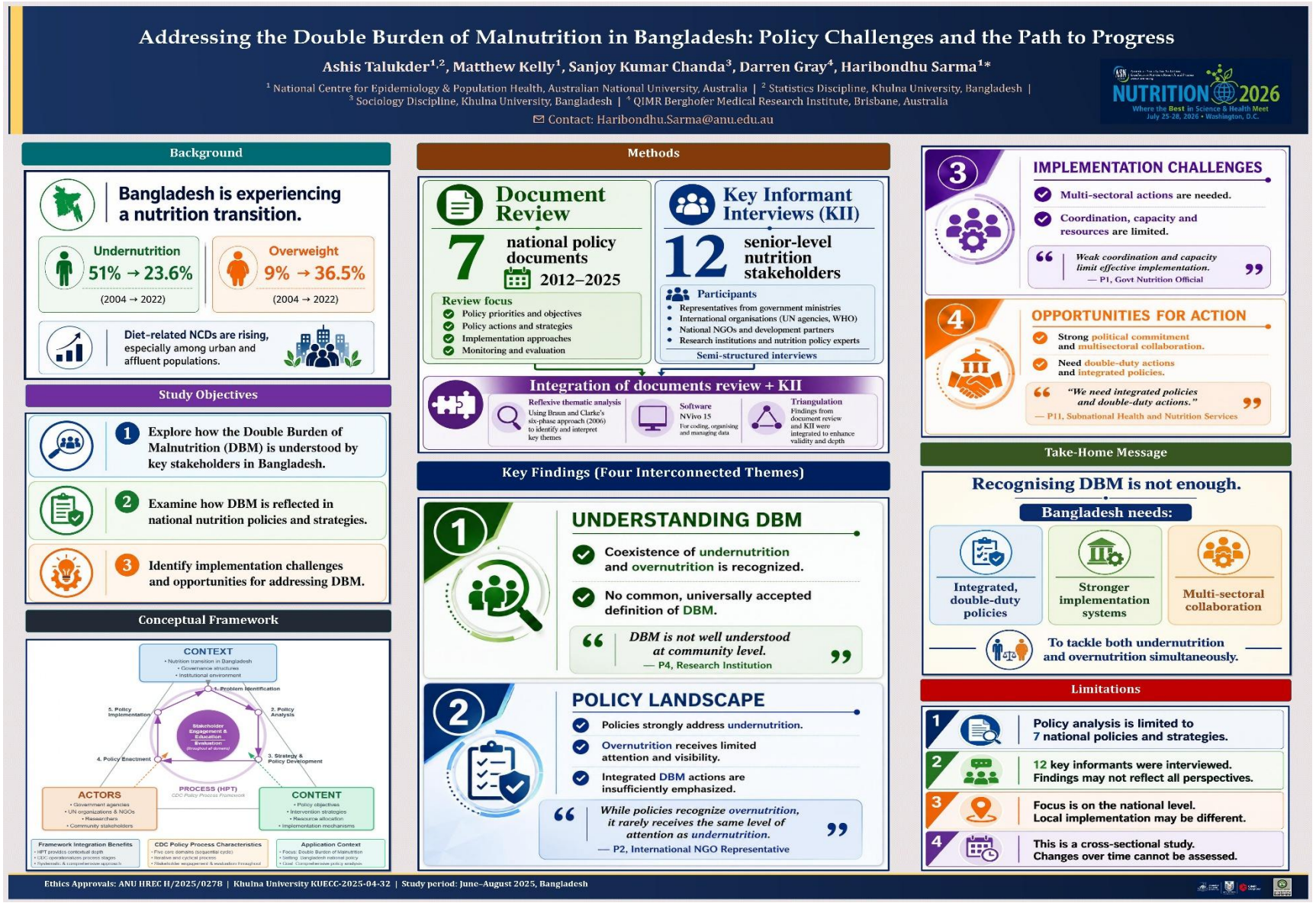
Target all populations
Include poor, rural, urban and affluent households facing nutrition transitions.

Key actions
- Promote maternal education
- Encourage breastfeeding
- Prevent intergenerational malnutrition

Policy impact
Reduce DBM and advance Sustainable Development Goals related to nutrition and health.

Future research priorities
- Use longitudinal designs to establish causality.
- Standardize DBM definitions for better comparability.
- Explore dietary patterns, food security, and household dynamics.

PROSPERO Registration: CRD420251155844


Addressing the Double Burden of Malnutrition in Bangladesh: Policy Challenges and the Path to Progress
Ashis Talukder[1,2], Matthew Kelly[1], Sanjoy Kumar Chanda[3], Darren Gray[4], Haribondhu Sarma[1]*
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NUTRITION 2026
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July 25-28, 2026 • Washington, D.C.
Background
Bangladesh is experiencing a nutrition transition.
Undernutrition
51% → 23.6%
(2004 → 2022)
Overweight
9% → 36.5%
(2004 → 2022)
Diet-related NCDs are rising, especially among urban and affluent populations.
Study Objectives
1 Explore how the Double Burden of Malnutrition (DBM) is understood by key stakeholders in Bangladesh.
2 Examine how DBM is reflected in national nutrition policies and strategies.
3 Identify implementation challenges and opportunities for addressing DBM.
Conceptual Framework
CONTEXT
• Nutrition transition in Bangladesh
• Governance structures
• Institutional environment
1. Problem Identification
2. Policy Analysis
3. Strategy & Policy Development
4. Policy Enactment
5. Policy Implementation
Stakeholder Engagement & Education
Evaluation
(Throughout all domains)
PROCESS (HPT)
CDC Policy Process Framework
ACTORS
• Government agencies
• UN organizations & NGOs
• Researchers
• Community stakeholders
CONTENT
• Policy objectives
• Intervention strategies
• Resource allocation
• Implementation mechanisms
Framework Integration Benefits
• HPT provides contextual depth
• CDC operationalizes process stages
• Systematic & comprehensive approach
CDC Policy Process Characteristics
• Five core domains (sequential cycle)
• Iterative and cyclical process
• Stakeholder engagement & evaluation throughout
Application Context
• Focus: Double Burden of Malnutrition
• Setting: Bangladesh national policy
• Goal: Comprehensive policy analysis
Methods
Document Review
7 national policy documents
2012–2025
Review focus
Policy priorities and objectives
Policy actions and strategies
Implementation approaches
Monitoring and evaluation
Key Informant Interviews (KII)
12 senior-level nutrition stakeholders
Participants
Representatives from government ministries
International organisations (UN agencies, WHO)
National NGOs and development partners
Research institutions and nutrition policy experts
Semi-structured interviews
Integration of documents review + KII
Reflexive thematic analysis
Using Braun and Clarke's six-phase approach (2006) to identify and interpret key themes
Software
NVivo 15
For coding, organising and managing data
Triangulation
Findings from document review and KII were integrated to enhance validity and depth
Key Findings (Four Interconnected Themes)
1 UNDERSTANDING DBM
Coexistence of undernutrition and overnutrition is recognized.
No common, universally accepted definition of DBM.
"DBM is not well understood at community level."
— P4, Research Institution
2 POLICY LANDSCAPE
Policies strongly address undernutrition.
Overnutrition receives limited attention and visibility.
Integrated DBM actions are insufficiently emphasized.
"While policies recognize overnutrition, it rarely receives the same level of attention as undernutrition."
— P2, International NGO Representative
3 IMPLEMENTATION CHALLENGES
Multi-sectoral actions are needed.
Coordination, capacity and resources are limited.
"Weak coordination and capacity limit effective implementation."
— P1, Govt Nutrition Official
4 OPPORTUNITIES FOR ACTION
Strong political commitment and multisectoral collaboration.
Need double-duty actions and integrated policies.
"We need integrated policies and double-duty actions."
— P11, Subnational Health and Nutrition Services
Take-Home Message
Recognising DBM is not enough.
Bangladesh needs:
Integrated, double-duty policies
Stronger implementation systems
Multi-sectoral collaboration
To tackle both undernutrition and overnutrition simultaneously.
Limitations
1 Policy analysis is limited to 7 national policies and strategies.
2 12 key informants were interviewed. Findings may not reflect all perspectives.
3 Focus is on the national level. Local implementation may be different.
4 This is a cross-sectional study. Changes over time cannot be assessed.
Ethics Approvals: ANU HREC H/2025/0278 | Khulna University KUECC-2025-04-32 | Study period: June–August 2025, Bangladesh

Appendix J

Other Publications During Candidature

[1] Baffour B, Das S, **Talukder A,** Richardson A. The effect of space, time and night-time light intensity on antenatal care coverage in Bangladesh. ***Spat Demogr*.** 2025;13(1). https://doi.org/10.1007/s40980-025-00144-4

[2] **Talukder A,** Sara SS, Khan ZI, et al. Prevalence and determinants of hypertension in South Asian urban communities: Findings from Demographic and Health Surveys (DHS) data of South Asian countries. ***J Hum Hypertens*.** 2024;38(3) https://doi.org/10.1038/s41371-023-00879-x

[3] Sara SS, Rahman MA, Rahman R, **Talukder A.** Prediction of suicidal ideation with associated risk factors among university students in the southern part of Bangladesh: Machine learning approach. ***J Affect Disord*.** 2024;349:502-508. https://doi.org/10.1016/j.jad.2024.01.092

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Appendix K

Printed Versions of Published Articles

Check for updates

Received: 17 April 2025 | Revised: 17 July 2025 | Accepted: 26 July 2025

Paper 1

DOI: 10.1111/1747-0080.70037

REVIEW

Nutrition & Dietetics Journal of Dietitians Australia WILEY

Defining double burden of malnutrition across individual, household and population level: A narrative review

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[Correction added on 20 August 2025, after first online publication: The third author's name has been corrected to "Md Abu Sayeed" in this version.]

Abstract

Aims: This study aims to evaluate the existing definitions of double burden of malnutrition and to synthesise and propose operational definitions at different levels, with the goal of improving consistency in measurement and policy development.

Methods: We conducted a narrative review that used structured search and narrative synthesis to review and summarise how double burden of malnutrition has been defined at different levels. We performed a structured search across PubMed, Web of Science and Scopus, focusing on peer-reviewed articles published between January 2010 and December 2024. We screened articles for relevance to double burden of malnutrition and categorised them based on the level of the definition, such as households, individuals and populations.

Results: Of the 60 selected studies, the majority originated from Latin America ($n = 19$, 32%), followed by South Asia ($n = 10$, 17%) and Southeast Asia ($n = 8$, 13%). At the household level, the most common definition of double burden of malnutrition was the coexistence of an overweight/obese mother and a stunted child. Individual-level definitions commonly included the coexistence of overweight/obesity with anaemia or stunting. However, definitions at the population level varied considerably and lacked consistency across studies.

Conclusions: Our findings highlight the need for consistent operational definitions of double burden of malnutrition across different levels of analysis. Drawing on existing literature, we synthesise practical definitions at different levels to more accurately reflect the coexistence of different forms of malnutrition. Clarifying these definitions can improve the comparability of prevalence estimates across contexts and support the development of more effective, evidence-based strategies to address the growing burden of double burden of malnutrition.

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KEYWORDS
definition of DBM, double burden of malnutrition, level of DBM assessment, systematic narrative review

1 | INTRODUCTION

The double burden of malnutrition refers to the simultaneous presence of undernutrition and overnutrition within households, individuals or populations.[1–5] This concept was first formally introduced at the 1992 International Conference on Nutrition, where it was defined primarily at the national level as the coexistence of overweight or obesity alongside undernutrition within a country.[6] Since then, significant shifts in dietary patterns, physical activity, disease burdens and life expectancy have transformed the global nutritional landscape, especially in many low- and middle-income countries.[7,8]

As a result, the double burden of malnutrition is now increasingly recognised not only as a national-level issue but also as a phenomenon occurring at more localised levels—within households and even individuals.[1,9] It remains a critical public health challenge, as highlighted in major research and publications, including *The Lancet* series titled *The Double Burden of Malnutrition*, published in December 2019.[1,10–12] The double burden of malnutrition undermines progress towards global health goals, exacerbates health inequalities and places dual pressure on healthcare systems by contributing to both infectious diseases and non-communicable diseases (NCDs).[11,12] This evolving nutritional reality—characterised by persistent undernutrition (e.g., stunting, wasting and micronutrient deficiencies) alongside a growing prevalence of overweight, obesity and diet-related NCDs—poses significant challenges to achieving sustainable development and advancing health equity in low- and middle-income countries.[9,13–15]

Globalisation and urbanisation are exacerbating this nutritional burden by creating environments where processed foods high in fats, sugars and salts increasingly replace traditional diets rich in whole grains, fruits and vegetables.[13] This shift has increased the double burden prevalence, especially in low- and middle-income countries, where undernutrition persists in children and overnutrition occurs in adults living in the same households.[1,16,17] In these contexts, the coexistence of undernutrition and overnutrition within the same individual is also becoming more common, as children who are undernourished in early childhood are more likely to become overweight in adulthood, heightening their risk for NCDs.[11] These overlapping challenges demand integrated interventions that address both aspects of malnutrition.

Despite growing recognition of the double burden of malnutrition, a key research gap lies in the absence of specific operational definitions and indicators, which hampers the development, implementation and evaluation of effective nutrition-related initiatives.[17] While the World Health Organization (WHO) outlines a broad conceptual framework,[9] it does not provide detailed operational guidance for defining and measuring double burden of malnutrition across individual, household and population levels. Early studies typically defined it as the presence of an overweight or obese mother and a stunted child within the same household,[18–20] but recent research has expanded this to include a wider range of anthropometric and biochemical outcomes.[21] This heterogeneity in operational definitions and measurement criteria not only results in inconsistent estimates of the prevalence of double burden of malnutrition but also hampers trend monitoring, cross-study comparability and the formulation of coordinated public health strategies.[22,23] Although a previous review identified existing operational definitions of the double burden of malnutrition and their frequency of use,[17] it neither proposed specific definitions tailored to individual, household and population levels nor attempted to construct a universal framework requiring global consensus. This gap may limit the ability to assess the full scope of the problem and develop consistent, evidence-based responses.

It is important to note that the term 'triple burden of malnutrition' has recently gained attention in research and practice to describe the simultaneous presence of undernutrition, micronutrient deficiencies and overnutrition.[24–26] The triple burden of malnutrition builds on the idea of the double burden by specifically including micronutrient deficiencies as a separate issue,[27,28] broadening the conceptualisation of malnutrition challenges. Moreover, micronutrient deficiencies can accompany either over- or under-nutrition in different ways and therefore this paper will focus on the most clearcut concept. Accordingly, this review focuses on the double burden definitions and indicators, where ongoing inconsistencies continue to hinder effective policy and programme development.[17]

In response to this challenge, this paper aims to review the definitions and indicators of the double burden of malnutrition used in current literature so far, with the goal of identifying gaps in the operationalisation of this concept. By exploring the different levels of double burden malnutrition—individuals, households and populations—and analysing the indicators used to assess malnutrition at each of these levels, this study seeks to provide a clearer framework for future research. This paper also aims to propose specific operational

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definitions of the double burden of malnutrition at different levels, along with practical measurement criteria that are essential for improving the accuracy of prevalence estimates and for guiding the development and monitoring of effective nutrition policies that address both undernutrition and overnutrition.

2 | METHODS

We performed a narrative review guided by systematic search strategies. We adopted a structured, transparent and rigorous approach, including clearly defined inclusion and exclusion criteria, PRISMA reporting and independent screening by two reviewers, with disagreements resolved by consensus involving a third reviewer if necessary. We did not register a protocol, conduct a formal risk of bias assessment or perform meta-analysis, as the heterogeneity of definitions and conceptual approaches made quantitative synthesis inappropriate. This hybrid approach aligns with the methodology of structured narrative reviews described previously,[29,30] and the review process is reported in accordance with the checklist PRISMA 2020 statement.[31] As the primary aim was to synthesise existing operational definitions rather than to conduct a quantitative synthesis, we did not register a formal systematic review protocol.

To aid readers from diverse disciplines, we provided detailed explanations of key technical terms used in this paper, such as operational definition of the double burden of malnutrition, systematic narrative review, stunting, wasting, obesity and diet-related NCDs in Table 1.

We conducted a structured search for peer-reviewed journal articles to ensure methodological transparency and quality. This search focused on articles published between January 2010 and December 2024. This timeframe was selected to capture the most recent developments in the conceptualisation and measurement of the double burden of malnutrition. For instance, the WHO Global Nutrition Policy Review, based on a 2009–2010 survey, highlighted growing policy interest in integrated approaches to undernutrition, micronutrient deficiencies and overnutrition—the key components of the double burden of malnutrition framework.[33]

In our search strategy, we used related terms, such as 'double burden of malnutrition,' 'dual burden of malnutrition,' 'stunted child or overweight mother' and acronyms (such as DBM, SCOWT and SCOM). The acronym 'SCOWT' (stunted child and overweight mother) has been used in previous literature to define the double burden of malnutrition.[34] A detailed overview of the search strategy is provided in Supporting Information S1.

To meet the objectives of our review, we included those studies published in scientific peer-reviewed journals based on the following criteria: (1) studies that provide clear definitions or conceptual frameworks of the double burden of malnutrition at the individual, household or population level; (2) analyses assessing the

TABLE 1 Explanation of key terminologies used in this study.

Key terminologies	Explanation
Operational definition of DBM	A specific and measurable definition used to identify or assess a concept in research or practice. In this study, it refers to how DBM is conceptually described in the literature and measured or assessed in applied research.
Systematic narrative review	A method of reviewing literature that follows a structured process but presents the findings through a narrative synthesis.
Stunting[a]	Stunting means a child is shorter than expected for their age. It usually happens when they do not get enough nutritious food for a long time or suffer from frequent illnesses. Stunting is often linked to poverty, poor health and lack of proper care in early childhood. It can affect both a child's growth and brain development.
Wasting[a]	Wasting means a child is too thin for their height. It usually happens because of not getting enough food or from losing weight due to illnesses like diarrhoea. Wasting can be serious and increase the risk of death in young children, but it can be treated with the right care and nutrition.
Overweight and obesity[a]	Overweight and obesity occur when a person has too much body fat for their height, which can harm their health. These conditions happen when a person takes in more energy (kilojoules or calories) than they burn through activity. Globally, people are eating more high-sugar and high-fat foods and are less physically active, which contributes to this problem.
Diet-related non-communicable diseases (NCDs)[a]	Diet-related NCDs include heart disease, stroke, certain cancers and diabetes. They are mainly caused by unhealthy eating habits and poor nutrition, which are major causes of illness around the world.

Abbreviations: DBM, double burden of malnutrition; NCDs, non-communicable diseases.
[a]*Source*: World Health Organization.[32]

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overlap between 'overnutrition' and 'undernutrition'; (3) studies that focus on households where one member is undernourished and another is overweight; (4) studies focused on individuals experiencing both undernutrition and overnutrition at the same time (e.g., overweight individual who is suffering from anaemia, etc); (5) studies aiming to address the double burden of malnutrition at the country level.

The exclusion criteria for this review are: (1) studies that focused exclusively on either undernutrition or overweight/obesity, without addressing their coexistence; (2) review articles; (3) research dealing solely with the clinical or biochemical aspects of malnutrition, without any link to the double burden of malnutrition; (4) studies that examined nutrition interventions but did not define or conceptualise the double burden of malnutrition; (5) grey literature; (6) we limited our review to English-language publications.

Furthermore, we included studies that explicitly defined and operationalised the double burden of malnutrition—either by formulating their own definitions or by explicitly applying a recognised definition, such as those from WHO. Studies that only mentioned the double burden of malnutrition without specifying how it was defined or measured were excluded. This ensured that the review focused on studies that contributed clear and applicable definitions, though we acknowledge this may have excluded some studies reflecting heterogeneity in practice.

We conducted a comprehensive literature search using three major electronic databases: PubMed, Scopus and Web of Science. The initial search yielded 2675 articles in total—868 from PubMed, 936 from Scopus and 871 from Web of Science. These records were imported into EndNote™ X9.2, where duplicates were identified and removed. After removing duplicate articles, we retained 1204 unique articles for the title and abstract screening phase.

Two reviewers independently screened the titles and abstracts of the 1204 unique articles using pre-defined inclusion and exclusion criteria. This initial screening identified 258 articles as potentially relevant, which were then selected for full-text review. At this stage, both reviewers were blinded to each other's selections to minimise bias. The inter-rater agreement during this phase was substantial, with a Cohen's κ of 0.84, indicating a high level of consistency between reviewers. Discrepancies in selection were discussed to reach a consensus, and a third reviewer was consulted when necessary to resolve disagreements.

During the full-text screening phase, the same predefined inclusion and exclusion criteria were applied as in the abstract screening stage. Each of the 258 articles was read in full by both reviewers, and detailed notes were maintained on the reasons for exclusion. The inter-rater agreement at this stage was also strong, with a Cohen's κ of 0.81, reflecting consistent application of the criteria. As before, any differences in judgement were resolved through discussion, with the involvement of the third reviewer if consensus could not be achieved. Following this thorough review, 198 articles were excluded for not meeting the eligibility criteria. As a result, 60 articles were included in the final analysis. The complete selection process is illustrated in Figure 1.

For each of the 60 articles included in the final review, we used a structured data extraction process to collect detailed information relevant to the review objectives. The extracted data focused on three core domains: (a) how the double burden of malnutrition was defined in each study; (b) the anthropometric or nutritional indicators used to measure undernutrition and overnutrition; and (c) the cut-off points or thresholds applied to classify nutritional status. Additional contextual information, such as year of publication, country or region of study and the level of analysis (individuals, households or populations), was also recorded (see Table S1).

We used a narrative synthesis approach to examine how the double burden of malnutrition has been conceptualised and measured across the included studies. Full-text articles were imported into NVivo 12, where a coding framework was developed to identify both the level of assessment (individual, household or population) and the relevant definitions. Text segments containing definitions were coded under a dedicated node, allowing for systematic extraction and organisation of definitions by assessment level. In addition, each article was coded to identify the presence of key terms such as 'double burden,' 'dual burden,' 'co-occurrence,' 'co-existence' and 'double and triple burden' within the text segments defining the double burden of malnutrition. Frequency counts for these terms were generated using NVivo's text query functions. All coding was independently verified by a second reviewer to ensure consistency. The coded data were exported into Microsoft Excel (2016) to facilitate tabulation and preparation for figure generation in R (version 4.4.0). Based on this synthesis, we proposed a set of operational definitions at each level of assessment, incorporating practical and feasible cut-off points to enhance consistency and comparability in future research.

This review article is based on previously published studies and does not involve any new studies with human participants or animals conducted by the authors. As such, ethical approval and informed consent were not required.

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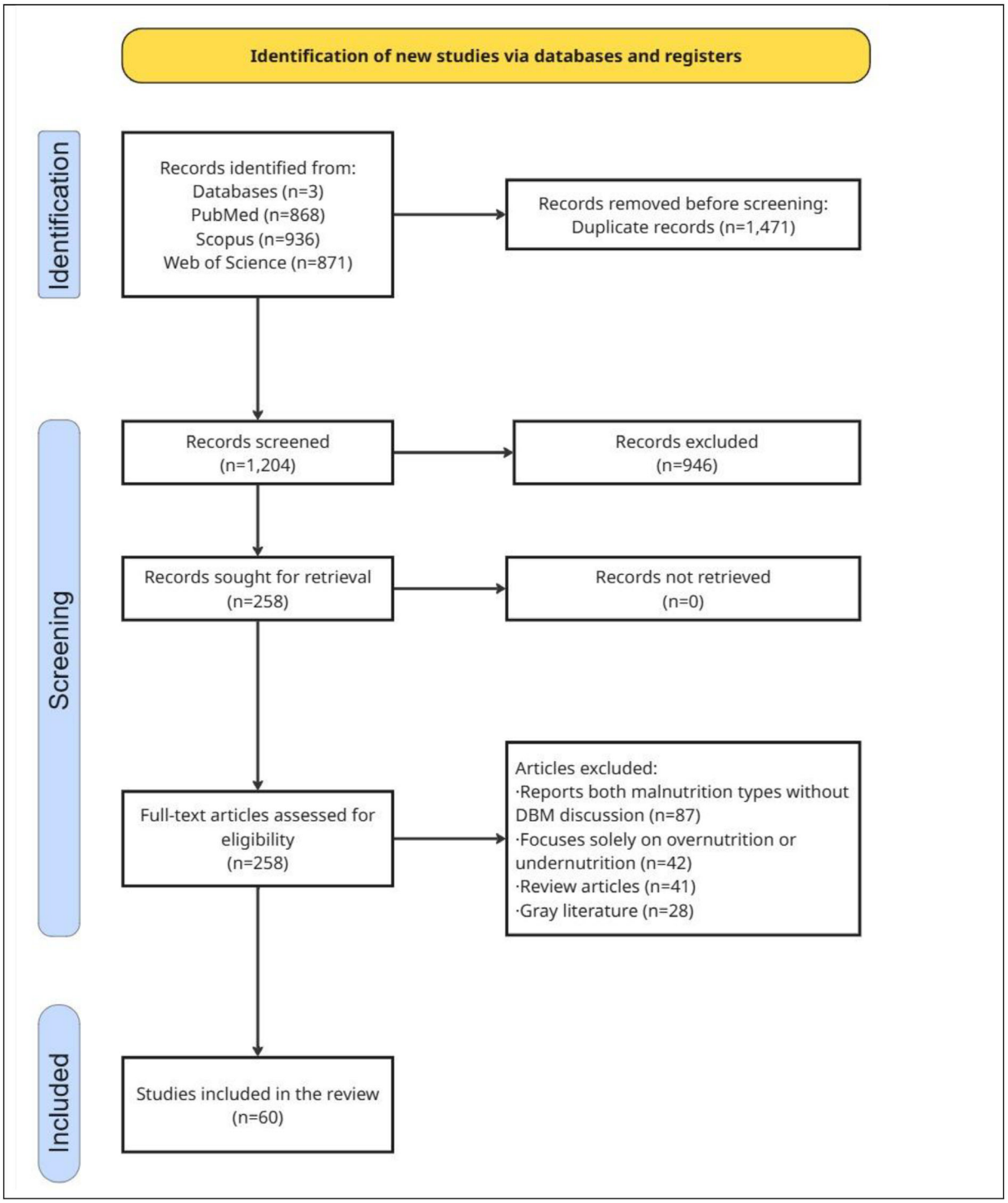

FIGURE 1 Flow diagram illustrating the identification, screening, eligibility assessment and inclusion of studies for the review. DBM, double burden of malnutrition.

3 | RESULTS

Of the 60 included articles, the majority (62%, $n = 37$) focused on the household level, followed by 23% ($n = 14$) at the individual level and 5% ($n = 3$) at the population level. Additionally, 10% ($n = 6$) of studies examined both household and individual levels. The term 'double burden' appeared most frequently in literature (80% of articles, $n = 48$) followed by 'dual burden' (6.7%, n = 4). Other related terms such as 'co-occurrence,' 'co-existence' and 'double and triple burden' appeared too rarely to be reported separately. In terms of geographical

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distribution, Latin America and the Caribbean accounted for the highest proportion of studies (32%, $n = 19$), followed by South Asia (20%, $n = 12$), Southeast Asia (13%, $n = 8$) and Sub-Saharan Africa (15%, $n = 9$). A smaller number of studies were conducted in East Asia (3%, $n = 2$). Furthermore, 17% ($n = 10$) of the studies included data from multiple countries (Figure 2).

Table 2 shows how the double burden of malnutrition has been operationally defined at different levels of measurement (households, individuals and populations) and shows the frequency of each specific definition across the 60 included studies. At the household level, a total of 62 coded definitions were identified. The most common definition—used in 25 studies (40.3%)—was the coexistence of an overweight or obese mother and a stunted child. A broader definition, pairing an overweight or obese mother with any form of child malnutrition (stunting, wasting or underweight), appeared in 19 studies (30.6%). Less frequent definitions included households with an overweight or obese mother and a wasted child (three studies, 4.8%), an overweight/obese mother and a child with micronutrient deficiency (two studies, 3.2%) or an anaemic child (five studies, 8.1%). Combinations such as an overweight child with an underweight mother, an overweight/obese mother with an underweight child or an overweight child with an anaemic mother were each

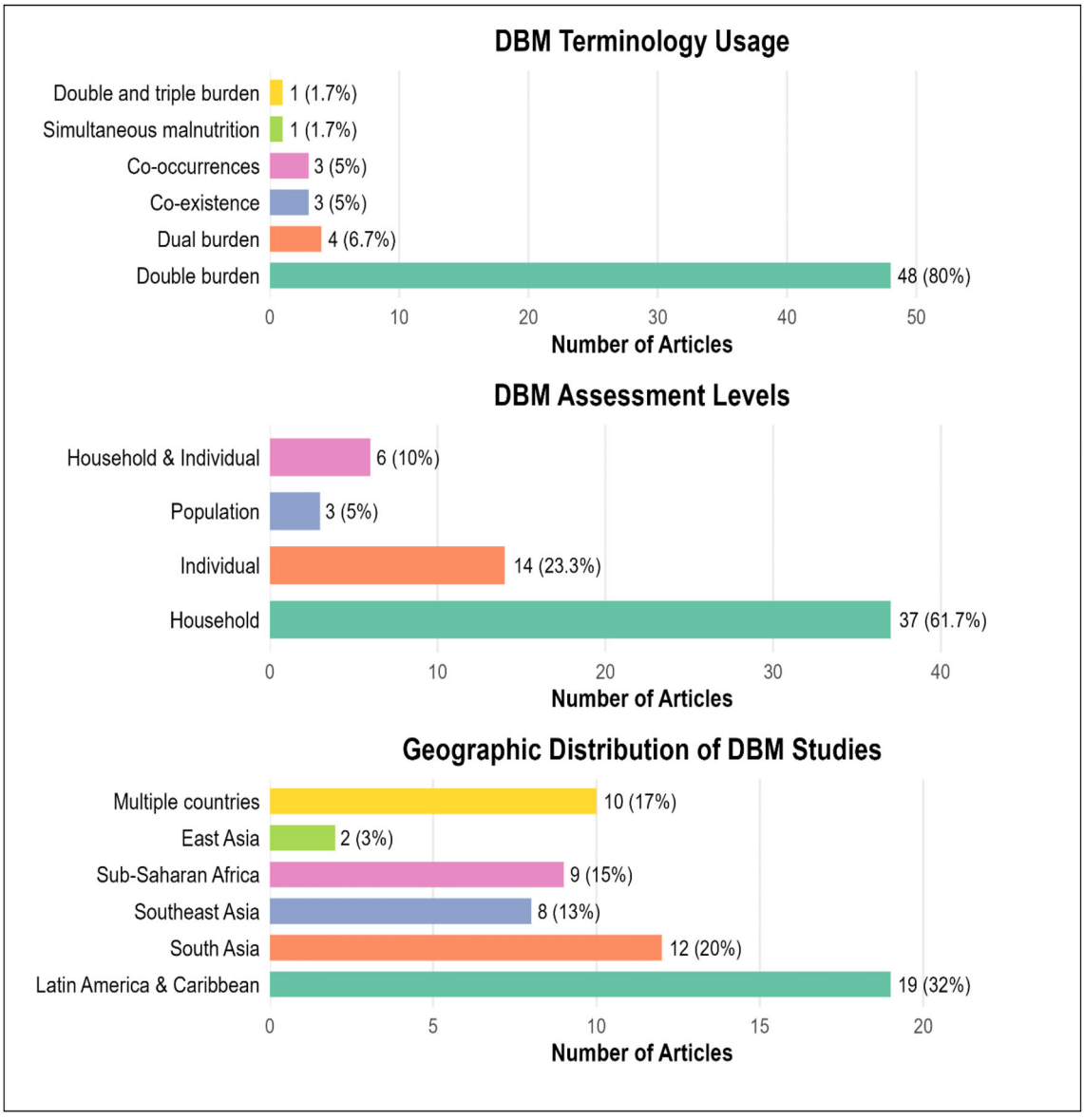

FIGURE 2 Key dimensions and research contexts based on geographical setting of double burden of malnutrition (DBM) reported across 60 included studies. The usage of DBM-related terminology was assessed by reviewing the definitions of included articles to identify which specific terms each article used to describe the double burden of malnutrition. For example, 48 articles used the term 'double burden' and four articles used 'dual burden' when defining or identifying DBM.

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TABLE 2 Summary of available operational definitions of double burden of malnutrition by assessment level.

Level of measurement	Operational definition	Total number of occurrences *n* (%)[a]
Household level	1. Overweight/obese mother and stunted child	25 (40.3)
	2. Overweight/obese mother and child having any form of malnutrition (stunting, wasting and underweight)	19 (30.6)
	3. Overweight/obese mother and wasted child	3 (4.8)
	4. Overweight/obese mother and child facing micronutrient deficiency	2 (3.2)
	5. Overweight/obese mother and anaemic child	5 (8.1)
	6. Overweight child and underweight mother	2 (3.2)
	7. Overweight/obese mother and underweight child	2 (3.2)
	8. Overweight child and anaemic mother	2 (3.2)
	9. Adult overweight and child overweight	1 (1.6)
	10. Adult underweight and child underweight	1 (1.6)
Individual level	1. Micronutrient deficiency and at least one cardiometabolic risk factor	2 (6.3)
	2. Underweight and at least one cardimetabolic risk factor	1 (3.1)
	3. Overweight/obesity and micronutrient deficiency within an individual/children	9 (28.1)
	4. Overweight/obesity and anaemia within an individual/children	9 (28.1)
	5. Overweight and stunting among under five children	8 (25.0)
	6. Anaemia and at least one cardiometabolic risk factor	1 (3.1)
	7. Underweight and anaemia within an individual/children	2 (6.3)
Population level	1. DBM measured by stunting and overweight thresholds: if (stunting >30% and overweight in children or adults >20%) or (wasting >15% and overweight in children or adults >20%) or (thinness in women >20% and overweight in children or adults >20%)	1 (33.3)
	2. DBM in a country when adult overweight and underweight prevalence >10%	1 (33.3)
	3. DBM is measured by the prevalence of stunting and overweight, using thresholds of 20% for stunting and 10% for overweight	1 (33.3)

Note: Micronutrient deficiency includes vitamin A deficiency or iodin deficiency or vitamin D deficiency or any combination of these indicators.
Abbreviation: DBM, double burden of malnutrition

[a]Many articles included multiple DBM definitions. In the table, the total number of occurrences of specific DBM definitions across the 60 included articles is 97; percentages are calculated based on occurrences within each assessment level: household ($n = 62$), individual ($n = 32$) and population ($n = 3$).

reported in two studies (3.2%). Rare definitions included adult overweight paired with child overweight or adult underweight paired with child underweight (one study each, 1.6%).

At the individual level, 32 coded definitions were identified. The most frequently used definitions—each reported in nine studies (28.1%)—were: (a) coexistence of overweight or obesity and a micronutrient deficiency (e.g., vitamin A, iodine or vitamin D); and (b) coexistence of overweight or obesity and anaemia within the same individual. The combination of overweight and stunting among children under five was used in eight studies (25.0%). Less common definitions included micronutrient deficiency combined with at least one cardiometabolic risk factor (two studies, 6.3%), underweight combined with a cardiometabolic risk factor (one study, 3.1%), anaemia combined with a cardiometabolic risk factor (one study, 3.1%) and the coexistence of underweight and anaemia (two studies, 6.3%).

At the population level, three distinct definitions were identified, each used in a single study (33.3%). Although the limited number of studies restricts generalisability, these examples reflect considerable variability in how the double burden of malnutrition is defined at this level. All three definitions were based on the simultaneous high prevalence of undernutrition and overweight/obesity within a population. One study applied thresholds such as stunting >30% and overweight >20%, or wasting >15% and overweight >20%, or underweight in women >20% and overweight >20%. Another defined the double burden of malnutrition as the coexistence of adult overweight and underweight, each exceeding 10% within the same year. The third used a combination of stunting >20% and overweight >10%. This variation in indicator

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selection and threshold values highlights the need for clearer, evidence-based definitions to improve consistency and comparability across future studies.

4 | DISCUSSION

The diverse definitions of the double burden of malnutrition identified in our review point to deeper conceptual and methodological challenges in establishing a unified definition. This variability is driven by the complexity of malnutrition, shifting nutrition patterns in low- and middle-income countries and inconsistent data availability.[1,35,36] Since the double burden of malnutrition typically encompasses undernutrition, micronutrient deficiencies and overweight/obesity, which may coexist at the individual, household or population levels,[1–3] these overlapping conditions make standardisation particularly challenging. Researchers often adapt definitions to fit specific study goals, populations or datasets, leading to inconsistent indicators, cut-offs and measurement approaches.[37–40] The absence of universally accepted criteria from global bodies further widens this gap. While some degree of heterogeneity is methodologically justifiable, it limits comparability across studies and complicates the design of coherent public health responses.[17] This review revealed considerable heterogeneity in how the double burden of malnutrition is conceptualised and defined across studies. At the individual level, definitions often combined overweight with undernutrition within the same individual, though specific indicators and cut-offs varied. At the household level, most studies defined it narrowly as an overweight mother and undernourished child dyad, ignoring other intra-household combinations. At the population level, definitions varied in the indicators and thresholds used, with some deviating from WHO standards.

These variations reflect differences in theoretical frameworks, data availability and cultural contexts, which complicate comparability. Recognising these gaps, we proposed operational definitions that address the observed inconsistencies. Specifically, our definitions expand the household-level conceptualisation beyond the mother–child dyad, align individual- and population-level indicators with WHO benchmarks and ensure measurability using commonly available data sources such as Demographic and Health Surveys and Multiple Indicator Cluster Surveys. This approach bridges the conceptual and methodological gaps identified in the literature.

We found that household-level studies most defined the double burden of malnutrition as the coexistence of an overweight or obese mother and a stunted child.[17,19,20,34,35,41–56] While this definition is practical—largely due to the availability of maternal and child data—it overlooks other important within-household nutritional disparities. Several studies called for broader definitions to include other dyads (e.g., underweight mothers with overweight children, or intergenerational combinations involving elderly members).[57–74] Building on these insights, our proposed household-level definition encompasses a wider range of within-household nutritional imbalances, making it more inclusive and context-sensitive.

At the individual level, we found a wide range of definitions.[37–40,75–87] Most commonly, the double burden of malnutrition is defined as the coexistence of overweight, obesity and anaemia in the same individual.[37–40,49,75–77] Some studies also examine combinations involving overweight or obesity with micronutrient deficiencies or stunting.[77–83] A few have extended the definition further to include cardiometabolic risk factors such as diabetes and hypertension.[76,84] Although these risk factors are important for understanding overall health, they reflect the consequences or risks of chronic diseases,[88] rather than the core nutritional imbalances central to the the double burden of malnutrition concept. To preserve conceptual clarity, it is important to distinguish it from the broader double burden of disease. In line with the previous literature, we argue that the double burden of malnutrition should primarily focus on the coexistence of undernutrition and overnutrition,[1–5] particularly in nutritional terms, rather than encompassing broader health risks. Including cardiometabolic risk factors may mix up nutrition problems with broader health issues that require different policy solutions. However, we acknowledge that the topic remains an area of ongoing debate, and future research may wish to explore hybrid definitions, especially in ageing or urban populations where such overlaps are more prevalent.[89,90]

At the population level, definitions often vary due to the use of different prevalence thresholds for undernutrition and overweight or obesity. For instance, one study defines the double burden of malnutrition based on a stunting prevalence of 20% and an overweight prevalence of 10%,[87] while another uses thresholds such as 10% or more for both adult underweight and overweight in a year.[91] These inconsistencies in threshold selection lead to varying estimates prevalence, making cross-country comparisons and trend analyses difficult. As a result, monitoring global progress and evaluating policy effectiveness become challenging. Previous research has highlighted that the absence of standardised thresholds can result in underestimating or overestimating the burden of the double burden of malnutrition,[92] potentially misguiding resource allocation and public health responses. In light of these issues, one study recommended establishing globally consistent criteria based on

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empirical evidence of associated health risks.[92] Our proposed threshold values aim to reflect this balance between empirical relevance and feasibility, but we also acknowledge the need for future validation in diverse country settings.

In our review, most studies relied on anthropometric indicators—such as stunting, wasting, underweight and overweight—to define and measure the double burden of malnutrition. While these indicators are widely used and offer useful insights, researchers always need to take special care so that the choice aligns with the specific aims of a study.[17] For instance, studies focused on maternal and child health commonly use the combination of maternal BMI and child stunting,[35,45] whereas research on adult population may require measures such as anaemia status and thinness or overweight.[38,70] This variation highlights that definitions and the selection of indicators should be informed by the research context and clearly aligned with study objectives.[17,93] Choosing indicators that match the population, setting and purpose of the study enhances the accuracy assessment and ensures that the resulting findings are more relevant and effective in addressing both the prevalence and underlying causes of the double burden of malnutrition in different settings. On the other hand, misalignment between indicators and study objectives can lead to inaccurate assessments and misleading conclusions. For example, while BMI is a widely used measure, it does not reflect body fat distribution and can underestimate obesity-related health risks in certain demographic groups.[94]

While our review highlights the importance of consistent definitions, it is equally important to recognise that its manifestation and measurement are shaped by environmental and contextual factors. Socioeconomic conditions, urbanisation, food systems, healthcare access and cultural practices all influence how different forms of malnutrition coexist.[95–99] For instance, rapid urbanisation often leads to greater consumption of energy-dense, nutrient-poor foods and sedentary lifestyles, contributing to overweight and obesity.[95–97] In contrast, rural areas may continue to struggle with food insecurity and undernutrition.[98,99] Therefore, adopting a definition that is grounded in its core concept but adapted to the study's specific objectives can enhance the relevance of research findings and increase the effectiveness of existing policies across diverse settings.

Given the existing challenges in defining the double burden of malnutrition using consistent nutrition indicators, we propose operational definitions at the individual, household and population levels. These definitions are derived from our synthesis of how it has been conceptualised across the included studies, and they are informed by both empirical patterns in the literature and international guidance to ensure consistency with global public health standards. Importantly, these definitions are designed to be both conceptually robust and practically measurable. Specifically, they can be operationalised using widely available data sources such as Demographic and Health Surveys, Multiple Indicator Cluster Surveys and other routine surveillance systems that collect anthropometric and micronutrient data at the individual and household levels. This approach bridges conceptual and methodological gaps and improves comparability of findings across contexts.

The specific operational definitions and corresponding cut-off points for each nutrition indicator are described below and further explained in Table 3, along with the justification for each selected threshold. Researchers can use these definitions based on the aim of the research. Proposed definitions at different levels are:

Household level: At the household level, the double burden of malnutrition occurs when there is a coexistence of contrasting forms of malnutrition within the same household. This can manifest as an adult member being overweight or obese while a child is undernourished, or an adult member being underweight while a child is overnourished, or when two household members—adults or children—experience opposite forms of malnutrition, with one being overweight and the other undernourished.

Individual level: At the individual level, the double burden of malnutrition is defined as the simultaneous presence of overweight or obesity alongside stunting, anaemia or other micronutrient deficiencies in the same individual, occurring at the same time during a given developmental stage (e.g., childhood, adolescence or adulthood).

Population level: At the population level, the double burden of malnutrition refers to the coexistence of a high prevalence of undernutrition and overweight or obesity within the same population. It is identified when the prevalence of overweight or obesity in children or adults exceeds 10%, alongside a stunting prevalence of over 20% or a wasting prevalence of over 10% or a underweight prevalence of over 10%.

This study has several advantages. By systematically examining definitions and indicators across individual, household and population levels, this study provides a comprehensive framework that supports more targeted and effective interventions. Our rigorous methodology, which includes well-defined inclusion and exclusion criteria as well as independent screening by multiple reviewers, enhances the reliability of our analysis and minimises selection bias. Additionally, all data extraction was cross-checked by a second reviewer to ensure consistency and accuracy. However, this study also has limitations. We did not register a protocol or conduct formal risk-of-bias assessments. Excluding grey literature from the systematic search may have omitted relevant evidence,

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TABLE 3 Cut-off points for measuring under and overnutrition with their rationale.

Level of measurement	Category	Cut-off points	Reason for considering the cut-off[a]
Household and Individual level DBM	Anthropometric measurements		
	Undernutrition		
	Stunting	• HAZ <−2 SD	Global standard cut-off proposed by WHO[100]
	Wasting	• WHZ <−2 SD	
	Underweight	• WAZ <−2 SD • BAZ <− 2 SD	
	Underweight for adult	• BMI <18.5 kg/m^2	
	Overnutrition		
	Overweight for adults	• BMI >25 kg/m^2	
	Overweight for under five children	• WHZ >+2 SD • BAZ >+2 SD	
	Overweight for adults (Asian population)	• BMI >23 kg/m^2	Due to the increased risk of cardiovascular disease and diabetes at lower BMI levels among Asians compared to non-Asians, the WHO recommended in 2004 using a modified threshold of 23.0 kg/m^2 to define overweight for Asians instead of 25.0 kg/m^2[101]
	Biochemical measurements		
	Anaemia	• Haemoglobin concentrations <12.0 g/dL (female) • Haemoglobin concentrations <13.0 g/dL (Male)	Worldwide accepted cut-off proposed by WHO.[102]
	Vitamin A deficiency	• Serum retinol levels, with a cut-off of <10 μg/dL	Worldwide accepted cut-off proposed by WHO.[103]
	Iodine insufficiency	• A urinary iodine excretion (UIE) of <50 μg/dL indicate iodine insufficiency	Previous studies used this cut-off.[104]
	Vitamin D deficiency	• Based on the guidelines of the American Society of Endocrinology, vitamin D deficiency can be characterised by Serum 25-hydroxyvitamin D [25(OH)D] concentration levels below 20 ng/mL.	Previous studies used this cut-off.[105]

(Continues)

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TABLE 3 (Continued)

Level of measurement	Category	Cut-off points	Reason for considering the cut-off[a]
Population level DBM	Population level	• For adults: prevalence of both over and undernutrition is greater than 10% • For children under five: Stunting prevalence >20%; Wasting prevalence >10%; Overweight prevalence >10%	For adult: A 10% prevalence was selected as a threshold for public health concern, as WHO and previous studies in LMICs indicate that adult underweight (BMI <18.5 kg/m^2) or overweight at this level signals poor nutrition and warrants public health attention.[92] For children under 5 years of age, a national prevalence of stunting above 20% or wasting above 10% and a prevalence of overweight above 10% has been suggested as indicating public health concerns.[106]

Abbreviations: BAZ, body-mass-index-for-age Z scores; BMI, body-mass-index; DBM, double burden of malnutrition; HAZ, height for age Z score; LMIC, low- and middle-income countries; SD, standard deviation; WHZ, weight for height Z score.

[a]The cut-off points summarised in the table were selected based on established global standards and widely accepted benchmarks, primarily drawing from World Health Organization (WHO) guidelines and commonly cited thresholds in nutrition literature. While some referenced reports and studies were not part of the primary pool of articles included in this review, they were incorporated to provide authoritative and practical guidance for defining malnutrition indicators relevant to DBM.

although authoritative grey literature (e.g., WHO guidelines) was cited to justify our proposed thresholds. The heterogeneity of study designs (e.g., cross-sectional vs. longitudinal) and our focus on explicit definitions may have excluded studies reflecting real-world diversity.

In our research, we propose practical definitions of the double burden of malnutrition at the household, individual and population levels that are more feasible for measurement. These proposed definitions may inform researchers and policymakers in the development of more effective strategies to address its rising prevalence. We also emphasise that clear and specific definitions are critical for designing robust research methodologies and formulating effective policy initiatives. Importantly, using consistent definitions can help incorporate the double burden of malnutrition indicators more effectively into national health surveillance systems and global monitoring frameworks, such as the Sustainable Development Goals and the WHO Global Nutrition Targets. Moreover, by carefully selecting indicators that align with the specific objectives of the research—whether for prevalence estimation, trend analysis or intervention evaluation—we can ensure those findings are both relevant and impactful.

AUTHOR CONTRIBUTIONS

AT and HS conceptualised and designed the study. AT and MAS conducted the literature search, while HS resolved any discrepancies in the selected articles. AT led the data analysis and interpretation of the results. AT drafted the manuscript, with HS, MK and DG supervising the analysis output. HS, MK, MAS and DG critically revised the manuscript for intellectual content. All authors reviewed and edited subsequent drafts, read and approved the final version and contributed to the decision to submit for publication.

CONFLICT OF INTEREST STATEMENT

No potential competing interest was reported by the author(s).

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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Research

Prevalence and trends of double burden of malnutrition at household-level in South and Southeast Asia

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Abstract

Background The double burden of malnutrition (DBM), which involves both undernutrition and overweight/obesity, has become a significant global health concern. Significant research gaps exist in understanding the prevalence and trends of DBM among mother–child pairs in South and Southeast Asia, as existing studies frequently concentrate on single countries or specific populations. Therefore, the objective of this study is to estimate the prevalence and trends of DBM by utilising the most updated nationally representative data from four selected countries in these regions.

Methods We analyzed cross-sectional, nationally representative secondary data from the Demographic and Health Survey, conducted from 2004 to 2022. The survey included households with at least one mother–child pair for Bangladesh, Cambodia, Nepal, and Timor-Leste. Using survey weights, we calculated the weighted prevalence of household level DBM, underweight children (< 5 years old), and overweight mothers ($BMI \geq 23 kg/m^2$) for each country. Using chi-square tests, we investigated associations between DBM prevalence and factors such as wealth index, place of residence, and child sex. We assessed socioeconomic disparities using odds ratios obtained from a multivariable logistic regression model.

Results The prevalence of DBM at household level in Bangladesh rose from 4 in 2004 to 13.8% in 2018, with underweight children decreasing from 47.6 to 21.5% and overweight or obese mothers increasing from 11.6 to 42.3%. We observed similar trends in Cambodia (DBM prevalence: 7.4% in 2005 to 14.3% in 2022; underweight child: 28.3% in 2005 to 16.5% in 2022; overweight/obese mother: 18.6% in 2005 to 48.8% in 2022), Nepal (DBM prevalence: 5.6% in 2006 to 12.3% in 2022; underweight child: 38.6% in 2006 to 19% in 2022; overweight/obese mother: 14.4% in 2006 to 48.7% in 2022), and Timor-Leste (DBM prevalence: 9.4% in 2009 to 15.8% in 2016; underweight child: 44.1% in 2009 to 40.8% in 2016). In all four nations, households with a higher socioeconomic level (richest) consistently had a higher likelihood of developing DBM (odds ratio > 1) compared to households with a lower socioeconomic status (poorest). Furthermore, mother–child pairs living in rural regions had a lower likelihood of developing DBM compared to urban settings.

Conclusion DBM is on the rise in households across South and South-east Asian nations, particularly in urban areas and among richest households. Despite several improvements in reducing underweight prevalence, persistent undernutrition remains a significant challenge in the region. Simultaneously, the rising prevalence of obesity is a growing concern. Future research should prioritise identifying country-specific risk factors of DBM and understanding factors contributing to the high prevalence of maternal overweight.

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Keywords Undernutrition · Overweight · Double burden of malnutrition · South and Southeast Asia · Prevalence · Trends

1 Introduction

The double burden of malnutrition (DBM) is the simultaneous presence of undernutrition (underweight, wasting, stunting, and micronutrient deficiencies) along with overnutrition (obesity or overweight) at various population levels, such as country, community, or household, as well as within individuals over their lifetimes [1]. DBM is frequently observed in households where a mother is overweight or obese and her child (< 5 years old) suffers from undernutrition [1]. The primary cause of this dual burden is the nutrition transition [2], which is associated with major shifts in the diet towards more refined carbohydrates, added sugars, edible oils, and foods derived from animals, as well as a decrease in physical activity, contributing to overweight or obesity in adults [3]. This major shift in dietary behaviour resulted in a transition from being mostly undernourished to having an increased risk of being overweight or obese [4]. Moreover, a combination of inadequate infant feeding practices, poor sanitation and hygiene, and limited access to nutritious foods may lead to an increased prevalence of undernutrition among children [5, 6].

The prevalence of DBM on a global scale is increasing. A recent study using data from 126 countries between 1999 and 2017 highlighted that the prevalence of total household-level DBM ranges between 3 and 35% [2]. During this period, the most common DBM pairs were stunted child-overweight mother pairs (1–24%), followed by overweight mother-wasted child pairs (0.3–10%), and underweight mother-overweight child pairs (0.1–4%) [2]. DBM is also a concern in several South and South-east Asian countries. In 2020, a systematic review and meta-analysis found that 28% of the South Asian population was underweight and 17% was overweight, while in South-east Asia, the rates were 20% for both conditions [15]. Another study across eight South and South-east Asian countries found a pooled prevalence of 10.0% for overweight mother-stunted child pairs, 7.0% for overweight mother-wasted child pairs, and 7.0% for overweight mother-underweight child pairs [7]. Additionally, this research found a 12.0% prevalence of DBM coexistence (overweight mothers and any kind of child undernutrition) at the household level [7]. Over time, India has experienced a rising prevalence of DBM at the household level, which will affect one out of every four families in 2021 [16]. In Nepal, one prior study showed that DBM impacted 6.6% of mother–child pairings [17]. In Cambodia, approximately one-fourth of stunted children under the age of five have an overweight or obese mother [18].

Household-level DBM has significant health and economic consequences. In terms of health, households with DBM experience immediate health impacts, such as stunted growth in children due to undernutrition, along with long-term obesity-related conditions in adults, including type 2 diabetes, hypertension, and certain cancers [4, 8]. This dual burden also increases the risk of chronic diseases, as children who experience stunting may become overweight in adulthood [11–13]. Managing these diverse health issues often requires costly medical interventions, which impose a substantial financial burden on families and increase national healthcare costs [4]. The economic impact is further worsened by reduced productivity due to illness, leading to lower household income [4]. Additionally, the cost of managing both undernutrition and obesity within the same household can lead to increased out-of-pocket expenses [14]. This financial strain can push families into deeper poverty, which continues the cycle of poverty and malnutrition. On a larger scale, DBM also hinders a country's economic development by reducing its gross national product [4].

While research on DBM has gained attention globally, significant gaps remain in estimating its prevalence and trends among mother–child pairs in South and South-east Asia. Existing studies on DBM often focus on single-country analyses or specific population groups [19–22], limiting our understanding of the broader regional context. Additionally, most studies in these regions use small-scale samples [47–50] and focus separately on the nutritional status of either the mother or the child, rather than both simultaneously. While some studies have estimated DBM prevalence at the household level within individual countries in South and South-east Asia, few have taken a region-wide perspective and often rely on outdated datasets [7, 23]. Therefore, this study aims to estimate the prevalence and trends of DBM using the most up-to-date nationally representative data from multiple countries in South and South-east Asia.

2 Methods

2.1 Study design and study area

We conducted a multi-country secondary data analysis that focused on four countries in South and Southeast Asia: Bangladesh, Cambodia, Nepal, and Timor-Leste. We chose these countries because they are currently experiencing nutrition transitions involving increased intake of hazardous processed foods, leading to a dual challenge of undernutrition and overnutrition [24–27], which further exacerbates the issue of DBM. These nations also represent diverse socio-economic contexts and different stages of economic development, providing the valuable opportunity to explore how various phases of nutritional transition affect DBM. While many South and Southeast Asian countries are experiencing similar nutritional transitions, we selected these four specifically due to the availability of necessary maternal and child nutrition data, including multiple time-point datasets, which enabled us to analyze trends over time. Some of the other countries in the region were excluded because they did not have adequate or complete access to the data on maternal and child nutrition, which is required to identify DBM at household level.

2.2 Data sources

We extracted necessary information from nationally representative cross-sectional data from the Demographic and Health Surveys (DHS), conducted between 2004 and 2022, for four South and Southeast Asian countries, Bangladesh (2004, 2007, 2011, 2014, 2018), Cambodia (2005, 2010, 2014, 2022), Nepal (2006, 2011, 2016, 2022), and Timor-Leste (2009–10 & 2016). DHS used a two-stage, stratified random sampling method. First, census enumeration areas (EAs) were chosen based on a probability proportional to size approach. Households were then randomly selected from the EA. Data were collected by face-to-face interviews with women aged 15–49 years and their children aged 0–5 years within these selected households. Participants provided voluntary written informed consent before interviews. Ethical approval was granted by both the ICF International institutional review board in Calverton, MD, USA, and individual review boards in each participating country. The DHS dataset is accessible from the DHS programme website, in compliance with a data-sharing policy. Comprehensive descriptions of DHS sampling procedures, questionnaire validation, and data collection methods are available on the DHS website [28].

2.3 Study population

We included households in this research that had a minimum of one mother–child pair. We then considered mother–child pairs from households that had information on both the mother's and her child's nutritional status. This resulted in different samples for each country and year. Samples missing information on child's nutrition status or mother's BMI were excluded. Details on the final sample included for each country and each time point are in Fig. 1.

2.4 Variables

We used several indicators, including height-for-age, weight-for-age, and weight-for-height, to identify the nutritional health of the participants. To determine the nutritional status of children, we applied the 2006 World Health Organisation (WHO) growth standard to calculate anthropometric z-scores. Children were classified into three categories based on these z-scores: stunted (height-for-age z-score < -2 standard deviation), underweight (weight-for-age z-score < -2 standard deviation), and wasted (height-for-height z-score < -2 standard deviation) [29, 30]. We calculated the maternal body mass index (BMI) as the product of $weight/height^2 (kg/m^2)$. We classified each mother into underweight ($BMI < 18.5 kg/m^2$) normal ($BMI : 18.5 - 22.9 kg/m^2$), and overweight/obese ($BMI \geq 23 kg/m^2$) by using Asian-specific BMI cutoffs [7, 31]. To determine household-level DBM, we identified households where the mother was overweight or obese and the child was undernourished, categorised as underweight, stunted, or wasted based on the three indicators mentioned above. Subsequently, we created a composite outcome variable indicating households where an overweight or obese mother coexisted with at least one form of child undernutrition, including being underweight, stunting, or wasting.

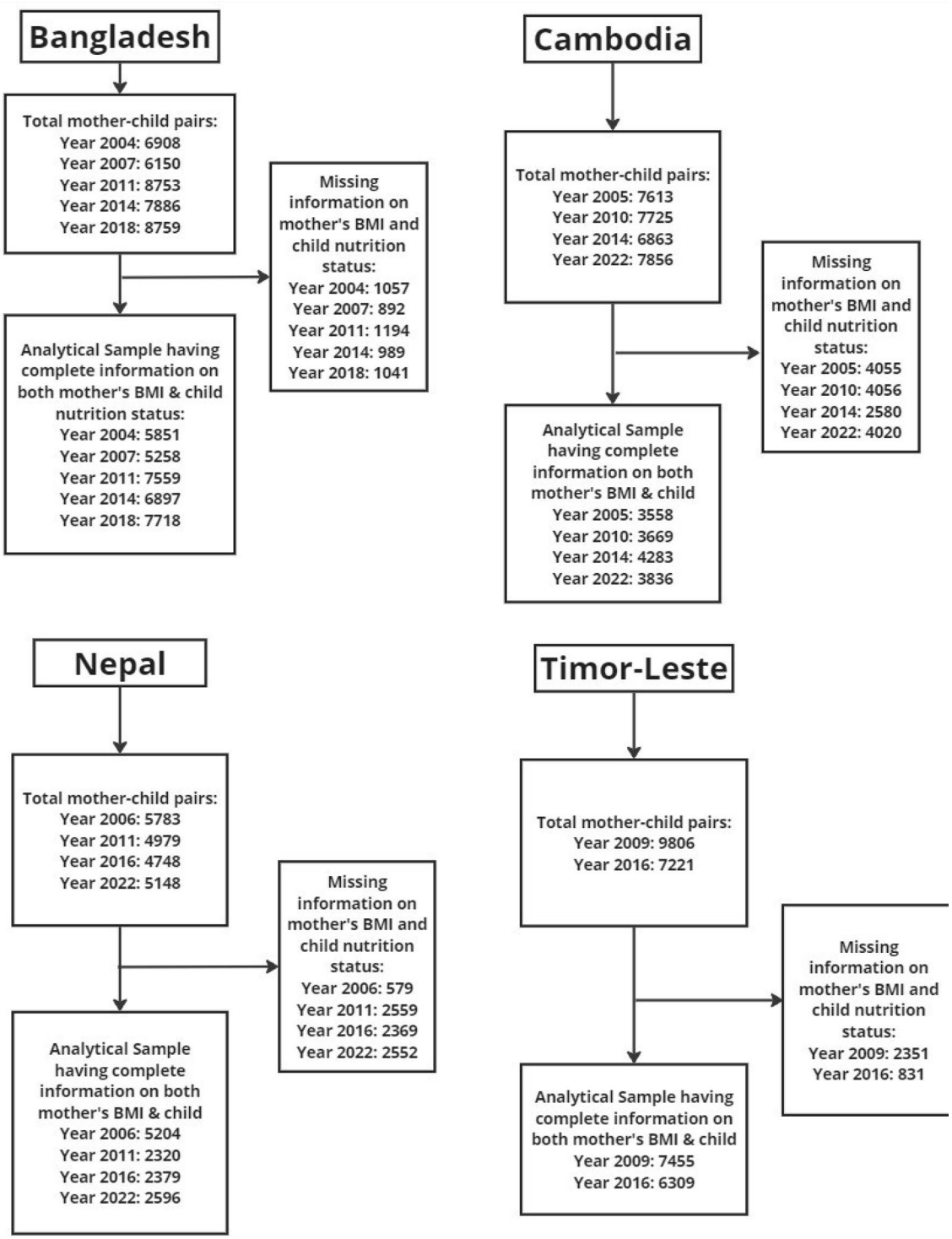

Fig. 1 Flow chart showing sample selection procedure

DBM: In the same household, there is an overweight or obese mother and a stunted, wasted, or underweight child.

We consider three exposure variables, including place of residence (urban or rural), child's sex (male or female), and household wealth index. The DHS utilised principal component analysis (PCA) to calculate the wealth index factor scores, which represent the overall living standard of a household. Based on these scores, we further categorised the wealth index into five quintiles: poorest, poorer, middle, richer, and richest. Initially, the DHS programme

computed a wealth score based on household characteristics via PCA and subsequently grouped households into quintiles based on this score [28].

2.5 Statistical analysis

We computed the weighted prevalence of DBM, underweight children, and overweight mothers for each country and available time points, taking into account the clustered sampling design and survey weights. Then, we performed a descriptive analysis to identify the characteristics of the study population. Using the chi-square test, we examined the significant association between DBM prevalence and various factors like wealth index, place of residence, and child sex. To assess socioeconomic disparities, we used odds ratios from a multivariable logistic regression model that used maximum likelihood estimation to find out how each predictor variable affected the chance of a mother–child pair developing DBM. We calculated odds ratios for extreme categories in the household wealth index (lowest quintile vs. highest quintile).

3 Results

Figure 2 displays the final analytical samples for each country and year, as well as the frequency distribution of background characteristics among mother–child pairs in Bangladesh, Cambodia, Nepal, and Timor-Leste. From 2004 to 2018, the percentage of mother–child pairs residing in urban regions of Bangladesh increased from 30.1% to 34.9%. In Cambodia, this proportion rose from 20.3 in 2005 to 35.2% in 2022. In Nepal, the proportion of urban mother–child pairs ranged from 22.5 in 2006 to 49.5% in 2022. Similarly, this proportion in Timor-Leste ranged from 21.6 in 2009 to 29.2% in 2016. In 2022, Nepal had the highest proportion of mother–child pairs living in the poorest households, with a rate of 33.2%, and Bangladesh had the lowest proportion, around 20% in 2007. On the other hand, the proportion of mother–child pairs living in the richest households was lowest in Nepal (11.3% in 2022) and highest in Cambodia (24% in 2014). Children's sex distribution is relatively equal across countries and time periods.

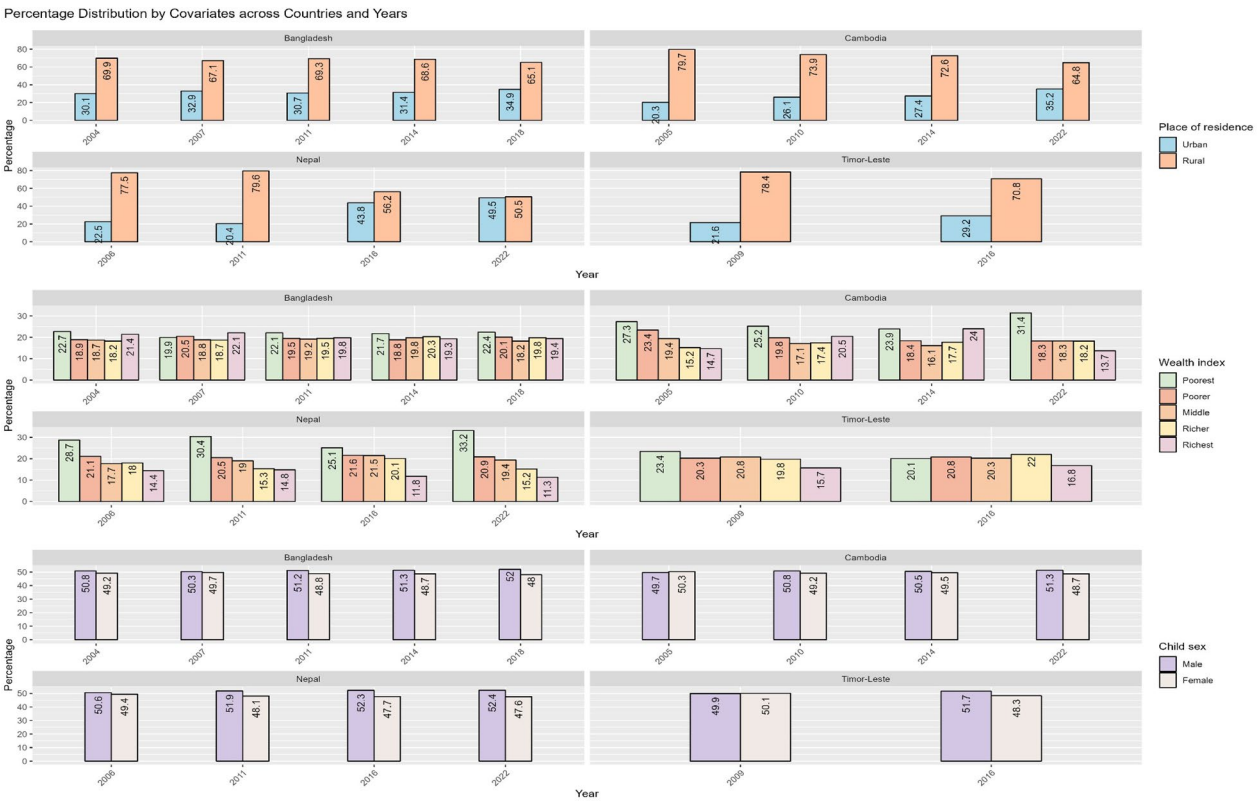

Fig. 2 Frequency distribution of the background characteristics of study participants from Bangladesh, Cambodia, Nepal, and Timor-Leste, displayed across countries and years

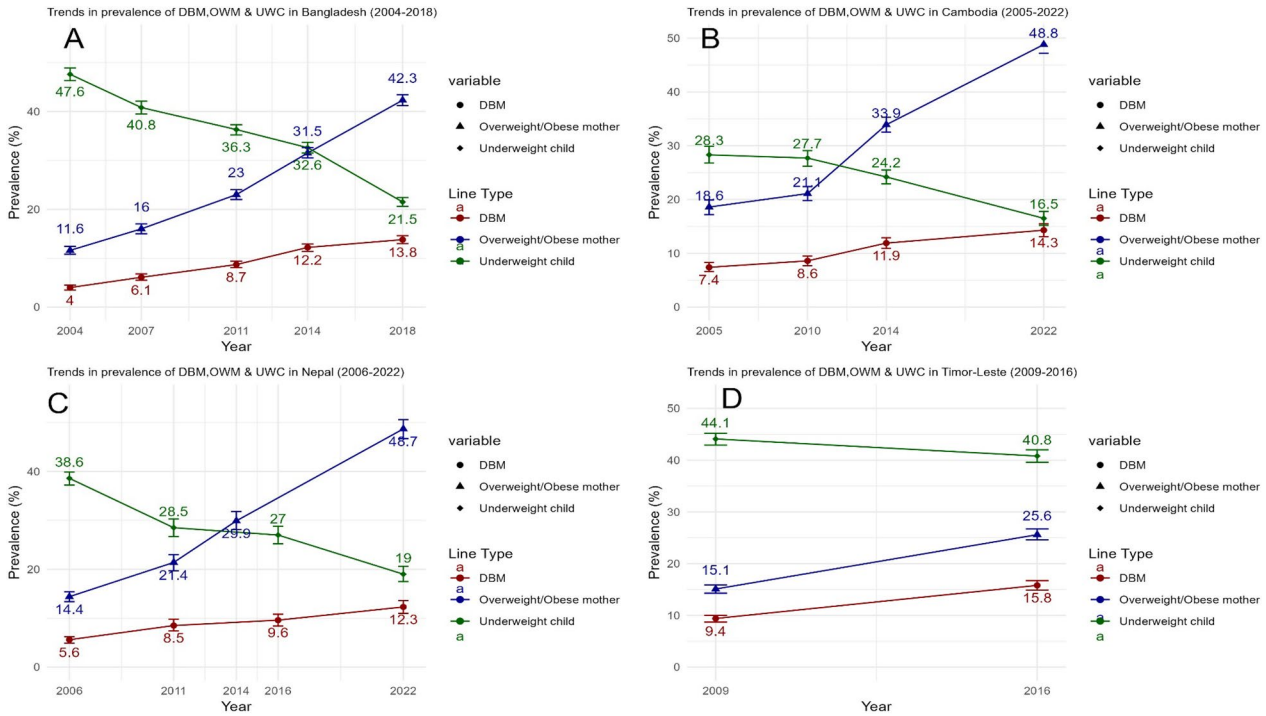

Fig. 3 Changes in the prevalence of household-level double burden of malnutrition (DBM) among mother–child pairs in Bangladesh (**A**), Cambodia (**B**), Nepal (**C**), and Timor-Leste (**D**). The figure illustrates the trends in DBM across these countries over time, highlighting variations in the prevalence rates within each country and providing a comparative view of how the DBM issue has evolved in different contexts. Each subfigure (**A**–**D**) corresponds to a specific country, showing how the prevalence of DBM among mother–child pairs has shifted over the years

Figure 3 depicts changes in DBM prevalence, underweight children, and overweight or obese mothers across different survey years in four countries. In Bangladesh, DBM prevalence has steadily risen from 4 in 2004 to 13.8% in 2018. During the same period, the prevalence of overweight or obese mothers in Bangladesh increased from 11.6 to 42.3%, while the prevalence of underweight children decreased from 47.6 to 21.5%. We observed comparable trends in Cambodia (DBM prevalence: 7.4% in 2005 to 14.3% in 2022; underweight child: 28.3% in 2005 to 16.5% in 2022; overweight/obese mother: 18.6% in 2005 to 48.8% in 2022), Nepal (DBM prevalence: 5.6% in 2006 to 12.3% in 2022; underweight child: 38.6% in 2006 to 19% in 2022; overweight/obese mother: 14.4% in 2006 to 48.7% in 2022), and Timor-Leste (DBM prevalence: 9.4% in 2009 to 15.8% in 2016; underweight child: 44.1% in 2009 to 40.8% in 2016; overweight/obese mother: 15.1% in 2009 to 25.6%). Although DBM is increasing over time for all countries, the overweight mother-stunted child has a higher prevalence than the other two types of DBM combination (overweight mother-wasted child and overweight mother-underweight child), indicating that stunting is more important to drive DBM prevalence than being underweight or wasted (Supplementary Fig. 1).

Table 1 presents the distribution of DBM across various background factors. We found that the latest survey data indicates a higher prevalence of DBM across different categories of each covariate in all the nations examined. In Bangladesh in 2018, we observed a higher prevalence of DBM among mother–child pairs living in urban settings (15.8%) and in richer households (16.4%). We also observed similar patterns in Nepal, where the prevalence of DBM was higher in the richest households (19.4%) and households in urban areas (14.2%) in 2022. Furthermore, in 2022, the prevalence of DBM in Cambodia was higher among urban families (19.4%) and the richest households (16.5%). In Timor-Leste, the richest (20%) and urban households (20%) had higher DBM incidence in 2016. It should be noted that, in Bangladesh and Timor-Leste, household-level DBM was significantly associated with place of residence and wealth index across all years ($p < 0.05$). In 2005, 2010, and 2022, we observed that both the wealth index and the place of residence were statistically significant in Cambodia. On the other hand, in Nepal, wealth index was significantly associated with DBM across all years, whereas place of residence was significant only in 2006 and 2022 ($p < 0.05$).

Figure 4 illustrates the changes in the prevalence of DBM among mother–child pairs in four countries, stratified by wealth index, place of residence, and child sex. In all four nations, households with higher wealth indexes are more likely

Table 1 Prevalence of household level DBM by covariates among mother–child pairs of Bangladesh, Cambodia, Nepal and Timor-Leste

Covariates	Bangladesh					Cambodia				Nepal				Timor-Leste	
	Year: 2004	Year:2007	Year:2011	Year:2014	Year: 2018	Year: 2005	Year:2010	Year:2014	Year:2022	Year:2006	Year:2011	Year:2016	Year:2022	Year:2009	Year: 2016
Place of residence															
Urban	7.7	8.9	12.4	14.8	15.8	10.7	11.1	13.2	19.4	7.1	9.9	10.0	14.2	12.5	20.0
Rural	3.2	5.2	7.6	11.2	11.9	7.1	8.1	11.6	12.1	5.3	7.8	9.6	11.1	8.5	12.8
Wealth index															
Poorest	2.1	2.9	4.4	8.3	11.1	6.0	6.7	11.2	11.0	5.5	6.4	10.9	11.2	5.7	9.0
Poorer	2.1	3.6	8.1	12.0	10.9	5.9	7.9	12.5	13.7	3.9	5.9	8.0	10.0	7.9	16.6
Middle	3.8	5.0	7.6	13.3	14.5	7.8	9.7	12.4	15.6	4.8	7.0	8.2	13.1	8.8	16.0
Richer	5.6	9.0	12.0	13.6	16.4	10.9	9.7	10.7	14.2	6.0	10.4	10.7	13.6	10.9	18.5
Richest	8.9	11.5	13.9	14.7	13.9	11.1	10.6	14.2	16.5	9.3	14.6	12.5	19.4	15.6	20.0
Child sex															
Male	3.9	6.9	9.0	12.4	13.5	7.4	9.1	12.0	15.4	5.5	7.6	9.7	12.4	10.0	15.5
Female	5.2	6.0	9.2	12.2	13.1	8.3	8.4	12.1	13.9	5.9	9.0	10.0	12.9	8.8	14.2

Each cell in the table denotes the prevalence of DBM among mother–child pairs across different covariates in Bangladesh, Cambodia, Nepal, and Timor-Leste. In both Bangladesh and Timor-Leste, DBM exhibits statistically significant associations with place of residence and wealth index throughout all observed years ($p < 0.05$). In Cambodia, these associations were significant in the years 2005, 2010, and 2022 ($p < 0.05$). In Nepal, the wealth index demonstrates a significant association with DBM across all years, while place of residence shows significance only in 2006 and 2022 ($p < 0.05$). Also, note that the p values were derived from chi-square tests

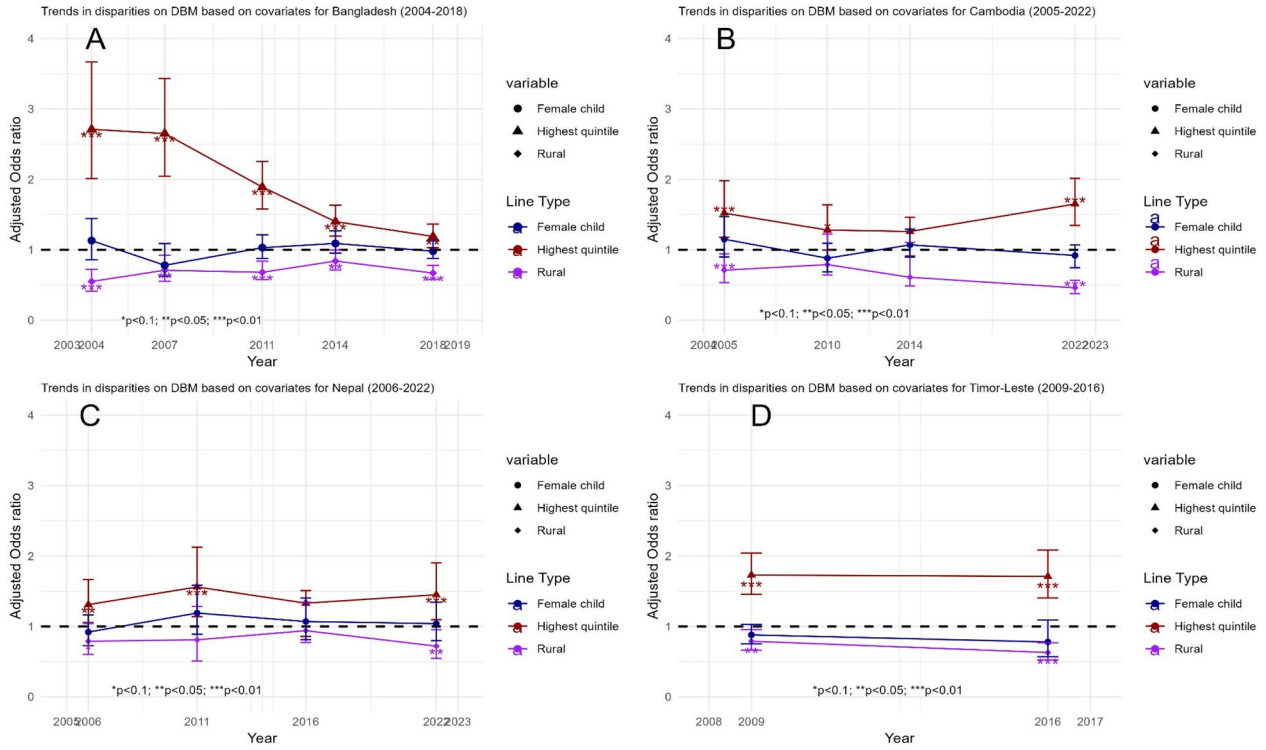

Fig. 4 Trends in disparities for household level DBM among mother–child pairs in Bangladesh (**A**), Cambodia (**B**), Nepal (**C**) & Timor-Leste (**D**) based on wealth index, place of residence, and child sex. Odds ratio was estimated by mutually adjusting for each other, considering wealth index: lowest quintile (Ref) & highest quintile; place of residence: urban (Ref) & rural, and child sex: male (Ref) & female. "Ref" is the reference category for the odds ratio

to experience DBM (odds ratio > 1) than those with lower wealth indexes. In 2004, for example, households in the upper income quintile in Bangladesh were 2.71 times more likely to have DBM than those in the lowest quintile (95% CI 2.01, 3.66). By 2018, the risk had declined but remained considerable, with families in the top quintile 1.19 times more likely to acquire DBM (95% CI 1.03, 1.36). From the beginning to the most recent survey years, we observed similar trends in Cambodia, Nepal, and Timor-Leste, where higher income quintiles were associated with an increased risk of DBM. This indicates the presence of socioeconomic disparity in each of these countries. Figure 3 also highlights that mother–child pairs in rural households have a lower likelihood of experiencing DBM compared to those in urban areas. [Bangladesh (2004): OR = 0.55 (CI 0.41, 0.72); Bangladesh (2018): OR = 0.67 (CI 0.58, 0.77); Cambodia (2005): OR = 0.71 (CI 0.53, 0.94); Cambodia (2022): OR = 0.46 (CI 0.37, 0.56); Nepal (2006): OR = 0.79 (CI 0.60, 1.04); Nepal (2022): OR = 0.72 (CI 0.54, 0.95); Timor-Leste (2009): OR = 0.79 (CI 0.71, 0.98); Timor-Leste (2016): OR = 0.63 (CI 0.53, 0.76)]. This relation indicates that the disparities exist between rural and urban regions in each country. However, we observed no notable patterns in relation to child sex across the nations.

4 Discussion

We performed a multi-country analysis to estimate the prevalence and trends of household-level DBM by using data from Bangladesh, Cambodia, Nepal, and Timor-Leste. Results indicate that the prevalence of DBM increased in all countries: from 4 to 13.8% in Bangladesh (2004–2018), 7.4 to 14.3% in Cambodia (2005–2022), 5.6 to 12.3% in Nepal (2006–2022), and 9.4 to 15.8% in Timor-Leste (2009–2016). Although the prevalence of underweight children decreased, the proportion of overweight or obese mothers increased substantially. DBM was notably higher in urban areas and rich households across all countries. We found significant associations between DBM, place of residence, and wealth index. Rich households continuously had a higher likelihood of DBM, indicating that urban–rural disparities were prominent, with urban areas showing higher DBM prevalence.

We found similar trends in all four countries: the number of DBM cases went up, the number of underweight children went down, and the number of overweight or obese mothers went up. This suggests that the increase in overweight mothers may be a factor in the rise in DBM cases, which is consistent with other studies [7, 32, 34]. Several societies are shifting towards diets that are high in processed foods, unhealthy fats, sugars, and refined carbohydrates, which are contributing to rising rates of overweight and obesity as well as decreased physical activity [2, 3]. Despite the decreasing prevalence of underweight children, the persistence of undernutrition remains a critical issue, exacerbated by factors such as limited access to nutritious foods, inadequate feeding practices, and susceptibility to infectious diseases [35]. Furthermore, in many societies, there exists a societal norm that compels women to prioritise their own dietary requirements, which may result in excessive eating and contribute to the growing prevalence of overweight and obesity [36]. Similarly, cultural restrictions that limit children's access to certain nutrients can exacerbate malnutrition issues. However, more research is necessary to know the actual reasons for these trends and the increasing prevalence of DBM [32].

Our study revealed that mother–child pairs residing in richest households have a higher risk of DBM in comparison to those residing in poorest households. One possible cause of these disparities is mothers' dietary practices in wealthy households. Mothers from wealthy households may be more likely to choose meals that are insufficient in essential nutrients and rich in fat, therefore increasing their potential to develop overweight or obesity [38–42]. While existing literature extensively suggests that children from poorer households are more likely to have underweight conditions compared to their wealthier counterparts [39–44], understanding why undernutrition persists among children in rich households requires further investigation.

We found significant differences between urban and rural regions in each of the four countries. Compared to households in urban areas, those in rural areas usually have a lower DBM burden. A variety of factors could potentially cause this phenomenon. First and foremost, we anticipate that the physically demanding nature of jobs like farming will encourage rural residents to engage in more physical activity [43]. Consequently, this might help prevent weight gain and lower the prevalence of metabolic disorders among pregnant women living in rural areas. Moreover, studies from Bangladesh [45] and China [44] indicate that urban women are more likely than rural women to be overweight or obese. As a result, urban families are more vulnerable to metabolic diseases due to an increased incidence of obesity [44]. Nevertheless, while urban children generally have a lower likelihood of experiencing undernutrition in comparison to their rural counterparts, this circumstance does not apply equally to all urban children, especially those who struggle with poverty. Challenges such as substandard housing, restricted access to services, susceptibility to environmental hazards, and inadequate and inconsistent incomes in densely populated low-income nations exacerbate the issue of food insecurity and malnutrition [46].

4.1 Strengths and limitation of the study

This research has several noteworthy strengths. The analysis is based on survey datasets that are nationally representative and have substantial sample sizes. This guarantees that the findings are statistically sound, accurate, and reliable. Furthermore, the DHS included all administrative divisions for the relevant nation, therefore ensuring the generalizability of these results to the whole country. Nevertheless, there are limitations. Given its cross-sectional design, the survey is unable to evaluate long-term changes in nutritional status. Moreover, relying only on BMI as a parameter for evaluating the nutritional condition of mothers is less reliable in comparison to more precise indicators such as waist-hip ratio and skinfold thickness.

5 Conclusion

In conclusion, the prevalence of DBM is increasing at the household level in selected South and Southeast Asian countries, especially in urban areas and rich households. Despite the reduction in underweight prevalence, the region continues to grapple with a significant undernutrition issue. Simultaneously, the rising prevalence of obesity presents a challenge. Further research is necessary to provide pragmatic remedies and preventive measures to address this complex problem. Future research should prioritize identifying country-specific risk factors that lead to a high prevalence of DBM and factors that contribute to a higher prevalence of maternal overweight. Furthermore, it is essential to explore risk factors specific to urban and rural locations for DBM, since this study revealed differences between these settings.

6 Research in context

6.1 Evidence before this study

We searched PubMed, Scopus, and Google Scholar to identify relevant studies of double burden of malnutrition using the keywords "double burden of malnutrition," "dual burden of malnutrition," "nutrition transition," "prevalence of double burden of malnutrition," "double burden households," "overweight mothers," "undernourished children," "South Asia," "South-east sia," " Bangladesh," " Cambodia," " Nepal," and Timor-Leste." While research on DBM has increased, significant gaps remain in estimating its prevalence and trends in South and South-east Asia. Most studies in these areas only examine the nutritional status of either the mother or the child, with few taking a comprehensive regional perspective.

6.2 Added value of this study

This study provides a comprehensive cross-country analysis of household-level DBM prevalence and trends in Bangladesh, Cambodia, Nepal, and Timor-Leste, revealing consistent increases in DBM across all four countries. Our findings highlight a rising prevalence of overweight or obese mothers alongside a declining prevalence of underweight children, suggesting that maternal overweight is a significant factor in DBM trends. This study also identified that there exist socioeconomic and urban-rural disparities of DBM prevalence among these countries.

6.3 Implications of all the available evidence

Increased consumption of ultra-processed foods and decreased physical activity lead to an increase in overweight mothers, while inadequate infant feeding and a lack of healthy foods at home may be the causes of persistent child undernutrition in households. The continuation of undernourished children and the increasing number of overweight mothers in the same households further increase the prevalence of DBM at the household level in the studied countries. The findings of this study indicate that wealthier households experience a higher DBM burden, possibly due to high-calorie diets and sedentary lifestyles, although the reasons for child undernutrition in rich families are unclear. Urban households experience greater DBM challenges than rural ones, possibly due to less physically demanding lifestyles and greater access to processed foods. Further research is critical for developing effective strategies for addressing DBM and exploring its complex socioeconomic determinants.

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Author contributions A.T. and H.S. conceptualized and designed the study. A.T. led the model development, natural history calibration, and was responsible for the collation and integration of data into the model, performed model analysis. A.T. drafted the manuscript. H.S., M.K. and D.G. supervised the analysis output. All authors reviewed and edited subsequent drafts. All authors read and approved the final report and made the decision to submit for publication.

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Data availability Data is freely available in the public domain with the following link: https://dhsprogram.com/data/dataset_admin/login_main.cfm?CFID=300458265&CFTOKEN=26bd09600ba5696-DE5E82D0-A6C1-5C66-C216C2CD9B9E82D9.

Declarations

Ethics approval and consent to participate This study used secondary data collected by MEASURE DHS. All procedures performed in this study involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. As the data is freely available on the website, ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements.

Informed consent Informed Consent was obtained from all the participants involved in the study.

Competing interests The authors declare no competing interests.

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Nutritional epidemiology and public health

Determinants of Household-Level Double Burden of Malnutrition in South and Southeast Asia: A Systematic Review and Meta-analysis

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A B S T R A C T

Background: The double burden of malnutrition (DBM), defined as the coexistence of undernutrition and overnutrition within the same household, is an increasing public health concern in South and Southeast Asia, yet evidence on its household-level determinants remains fragmented.

Objectives: This systematic review and meta-analysis aimed to synthesize evidence on factors associated with household-level DBM in South and Southeast Asia.

Methods: PubMed, Scopus, and Web of Science were searched for observational studies published between January 2000 and September 2025. Two reviewers (AT & MAS) independently screened studies, extracted data, and assessed quality using the Newcastle–Ottawa Scale adapted for cross-sectional studies. Random-effects meta-analyses were conducted for factors reported in ≥5 studies, and pooled odds ratios (ORs) with 95% confidence intervals (CIs) were estimated.

Results: Thirty studies were included, of which 26 were eligible for meta-analysis. Urban residence (OR = 1.38, 95% CI: 1.20, 1.59), higher household wealth (OR = 1.55, 95% CI: 1.31, 1.83), older maternal age (OR = 2.22, 95% CI: 1.97, 2.50), maternal short stature (OR = 1.90, 95% CI: 1.69, 2.13), older child age (OR = 1.79, 95% CI: 1.44, 2.23), and cesarean delivery (OR = 1.76, 95% CI: 1.20, 2.57) were associated with higher likelihood of DBM. Higher maternal education and breastfeeding were found to be protective factors.

Conclusions: Effective interventions should adopt integrated, life-course approaches that simultaneously address undernutrition and overnutrition across critical stages, particularly during adolescence, pregnancy, and early childhood. Policies should prioritize maternal education, breastfeeding promotion, and adolescent nutrition to break intergenerational cycles of malnutrition.

This study was registered at PROSPERO as CRD420251155844.

Keywords: double burden of malnutrition, household, systematic review, meta-analysis, South Asia, Southeast Asia

Introduction

The double burden of malnutrition (DBM) is a growing public health concern in South and Southeast Asia, where undernutrition, such as stunting, wasting, and micronutrient deficiencies, occurs alongside rising rates of overweight, obesity, and diet-related noncommunicable diseases [1,2]. This paradoxical coexistence has emerged as countries undergo rapid demographic and socioeconomic transitions that reshape dietary patterns and lifestyles [3]. As a result, many households face both forms of malnutrition simultaneously. Limited household resources, unequal food distribution, and poor diet quality combine with reduced physical activity to create conditions where children remain undernourished, whereas adults gain excess weight [4,5].

Early-life malnutrition also carries profound consequences for child development. Stunting during the first 1000 d of life

Abbreviations: ANC, antenatal care; CI, confidence interval; DBM, double burden of malnutrition; DHS, demographic and health survey; GRADE, Grading of Recommendations, Assessment, Development and Evaluations; NOS-xs, Newcastle–Ottawa Scale adapted for cross-sectional studies; OR, odds ratio; OWM + SC, overweight mother with stunted child; OWM + SC/WS/UW, overweight mother with stunted, wasted, or underweight child; OWM + UWC, overweight mother with underweight child; OWM + WC, overweight mother with wasted child; PICOS, population, intervention/exposure, comparator, outcomes, study design.

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impairs early brain development, reduces cognitive performance, and is associated with lower educational attainment and diminished economic productivity in adulthood [6–8]. It is estimated that >200 million children aged <5 y in low- and middle-income countries are failing to reach their developmental potential as a direct consequence of undernutrition, poverty, and inadequate caregiving environments [6]. The consequences extend beyond immediate health concerns, as stunted children often become short-statured mothers who are more likely to deliver low-birth-weight infants with increased risk of growth faltering, thereby transmitting malnutrition risk to the next generation and threatening long-term development progress across the region [4].

The magnitude of this problem is particularly alarming in South and Southeast Asia, which together account for ~54% of the global burden of child stunting, while simultaneously experiencing the fastest rates of increase in adult overweight and obesity [9]. In Bangladesh, Nepal, and India, DBM affects between 8% and 14% of households, where undernourished children and mothers with overweight or obesity coexist under the same roof [5,10]. In various Indian districts, school-aged children experience high rates of both undernutrition and overnutrition at the population level, with notable gender disparities in the distribution of these conditions [11]. These 2 regions share critical characteristics that make them ideal for comparative analysis: they are home to over one-third of the world's population, have experienced rapid but uneven economic growth, are undergoing accelerated nutrition transition, yet continue to face persistent poverty and food insecurity [3, 12–14]. These epidemiological trends are systematic manifestations of broader societal transformations. Globalization and rapid urbanization have fundamentally altered food environments throughout the region, increasing availability and affordability of processed foods laden with fats, sugars, and refined carbohydrates while simultaneously transforming occupational structures toward more sedentary work [3,13]. Yet amid these changes, poverty and food insecurity persist, continuing to restrict access to the diverse, nutrient-dense foods necessary for optimal child growth and development [14]. The consequence is a widening nutritional inequality where economic progress and urbanization do not automatically translate into improved health outcomes for all household members.

These epidemiological patterns are shaped by profound socioeconomic inequities in the distribution of undernutrition and overnutrition. An analysis of 80 countries shows that stunting among children aged <5 y is inversely associated with family wealth, with the poorest families bearing the greatest burden, particularly in South Asia [15]. In contrast, overweight children are more common among wealthier households in low- and middle-income countries, although obesity rates are increasing more rapidly among socioeconomically vulnerable populations [15]. This creates a double inequity at the household level, where poorer families face persistent child undernutrition alongside rising adult overweight, whereas wealthier households experience growing overnutrition even as pockets of child undernutrition persist [13]. The intergenerational transmission of stunting and obesity is embedded in these socioeconomic structures, including food insecurity, gender inequity, and limited access to healthcare and education, indicating that nutrition-specific interventions alone cannot break these cycles [15,16].

These population-level patterns manifest clearly at the household level, which acts as the fundamental unit for understanding and addressing DBM. Within households, the mother–child dyad represents an important relationship, as maternal nutritional status, knowledge, and behaviors exert profound influences on children's growth trajectories [17,18]. However, complex intrahousehold dynamics, shaped by economic resources, structures, educational attainment, and cultural norms, determine how food and care are distributed among family members [19,20]. Among these factors, maternal education stands out as an important determinant, influencing nutrition knowledge, child feeding practices, dietary choices, and healthcare-seeking behaviors [13,21]. Mothers with higher education demonstrate greater capacity to navigate complex and changing food environments, making informed decisions that help prevent child undernutrition while avoiding their own overnutrition [13,22]. Effective interventions must therefore address these interconnected household dynamics rather than treating child and maternal malnutrition as isolated problems.

Drawing on the established conceptual pathways described above, this review is guided by a conceptual framework that organizes the determinants of household-level DBM across 3 interrelated domains—contextual, household and maternal, and child-level factors—operating within an intergenerational cycle of malnutrition. At the contextual level, urbanization, economic growth, and globalization reshape food environments and lifestyles by increasing access to energy-dense foods and sedentary behaviors, whereas persistent poverty and food insecurity constrain access to diverse, nutrient-rich diets. At the household and maternal level, socioeconomic position, maternal education, age, and stature influence resource allocation and health-related behaviors, with maternal education playing a central role in shaping nutrition knowledge, feeding practices, dietary choices, and healthcare utilization. At the child level, factors such as age, breastfeeding practices, and mode of delivery directly affect growth trajectories and nutritional outcomes, with suboptimal feeding practices increasing the likelihood of undernutrition. These domains are interconnected through an intergenerational pathway, whereby undernourished girls are more likely to become short-statured mothers and give birth to low-birth-weight infants, thereby perpetuating DBM across generations (Figure 1).

Despite growing recognition of DBM as a critical public health priority in South and Southeast Asia, significant gaps persist in the understanding of its household-level determinants. Although numerous studies have investigated potential risk factors across sociodemographic, economic, dietary, behavioral, and environmental domains, the evidence base remains fragmented and inconsistent [10,23–26]. These inconsistencies stem from 2 main sources. First, genuine contextual heterogeneity exists across countries at different stages of nutritional transition, whereby the same determinants, such as household wealth or urbanization show divergent associations depending on the local economic and food environment, as evidenced by differing findings across Myanmar [23], India [25], and Bangladesh, Nepal, Pakistan, and Myanmar collectively [26]. Second, substantial methodological variation limits comparability, including differences in the operational definition of DBM. Some studies restrict the definition to mothers with overweight or obesity with stunted children [23,24] whereas others apply

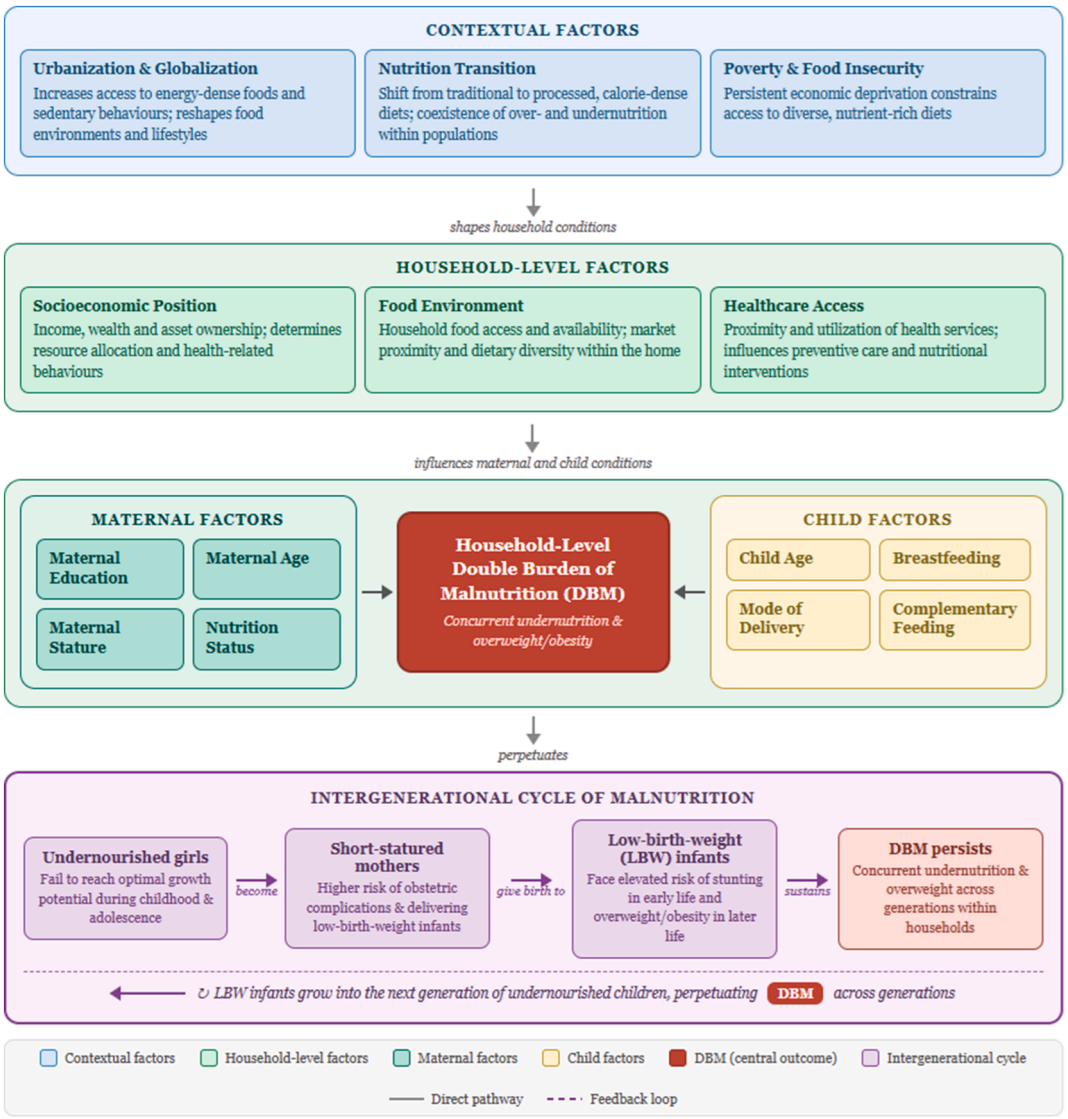

FIGURE 1. Conceptual framework illustrating the hypothesized pathways through which contextual, household-level, maternal, and child factors contribute to DBM within households in South and Southeast Asia. Solid arrows represent direct hypothesized associations; the curved feedback arrow denotes the intergenerational cycle of malnutrition. DBM, double burden of malnutrition; LBW, low-birth-weight.

broader criteria encompassing additional malnutrition combinations [25,26]. Variation in sample selection and covariate adjustment strategies further compounds this problem. Together, these contextual and methodological sources of variation produce a scattered evidence base that is difficult to interpret and challenging to translate into coherent policy guidance.

An important contribution to this field was made by Biswas et al. [24], who drew on large, harmonized Demographic and Health Survey (DHS) data from multiple countries in South and Southeast Asia to characterize the patterns and determinants of household-level DBM across the region. That study provided valuable cross-national evidence on the sociodemographic correlations of DBM and established a foundational understanding of how household and maternal characteristics relate to the coexistence of child undernutrition and maternal overweight. However, by relying on a single harmonized dataset and a predominantly descriptive analytical framework, it was not designed to systematically pool effect estimates across independently conducted studies or to formally quantify the magnitude and consistency of associations identified in the broader primary literature. Consequently, several important questions remain unresolved. First, when the full body of independently conducted studies is considered, how robust and generalizable are the associations identified using a single harmonized survey dataset? Second, do the direction and magnitude of key associations vary systematically with the geographic subregion examined or the operational definition of DBM used? Third, given the rapidly evolving nutritional landscape across South and Southeast Asia, do more recently published studies corroborate or challenge the conclusions of that earlier work?

To address these critical knowledge gaps, we conducted a comprehensive systematic review and meta-analysis to synthesize evidence on household-level factors associated with DBM in South and Southeast Asia. Although a previous systematic review examined the global prevalence and predictors of household-level DBM [27], its focus was mainly on

methodological heterogeneity and prevalence patterns and did not conduct a meta-analysis or specifically synthesize household-level determinants in South and Southeast Asia. In addition, a recent systematic review and meta-analysis assessed DBM among mother–child pairs in Ethiopia [28], but its findings were restricted to a single-country context. No previous review has comprehensively synthesized household-level factors associated with DBM specifically across the diverse contexts of South and Southeast Asia, where the burden is particularly high and rapidly evolving [5]. Through systematic identification of relevant studies, rigorous quality assessment, and pooling effect estimates using meta-analytical techniques, we sought to identify consistent patterns across diverse settings and populations. This review was designed to answer 2 fundamental questions: first, what household-level factors show consistent associations with DBM across South and Southeast Asian contexts? Second, how strong are these associations, and do they vary systematically by geographical region or operational definition of DBM? By providing a comprehensive synthesis of household-level determinants of DBM in this region, this review aimed to establish a robust evidence foundation for designing integrated nutrition policies and programs capable of breaking the cycle of dual malnutrition that threatens the health and prosperity of millions of families across South and Southeast Asia.

Methods

We conducted this systematic review following the PRISMA guidelines to ensure a rigorous and transparent approach. The review was prospectively registered with PROSPERO (CRD420251155844), and the completed PRISMA checklist outlining all stages of the review process is provided in **Supplementary File**.

Study selection and eligibility criteria

Observational and longitudinal studies that investigated factors associated with DBM at the household level were included according to our research questions and guided by population, intervention/exposure, comparator, outcomes, and study design framework (Table 1).

TABLE 1
PICOS criteria for inclusion of studies.

Component	Inclusion criteria
P	Households or mother–child pairs in South Asia (Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka) and Southeast Asia (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Vietnam).
I	Sociodemographic, economic, dietary, behavioral, environmental, and maternal or child characteristics that may be associated with DBM (e.g., household wealth, parental education, dietary diversity, urban or rural residence).
C	Not applicable.
O	DBM defined at household level (e.g., mother overweight/obese and child stunted/wasted/underweight; household with undernourished and overnourished members).
S	Quantitative observational studies (cross-sectional, case-control, cohort) and longitudinal studies that investigated factors associated with DBM at the household level.

Abbreviations: DBM, double burden of malnutrition; PICOS, Population, Intervention/Exposure, Comparator, Outcomes, Study Design.

Exclusion criteria

Studies were excluded if they were conducted outside South and Southeast Asia or focused on only a single form of malnutrition, such as stunting, wasting, underweight, or overweight/obesity. We also excluded studies conducted solely at the population or national level, without disaggregated household- or mother–child-level data. Additionally, reviews, editorials, commentaries, conference abstracts without full data, study protocols, and letters were not considered. Studies lacking sufficient information on risk factors of DBM, as well as publications in languages other than English, were also excluded.

Search strategy

We conducted a comprehensive literature search in 3 major electronic databases: PubMed, Scopus, and Web of Science for studies published between 1 January, 2000 and 15 September, 2025. The year 2000 was chosen as the starting point because the concept of DBM began gaining prominence in global health research around this time [29]. To identify additional relevant studies not captured in the database search, grey literature and reference lists of included articles were also hand-searched. The search strategy incorporated key terms, including "double burden of malnutrition," "households," "mother–child pair," and "risk factors." Detailed search strategies for each database are provided in Supplementary Table 1.

Study screening and data extraction

Study screening and data extraction were conducted independently and in duplicate to minimize the risk of error and bias. Two reviewers (AT and MAS) independently screened all retrieved records at the title and abstract stage to assess relevance, followed by an independent full-text review of potentially eligible studies to confirm eligibility. Any disagreements at either screening stage were resolved through discussion or, when necessary, by consultation with a third reviewer (HS). Data extraction was subsequently performed independently by the same 2 reviewers (AT and MAS). Each reviewer extracted data from all included studies separately, without access to the other reviewer's extractions. The extracted information included first author, year of publication, country or region, study design, sample size, study population, definitions used to identify household-level DBM, outcome measures, exposure factors examined, and the main findings on associations between these factors and DBM. Once both reviewers had completed independent extractions for all included studies, the 2 sets of extracted data were compared systematically, and any discrepancies were identified and resolved through discussion and cross-checking against the original study reports. Where disagreement persisted, the third reviewer (HS) provided a final decision to ensure consistency and accuracy across all extracted data.

Risk of bias assessment

Two independent reviewers assessed the risk of bias for each included study using a modified version of the Newcastle–Ottawa Scale adapted for cross-sectional studies (NOS-xs)

[30]. The adapted scale comprised 3 domains: *1*) study sample selection (maximum 2 stars), *2*) assessment of exposure and outcome (maximum 4 stars), and *3*) confounding factors (maximum 3 stars), with a total possible score of 9 stars. The assessment evaluated the representativeness of the study sample, the adequacy of the sample size, the validity and reliability of the measurement tools for exposure and outcome, and the appropriate control and measurement of confounders. Each item within the domains was rated according to predefined criteria, and a single best answer was selected per item. Studies scoring 7–9 stars were considered to have a low risk of bias (good quality), 5–6 stars indicated a moderate risk of bias (satisfactory quality), and 0–4 stars reflected a high risk of bias (unsatisfactory quality) [30]. Any discrepancies between reviewers were resolved through discussion and consensus.

Statistical methods

We used Microsoft Excel 2019 to organize our data and RStudio (Posit Software, PBC; R version 4.3.1) to perform the analyses. To address our first research question on identifying factors associated with DBM, we calculated odds ratios (ORs) with 95% confidence intervals (CIs) as the summary measures of effect. Although not all factors were reported in every study, meta-analyses were conducted for those factors reported in ≥5 studies with extractable raw data. For studies that examined multiple forms of child undernutrition (stunting, wasting, or underweight) in combination with maternal overweight/obesity, we extracted data for each DBM definition separately. When studies reported results for more than 1 DBM definition, we included all available combinations in the overall meta-analysis and subsequently conducted subgroup analyses based on DBM definition categories: *1*) overweight mother with stunted child (OWM + SC), and *2*) composite definitions that included overweight mother with stunted, wasted, or underweight child (OWM + SC/WS/UW).

To address our second research question regarding how associations vary by strength and geographic location, we performed subgroup analyses stratified by: *1*) DBM definition (OWM + SC compared with composite definitions), and *2*) geographic region (South Asia compared with Southeast Asia). For each subgroup, we calculated pooled OR and 95% CIs separately and compared effect sizes across subgroups. Factors not suitable for meta-analysis due to insufficient data (<5 studies) were summarized qualitatively in a narrative synthesis.

Heterogeneity was assessed for clinical, methodological, and statistical differences using the I^2 statistic and Q-test (P value). Given the expected heterogeneity across diverse populations and settings, a random-effects model was applied for all meta-analyses using the DerSimonian–Laird method. Interpretation of I^2 values followed standard guidelines: 0%–40% indicating low heterogeneity, 30%–60% moderate heterogeneity, 50%–90% substantial heterogeneity, and 75%–100% considerable heterogeneity.

To evaluate the robustness of our findings, we performed leave-1-out sensitivity analyses by sequentially removing each study and recalculating the pooled effect estimates. This approach assessed whether any single study disproportionately influenced the overall results. Publication bias was assessed using Egger's regression test and visual inspection of funnel plots for asymmetry. A P value < 0.05 in Egger's test was considered indicative of potential publication bias.

All statistical analyses were conducted using the "meta" and "metafor" packages in R. Forest plots were generated to visualize pooled effect estimates and their CIs for each factor, and funnel plots were created to assess publication bias.

Ethical consideration

No ethical approval is required as we are doing this research based on published papers.

Results

Overview of the literature screening process

A total of 1021 records were identified through 3 database searches (PubMed = 237, Scopus = 367, and Web of Science = 417) and other sources such as citation searching and grey literature (n = 17). After removing 436 duplicate records (8 manually and 428 using Covidence software), 602 studies remained for title and abstract screening. Of these, 512 studies were excluded as they did not meet the inclusion criteria (Figure 2). The full texts of 90 studies were reviewed for eligibility, and 60 were excluded for reasons such as focusing only on women or children, failing to define DBM, failing to assess associated factors, or being conducted outside South and Southeast Asia. Finally, 30 studies [10,13,23–26,31–54] met the inclusion criteria and were included in this systematic review, of which 26 were eligible for meta-analysis (the list of articles is available in Table 2) as we were able to extract raw data from these studies. We were unable to extract raw data from 4 studies because the data were presented in an unsuitable format; therefore, these studies were excluded from the meta-analysis. The selection process is summarized in Figure 2, which presents the PRISMA flow diagram of study inclusion.

Characteristics of included studies

The key characteristics of studies included in the systematic review on factors associated with DBM at the household level in South and Southeast Asia are presented in Supplementary Table 2. All studies employed a cross-sectional design and covered a wide range of countries, including Bangladesh, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, Myanmar, Cambodia, and Timor-Leste. Sample sizes varied considerably, ranging from fewer than 300 households in small-scale studies to >700,000 households in large multicountry analyses. Most studies (17 studies) defined DBM as the coexistence of a mother with overweight or obesity and a stunted child (OWM + SC). However, several studies (14 studies) used broader definitions that also considered other forms of child undernutrition, such as wasting or underweight, resulting in alternative combinations like OWM+WC (overweight mother–wasted child), OWM + UWC (overweight mother–underweight child), or OWM + SC/WC/UW (overweight mother with any stunted, wasted, or underweight child). Most studies reported adjusted odds ratios as the main effect measure, whereas a few presented crude OR, or descriptive statistics. The methodological quality of the studies assessed using the NOS-xs, ranged from 7 to 9, indicating that the included studies were of good quality [30]. The NOS-xs ratings by each domain are available in Supplementary Table 3.

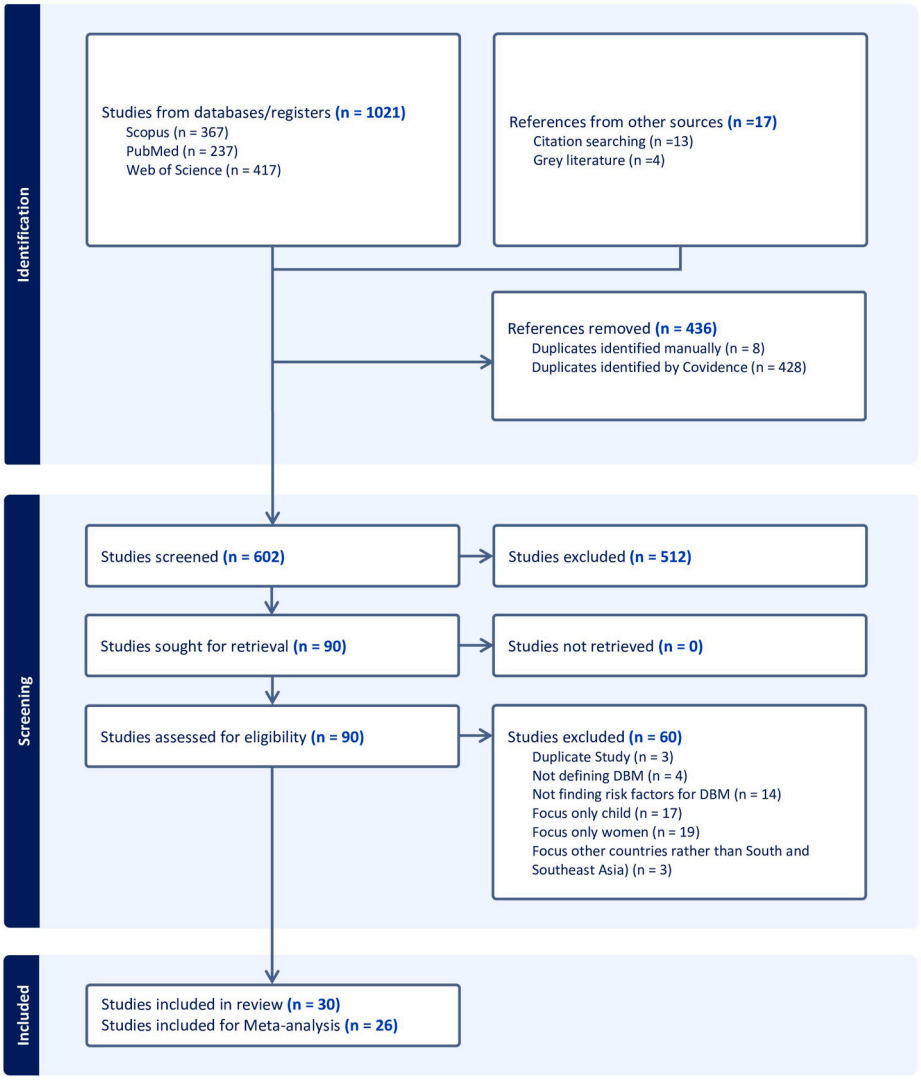

FIGURE 2. PRISMA flow diagram illustrating the selection process of studies included in the systematic review.

Meta-analysis results of factors associated with DBM

We conducted a meta-analysis reported in ≥5 studies, for which raw data could be extracted. This analysis summarized the pooled effects of these 12 factors associated with DBM in South and Southeast Asia. These factors were grouped into 4 major categories: household-level factors, parental-level factors, child-level factors, and behavioral and healthcare-related factors. Most of the included factors exhibited moderate to high heterogeneity, reflecting contextual variations across countries in the region. Table 3 presents the definitions and categorizations of the 12 factors included in the meta-analysis. The data collection periods of the included studies, along with the distribution of these sociodemographic factors across study populations, are provided in Table 2.

Household-level factors

Urban residence and higher household wealth were both significantly associated with increased likelihood of DBM (detailed in Supplementary Figures 1–12, Figure 3). Households in urban areas were 38% more likely to experience DBM than their rural counterparts (pooled OR = 1.38, 95% CI: 1.20, 1.59; $I^2 = 84.4\%$). Similarly, households in the richest wealth quintile were 55% more likely to experience DBM compared with the poorest households (pooled OR = 1.55, 95% CI: 1.31, 1.83; $I^2 = 71.9\%$).

Parental-level factors

Maternal characteristics showed stronger and more consistent associations with DBM than paternal factors. Households with older mothers (≥25 y) were more than twice as likely to experience DBM compared with those with younger mothers (pooled OR = 2.22, 95% CI: 1.97, 2.50; $I^2 = 46.6\%$). Maternal short stature was also associated with 90% higher likelihood of DBM (pooled OR = 1.90, 95% CI: 1.69, 2.13; $I^2 = 0\%$). Moreover, higher maternal education reduced the odds of DBM by 33% (pooled OR = 0.67, 95% CI: 0.55, 0.80; $I^2 = 74.9\%$). On the other hand, neither paternal education nor maternal working status showed statistically significant associations with DBM.

Child-level factors

At the child level, both age and sex were examined as predictors of DBM. Children aged 24–59 mo were 79% more likely to be in DBM-affected households compared with younger

TABLE 2
Characteristics of included studies and distribution of selected 12 sociodemographic factors across study populations.

Study (author, year)	Country	Data collection period (related survey)	Sample size (*n*)	Effectmeasure	Household-level factors (2)			Parental-level factors (5)					Child-level factors (2)		Behavioral and healthcare factors (3)		
					Place of residence urban vs. rural	Wealth status rich vs. poor		Maternal age ≥25 y vs. 15–24 y	Maternal stature <150 cm vs. ≥150 cm	Maternal education high (s/higher) vs. low (none/ primary)	Paternal education high (s/higher) vs. low (none/ primary)	Maternal working status yes (employed) vs. no	Child age 24–59 mo vs. 0–23 mo	Child sex male vs. female	Breastfeeding status yes vs. no	C-section yes vs. no (vaginal)	Media exposure yes vs. no
					Urban (%)	Rich (%)	Poor (%)	≥25 y (%)	<150 cm (%)	High (%)	High (%)	Yes (%)	24–59 mo (%)	Male (%)	Yes (%)	Yes (%)	Yes (%)
Anik et al. (2019) [26]	**Bangladesh**	**2014 (BDHS)**	**6478**	**Adjusted OR**	**25.8**	**40.2**	**39.1**	**51.5**	—	**57.1**	—	**25.5**	**54.2**	**52.7**	**56.6**	—	**37.2**
Anik et al. (2019)	**Nepal**	**2016 (NDHS)**	**2670**	**Adjusted OR**	**53.9**	**35.1**	**42.9**	**51.6**	—	**50.3**	—	**46.1**	**28.1**	**53.4**	**92.7**	—	**77.5**
Anik et al. (2019)	**Pakistan**	**2012–13 (PDHS)**	**5770**	**Adjusted OR**	**30.2**	**35.2**	**45.9**	**79.9**	—	**27.1**	—	**26.2**	**45.1**	**52.5**	**50.7**	—	**45.4**
Anik et al. (2019)	**Myanmar**	**2015–16 (MDHS)**	**3541**	**Adjusted OR**	**22.9**	**33.9**	**48.8**	**81.7**	—	**38.5**	—	**56.8**	**52.9**	**51.2**	**54.9**	—	**82.7**
Das et al. (2018) [32]	**Bangladesh**	**2014 (BDHS)**	**5951**	**Adjusted OR**	—	**41.0**	**39.2**	**49.6**	—	**58.1**	**46.4**		—	—	—	**24.0**	**36.5**
Gaupholm et al. (2023) [34]	**Philippines**	**2013 (NNS)**	**5837**	**Adjusted OR**	—	**37.1**	**42.1**	—	—	**15.7**	—	**42.48**	—	—	—	—	—
Hauqe et al. (2017) [35]	**Bangladesh**	**2014 (BDHS)**	**5697**	**Adjusted OR**	**26.0**	**40.3**	**39.4**	**52.1**	—	—	—	**26.1**	**52.7**	—	—	—	—
Hong et al. (2020) [23]	**Myanmar**	**2015–16 (MDHS)**	**5687**	**Adjusted OR**	**21.8**	**35.3**	**32.3**	**81.9**	**31.4**	**36.2**	—			—	—	—	—
Ihab et al. (2013) [36]	**Malaysia**	**2012 (primary data)**	**223**	**Unadjusted OR**	—	—	—	—	—	**66.0**	—	**69.0**	—	—	—	—	—
Jayalakshmi et al. (2019) [37]	**India**	**2012 IHDS-II**	**344**	**Unadjusted OR**	**56.4**	—	—	—	—	—	**33.7**	—	—	—	—	—	—
Khaliq et al. (2025) [38]	**Pakistan**	**2017–18 (PDHS)**	**6198**	**Adjusted OR**	**45.1**	**35.4**	**45.2**	—	—	**34.2**	—	**15.6**	—	**48.7**	—	**17.5**	—
Krismanita et al. (2022) [40]	**Indonesia**	**2019 (primary data)**	**274**	**Adjusted OR & Unadjusted OR**	—	**34.7**	**65.3**	—	**47.1**	**21.9**	**42.3**	—	—	—	**35.8**	—	—
Limon et al. (2021) [41]	**Bangladesh**	**2017–18 (BDHS)**	**3772**	**Adjusted OR**	**33.3**	**37.2**	**41.5**	—	—	**62.3**	**42.9**	—	—	—	—	—	—
Mahmudiono et al. (2018) [54]	**Indonesia**	**2013 (RISKESDAS)**	**685**	**Adjusted OR**	—	—	—	—	—	**53.3**	—	—	—	—	—	—	—
Nakphong et al. (2021) [42]	**Cambodia**	**2014 (CDHS)**	**14,988**	**Adjusted OR**	—	**22.2**	**33.4**	**75.7**	**30.6**	—	—	**66.4**	**60.1**	—	—	—	—
Oddo et al. (2012) [43]	**Indonesia**	**2007 (IDHS)**	**247,126**	**Adjusted OR**	—	**32.6**	**43.7**	**68.4**	**51.6**	**36.1**	—	—	—	**51.0**	**55.2**	—	—
Oddo et al. (2012)	**Bangladesh**	**2004 (BDHS)**	**168,317**	**Adjusted OR**	—	**29.3**	**45.2**	**60.7**	**45.4**	**29.9**	—	—	—	**52.0**	**65.3**	—	—
Patel et al. (2020) [25]	**India**	**2015–16 (NFHS-4)**	**184,680**	**Adjusted OR**	**29.1**	**34.9**	**45.1**	**66.0**	—	**58.2**	—	—	**62.0**	**52.9**	**46.7**	**18.4**	—
Rachmah et al. (2021) [44]	**Indonesia**	**2018 (primary data)**	**436**	**Adjusted OR**	—	—	—	—	—	**61.9**	**69.4**	**25.7**	—	—	—	—	—
Rahman et al. (2021) [45]	**Bangladesh**	**2017–18 (BDHS)**	**7662**	**Adjusted OR**	**30.9**	**38.9**	**41.7**	**85.2**	—	**56.0**	**44.0**	—	—	—	**58.2**	**15.3**	**49.6**
Ramasubramani et al. (2024) [10]	**India**	**2019–21 (NFHS-5)**	**167,380**	**Adjusted OR**	**26.5**	**30.5**	**49.8**	**89.2**	—	**67.2**	—	—	**67.8**	**51.7**	**61.9**	**21.5**	—
Saibul et al. (2009) [46]	**Malaysia**	**2002–05 (Primary Data)**	**227**	**Unadjusted OR**	—	—	—	—	—	—	—	**24.7**	—	—	—	—	—
Sarker et al. (2022) [47]	**Bangladesh**	**2017–18 (BDHS)**	**8697**	**Adjusted OR**	—	**38.3**	**44.8**	**75.2**	—	—	**49.4**	**40.8**	—	—	—	—	**42.4**
Sekiyama et al. (2015) [48]	**Indonesia**	**2006-07 (ENVRERA Project)**	**242**	**Unadjusted OR**	—	—	—	—	**54.2**	**21.5**	—	**24.7**	—	—	—	—	—
Sengupta et al. (2025) [49]	**India**	**2019–21 (NFHS-5)**	**360**	**Adjusted OR**	—	—	—	—	—	**56.1**	**35.0**	—	—	**51.1**	—	—	—
Shariff et al. (2024) [50]	**Malaysia**	**2017– 19 (Primary Data)**	**451**	**Adjusted OR**	—	—	—	—	—	**5.7**	**39.5**	**16.2**	**54.8**	**49.9**	—	—	—
Singh et al. (2023) [52]	**India**	**2019–21 (NFHS-5)**	**122,922**	**Adjusted OR**	**26.4**	**35.2**	**45.2**	**60.3**	—	**69.3**	—	—	—	**52.2**	**81.2**	**23.6**	—
Sunuwar et al. (2020) [51]	**Nepal**	**2016 (NDHS)**	**2261**	**Adjusted OR**	—	**35.9**	**42.1**	**58.9**	**10.0**	**46.8**	**62.1**	**59.6**	**58.3**	**52.7**	**78.8**	**9.8**	—
Sutopa et al. (2022) [53]	**Bangladesh**	**2017–18 (BDHS)**	**4377**	**Adjusted OR**	**33.5**	**37.0**	**42.5**	**45.5**	—	**57.9**	**22.4**	**22.6**	—	—	**88.0**	**23.0**	**64.6**
Talukder et al. (2024) [13]	**Bangladesh**	**2017–18 (BDHS)**	**7718**	**Adjusted OR**	**35.0**	**39.2**	**42.2**	—	—	**64.1**	—	—	—	**51.9**	**60.2**	—	—
Talukder et al. (2024)	**Cambodia**	**2014 (CDHS)**	**3836**	**Adjusted OR**	**35.3**	**34.0**	**45.3**	—	—	**74.7**	—	—	—	**51.1**	**36.3**	—	—
Talukder et al. (2024)	**Nepal**	**2016 (NDHS)**	**2596**	**Adjusted OR**	**49.4**	**36.6**	**42.9**	—	—	**71.0**	—	—	—	**50.2**	**65.8**	—	—
Talukder et al. (2024)	**Timor-Leste**	**2016 (TDHS)**	**6309**	**Adjusted OR**	**29.2**	**38.7**	**45.8**	—	—	**55.8**	—	—	—	**51.7**	**53.4**	—	—

Data presentation: Each cell reports the percentage (%) distribution of the several categories of the selected covariates within the total analytic sample for that study. Values represent sample proportions, not effect sizes.
Effect measure: adjusted OR, adjusted odds ratio; unadjusted OR, crude OR.
— (em dash): Indicates that the proportion of the factors was not able to extract or not reported in that study.
Variable categories (consistent with Table 3):
- Place of residence: Urban (%) compared with rural.
- Wealth status (Wealth Index): Studies used wealth index factor scores derived from household asset ownership. The wealth index was operationalized in 2 ways across the included literature:
  Five-category scale (poorest/poorer/middle/richer/richest): To ensure comparability, the 2 lowest quintiles (poorest + poorer) were merged to form the "Poor" group and the 2 highest quintiles (richer + richest) were merged to form the "Rich" group. The middle quintile was excluded from the binary comparison.
  Three-category scale (poor/middle/rich): The "Poor" and "Rich" categories were used directly as reported, with the middle category excluded from the binary comparison.
- Maternal age: ≥25 y vs. 15–24 y
- Maternal stature: <150 cm vs. ≥150 cm
- Maternal education: high = secondary or higher vs. low = none/primary
- Paternal education: high = secondary or higher vs. low = none/primary
- Maternal working status: yes = employed vs. no = not employed
- Child age: 24–59 mo vs. 0–23 mo
- Child sex: male vs. female
- Breastfeeding status: yes = currently breastfeeding vs. no
- C-section delivery: yes vs. no = vaginal delivery
- Media exposure: yes = exposed to TV/radio/newspaper vs. no

Abbreviations: BDHS, Bangladesh Demographic and Health Survey; CDHS, Cambodia Demographic and Health Survey; ENVRERA, Environmental Research in Rural Asia; IDHS, Indonesia Demographic and Health Survey; IHDS-II, India Human Development Survey, Wave 2; MDHS, Myanmar Demographic and Health Survey; NDHS, Nepal Demographic and Health Survey; NFHS, National Family Health Survey (India); NNS, National Nutrition Survey (Philippines); PDHS, Pakistan Demographic and Health Survey; RISKESDAS, Riset Kesehatan Dasar (Indonesia National Basic Health Research); TDHS, Timor-Leste Demographic and Health Survey.
Studies included (*n* = 33 study-country observations from 26 unique publications):
Anik et al. (2019) (Bangladesh, Nepal, Pakistan, Myanmar); Das et al. (2018); Gaupholm et al. (2023); Hauqe et al. (2017); Hong et al. (2020); Ihab et al. (2013); Jayalakshmi et al. (2019); Khaliq et al. (2025); Krismanita et al. (2022); Limon et al. (2021); Mahmudiono et al. (2018); Nakphong et al. (2021); Oddo et al. (2012) [Indonesia, Bangladesh]; Patel et al. (2020); Rachmah et al. (2021); Rahman et al. (2021); Ramasubramani et al. (2024); Saibul et al. (2009); Sarker et al. (2022); Sekiyama et al. (2015); Sengupta et al. (2025); Shariff et al. (2024); Singh et al. (2023); Sunuwar et al. (2020); Sutopa et al. (2022); Talukder et al. (2024) (Bangladesh, Cambodia, Nepal, Timor-Leste).

TABLE 3
Definitions of the 12 key factors included in meta-analysis.

Category	Factor	Definition/measurement
Household level	Place of residence	Urban vs. rural household location
	Wealth status	Household wealth quintile (rich vs. poor). Studies used wealth index factor scores derived from household asset ownership. The wealth index was operationalized in 2 ways across the included literature: • Five-category scale (poorest/poorer/middle/richer/richest): to ensure comparability, the 2 lowest quintiles (poorest + poorer) were merged to form the "Poor" group and the 2 highest quintiles (richer + richest) were merged to form the "Rich" group. The middle quintile was excluded from the binary comparison. • Three-category scale (poor/middle/rich): the "Poor" and "Rich" categories were used directly as reported, with the middle category excluded from the binary comparison.
Parental level	Maternal age	Mother's age at time of survey (≥25 vs. 15–24 y)
	Maternal stature	Mother's height (<150 vs. ≥150 cm)
	Maternal education	Maternal educational attainment was categorized as "High" for secondary or higher education and "Low" for no or primary education.
	Paternal education	Father's educational attainment was categorized as "High" for secondary or higher education and "Low" for no or primary education.
	Maternal working status	Whether mother was employed outside home (Yes vs. No)
Child level	Child age	Age of child in household (24–59 vs. 0–23 mo)
	Child sex	Sex of child (male vs. female)
Behavioral and healthcare	Breastfeeding status	Current breastfeeding status was assessed at the time of the survey, with children coded as "Yes" if they were currently breastfeeding and "No" otherwise.
	C-section	Among mother–child pairs where the baby was born via C-section is coded as "Yes" Otherwise "No."
	Media exposure	Household media exposure was coded as "Yes" if the respondent watched TV, listened to the radio, or read newspapers at least once a week, and "No" otherwise.

Abbreviation: C-section, cesarean section

children aged 0–23 mo (pooled OR = 1.79, 95% CI: 1.44, 2.23; I^2 = 28.9%). However, child sex was not significantly associated with DBM (pooled OR = 0.96, 95% CI: 0.88, 1.04; I^2 = 71.8%).

Behavioral and healthcare-related factors

Behavioral and health service–related factors also showed notable associations. Current breastfeeding status of the child emerged as a strong protective factor against DBM (pooled OR = 0.59, 95% CI: 0.52, 0.68; I^2 = 65.1%), with mother–child pairs where the child was currently being breastfed at the time of survey showing lower odds of DBM compared with pairs where the child was not currently breastfed. We acknowledge that this finding is most applicable to children aged <24 mo. Also, cesarean delivery for the birth of a child was significantly associated with higher odds of DBM (pooled OR = 1.76, 95% CI: 1.20, 2.57; I^2 = 77.5%) compared with vaginal delivery. Media exposure showed no significant association with DBM (pooled OR = 1.16; 95% CI: 0.79, 1.69; I^2 = 66.4%).

Additional factors associated with DBM

Beyond the 12 factors included in the meta-analysis, several additional determinants were identified across individual studies. Five studies [35,43,45,52,53] found that households where the child was a later-born child (second or higher in the birth order) had an increased risk of DBM compared with households with firstborn children. Similarly, 4 studies [34,38,43,52] reported that larger household size, measured by the total number of household members, was associated with higher DBM risk. Two studies [13,53] indicated that antenatal care (ANC) visits reduced DBM risk, whereas 4 studies [19,34,49,50] linked household food insecurity with higher DBM likelihood. Evidence from 1 study [44] suggested that higher protein intake among children and higher fat intake among mothers were associated with an increased risk of DBM.

Subgroup analysis

To explore potential sources of heterogeneity and assess whether associations differed by DBM definition and region, we conducted subgroup analyses based on 2 commonly used DBM definitions (OWM + SC compared with composite definitions including OWM + SC/WS/UW) and geographic region (South Asia compared with Southeast Asia) (Figure 4).

Across DBM definitions, the direction and magnitude of associations were highly consistent (Figure 4). Older maternal age, higher household wealth, short maternal stature, older child age, and cesarean delivery were associated with increased likelihood of DBM under both definitions, with similar effect sizes (e.g., maternal age: OR = 2.01 compared with 2.16; child age: OR = 2.44 compared with 2.13). Likewise, maternal education and breastfeeding were protective under both definitions, with comparable effect estimates (maternal education: OR = 0.70 compared with 0.63; breastfeeding: OR = 0.48 compared with 0.68). These findings suggest that the associations between key determinants and DBM were robust and not meaningfully modified by DBM definition.

Similarly, regional subgroup analysis showed comparable effect sizes across South Asia and Southeast Asia (Figure 4). Higher wealth (OR = 1.68 compared with 1.55), short maternal stature (OR = 1.96 compared with 1.75), and older child age (OR = 2.24 compared with 2.15) were associated with increased likelihood of DBM in both regions. Maternal education (OR = 0.73 compared with 0.59) and breastfeeding (OR = 0.60 compared with 0.59) were protective in both regions. Although minor differences in magnitude were observed, the overall similarity in effect estimates indicates no clear evidence that

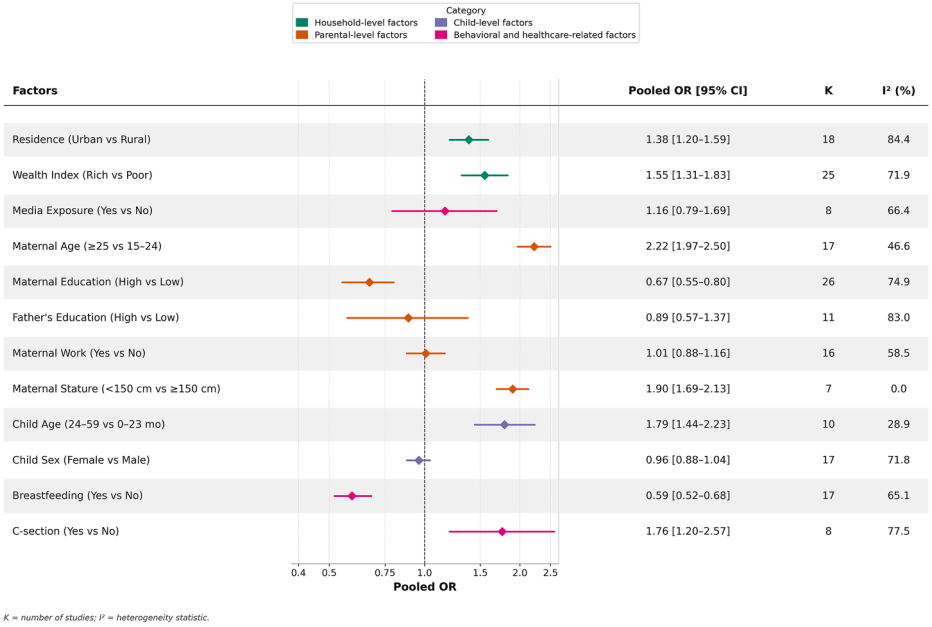

FIGURE 3. Pooled estimates of factors associated with household-level DBM in South and Southeast Asia. Last category of each factor is considered as reference category. K, number of studies to estimate the pooled estimate. Factor-specific Forest plots are available in Supplemental Figures 1–12. CI, confidence interval; DBM, double burden of malnutrition; OR, odds ratio.

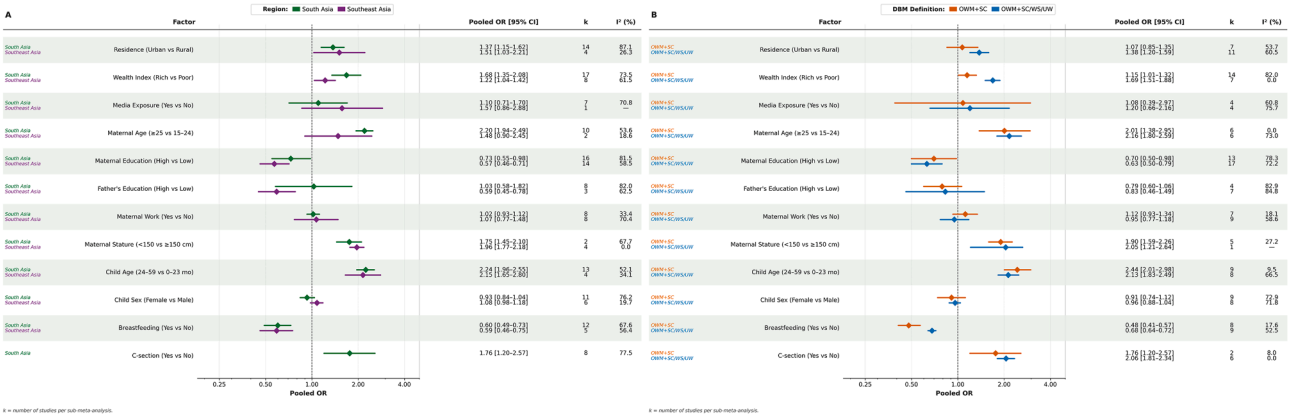

FIGURE 4. Subgroup analysis of factors associated with the DBM by region (A) and DBM definition (B). Last category of each factor is considered as reference category. K, number of studies to estimate the pooled estimate. CI, confidence interval; DBM, double burden of malnutrition; OWM + SC, overweight mother with stunted child; OWM + SC/WS/UW, overweight mother with stunted, wasted, or underweight child; OWM + UWC, overweight mother with underweight child; OWM + WC, overweight mother with wasted child.

geographical region substantially modified the associations between these factors and DBM. Subgroup analyses also reduced heterogeneity for several factors, suggesting that variation in DBM definitions and study settings contributed to between-study variability without fundamentally altering the observed relationships.

Sensitivity analysis

We conducted leave-one-out sensitivity analyses, removing 1 study at a time to assess the robustness of the pooled estimates (Figure 5). These analyses showed that the results for most factors were stable, suggesting that no single study had an undue influence. Urban residence, higher household wealth, older maternal age, maternal short stature, older child age, and cesarean delivery increased the risk of DBM across all iterations of the sensitivity analysis. On the other hand, maternal education and breastfeeding remained protective factors. However, a notable exception was observed for cesarean delivery, where the removal of the Khaliq et al.'s [38] study resulted in a meaningful upward shift in the pooled estimate, such that the lower bound of the 95% CI exceeded the original overall point estimate. This indicates that the Khaliq study exerts a moderating influence on the cesarean delivery estimate, and that the association between cesarean delivery and DBM may be stronger than the overall pooled estimate suggests when this study is excluded. This finding warrants cautious interpretation of the cesarean delivery result and highlights the need for additional studies on this association across diverse settings.

Publication bias

The funnel plots presented in Figure 6 showed a largely symmetrical distribution, suggesting minimal publication bias

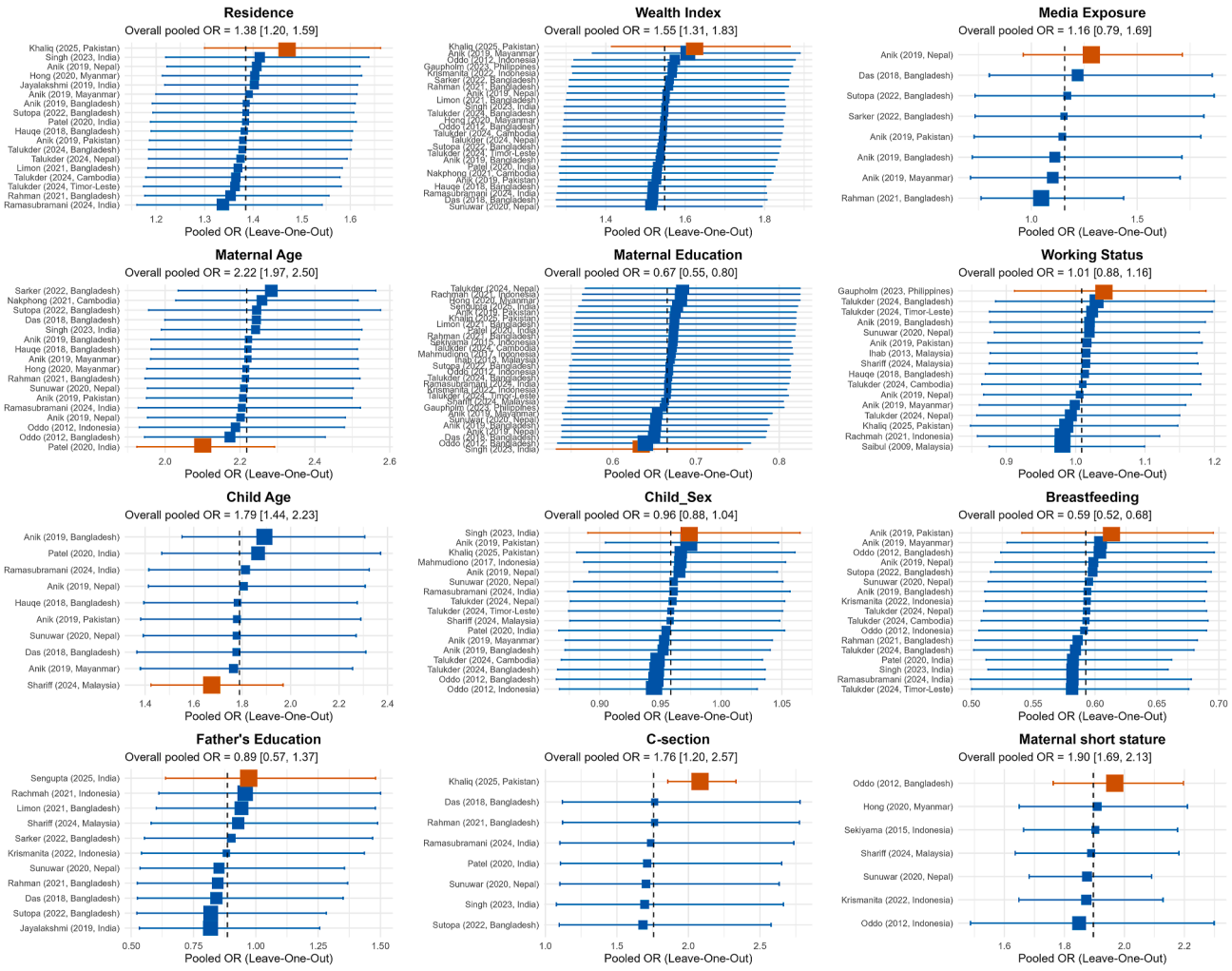

FIGURE 5. Sensitivity analysis showing the influence of individual studies on the pooled estimates of factors associated with DBM. Each data point represents the pooled OR recalculated after sequentially removing 1 study at a time. Blue squares represent individual leave-one-out pooled estimates with their 95% CIs. The orange square identifies the study whose removal produces the greatest change in the pooled estimate, indicating the single most influential study for that factor. The dashed vertical line represents the overall pooled estimate based on all included studies. CI, confidence interval; DBM, double burden of malnutrition; OR, odds ratio.

across the included studies. This visual assessment was supported by Egger's test, which yielded nonsignificant results ($P > 0.05$), further confirming that publication bias is unlikely to have influenced our findings.

Discussion

This study addresses a critical evidence gap by providing the first comprehensive meta-analytic synthesis of household-level determinants of DBM across South and Southeast Asia. Although previous reviews have examined global prevalence and predictors without quantitative pooling, and a recent systematic review and meta-analysis was limited to a single-country context in Ethiopia, no prior study has generated region-specific pooled estimates for this diverse setting. By synthesizing evidence from 30 studies across this region and conducting meta-analysis for 12 factors, this review makes several contributions to existing literature. It provides the first region-specific pooled estimates for key risk factors, including urban residence, household wealth, maternal short stature, and notably, cesarean delivery, an association previously identified only in isolated studies. These findings challenge the common assumption that DBM is predominantly driven by poverty, underscore the importance of intergenerational influences, and highlight cesarean delivery as a potentially under-recognized upstream factor. Overall, this study advances the evidence base from fragmented single-country findings to a coherent, regionally grounded synthesis that can inform more targeted nutrition strategies in South and Southeast Asia.

Household-level factors: urbanization, wealth, and nutrition transition

Our meta-analysis showed that both urban residence (38% higher likelihood) and higher household wealth (55% higher likelihood) were significantly associated with DBM, with both associations remaining robust across sensitivity analyses. These findings provide strong quantitative evidence that the burden is shifting toward more affluent and urban populations. This pattern is consistent with previous studies highlighting the role of rapid urbanization and economic growth in reshaping dietary

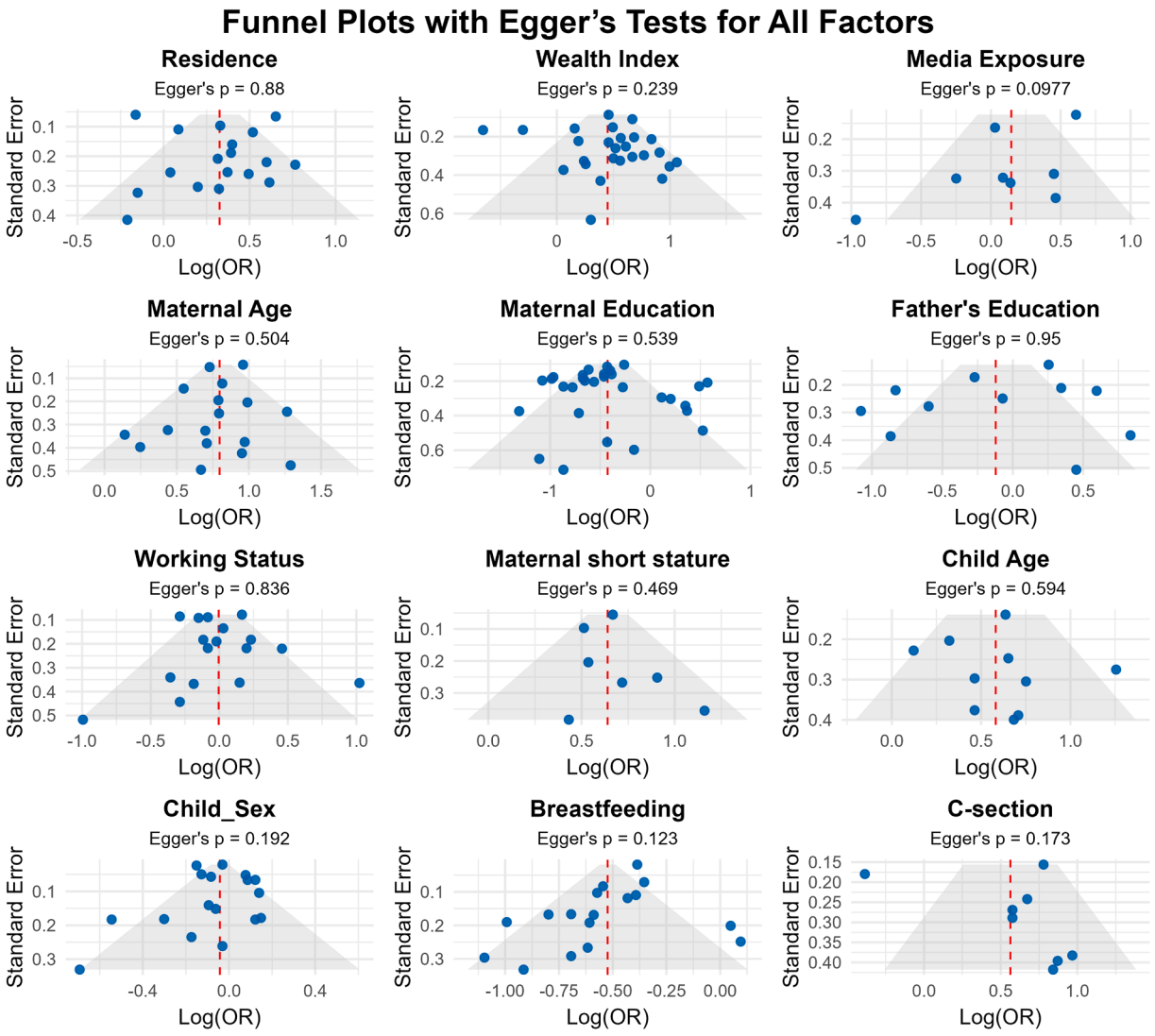

FIGURE 6. Funnel plots with results of Egger's test assessing publication bias across all identified factors. OR, odds ratio.

patterns and lifestyles across the region [1,2,5,13,24,26]. In such environments, greater access to energy-dense, nutrient-poor foods and more sedentary lifestyles contribute to maternal overweight, whereas persistent structural and social barriers—such as limited access to diverse child foods, suboptimal feeding practices, and inadequate childcare—continue to drive child undernutrition [3,55].

The positive association between household wealth and DBM observed in our pooled estimates indicates that economic resources alone are insufficient to ensure optimal nutrition for all household members, a pattern also reported in Indonesia, Nepal, and Bangladesh [44,51,56]. Rather, these findings suggest that DBM is shaped by how resources are distributed and utilized within households. This may explain why DBM persists in wealthier settings, where maternal diets shift toward excess energy intake, whereas children continue to experience inadequate dietary diversity or care, reflecting intrahousehold nutritional inequalities [57]. At the same time, poorer households in urban areas may face disproportionate barriers to healthy diets despite living in food-rich environments. Structural constraints such as unhealthy food environments, limited income, and poor access to fresh foods may increase the risk of both undernutrition and overnutrition within the same household [58]. The stronger associations observed in South Asia compared with Southeast Asia in our subgroup analysis suggest that the mechanisms driving DBM may differ between regions. This could reflect more pronounced intrahousehold nutritional inequalities in South Asian contexts, potentially influenced by deeper gender disparities, differential feeding practices, or other sociocultural factors that shape resource allocation within households. It is important to note that we are measuring the coexistence of overnutrition and undernutrition within households, which may have distinct drivers beyond the nutrition transition factors that influence overnutrition alone.

Maternal factors: the central role of mothers

Our meta-analysis identified older maternal age (≥25 y) as one of the strongest risk factors for household-level DBM, with these mothers having more than twice the likelihood of DBM compared with younger mothers. This large effect likely reflects 2 concurrent processes within the same household: older mothers are at higher risk of overweight due to cumulative weight retention from multiple pregnancies, metabolic changes,

and reduced physical activity [59], whereas their children (often from earlier pregnancies) may experience persistent stunting due to suboptimal nutrition during critical growth periods [17].

Maternal short stature also emerged as a strong risk factor, associated with a 90% higher likelihood of DBM. Short stature is not merely a biological trait but serves as a marker of chronic undernutrition during the mother's own childhood and adolescence [60,61]. This dual burden operates in 2 directions: short-statured mothers are more likely to have low-birth-weight infants and children with growth faltering [62,63], whereas simultaneously being at higher risk of overweight due to metabolic adaptations, lower lean body mass, and exposure to obesogenic environments [64]. Additionally, shorter individuals are more likely to be classified as overweight based on BMI, as BMI is a function of height and weight, making it easier for shorter people to reach the overweight threshold at lower absolute weights. These findings highlight the importance of improving adolescent nutrition as a strategy to prevent the intergenerational perpetuation of malnutrition.

In contrast, higher maternal education reduced the likelihood of DBM by 33%, making it one of the strongest modifiable protective factors. This protective effect is well established in the nutrition literature, as educated mothers generally possess better knowledge of nutrition, greater autonomy in household decision-making, and improved access to health services [13,21]. By enhancing mothers' capacity to make informed feeding choices, access healthcare promptly, and support their children's nutritional needs, education directly contributes to improved household nutrition [21]. In contrast, the absence of a significant association between paternal education and DBM suggests that mothers have a much stronger influence on household nutrition, given their central role in caregiving and food preparation in most South and Southeast Asian settings. Interestingly, maternal working status showed no significant association with DBM, which may be due to variations in employment types, working conditions, and the availability of childcare support across different settings.

Child-level factors: age and developmental vulnerability

Children aged 24–59 mo were 79% more likely to be in a DBM-affected household compared with children aged 0–23 mo. This age gradient reflects the cumulative effects of inadequate complementary feeding, repeated infections, and environmental exposures during early childhood [65,66]. Growth faltering often accelerates after 6 mo of age, when breast milk alone becomes insufficient, and appropriate complementary foods are frequently unavailable or improperly introduced [67,68]. Meanwhile, maternal weight gain may continue or even accelerate during this period, particularly in households undergoing nutrition transition, further contributing to the household-level double burden.

Behavioral and healthcare factors

Breastfeeding was associated with a 37% lower likelihood of household-level DBM, and this protective association was consistent across subgroups defined by both DBM definition and geographic region, making it one of the most robust findings of this review. This finding is consistent with extensive evidence on its benefits for both child growth and maternal health [69,70]. Exclusive breastfeeding for the first 6 mo, followed by continued breastfeeding $\leq$2 y or beyond, provides optimal nutrition for infants and young children while supporting maternal weight management through increased energy expenditure [23,71,72]. Additionally, breastfeeding reduces the risk of childhood infections, which are major contributors to stunting, further reinforcing its protective role [73–75]. These findings highlight the importance of promoting and supporting breastfeeding as a cornerstone of DBM prevention strategies.

Cesarean delivery was associated with a 76% higher likelihood of household-level DBM, although this estimate warrants cautious interpretation, as sensitivity analysis indicated that removing a single influential study increased the pooled estimate, suggesting that the true association may be even stronger than the overall result. Multiple plausible pathways may explain this association. Cesarean delivery can delay lactation initiation, reduce breastfeeding duration, and alter infant gut microbiota, all of which may negatively impact child growth [72,76,77]. Furthermore, cesarean delivery is more common among women with overweight or obesity, who may face higher risks of surgical complications and challenges in postpartum weight management [78,79]. Reduced mobility and physical activity during recovery may also exacerbate postpartum weight retention, contributing to maternal overweight in the household [79,80].

Additional factors: emerging evidence

Several factors identified in the narrative synthesis, however not included in the meta-analysis due to limited data, are also important to consider. Higher birth order and larger household size were associated with increased DBM risk, likely due to reduced availability of food and caregiving for each child within the household [34,36,38,43,52]. Attending ANC visits was linked to reduced DBM risk, highlighting the importance of prenatal nutrition counseling and maternal health monitoring in mitigating household malnutrition [13,53]. Household food insecurity was also consistently associated with higher DBM likelihood, emphasizing the fundamental role of adequate food access in preventing malnutrition [19,34,49,50]. Moreover, several dietary factors—such as excessive protein intake in children, higher maternal fat intake, and imbalanced energy intake—may further contribute to DBM [34,44]. These findings indicate the need for longitudinal studies with detailed dietary assessments to clarify causal pathways and inform targeted dietary interventions.

Implications for policy and practice

The findings of this systematic review challenge the longstanding assumption that malnutrition is primarily a problem of poverty and food insecurity [81]. DBM is increasingly concentrated in urban and wealthier households, meaning that conventional poverty-targeted nutrition programs are misaligned with the population now most affected [2,5]. National nutrition policies, therefore, need to expand beyond food security frameworks to include regulatory responses to obesogenic food environments, such as restrictions on unhealthy food marketing and fiscal policies on sugar-sweetened beverages [2]. At the same time, investment in child undernutrition programs must be sustained, as both forms of malnutrition coexist within the same households. Addressing the intergenerational nature of DBM is

equally critical. Maternal short stature, older maternal age, and cesarean delivery all point to mechanisms that transmit nutritional risk across generations [4,62,63]. Investing in girls' education and women's empowerment directly disrupts these cycles by improving maternal nutrition knowledge, healthcare-seeking behavior, and household decision-making [13,21]. Programs targeting adolescent girls and young women before pregnancy can improve birth outcomes and reduce downstream DBM risk, and must therefore be repositioned as explicit upstream prevention strategies rather than standalone health activities [69,82]. Supporting breastfeeding through enforcement of the International Code of Marketing of Breast-milk Substitutes [82], paid maternity leave, and workplace lactation programs can simultaneously reduce child undernutrition and maternal overweight [72].

Research recommendations

Our findings highlight the need for longitudinal studies with detailed dietary assessments to clarify the causal pathways underlying household-level DBM. Understanding these mechanisms is essential, as it allows interventions to address not only observed associations but also the processes through which maternal and child nutrition risks are transmitted across generations. Moreover, evidence on the long-term consequences and temporal dynamics of DBM remains limited, making prospective studies critical to track how undernutrition and overnutrition coevolve within households and across the life course [83]. In addition, future research should assess the impact of specific policies and large-scale nutrition programs, particularly those targeting obesity prevention, food environments, and social protection. Evidence from existing evaluations is limited and inconsistent, leaving gaps in understanding which interventions can simultaneously reduce both undernutrition and overweight [84]. Strengthening longitudinal research and conducting rigorous program evaluations will expand the evidence base needed to design and scale interventions that effectively reduce DBM in South and Southeast Asia.

Strengths and limitations

This study represents one of the most comprehensive efforts to systematically review and quantitatively synthesize evidence on factors associated with household-level DBM in South and Southeast Asia. By integrating findings from multiple countries, it captures regional diversity and identifies both common and context-specific determinants of DBM. A comprehensive search across multiple databases, supplemented with manual searches, minimized the likelihood of missing relevant literature. All included studies demonstrated good methodological quality as assessed using the NOS-xs tool. Meta-analyses of 12 factors allowed quantification of pooled effects and assessment of heterogeneity, whereas subgroup analyses by DBM definition and region helped explain contextual variations. Sensitivity analyses and publication bias assessments confirmed the robustness and reliability of our findings, providing a strong evidence base to inform regional policy and programmatic responses.

However, several limitations should be acknowledged. First, all included studies employed cross-sectional designs, precluding causal inference. Longitudinal studies are needed to establish temporal relationships and identify critical windows for intervention. Second, substantial heterogeneity was observed for most factors, reflecting variations in study populations, DBM definitions, measurement methods, and analytical approaches. Although subgroup analyses partially explained this heterogeneity, residual variability remained. Third, the definition of DBM varied across studies, with some using composite definitions that combined multiple forms of child undernutrition. Although our subgroup analyses addressed this issue, standardized DBM definitions would facilitate more direct comparisons. Fourth, media exposure was consistently measured using a standard DHS definition (television, radio, or newspapers at least once per week). Although this supports comparability, it may not reflect current digital media landscapes, potentially limiting its validity in more recent study contexts. Fifth, we were unable to conduct meta-analyses for several potentially important factors due to insufficient data, including household size, birth order, food security, and dietary patterns. Sixth, a formal certainty of evidence assessment using the Grading of Recommendations, Assessment, Development and Evaluations approach was not undertaken, as its application to observational etiological evidence remains methodologically debated [85]. Readers should therefore interpret the pooled estimates with appropriate caution, considering the cross-sectional nature of included studies, the substantial heterogeneity observed for several factors, and the variation in DBM definitions across studies.

In conclusions, this systematic review and meta-analysis provide a comprehensive synthesis of household-level determinants of DBM in South and Southeast Asia. Findings of this study highlight the need for integrated, context-specific interventions that address both undernutrition and overnutrition across the life course. Policies should target not only poor and rural populations but also urban and affluent households experiencing nutrition transitions. Encouraging maternal education, promoting breastfeeding, and implementing interventions to prevent intergenerational malnutrition are critical to reducing DBM and achieving sustainable development goals related to nutrition and health. Future research should utilize longitudinal designs to establish causality, standardize DBM definitions to enhance comparability, and investigate the role of dietary patterns, food security, and household dynamics in DBM etiology.

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Author contributions

The authors' responsibilities were as follows – AT, HS: conceptualized and designed the study; AT, MAS: conducted the literature search; HS: resolved any discrepancies in the selected articles; AT: led the data analysis and interpretation of the results and drafted the manuscript; HS, MK, DG: supervising the analysis output; HS, MK, MAS, DG: critically revised the manuscript for intellectual content; and all authors: reviewed and edited subsequent drafts, read and approved the final version, and contributed to the decision to submit for publication.

Declaration of Generative AI and AI-assisted technologies in the writing process

The author(s) declare that no generative AI or AI-assisted technologies were used in the writing of this manuscript.

Conflict of interest

The authors report no conflicts of interest.

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Data availability

This review relied exclusively on publicly accessible data sources. The data processing methods described in the manuscript, along with the R scripts, are available from the corresponding author upon reasonable request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cdnut.2026.107683.

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Influence of Maternal Education and Household Wealth on Double Burden of Malnutrition in South and Southeast Asia

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ABSTRACT

The double burden of malnutrition (DBM), defined by the coexistence of undernutrition and overnutrition within households, poses significant public health challenges in South and Southeast Asia. While previous studies have examined the individual effects of maternal education and household wealth on DBM, findings remain inconsistent, and little is known about how these factors interact across different contexts. To address this gap, we used nationally representative Demographic and Health Survey (DHS) data from Bangladesh (2017–2018), Cambodia (2022), Nepal (2022) and Timor-Leste (2016) to analyse the interaction between maternal education and household wealth in shaping DBM risk. These countries were selected due to their ongoing nutritional transition, which has contributed to the increasing prevalence of DBM. For the analysis, we used DHS data, which employs a standardised multistage cluster sampling method and probabilistic methods to ensure representativeness. In this study, we selected mother–child pairs from the DHS survey, focusing on children aged 0–59 months and nonpregnant mothers at the time of the survey. We included those pairs for which both the mother and child had valid weight and height measurements. Maternal education and household wealth were identified as the primary exposures. To examine their interaction and the impact of other covariates on DBM, we employed multivariable logistic regression models. Our study found that DBM prevalence was higher in urban and wealthier households, with the highest rates observed in Timor-Leste and Cambodia. Multivariable logistic regression indicated that lower maternal education increased DBM risk, especially in affluent households (OR 2.07–3.29). Conversely, higher maternal education was associated with lower DBM prevalence. Additionally, breastfeeding and antenatal care visits emerged as protective factors. These findings indicate the necessity for specific interventions aimed at enhancing maternal education and promoting healthy dietary practices, particularly in rich households. Additionally, reinforcing breastfeeding practices and increasing antenatal care visits are essential strategies to mitigate the risks associated with DBM.

1 | Introduction

The coexistence of undernutrition (stunting, wasting, underweight and micronutrient deficiencies) and overnutrition (obesity or overweight) is known as the double burden of malnutrition (DBM), which can be measured at individual, household, community and country levels (Popkin et al. 2020). The primary driver of DBM is the nutrition transition, which involves significant shifts toward diets high in sugars, and fats alongside reduced physical activity (Popkin et al. 2020; Wells et al. 2020). In South and Southeast Asia, this transition is marked by a growing reliance on processed and fast foods, which

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Summary

- DBM is highly prevalent in South and Southeast Asia, with urban and wealthier households showing elevated rates, such as 15.8% in urban Bangladesh and 20.0% in urban Timor-Leste.
- Lower maternal education significantly increases the risk of DBM, especially in rich households, with odds ratios (OR) of 2.07 in Bangladesh, 3.29 in Nepal and 2.37 in Timor-Leste, while breastfeeding consistently acts as a protective factor.
- Specific interventions focusing on improving maternal education, promoting healthy dietary practices, reinforcing breastfeeding and enhancing antenatal care are critical to mitigating DBM in the region.

are replacing traditional, nutrient-dense diets rich in grains, vegetables and legumes (Gao et al. 2020; Bishwajit 2015; Baker and Friel 2014; Lipoeto et al. 2012). The shift is particularly evident in urban areas where economic growth, globalization and increased availability of cheap, highly processed foods have changed eating habits (Popkin and Ng 2021). This dietary shift is linked to rising rates of obesity and related non-communicable diseases, such as diabetes and hypertension, particularly among teenagers and adults (Popkin and Ng 2021; World Health Organization 2017; Leocádio et al. 2021). At the same time, child undernutrition persists due to factors like limited access to nutritious food and poor sanitation (World Health Organization 2017; Leocádio et al. 2021). As a result, the region is experiencing a simultaneous increase in obesity and undernutrition, which presents unique public health challenges.

Household-level DBM, where one person is overweight and another is underweight within the same household, is a crucial area for research and policy development because households containing underweight and overweight members is challenging for nutrition policy to address (Black et al. 2017). In South and Southeast Asia, rapid nutrition transitions, coupled with persistent child malnutrition, have contributed to a rising prevalence of household-level DBM. In Bangladesh, DBM increased from 4% in 2004 to 13.8% in 2018, with similar trends seen in Cambodia, Nepal and Timor-Leste (Talukder et al. 2024). Another study reported that 10.0% of households in this region had overweight mothers with stunted children and 7.0% had overweight mothers with wasted children (Biswas et al. 2020). Household-level DBM leads to severe health complications and higher healthcare costs, as addressing both undernutrition and obesity simultaneously requires more comprehensive and diverse medical care than treating either condition alone (World Health Organization 2017; Guevara-Romero et al. 2021; Fabron et al. 2023).

Previous studies have identified a number of risk factors for DBM (Hong 2020; Anik et al. 2019; Blankenship et al. 2020; Das et al. 2019; Patel et al. 2020; Seferidi et al. 2022; Ahinkorah et al. 2021; Kosaka and Umezaki 2017; Mekonnen et al. 2024; Oddo et al. 2012; Kimani-Murage et al. 2015; Wong et al. 2015; Roemling and Qaim 2013), with maternal education consistently highlighted as a key determinant. However, its association with household DBM remains inconsistent. For example, research in Myanmar found that households with mothers who had primary education had 62% higher likelihood of experiencing DBM compared to those with no maternal education (Hong 2020), while in India, mothers with secondary education had a 38% higher likelihood of DBM (Ramasubramani et al. 2024). In contrast, other studies indicate a protective effect, with higher maternal education linked to a lower DBM risk (Biswas et al. 2020; Ahinkorah et al. 2021; Kosaka and Umezaki 2017). A study in Bangladesh reported that households with mothers who had only primary education were 71% more likely to experience DBM than those where mothers had higher education (Sarker et al. 2022). In Ethiopia, mothers with college or higher education were 74% less likely to experience DBM compared to illiterate mothers (Mekonnen et al. 2024), and in Indonesia, higher maternal education was associated with a 22% lower likelihood of DBM (Oddo et al. 2012). Meanwhile, some studies found no significant association between maternal education and DBM.

The household wealth index is also a significant risk factor for DBM, with inconsistent results across previous studies. Some research suggests that higher income increases the risk of DBM (Biswas et al. 2020; Hong 2020; Patel et al. 2020; Mekonnen et al. 2024; Oddo et al. 2012). A study in South and Southeast Asia found that wealthier households had a 44% higher likelihood of experiencing DBM (Biswas et al. 2020). Similarly, in India, the risk was found to be 97% higher among wealthier households (Ramasubramani et al. 2024). In Bangladesh, wealthier households had a 38% greater likelihood of experiencing DBM (Sarker et al. 2022). In Pakistan and Ethiopia, the risk of DBM was more than double among richer households compared to poorer ones (Anik et al. 2019; Mekonnen et al. 2024). Conversely, other studies indicate that lower income may be more strongly associated with DBM. Research in Malaysia found that lower-income households were 30% more likely to experience DBM than wealthier households (Wong et al. 2015). Similarly, a study in Indonesia revealed that DBM prevalence was highest among the poorest population groups (Oddo et al. 2012).

Based on the above literature review, it is evident that maternal education and household wealth index both have significant effects on DBM at the household level, and both factors have contradictory relations with DBM. This inconsistency highlights the need for further research to clarify how these factors interact with DBM, particularly in South and Southeast Asia. Although, previous studies have explored the individual effects of maternal education and the wealth index on DBM (Hong 2020; Anik et al. 2019; Blankenship et al. 2020; Das et al. 2019; Patel et al. 2020; Seferidi et al. 2022; Ahinkorah et al. 2021; Kosaka and Umezaki 2017; Mekonnen et al. 2024; Oddo et al. 2012; Kimani-Murage et al. 2015; Wong et al. 2015; Roemling and Qaim 2013), none have investigated their interaction. Addressing this gap, our study contributes to the literature by examining how maternal education modifies the association between household wealth and DBM, providing a more comprehensive understanding of the socioeconomic determinants of DBM. Moreover, it is critical for policymakers to explore their interaction to develop effective strategies for preventing and managing all forms of malnutrition in this region. Therefore, our study aims to identify potential risk factors for household-level DBM within specific countries in South and Southeast Asia, with a focus on the interaction

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between maternal education and the wealth index. This will help us to clarify the role of maternal education in shaping the impact of wealth on DBM at the household level in South and South-east Asia.

2 | Methods

2.1 | Sources of Data and Study Population

We used the most recent data from the Demographic Health Survey (DHS) for four countries in South and South-east Asia: Bangladesh (BDHS 2017–2018), Cambodia (CDHS 2022), Nepal (NDHS 2022), and Timor-Leste (TLDHS 2016). We have chosen these countries because they are experiencing a nutritional transition from traditional diets to processed foods (Talukder et al. 2024; Khan and Talukder 2013; Subedi et al. 2017; Grieve 2024; Fry and Sigh 2024). This shift has led to both undernutrition and overnutrition, thereby increasing the prevalence of DBM across these countries. Moreover, DHS in these countries provided detailed and extensive information on various aspects of nutritional status, including anthropometric measurements and several health indicators for both mothers and children, which was essential for our study.

The DHS conducts cross-sectional surveys in low- and middle-income countries (LMICs). From the very beginning, the MEASURE DHS project has supported these standardised household surveys, focusing on health, socioeconomic status, nutrition and fertility among women of reproductive age (15–49 years) (DHS program 2024). To ensure that each unit has a specific chance of selection, the DHS employs a standardised sampling design that includes multistage cluster sampling and probabilistic methods (DHS Program 2024). The process begins with selecting proportional clusters, or enumeration areas, based on the latest population and housing census. We then systematically choose households from these clusters (DHS program 2024). Although the DHS sampling framework and sample designs vary from country to country, in most of the included surveys, sampling was stratified according to urban and rural areas, as well as geographical or administrative regions. Detailed information about the DHS sampling methodology and data collection procedures is available in the DHS reports for each country (National Institute of Statistics [NIS] MoH and ICF 2023; Ministry of Health and Population [Nepal], New ERA, and ICF 2023; NIPORT and ICF 2020; General Directorate of Statistics (GDS) and ICF 2018).

In this study, we selected mother–child pairs from the DHS survey, focusing on children aged 0 to 59 months and non-pregnant mothers at the time of the survey. We included those pairs with valid measures of weight and height for both the mother and her child. Observations with missing data on essential variables required to calculate the child's nutritional status and the mother's BMI were excluded. This approach resulted in varying sample sizes by country and year. For instance, in Bangladesh, we initially had 8759 mother–child pairs from 2018. After excluding 1041 pairs due to missing data on child nutrition and mothers' BMI, the final sample size for analysis was $n = 7718$ pairs. We applied the same process to other three countries, yielding final sample sizes for Cambodia ($n = 3836$), Nepal ($n = 2596$), and Timor-Leste ($n = 6309$).

2.2 | Outcome Variable

The DHS used anthropometric measurements (weight and height/length) to assess the nutritional status of children under five. We used key indicators such as height-for-age, weight-for-age and weight-for-height. We applied the 2006 World Health Organisation (WHO) growth standards to calculate anthropometric z-scores for children. Based on these z-scores, children were classified as stunted (height-for-age z-score < -2), underweight (weight-for-age z-score < -2) or wasted (weight-for-height z-tally < -2). For mothers, we calculated body mass index (BMI) as weight (kg) divided by height squared (m^2). In most previous studies, maternal overweight or obesity was defined as a BMI of 25.0 kg/m^2 or higher. However, due to the increased risk of cardiovascular disease and diabetes at lower BMI levels among Asians compared to non-Asians, the WHO recommended in 2004 using a modified threshold of 23.0 kg/m^2 to define overweight for Asians instead of 25.0 kg/m^2 (WHO Expert Consultation 2004). Consequently, in this study, maternal weight status was categorised as follows: underweight (BMI < 18.5 kg/m^2), normal weight (18.5–22.9 kg/m^2), overweight/obese ($\geq$ 23 kg/m^2).

To identify household-level DBM, we looked for households where the mother was overweight or obese and the child was undernourished (underweight, stunted, or wasted). We created a composite outcome variable for households where an overweight or obese mother coexisted with at least one form of child undernutrition. Thus, DBM refers to a household with an overweight or obese mother and a stunted or wasted, or underweight child.

2.3 | Exposures and Covariates

We used maternal education and the wealth index as key exposures in this study. We measured maternal education using the highest level of education obtained and the number of years of education completed. After that, maternal education was categorised into three levels: no or primary education, secondary education, and higher education. The wealth index, a composite measure reflecting overall household living standards, was derived using principal component analysis (PCA) by the DHS program (National Institute of Statistics [NIS] MoH and ICF 2023; Ministry of Health and Population [Nepal], New ERA, and ICF 2023; NIPORT and ICF 2020; General Directorate of Statistics (GDS) and ICF 2018). Households were initially divided into five quintiles (Q) based on PCA results: $Q1$: poorest, $Q2$: poorer, $Q3$: middle, $Q4$: richer, and $Q5$: richest. For our analysis, we simplified this into three categories: poor ($Q1$/$Q2$), middle ($Q3$), and rich ($Q4$/$Q5$).

We also considered several covariates that may also influence nutrition status based on existing literature, including both individual and household-level factors. Individual-level variables included the mother's employment status (employed or not), continuous breastfeeding status (yes, no), child sex (male, female), and the number of antenatal care (ANC) visits during pregnancy ($\leq$ 4 visits or > 4 visits). Household-level covariates included geographical location (rural or urban) and household size ($\leq$ 4 members or > 4 members).

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2.4 | Statistical Analysis

In the analysis, we applied the sampling weights provided in the DHS data set to adjust for the complex survey design, including stratification and clustering. This approach ensured that the findings were nationally representative and accounted for design effects, reflecting the actual distribution of the population. We conducted a descriptive analysis to outline the characteristics of the study population. We employed bivariate chi-square tests to explore the association between all predictor variables and DBM, given that both the dependent and independent variables in the study were categorical. We then fitted binary logistic regression models to evaluate the impact of risk factors on DBM, considering two distinct categories of DBM (yes/no). We evaluated the effects of predictor variables on the dependent variable (household-level DBM) using odds ratios (OR), comparing each category to a reference category where the OR equals 1. An OR greater than 1 indicates higher odds of household-level DBM compared to the reference category, and vice versa.

To analyse the interaction effects of maternal education and household wealth on DBM, we applied multivariable logistic regression models using data from Bangladesh, Cambodia, Nepal, and Timor-Leste, as well as regional datasets for South Asia (Bangladesh and Nepal) and Southeast Asia (Cambodia and Timor-Leste). We selected these two variables for interaction analysis because both independently influence DBM, but their combined effect remains unclear. Investigating their interaction allows us to assess whether higher maternal education mitigates the DBM risk associated with wealth. The interaction terms were constructed by cross-classifying the three categories of maternal education (primary, secondary and higher) with the three categories of household wealth (poor, middle and rich), resulting in nine distinct groups. In all models, households with "poor wealth and no/primary education" were set as the reference category. The logistic regression analysis estimated ORs and 95% confidence intervals (CIs) for each interaction category.

To account for potential confounding variables that could influence the relationship between the primary exposures and the outcome, we adjusted for several key factors, including child sex, maternal employment status, the number of ANC visits, breastfeeding status and household size. These variables were selected based on their potential to confound the relationship between maternal education, household wealth and the prevalence of DBM. To ensure that the predictors in our models were not highly correlated with each other, we tested for multicollinearity among predictors (variance inflation factor < 5). We chose the final model based on the Akaike Information Criterion (AIC), with the model having the lowest AIC being preferred. We assessed the goodness of fit of the regression model using the Hosmer and Lemeshow test, which evaluates how well the predicted probabilities align with the observed outcomes across different risk groups. A nonsignificant result ($p > 0.05$) indicates that there is no substantial discrepancy between the observed and expected values, suggesting that the model adequately fits the data. This implies that the model's predictions are reliable and that it appropriately captures the relationship between predictor variables and the outcome. We performed all the data analysis using SPSS and R (R Foundation for Statistical Computing, Vienna, Austria) software.

2.4.1 | Ethics Statement

This study used secondary data collected by MEASURE DHS. All procedures performed in this study involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. As the data are freely available on the website, ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements.

3 | Results

3.1 | Prevalence of Household-Level DBM

Table 1 presents the prevalence of DBM at the household level across various background characteristics in Bangladesh, Cambodia, Nepal and Timor-Leste. DBM was more prevalent in urban and wealthier households across all countries, with significant differences observed between socioeconomic groups. Households where mothers had lower educational attainment also exhibited higher DBM prevalence. While household size showed inconsistent associations, larger households (more than four members) in Cambodia (15.6%) and Timor-Leste (15.3%) had higher DBM prevalence. Maternal employment status displayed country-specific variations, with nonworking mothers in Nepal associated with lower DBM prevalence (11%), while no significant differences were observed in other countries. Breastfeeding was consistently linked to lower DBM prevalence, suggesting its potential protective effect. Additionally, inadequate ANC (fewer than four visits during pregnancy) was associated with higher DBM prevalence, emphasizing the importance of maternal healthcare access in mitigating nutritional disparities at the household level.

3.2 | Distribution of Participants According to Maternal Education and Wealth Index

Figure 1 shows the distribution of participants by socioeconomic status (poor, middle, rich) and education level (no/primary, secondary, higher) across Bangladesh, Cambodia, Nepal and Timor-Leste. The figure reveals that mothers with no or primary education are most prevalent among poor households, accounting for 53.7% in Bangladesh, 71.1% in Cambodia, 69.6% in Nepal and 67.2% in Timor-Leste. Middle-income households show more varied distributions, typically having a higher percentage of mothers with secondary education, such as 55.2% in Bangladesh and 48.1% in Timor-Leste, whereas no or only primary education remains prevalent in Cambodia (51.4%) and Nepal (52.9%). Among rich households, mothers' education levels are more diverse, with secondary education being the most common in Nepal (51.4%), Cambodia (53.2%) and Timor-Leste (63.2%). Across all socioeconomic groups, particularly in

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TABLE 1 | Prevalence of double burden of malnutrition (DBM) at household level by background characteristics in Bangladesh, Cambodia, Nepal and Timor-Leste along with associated *p* values obtained from chi-square test.

	Bangladesh ($n = 7718$)		Cambodia ($n = 3836$)		Nepal ($n = 2596$)		Timor-Leste ($n = 6309$)	
Covariates	***n* (%)**	***p* value**	***n* (%)**	***p* value**	***n* (%)**	***p* value**	***n* (%)**	***p* value**
Place of residence								
Urban	427 (15.8)	$p < 0.01$	262 (19.4)	$p < 0.01$	182 (14.2)	$p < 0.05$	368 (20.0)	$p < 0.01$
Rural	597 (11.9)		300 (12.1)		146 (11.1)		571 (12.8)	
Child sex								
Female	487 (13.2)	0.598	260 (13.9)	0.202	160 (12.4)	0.650	433 (14.2)	0.147
Male	545 (13.6)		302 (15.4)		168 (12.9)		506 (15.5)	
Wealth index								
Poor	361 (11.0)	$p < 0.01$	218 (11.9)	$p < 0.01$	151 (10.8)	$p < 0.01$	266 (10.3)	$p < 0.01$
Middle	203 (14.5)		109 (15.5)		66 (13.1)		204 (16.0)	
Rich	460 (15.2)		235 (18.0)		111 (16.1)		469 (19.2)	
Mother's education								
No/Primary	390 (14.0)	$p < 0.01$	379 (17.8)	$p < 0.01$	211 (14.0)	$p < 0.05$	355 (12.8)	$p < 0.01$
Secondary	498 (13.6)		168 (11.0)		105 (10.5)		514 (17.0)	
Higher	136 (10.6)		115 (8.6)		112 (13.3)		70 (14.1)	
Household member								
< 4	308 (12.6)	0.226	201 (13.2)	$p < 0.05$	104 (12.4)	0.763	119 (12.8)	$p < 0.05$
> 4	716 (13.6)		361 (15.6)		224 (12.8)		820 (15.3)	
Working status of mother								
No	601 (13.1)	0.682	212 (14.3)	0.641	120 (11.0)	$p < 0.05$	612 (15.1)	0.532
Yes	423 (13.5)		350 (14.9)		208 (13.8)		327 (14.5)	
Breastfeeding status								
No	494 (16.0)	$p < 0.01$	417 (17.1)	$p < 0.01$	152 (17.2)	$p < 0.01$	508 (17.3)	$p < 0.01$
Yes	530 (11.4)		145 (10.4)		176 (10.3)		431 (12.8)	
ANC visits								
< 4	319 (13.3)	$p < 0.05$	120 (15.6)	$p < 0.05$	137 (11.8)	$p < 0.05$	439 (15.8)	$p < 0.05$
> 4	245 (11.4)		172 (12.1)		115 (7.9)		207 (13.3)	

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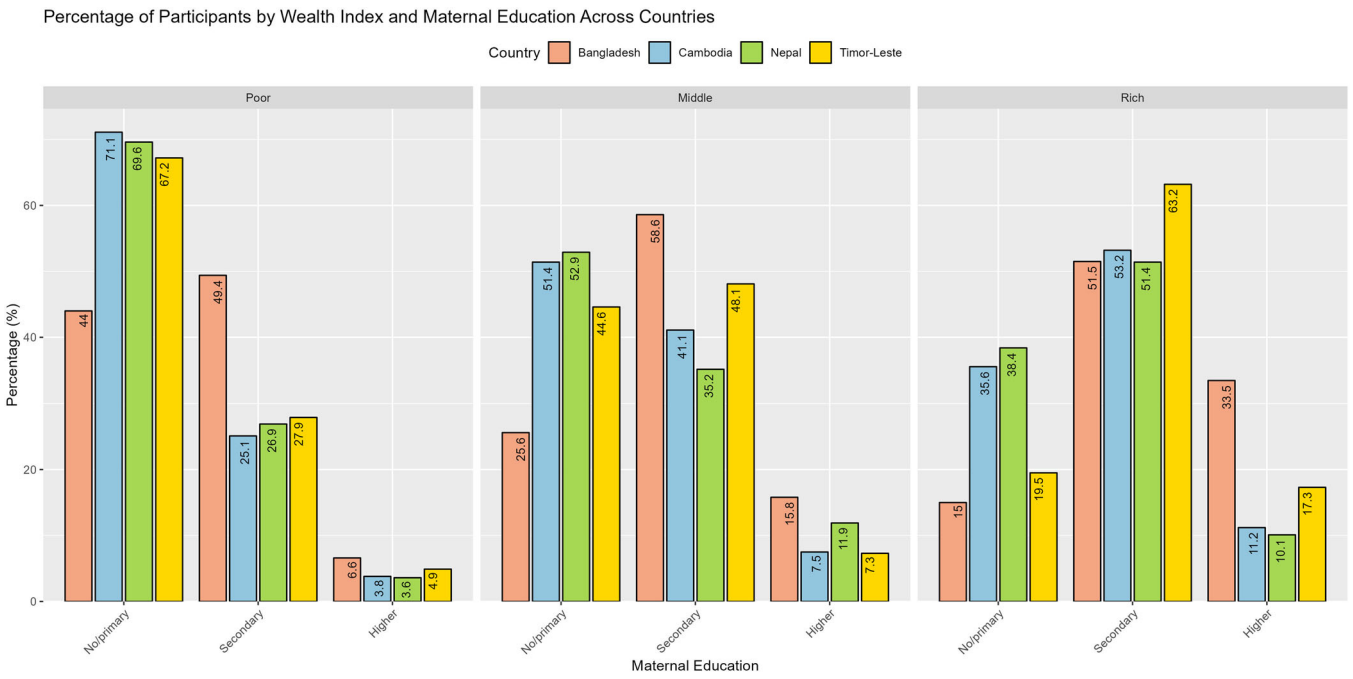

FIGURE 1 | Percentage distribution of participants by wealth index and maternal education across countries.

poor households, the proportion of mothers with higher education remains consistently low.

3.3 | Determinants of Household-Level DBM

Table 2 depicts the risk factors associated with household-level DBM among the four countries. To identify these risk factors, we used a multivariate logistic regression model and presented them as adjusted odds ratios (AOR) of explanatory variables with 95% confidence intervals (95% CI) and the Hosmer and Lemeshow goodness of fit test. The findings indicate that the place of residence was strongly associated with a higher prevalence of DBM in all four countries. For example, in Bangladesh, urban households were 43% (AOR 1.43; 95% CI: 1.17, 1.76) more likely to suffer from DBM compared to rural households. Wealthier households, particularly those classified as "rich," have a higher likelihood of DBM, with the most pronounced effect in Bangladesh (AOR 1.60; 95% CI: 1.27, 2.03) and Nepal (AOR 1.83; 95% CI: 1.20, 2.78). Similarly, households with mothers having no or only primary education face increased DBM risk, with the highest AORs observed in Nepal (AOR 2.98; 95% 95% CI: 1.06, 3.49). Larger households (more than four members) show increased odds of DBM in Cambodia (AOR 1.39; 95% CI: 1.06, 1.82), although the effect is not significant in other countries. In any country, the mother's working status does not show a significant relationship with DBM. However, breastfeeding status was found to be a protective factor against DBM across all countries, with the strongest protective effect noted in Nepal (AOR 0.41; 95% CI: 0.25, 0.69). Moreover, households where mothers received less than four ANC visits are more likely to experience DBM, with significant associations found in Bangladesh, Cambodia and Nepal. The Hosmer and Lemeshow test results, with p values ranging from 0.14 to 0.82, confirm that the logistic regression models provide a good fit across all countries. These values indicate that the models appropriately capture the relationship between explanatory variables and household-level DBM, supporting the reliability of the findings.

3.4 | Country Wise Interaction Effects Between Maternal Education and Wealth Index on Household-Level DBM

Table 3 presents the regression model estimates for the interaction effects of wealth index and mother's education on household-level DBM in Bangladesh, Cambodia, Nepal and Timor-Leste. Interaction analysis confirmed that DBM risk was significantly higher in affluent households where mothers had lower education (ORs: 2.07–3.29), particularly in Nepal. However, high maternal education mitigated this risk, reducing odds of DBM by 51% in Nepal (OR: 0.49, 95% CI: 0.33–0.74), 54% in Cambodia (OR = 0.46; 95% CI: 0.48–0.88) and 47% in Timor-Leste (OR = 0.53; 95% CI: 0.38–0.74). This protective effect of higher maternal education is further highlighted in Nepal, where poor households with mothers having higher education also demonstrate a 51% lower likelihood of DBM (OR = 0.49; 95% CI: 0.31–0.79). However, rich households with mothers having secondary education show a 54% higher likelihood of DBM in Bangladesh (OR = 1.54; 95% CI: 1.26–1.88) but not in Cambodia, Nepal or Timor-Leste.

3.5 | Region Wise Interaction Effects Between Maternal Education and Wealth Index on Household-Level DBM

Table 4 highlights the interaction between the wealth index and maternal education on household-level DBM in South Asia (Bangladesh and Nepal) and Southeast Asia (Cambodia and Timor-Leste). In both regions, affluent households with mothers having no or primary education are more likely to experience DBM, with the risk higher in South Asia (OR = 2.17; 95% CI: 1.73–2.71).

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TABLE 2 | Regression model estimates of household-level DBM in Bangladesh, Cambodia, Nepal and Timor-Leste along with Hosmer and Lemeshow goodness of fit test.

Covariates	Bangladesh AOR (95% CI)	Cambodia AOR (95% CI)	Nepal AOR (95% CI)	Timor-Leste AOR (95% CI)
Place of residence				
Rural	Reference	Reference	Reference	Reference
Urban	1.43 (1.17, 1.76)***	1.72 (1.29, 2.29)***	1.54 (1.03, 2.33)**	1.55 (1.26, 1.91)***
Child sex				
Female	Reference	Reference	Reference	Reference
Male	1.04 (0.91, 1.18)	1.12 (0.94, 1.35)	0.95 (0.75, 1.19)	1.11 (0.97, 1.27)
Wealth index				
Poor	Reference	Reference	Reference	Reference
Middle	1.42 (1.11, 1.82)***	1.34 (0.94, 1.91)	1.02 (0.62, 1.69)	1.58 (1.25, 2.02)***
Rich	1.60 (1.27, 2.03)***	1.40 (1.03, 1.96)**	1.83 (1.20, 2.78)***	1.69 (1.33, 2.16)***
Mother's education				
No/Primary	1.54 (1.15, 2.08)***	2.06 (1.08, 3.95)**	2.98 (1.06, 3.49)**	1.47 (1.06, 2.05)**
Secondary	1.43 (1.09, 1.87)**	1.18 (0.62, 2.26)	2.78 (0.98, 3.72)	1.46 (1.08, 1.97)**
Higher	Reference	Reference	Reference	Reference
Household member				
< 4	Reference	Reference	Reference	Reference
> 4	1.09 (0.90, 1.32)	1.39 (1.06, 1.82)**	1.29 (0.88, 1.90)	0.97 (0.78, 1.19)
Working status of mother				
No	Reference	Reference	Reference	Reference
Yes	0.86 (0.72, 1.03)	1.03 (0.79, 1.34)	1.26 (0.88, 1.80)	0.92 (0.77, 1.09)
Breastfeeding status				
No	Reference	Reference	Reference	Reference
Yes	0.64 (0.52, 0.81)***	0.68 (0.52, 0.89)***	0.41 (0.25, 0.69)***	0.74 (0.62, 0.87)***
ANC visits				
< 4	Reference	Reference	Reference	Reference
> 4	0.71 (0.59, 0.86)***	0.63 (0.48, 0.82)***	0.56 (0.38, 0.84)***	0.91 (0.76, 1.09)
Goodness of fit				
Hosmer and Lemeshow test	$\chi^2 = 12.94$	$\chi^2 = 9.33$	$\chi^2 = 4.39$	$\chi^2 = 8.14$
	p value = 0.14	p value = 0.32	p value = 0.82	p value = 0.42

Note: AOR, adjusted odds ratio, which is calculated by adjusting all the covariates in the model.
**$p < 0.05$; ***$p < 0.01$.

Conversely, affluent households with mothers who have higher education are 66% less likely to face DBM, especially in Southeast Asia (OR = 0.34; 95% CI: 0.19–0.49). Maternal education also lowers DBM risk by 41% at poor households in South Asia (OR = 0.59; 95% CI: 0.42–0.84), though this effect is not significant in Southeast Asia. Middle-income households with mothers having no or primary education show a higher likelihood of DBM across both regions, but no significant difference is found for those with secondary or higher education.

4 | Discussion

In this study, we observed substantial differences in the prevalence and determinants of household-level DBM across Bangladesh, Cambodia, Nepal and Timor-Leste. Our findings indicate that urban and affluent households were more likely to experience higher DBM prevalence, with urban areas in Cambodia and wealthier households in Timor-Leste showing the highest levels. Additionally, households where mothers had lower educational attainment were disproportionately affected by DBM. In Cambodia, factors like larger household size and fewer ANC visits were further associated with increased DBM risk. Our multivariable logistic regression analysis confirmed that urban residence and household wealth were key risk factors for DBM, while continuous breastfeeding consistently emerged as a protective factor across all countries. Notably, our findings underscore the complex relationship between wealth and education, as we found that affluent households with less-educated mothers were more likely to experience DBM.

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TABLE 3 | Regression model estimates for the interaction effect of wealth index and mother's education for household-level DBM in Bangladesh, Cambodia, Nepal and Timor-Leste.

Interaction effect: Wealth index × mother's education	Bangladesh OR (95% CI)	Cambodia OR (95% CI)	Nepal OR (95% CI)	Timor-Leste OR (95% CI)
Poor × No/primary education	Reference	Reference	Reference	Reference
Poor × Secondary education	1.04 (0.84, 1.31)	0.33 (0.43, 2.49)	0.87 (0.59, 1.28)	0.87 (0.64, 1.18)
Poor × Higher education	0.67 (0.36, 1.27)	0.65 (0.28, 1.13)	0.49 (0.31, 0.79)***	1.13 (0.34, 3.77)
Middle × No/primary education	1.59 (1.19, 2.12)***	0.98 (0.73, 1.32)	1.53 (0.84, 2.79)	1.99 (1.12, 3.53)**
Middle × Secondary education	1.19 (0.93, 1.54)	0.92 (0.59, 1.28)	0.86 (0.51, 1.48)	1.09 (0.74, 1.59)
Middle × Higher education	1.27 (0.82, 1.97)	0.72 (0.47, 1.11)	0.89 (0.55, 1.46)	1.51 (0.63, 3.61)
Rich × No/primary education	2.07 (1.62, 2.65)***	1.37 (1.03, 1.83)**	3.29 (1.88, 5.75)***	2.37 (1.81, 3.13)***
Rich × Secondary education	1.54 (1.26, 1.88)	0.37 (0.49, 2.91)	1.42 (0.62, 1.38)	0.86 (0.59, 1.25)
Rich × Higher education	0.98 (0.79, 1.28)	0.46 (0.48, 0.88)**	0.49 (0.33, 0.74)***	0.53 (0.38, 0.74)***

Note: Estimates are obtained by controlling other covariates in the model.
**$p < 0.05$; ***$p < 0.01$.

TABLE 4 | Regression model estimates for the interaction effect between wealth index and mother's education for household-level DBM in South Asia (Bangladesh and Nepal) and Southeast Asia (Cambodia and Timor-Leste).

Interaction effect: Wealth index × mother's education	South Asia ($N = 10, 713$) (Bangladesh and Nepal) OR (95% CI)	Southeast Asia ($N = 10, 348$) (Cambodia & Timor-Leste) OR (95% CI)
Poor × No/primary education	Reference	Reference
Poor × Secondary education	1.01 (0.84, 1.22)	0.91 (0.75, 1.11)
Poor × Higher education	0.59 (0.42, 0.84)***	0.68 (0.24, 1.91)
Middle × No/primary education	1.58 (1.21, 2.03)***	1.55 (1.28, 1.89)***
Middle × Secondary education	1.12 (0.89, 1.41)	1.07 (0.87, 1.32)
Middle × Higher education	1.13 (0.82, 1.54)	0.93 (0.42, 2.08)
Rich × No/primary education	2.17 (1.73, 2.71)***	1.55 (1.27, 1.89)***
Rich × Secondary education	1.31 (0.81, 1.61)	1.01 (0.77, 1.31)
Rich × Higher education	0.43 (0.27, 0.59)***	0.34 (0.19, 0.49)***

Note: Estimates are obtained by controlling other covariates in the model.
***$p < 0.01$.

In contrast, in Cambodia, Nepal and Timor-Leste, rich households with more educated mothers showed a lower likelihood of facing DBM challenges. Overall, both South Asia and Southeast Asia demonstrated a heightened DBM risk among middle- or high-income households with less-educated mothers, whereas wealthier households with more educated mothers were less likely to face such challenges in both regions.

Our study revealed that both maternal education and wealth significantly influence the likelihood of developing DBM at the household level. Specifically, households with less-educated mothers are more prone to experience DBM compared to those with higher-educated mothers, aligning with findings from previous studies (Biswas et al. 2020; Ahinkorah et al. 2021; Kosaka and Umezaki 2017; Mekonnen et al. 2024; Oddo et al. 2012). Conversely, wealthier households also demonstrate a higher likelihood of DBM when compared to poorer households, consistent with research conducted in Bangladesh and neighbouring countries (Biswas et al. 2020; Hong 2020; Patel et al. 2020; Mekonnen et al. 2024; Oddo et al. 2012). These findings challenge the conventional link between higher wealth and greater educational attainment, suggesting the need for an interaction analysis between the wealth index and maternal education.

Our interaction analysis indicated that DBM is particularly prevalent in wealthy households with less-educated mothers across all studied countries, whereas it is less common in wealthy households with higher-educated mothers in Cambodia, Nepal and Timor-Leste. This discrepancy may be attributed to dietary transitions in affluent households, which often lead to an increased consumption of energy-dense, nutrient-poor foods, thereby heightening the risk of overweight and obesity (Biswas et al. 2017; Ahmed et al. 2020). Additionally, less-educated mothers may lack the knowledge and awareness necessary for

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making informed nutritional and lifestyle choices, which exacerbates the risk of DBM (Fanzo et al. 2019). In contrast, higher-educated mothers in wealthier households are more likely to adopt healthier nutritional practices, contributing to a reduced prevalence of DBM (Rayhan and Khan 2006; Kishawi et al. 2016).

Our study also revealed that place of residence is a significant factor for household-level DBM in all the selected countries. Urban households were more likely to experience DBM than their rural counterparts, a finding consistent with previous studies conducted in India (Patel et al. 2020). Research shows that women in urban areas have a higher prevalence of obesity compared to those in rural areas, which further increases the risk of metabolic diseases in urban households (Hasan et al. 2015). Unhealthy dietary practices and sedentary lifestyles with a lack of physical activity further elevate the risk of overweight and obesity in urban settings (Patel et al. 2020; Hasan et al. 2015). Although urban children on average are less likely to suffer from undernutrition compared to rural children, this does not extend uniformly to all urban children, especially those living in poverty. In densely populated low-income urban areas, challenges such as inadequate housing, limited access to services, vulnerability to environmental dangers, and insufficient and irregular earnings contribute to food insecurity and malnutrition (Talukder et al. 2024; Bartlett and Tacoli 2021).

Our findings indicated that breastfeeding is a crucial protective factor against DBM at the household level in all the selected countries. Households with mothers who engage in continuous breastfeeding for their child are less likely to experience DBM compared to those where mothers do not maintain continuous breastfeeding. This finding aligns with previous studies (Hong 2020). Breastfeeding not only meets children's daily nutritional needs by providing essential micronutrients, but also helps mothers lose postpartum weight by burning extra calories (Oddy et al. 2006; Krause et al. 2011). As a result, inadequate breastfeeding practices can lead to both maternal overweight and child malnutrition. Additionally, the duration of breastfeeding plays a key role in reducing the risk of DBM. Studies show that exclusive breastfeeding for up to 6 months has been shown to improve children's health and nutritional outcomes and reduce postpartum weight retention (Hong 2020). Therefore, promoting optimal breastfeeding practices is essential for supporting children's growth and development and preventing maternal obesity.

Our study also identified that households where mothers received less than four ANC visits are more likely to experience DBM in all four countries. This is likely because antenatal visits are critical for providing nutritional guidance, early health issue detection, and necessary supplements like iron and folic acid (Luwangula et al. 2022; Marshall et al. 2021). On the other hand, inadequate ANC leaves mothers without crucial information on proper nutrition during pregnancy and breastfeeding (Brink et al. 2022), potentially leading to poor dietary practices that result in undernutrition for the child and obesity for the mother. Additionally, fewer antenatal visits may result in undiagnosed or poorly managed maternal health conditions, which can negatively impact foetal growth and development (Rayment-Jones et al. 2021), further exacerbating the risk of malnutrition in children. Therefore, increasing the frequency and quality of ANC visits is critical to reducing the risk of DBM by ensuring that both mothers and their children receive the necessary health support and nutritional guidance during this crucial period.

Household size is found to be an important predictor of DBM in Cambodia. Numerous factors related to resource management and nutritional challenges within Cambodian households may contribute to this increased risk. In larger families, distributing food and resources among more members can become a complicated effort to provide adequate and balanced nutrition for everyone (Das et al. 2019). This competition for limited food supplies may result in insufficient nutrient intake for some members (Fooken and Vo 2021). Moreover, economic constraints often faced by larger households can further limit their access to quality food and healthcare services (Blankenship et al. 2020), exacerbating both undernutrition and overweight issues simultaneously. In contrast, households in other countries studied may experience different household dynamics or resource allocations that help to mitigate the effects of household size on DBM. Thus, the relationship observed in Cambodia indicates the importance of considering contextual factors when assessing nutritional outcomes in diverse settings.

The patterns of DBM observed across the studied countries can be better understood by considering their diverse cultural, economic and social contexts. In South and Southeast Asia, rapid urbanization and dietary shifts have led to greater reliance on processed foods, especially in wealthier households with lower maternal education, contributing to the rise of DBM (Gao et al. 2020; Bishwajit 2015; Lipoeto et al. 2012). Deeply entrenched social hierarchies and gender norms in these countries often influence food distribution within households, with men and older family members being prioritized (Diamond-Smith et al. 2022; Harris-Fry et al. 2017), which exacerbates child undernutrition and increases the risk of overweight among women. Timor-Leste, with its limited economic development and persistent food insecurity (Development Asia 2024; Nomura et al. 2023), faces a unique challenge where DBM is emerging alongside ongoing efforts to address chronic malnutrition. These contextual differences highlight the need for targeted, culturally sensitive interventions that address the specific sociocultural and economic drivers of DBM in each country.

4.1 | Strength and Limitations

Our study has several strengths and limitations. One of its key strengths is its reliance on nationally representative surveys with large sample sizes and minimal missing data, which enhances the reliability and precision of the findings. The use of DHS data offers significant advantages, including high response rates, comprehensive national coverage, standardized data collection procedures and rigorous interviewer training. Despite these advantages, the cross-sectional design of the study limits the ability to establish causal relationships, a limitation that could be addressed through a longitudinal study. Additionally, the study could not account for other potentially significant

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factors related to DBM and household-level factors, such as daily dietary patterns, physical activity, caregiving practices, cultural influences, and detailed pregnancy and birth information, as these variables are not included in the DHS data set.

5 | Conclusion

Our findings show that DBM particularly affects rich households with less-educated mothers, while it is less likely to affect households with more educated mothers. We also found that breastfeeding and ANC visits serve as protective factors against DBM. To reduce the increasing rate of DBM, we recommend a number of policy actions. First, interventions should aim to enhance maternal education on nutrition and health, empowering mothers to make informed dietary choices. Targeted nutrition programmes should focus on addressing the paradox of wealth and malnutrition by promoting dietary diversity and reducing the consumption of processed foods in affluent households. It is essential to prioritise the promotion of continuous breastfeeding for at least 12 months to support optimal child health and maternal well-being. Additionally, increasing ANC visits should be encouraged, as these visits offer crucial nutritional guidance and monitoring for both mothers and children. Policies should focus on improving dietary quality and nutritional practices in wealthier households to mitigate the risks associated with high wealth and poor nutritional habits. Lastly, follow-up studies, including qualitative research and intervention trials, could provide valuable insights into effective strategies for reducing the prevalence of DBM in these regions.

Author Contributions

A.T. and H.S. conceptualized and designed the study. A.T. led the data analysis and interpretation of the results. A.T. drafted the manuscript, with H.S., M.K. and D.G. supervising the analysis output. H.S., M.K. and D.G. critically revised the manuscript for intellectual content. All authors reviewed and edited subsequent drafts, read and approved the final version, and contributed to the decision to submit for publication.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data are freely available in the public domain at the following link: https://dhsprogram.com/data/dataset_admin/login_main.cfm?CFID=300458265&CFTOKEN=26bd09600ba5696-DE5E82D0-A6C1-5C66-C216C2CD9B9E82D9.

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Caesarean deliveries and double burden of malnutrition: a multicountry analysis in South and Southeast Asia

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ABSTRACT

Background: The increasing prevalence of caesarian section (C-section) births in South and Southeast Asia poses potential public health challenges by influencing maternal and child nutrition. These changes may contribute to the growing double burden of malnutrition (DBM), where maternal overweight/obesity coexists with child undernutrition. This study explores how C-section deliveries are linked to household-level DBM in three countries in this region. Understanding this link is key for developing effective interventions to improve maternal and child nutrition and reduce health burdens.

Methods: We analysed 2022 Demographic and Health Survey (DHS) data from Bangladesh, Cambodia, and Nepal, including women aged 15–49 with at least one child, with available nutritional and delivery mode data. Chi-square tests, analysis of variance, and two-level logistic regression were used to assess the association between C-sections and DBM.

Results: C-section deliveries were linked to a significantly higher risk of DBM in Bangladesh and Nepal. Delayed breastfeeding initiation after C-section further increased this risk. Urban households showed higher DBM rates, while longer breastfeeding duration was protective.

Conclusion: To reduce DBM, policies should focus on limiting unnecessary C-sections, promoting early and sustained breastfeeding, and supporting maternal postpartum health—especially in urban areas where risks are higher. Understanding local factors is crucial for effective interventions.

Keywords: breastfeeding practices; caesarean section (C-section); double burden of malnutrition (DBM); maternal obesity; multilevel logistic regression; south and Southeast Asia

Introduction

The health and nutritional impact of caesarean section (C-section) births on mothers and children is a major concern in maternal and child health. While C-sections are often necessary to prevent maternal and neonatal morbidity and mortality, they can also lead to significant health and nutritional challenges for both mothers and children.[1,2] C-section deliveries may increase the risk of maternal complications, including infections, prolonged recovery times, and difficulties in subsequent pregnancies.[3–6] These complications can interfere with optimal feeding practices, particularly breastfeeding, which is essential for child nutrition and immune protection.[7,8] Additionally, the surgical nature of C-sections may disrupt early mother–child bonding, potentially affecting the successful initiation of breastfeeding.[8–10] This can contribute to inadequate child nutrition and an increased risk of malnutrition in early childhood.[11,12]

Infants delivered via C-section are less likely to be exclusively breastfed, often due to maternal recovery challenges such as pain, fatigue, and delayed lactation initiation.[13–15] This can lead to increased reliance on formula feeding,[14–17] which may not provide the same immune and nutritional benefits as breast milk, potentially affecting child growth and metabolism and increasing the risk of undernutrition.[18–21] Additionally, disruptions in gut microbiota composition among C-section-delivered infants can impair nutrient absorption and increase the risk of obesity, metabolic syndrome, and other noncommunicable diseases later in life.[22–24]

The postpartum period after a C-section presents unique challenges for mothers, including longer recovery times,

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limited mobility, and metabolic changes such as insulin resistance and altered lipid metabolism, which increase the risk of excessive weight gain and obesity.[12,25–28] Postpartum fatigue and psychological stress may also influence dietary habits, worsening weight retention.[28] Recent evidence shows that mothers who undergo C-section deliveries are more likely to experience postpartum overweight and obesity.[29–31] For example, one study found that 21.5% of C-section mothers were obese compared to 13.2% of those with vaginal births, and their children also had a higher risk of obesity by age three.[32] A meta-analysis of 28 studies further reported a 34% increased risk of childhood obesity among caesarean-delivered children.[33] In low-income settings such as Ghana, C-section births have also been linked to lower height-for-age z-scores, indicating a greater risk of stunting.[18] Similarly, India's National Family Health Survey (NFHS)-5 (2019–21) data shows that children born via C-section experience higher rates of stunting, wasting, and underweight than those born vaginally.[34] As maternal overweight is also a known risk factor for C-section delivery,[35–37] these findings suggest a plausible bidirectional pathway linking C-section births to the double burden of malnutrition (DBM) at the household level—where overnutrition in mothers and undernutrition in children coexist.

Although a few studies have highlighted this potential link, the evidence remains limited. One previous study examined the association between C-section births and household-level DBM using an earlier wave of Bangladesh Demographic and Health Survey (DHS) data,[12] but it was restricted to a single-country context and did not consider broader regional patterns. Moreover, household nutrition dynamics may have shifted in recent years due to changing health systems, rising urbanization, and evolving food environments, making updated evidence essential. Our study responds to this need by analysing the most recent DHS data from Bangladesh, Cambodia, and Nepal to assess the relationship between C-section deliveries and household-level DBM. By incorporating geographic and urban–rural dimensions, this study offers a regional and comparative perspective, providing timely evidence to inform integrated maternal and child nutrition strategies across South and Southeast Asia.

Methods

Data source and study population

We analysed data from the most recent DHSs conducted in 2022 in Bangladesh, Cambodia, and Nepal. These countries were purposefully selected based on three key criteria. First, all three are undergoing rapid nutritional transitions, characterized by a shift from traditional diets to increased consumption of processed and unhealthy foods—contributing to DBM at the household level.[38–40] Second, they represent a range of socioeconomic and public health contexts, providing an opportunity to examine how differing stages of development influence the relationship between caesarean births and household nutritional outcomes.[41] Third, the DHS datasets from these countries offer rich, standardized, and nationally representative data on maternal and child health and nutrition, including anthropometric and health indicators essential for our analysis, and are collected using rigorous, comparable methodologies supported by the MEASURE DHS project.[42]

The DHS employs a robust multistage cluster sampling design, ensuring every unit has a defined probability of selection. Clusters, often enumeration areas (EAs) from recent population and housing censuses, were selected proportionally. Households within these clusters were then systematically sampled. While sampling designs vary slightly by country, most surveys stratify samples by urban and rural areas and geographical or administrative regions.

The height and weight of both mothers and children were measured by trained personnel following standardized procedures used in the DHS. Digital weighing scales (e.g. SECA, a well-known brand for producing digital weighing scales or UNICEF models) were used to measure weight, while height and length were measured using portable measuring boards (such as ShorrBoard® or equivalent UNICEF devices). Children under 24 months were measured lying down (recumbent length), and older children and adults were measured standing. To ensure measurement accuracy, a subset of children were randomly selected for repeat measurements, and extreme anthropometric values were rechecked according to DHS guidelines.[43–45]

For this study, we selected mother–child pairs from the DHS survey, focusing on nonpregnant women aged 15–49 years who had at least one child. We included those pairs with valid measures of weight and height for both the mother and her child. For assessing the association between C-section delivery and DBM, we included pairs where the mother had completed nutritional information and where data were available on the mode of delivery—specifically, whether the child was delivered via C-section or vaginal birth (normal delivery). Additionally, we ensured that nutritional information for the corresponding child was accessible. If a mother had more than one child, we selected the most recent birth with complete nutritional and delivery data. Observations with missing or flagged data for either maternal BMI or child nutritional status were excluded to ensure data quality and to accurately calculate the DBM outcome. For instance, in Bangladesh, 4652 mother–child pairs were initially

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eligible, but 520 pairs (11.2%) were excluded due to missing or flagged values, resulting in a final analytic sample of 4132 pairs. Similarly, after applying the same eligibility criteria, the final analytic samples were 3836 in Cambodia and 2596 in Nepal.

Outcome variable

Our primary outcome was the household-level DBM, defined as a pair where the mother was overweight or obese (BMI $\geq$ 23.0 kg/m^2 for Asians)[46] and the child was undernourished (stunted, wasted, or underweight, with z-scores < -2). We focused on this pattern because it is more prevalent in these settings and widely documented in the literature.[34] The reverse pattern—undernourished mother and overnourished child—was rare in our data and thus excluded from analysis.

Exposures and covariates

The main exposure variable was whether the child was delivered via C-section. We classified this as 'Yes' for C-section births and 'No' for vaginal deliveries. Based on existing literature, we included several covariates. At the individual level, we considered maternal age (15–23, 24–30, and >30 years), early initiation of breastfeeding (within or after 1 hour), breastfeeding duration (in months), and birth order (first birth, second birth, otherwise). At the cluster level, we included place of residence (urban/rural) and community-level antenatal care (ANC) coverage. To estimate community ANC coverage, we calculated the proportion of women in each cluster who attended at least four ANC visits during pregnancy and categorized them as either low (<50%) or high (≥50%).

Statistical analysis

We applied DHS sampling weights to account for the complex survey design, including stratification and clustering. Descriptive statistics and bivariate analyses [chi-square and analysis of variance (ANOVA)] were conducted. To address clustering, we used two-level multilevel logistic regression models with the 'glmer' function in R, including interaction terms between C-section and delayed breastfeeding initiation, and between C-section and household wealth. Adjusted odds ratios, standard errors, and 95% CIs for interactions were obtained using the delta method via the 'margins' package. We checked for multicollinearity (Variance Inflation Factor (VIF) < 5) and assessed model fit using the Hosmer–Lemeshow test. We also used the Getis-Ord Gi* statistic to identify spatial clusters of DBM and C-section deliveries at the district level.[46–48] This method allowed us to detect statistically significant hot spots by comparing local and global means.[46] More details on the statistical analysis are available in the online supplementary material.

Results

The prevalence of DBM and C-section deliveries revealed distinct patterns across the three countries (Fig. 1). Bangladesh had an alarmingly high prevalence of C-section deliveries (45.6%), indicating a possible overuse of surgical births that far exceeded the WHO recommended threshold. In contrast, Cambodia (14.6%) and Nepal (16.9%) had much lower rates, suggesting relatively more conservative use of C-sections. Despite these differences, DBM prevalence remained somewhat similar between Bangladesh (14.2%) and Cambodia (14.3%), with Nepal slightly lower (12.3%).

Table 1 highlights the prevalence of DBM across the selected countries. DBM was prevalent among mothers who had C-section deliveries—15.4% in Bangladesh, 16.4% in Cambodia, and 25.2% in Nepal—indicating that surgical birth may disrupt early maternal and child nutritional dynamics. The increasing prevalence with maternal age, especially among those aged 30 or above, may reflect cumulative nutritional risks and lifestyle changes. Households with delayed initiation of breastfeeding (after 1 hour) and those in urban areas had higher DBM prevalence, suggesting that surgical delivery practices and urban dietary transitions could be contributing factors. Lower community ANC coverage had higher DBM prevalence in Nepal and Cambodia, possibly pointing to gaps in prenatal nutrition education and follow-up. Moreover, households affected by DBM had shorter mean breastfeeding durations—14.5 months in Bangladesh, 13.7 months in Cambodia, and 16.2 months in Nepal—supporting the hypothesis that reduced breastfeeding may limit child nutrition while maternal overweight persists. These findings suggest that both clinical practices and broader socioenvironmental contexts shape the dual burden of malnutrition within households.

Table 2 presents adjusted odds ratios (AORs) from a two-level logistic regression of factors associated with DBM. In Nepal, children born via C-section were 72% more likely to live in a household experiencing DBM (AOR = 1.72, 95% CI: 1.09–2.70), and in Bangladesh, the likelihood was more than double (AOR = 2.60, 95% CI: 1.55–4.37). This suggests that surgical births may influence early feeding patterns or maternal recovery, with downstream nutritional consequences. Delayed initiation of breastfeeding independently elevated the odds of DBM in all three countries, emphasizing the nutritional importance of early breastfeeding. Shorter breastfeeding duration also showed a negative association

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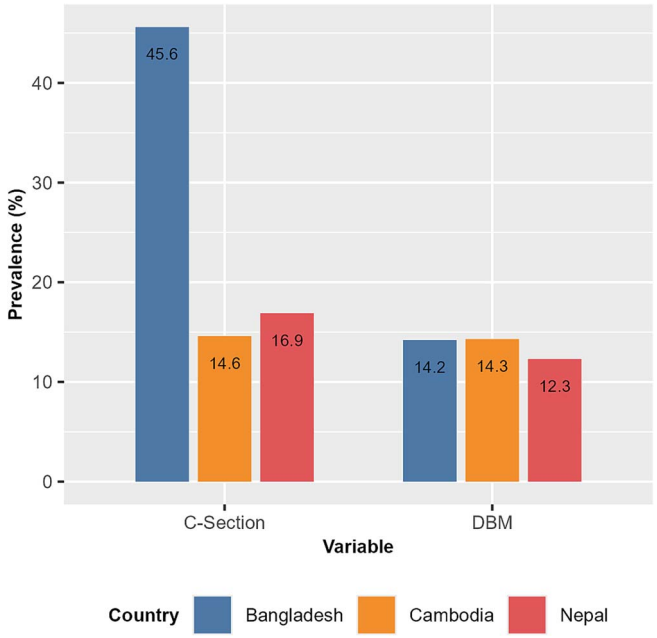

Figure 1 Prevalence of DBM (response variable) and C-section (exposure variable) for Bangladesh, Cambodia, and Nepal.

with DBM, reinforcing the protective role of breastfeeding. At a contextual level, urban households were more prone to DBM, likely reflecting shifts in diet and lifestyle. The effect of C-sections in urban areas in Nepal and Bangladesh indicate that urbanization and C-section births may together increase DBM vulnerability. Lastly, high community ANC coverage served as a protective factor in Nepal, indicating the potential of community-level interventions in mitigating DBM risks. The Hosmer–Lemeshow test, with insignificant *P*-values, confirms that the multilevel regression models appropriately capture the relationship between DBM and independent variables, supporting the reliability of the findings.

Figure 2 displays the hot spot analysis results for the prevalence of DBM and C-section deliveries across Bangladesh, Cambodia, and Nepal. The analysis revealed notable geographic overlaps between DBM and C-section hot spots. We identified one region each in Bangladesh and Nepal as a common hot spot where DBM and C-section intersected (Fig. 2). In Cambodia, this overlap was more pronounced, with three regions exhibiting concurrent hot spots. These findings point to a possible spatial relationship between DBM and C-section deliveries in certain areas of the selected countries.

Discussion

What is already known on this topic

While some studies suggest that children born via C-section are more likely to live in households experiencing DBM,[12,49] a comprehensive regional analysis remains lacking. C-section deliveries can disrupt the infant's microbiota, increasing their susceptibility to obesity and metabolic disorders later in life,[47,48] and potentially contributing to maternal obesity through altered energy metabolism and fat storage.[47] In resource-limited settings, the higher cost of C-sections can strain household finances, reducing access to nutritious food and healthcare,[50–52] leading to child undernutrition and prompting reliance on cheaper, energy-dense, low-nutrient foods that promote maternal overweight.[53,54] Longer recovery times after C-sections may also affect subsequent pregnancies and overall health,[12] creating a cycle of poor maternal nutrition. Overweight or obese mothers may, in turn, be more likely to give birth to undernourished children,[55] perpetuating DBM within households.

Main findings of this study

C-section deliveries were strongly associated with an increased likelihood of DBM, particularly in Bangladesh and Nepal, where the risk was compounded when breastfeeding was delayed. Urban households across all three countries were more likely to experience DBM, indicating that urbanization can be a contributing factor to the increase in the prevalence of this condition. Furthermore, longer breastfeeding durations appeared to reduce the likelihood of DBM, emphasizing the protective role of extended breastfeeding in mitigating malnutrition. Our analysis also highlighted geographic areas in each country where both high rates of DBM and C-section

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Table 1 Prevalence of double burden of malnutrition (DBM) at household level by background characteristics in Bangladesh, Cambodia, and Nepal along with associated *P*-values obtained from chi-square test (categorical variable) and ANOVA (continuous variable).

Variable	*Type*	*Bangladesh*		*Cambodia*		*Nepal*	
		DBM n (%)	*P-value*	*DBM n (%)*	*P-value*	*DBM n (%)*	*P-value*
C-section (CS)	**Categorical**		<.05				<.01
No		167 (12.2)		262 (13.4)	.144	258 (11.1)	
Yes		177 (15.4)		56 (16.4)		170 (25.2)	
Mother's age (year)	**Categorical**		<.05		<.05		
15–23		170 (12.5)		89 (13.4)		101 (11.8)	.382
24–30		242 (14.4)		203 (13.6)		153 (12.5)	
30+		177 (16.2)		270 (16.1)		74 (14.4)	
Early initiation breastfeeding (EIB)	**Categorical**		<.05		<.01		<.01
Within 1 hour		104 (12.1)		273 (13.3)		186 (12.3)	
After 1 hour		246 (15.4)		30 (20.4)		163 (17.2)	
Birth order	**Categorical**				.223		.660
First birth		224 (14.1)	.363	184 (14.1)		131 (12.1)	
Second birth		212 (15.2)		189 (13.9)		103 (12.6)	
Otherwise		153 (13.3)		189 (16.1)		94 (13.5)	
Place of residence	**Categorical**		<.05		<.01		<.05
Rural		377 (13.4)		300 (12.1)		146 (11.1)	
Urban		212 (16.0)		262 (19.4)		182 (14.2)	
Community ANC coverage	**Categorical**		.455		<.10		<.05
Low		375 (14.6)		80 (14.9)		272 (13.3)	
High		214 (13.7)		469 (11.5)		51 (10.1)	
Months of breastfeeding	**Continuous**	**Mean (SD): 14.5 (5.64)**	<.01	**Mean (SD): 13.7 (5.21)**	<.01	**Mean (SD): 16.2 (6.22)**	<.05

deliveries were concentrated, suggesting that local factors may be driving these overlapping trends.

What this study adds

To our knowledge, this is the first region-wide study across Bangladesh, Cambodia, and Nepal to examine the association between C-section delivery and household-level DBM using the most recent nationally representative DHS data. Although the findings may not be fully generalizable to all of South and Southeast Asia due to cultural, dietary, and health system differences, they offer valuable case studies to guide future research in similar contexts. We found that delayed initiation of breastfeeding significantly increased DBM risk across all countries, particularly when combined with C-section deliveries, consistent with previous studies.[12,49] One explanation is that C-section births are more likely to delay breastfeeding initiation,[56,57] depriving infants of essential early nutrition and immune protection,[58] while disrupted maternal hormonal and metabolic processes may further raise the obesity risk.[59–61]

Although Bangladesh reports a higher rate of C-section deliveries, the prevalence of DBM remains comparable to that in Cambodia and Nepal. One possible explanation is that C-sections in Bangladesh are predominantly concentrated among urban and wealthier households,[62,63] where child undernutrition tends to be lower due to better access to healthcare, improved maternal education, and better infant feeding practices.[64] While maternal overweight is more common in these groups, the relatively better nutritional status of children may reduce the overall likelihood of DBM. This pattern may help explain why rising C-section rates in Bangladesh have not yet translated into higher DBM prevalence, although continued monitoring is warranted as nutrition transitions progress. We also emphasize that households with a history of C-sections are more likely to experience DBM, which is a key message for guiding public health responses.

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Table 2 Multilevel logistic regression model estimates for DBM in Bangladesh, Cambodia, and Nepal.

Variable	*Category*	*Bangladesh*		*Cambodia*		*Nepal*	
		AOR (95% CI)	*P-value*	*AOR (95% CI)*	*P-value*	*AOR (95% CI)*	*P-value*
Individual factors							
C-section (CS)	**No (ref.)**						
	Yes	2.60 (1.55, 4.37)	<.01	1.71 (0.72, 4.07)	.227	1.72 (1.09, 2.70)	<.05
Mother's age (year)	**15–23 (ref.)**						
	24–30	1.01 (0.72, 1.42)	.934	0.97 (0.63 1.48)	.895	0.96 (0.69, 1.32)	.815
	30+	0.89 (0.58, 1.35)	.576	0.83 (0.50, 1.36)	.483	1.11 (0.73, 1.70)	.621
Early initiation breastfeeding (EIB)	**Within 1 hour (ref.)**						
	After 1 hour	1.82 (1.15, 2.88)	<.01	3.12 (1.28, 7.61)	<.05	1.66 (1.26, 2.19)	<.01
Birth order	**First birth (ref.)**						
	Second birth	1.16 (0.84, 1.61)	.364	0.86 (0.57, 1.28)	.451	0.97 (0.71, 1.34)	.881
	Otherwise	1.06 (0.71, 1.59)	.779	1.39 (0.88, 2.21)	.158	1.05 (0.72, 1.53)	.798
Months of breastfeeding	**Continuous**	0.69 (0.51, 0.94)	<.05	0.47 (0.32, 0.71)	<.01	0.67 (0.51, 0.91)	<.01
Interaction (CS × EIB)	**CS : Yes × EIB : After 1 hour**	1.90 (1.07, 3.38)	<.05	1.47 (1.01, 2.14)	<.05	3.26 (1.79, 5.94)	<.01
Cluster level factors							
Place of residence (PR)	**Rural (ref.)**						
	Urban	2.11 (1.41, 3.16)	<.01	1.80 (1.21, 2.68)	<.01	2.09 (1.47, 2.98)	<.01
Community ANC coverage	**Low (ref.)**						
	High	0.96 (0.68, 1.31)	.785	0.97 (0.61, 1.61)	.995	0.58 (0.39, 0.85)	<.01
Interaction (CS × PR)	**CS : Yes × PR : Urban**	1.82 (1.08, 3.06)	<.05	1.52 (0.66, 3.51)	.318	1.92 (1.41, 4.09)	<.01
		CRE = 0.58		**CRE = 0.69**		**CRE = 0.63**	
		ICC = 0.10		**ICC = 0.20**		**ICC = 0.11**	
Hosmer–Lemeshow test		**χ^2 = 18.66**		**χ^2 = 11.38**		**χ^2 = 5.44**	
		***P*- value = .28**		***P*- value = .23**		***P*- value = .65**	

Notes: CRE, cluster random effect. Interaction effects were estimated for C-section (CS) with early initiation of breastfeeding (EIB) and C-section (CS) with place of residence (PR). Estimates were obtained by controlling other covariates in the model.

We found that extended breastfeeding plays an important role in reducing DBM risk. Households where mothers breastfed longer were significantly less likely to experience DBM, consistent with prior research on benefits for both mothers and children.[65–67] Longer breastfeeding supplies essential micronutrients for child growth and supports postpartum weight loss in mothers.[68,69] Evidence also shows that exclusive breastfeeding for up to 6 months improves child health and nutrition while reducing maternal weight retention.[70] Promoting optimal breastfeeding is therefore crucial to healthy growth, preventing maternal obesity, and breaking the DBM cycle in vulnerable households.

Urban households were more likely to experience DBM than rural households, consistent with previous studies.[71] Higher obesity rates among urban women stem from unhealthy diets, sedentary lifestyles, and limited physical activity.[72,73] Although urban children generally face lower undernutrition rates, factors such as food insecurity and inadequate services in low-income urban areas still contribute to malnutrition.[74] We also found that high community-level ANC coverage significantly reduced DBM risk in Nepal but not in Bangladesh or Cambodia, likely reflecting differences in service quality and content. In Nepal, a strong healthcare infrastructure and effective nutrition education through ANC may play a protective role.[75,76]

Our spatial analysis identified overlapping hot spots of DBM and C-section deliveries, particularly in Cambodia, with distinct clusters in Bangladesh and Nepal as well. These patterns may reflect disparities in healthcare access, socioeconomic conditions, and maternal and child health

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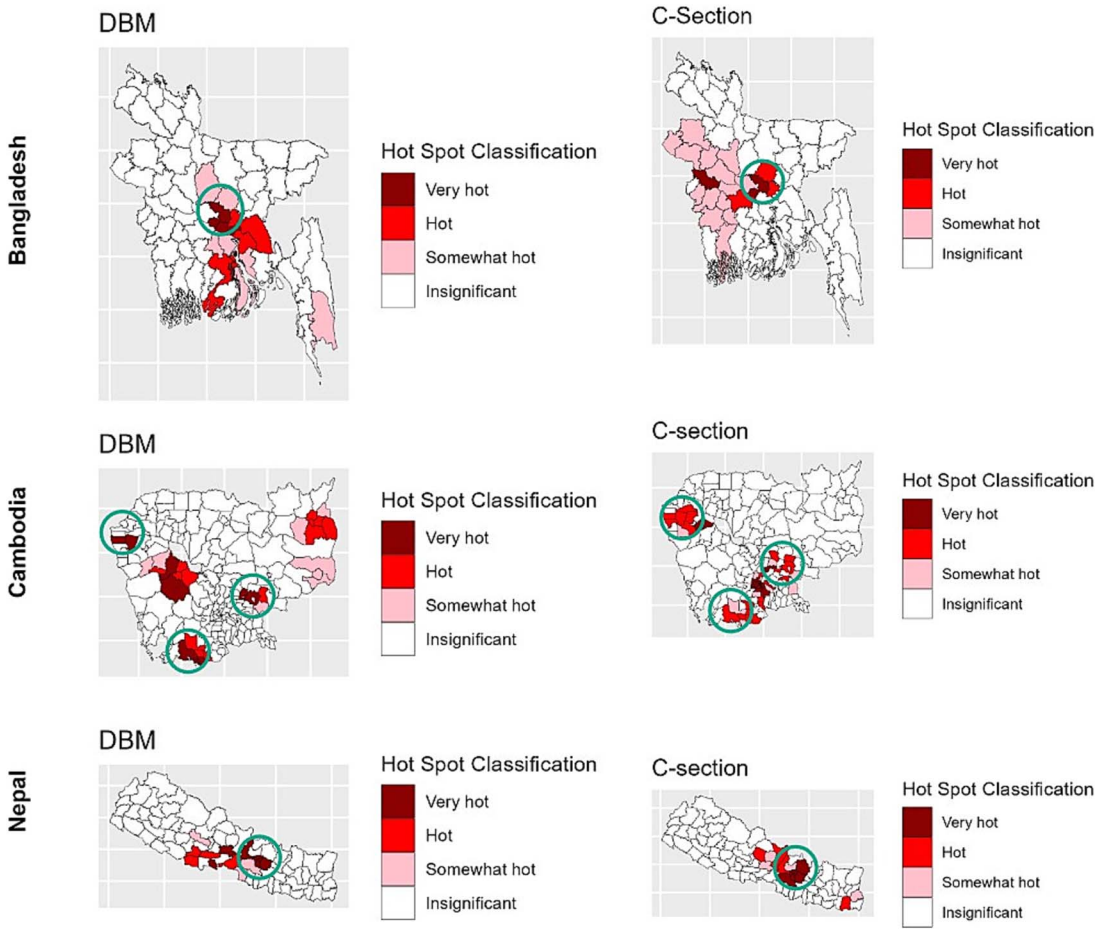

Figure 2 Hot spot analysis for DBM (response variable) and C-section (exposure variable) of Bangladesh, Cambodia, and Nepal. Circles represent common regions for both DBM and C-section. Note: Very hot: hot spot (99% confidence); hot: hot spot (95% confidence); somewhat hot: hot spot (90% confidence).

practices.[77,78] Identifying these geographic patterns underscores the need for localized interventions to address both malnutrition and the overuse of C-section deliveries.

This study has several strengths. Using nationally representative DHS data from Bangladesh, Cambodia, and Nepal ensures robust, generalizable findings across diverse settings. Standardized methods and high response rates enhance reliability and comparability. Focusing on countries in rapid nutrition transition provides valuable regional insights into household-level DBM. Multilevel modelling strengthens the analysis by accounting for clustering and contextual factors. Overall, the study addresses a substantial evidence gap on the intersection between C-section deliveries and DBM, offering novel insights with direct implications for maternal and child health programs and policy development in transitioning economies.

Limitations of this study

This study has some limitations. The cross-sectional design limits causal interpretations. Additionally, we were unable to account for other potentially important factors influencing DBM, such as daily dietary patterns for children under 5 (0–59 months), physical activity, caregiving practices, cultural factors, and detailed pregnancy and birth data, which is not included in the DHS dataset. The absence of confounders like household income and healthcare access may have also influenced the findings. Moreover, using data from only three countries restricts the generalizability of results across South and Southeast Asia, given the diverse socioeconomic and health system contexts. Therefore, caution is advised when applying these findings beyond the countries studied.

Conclusion

This study identifies a significant association between C-section deliveries and rising prevalence of DBM in Bangladesh and Nepal, highlighting the need to limit unnecessary surgical births through stricter clinical guidelines and health system oversight. Promoting early initiation of

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breastfeeding after C-sections, alongside postpartum weight management, is a crucial preventive measure. Strengthening community-based ANC services with nutritional counselling can effectively address DBM at the local level. Addressing urban–rural disparities requires improving access to nutritious foods and promoting healthier lifestyles in urban areas. Importantly, policy responses and interventions must be context-specific, accounting for the regional health infrastructure, cultural norms, and geographic differences. Supporting locally driven research and fostering multisectoral collaboration will be key to developing and implementing effective strategies to reduce DBM and unnecessary C-sections in South and Southeast Asia.

Supplementary data

Supplementary data is available at *Journal of Public Health* online

Conflict of interest. The authors declare no conflict of interest.

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Ethical approval

This study analysed secondary data provided by MEASURE DHS. All the research procedures involving human participants adhered to the ethical standards outlined by the national research committee and the 1964 Declaration of Helsinki, along with its later amendments or equivalent ethical principles. Given that the data is publicly available on the website, ethical review and approval were not necessary for this study, in accordance with local regulations and institutional guidelines.

Data availability

Data is freely available in the public domain with the following link: https://dhsprogram.com/data/dataset_admin/login_main.cfm?CFID=300458265&CFTOKEN=26bd09600ba5696-DE5E82D0-A6C1-5C66-C216C2CD9B9E82D9.

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Review Article

Addressing the double burden of malnutrition in Bangladesh: Evidence from National Policy Documents and gaps in policy integration

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ABSTRACT

Background: Bangladesh faces a growing double burden of malnutrition (DBM), where persistent undernutrition coexists alongside rapidly rising overweight and obesity. Despite numerous national policies addressing malnutrition, the extent to which these policies explicitly recognize and integrate DBM remains unclear.

Objective: This study critically analyzes major national nutrition, food security, health, and agriculture policies in Bangladesh to assess DBM integration and identify gaps requiring urgent policy attention.

Methods: We conducted a narrative policy analysis of five purposively selected national policy documents on nutrition implemented between 2015 and 2030. Policies were evaluated using a structured analytical framework informed by Hawkes et al.'s double-duty actions framework, the Essential Nutrition Actions framework of the World Health Organization, and the policy principles of the Global Nutrition Report. The analysis examined three dimensions: (i) recognition and framing of DBM, (ii) intervention design and content, and (iii) implementation systems. Data were extracted using a pre-specified template, verified by a second reviewer, and compared against framework components to identify gaps. Recommendations were then classified into immediate, medium-term, and long-term priorities based on feasibility and urgency.

Results: All five policies demonstrated comprehensive undernutrition programming, with measurable targets. However, overnutrition has received minimal attention in all the policies. Only the National Nutrition Policy (2015) explicitly acknowledged DBM, but this fell short of an integrated operational framework. The remaining four policies continued to treat malnutrition as synonymous with undernutrition, leaving overnutrition largely invisible as a policy concern. No policy has provided integrated service delivery models, household-level DBM strategies, life-course surveillance systems, or food environment regulations. Seven critical gap categories were identified: service delivery, monitoring and evaluation, human resources, dietary guidelines, food environment regulation, equity and targeting, and multi-sectoral coordination.

Conclusions: Bangladesh's nutrition policies remain structurally misaligned with its evolving DBM burden. Urgent policy actions are needed to explicitly recognize DBM as a distinct policy problem, establish integrated operational frameworks, develop household-level strategies, strengthen food environment regulations, and build multisectoral governance capacity. Phased recommendations spanning immediate, medium-term, and long-term timeframes are proposed to guide systematic DBM policy integration and support progress toward Sustainable Development Goal targets.

Introduction

The double burden of malnutrition (DBM) represents one of the most complex public health challenges faced by low- and middle-income countries (LMICs) in the 21st century [1]. DBM is characterized by the coexistence of undernutrition (stunting, wasting, and micronutrient deficiencies) along with overweight, obesity, and diet-related non-communicable diseases (NCDs) within the same population, household, or individual across the life course [2,3]. This phenomenon reflects the nutritional transition occurring in many LMICs, driven by rapid urbanization, dietary shifts toward processed foods, sedentary lifestyles, and persistent poverty [4,5].

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Bangladesh has exemplified this transition. While the country has made remarkable progress in reducing childhood undernutrition over the past two decades, with stunting declining from 51% in 2004 to 23.6% in 2022, the rising rates of overweight and obesity present new challenges [6,7]. The Bangladesh Demographic and Health Survey (BDHS) 2022 reported that 36.5% of women aged 15–49 were overweight/obese, an increase from 9% in 2004 [7]. Moreover, DBM occurs at the household level, with studies indicating that the proportion of Bangladeshi households with members experiencing both undernutrition and overnutrition simultaneously has increased from 4% in 2004 to 14.2% in 2022 [8,9].

The etiology of DBM is multifaceted, involving complex biological, behavioral, and environmental pathways [10]. Maternal and early childhood undernutrition can program metabolic changes that increase susceptibility to obesity and NCDs in later life, a phenomenon known as "developmental programming" [11,12]. Additionally, the nutrition transition characterized by increased consumption of energy-dense, nutrient-poor processed foods, combined with reduced physical activity, contributes to rapid weight gain among populations previously experiencing food insecurity [5,13]. In Bangladesh, rapid urbanization, increased household incomes, aggressive marketing of ultra-processed fast foods, and changing food systems have accelerated this transition [14,15].

Addressing DBM requires fundamentally different policy approaches than addressing undernutrition or overnutrition in isolation [16]. Effective DBM management demands integrated interventions that simultaneously prevent and treat both forms of malnutrition across the life course; household-level strategies that recognize the coexistence of multiple forms within families; food systems approaches that ensure availability and affordability of diverse, nutritious foods; regulatory frameworks that create healthier food environments by limiting unhealthy food marketing and promoting healthy options; and multisectoral coordination linking health, agriculture, education, social protection, and urban planning [3,17,18].

Despite growing recognition of DBM as a critical public health issue, many countries' nutrition policies remain siloed, addressing undernutrition and overnutrition through separate programs and platforms [19]. The World Health Organization (WHO) and UNICEF have called for integrated approaches to DBM, emphasizing the need for policy coherence, service integration, and life-course perspectives [20,21]. However, limited evidence exists on how national policies in DBM-affected countries have adapted to this challenge, particularly in South Asia, where the burden is substantial [8].

This study aims to critically analyze the integration of DBM considerations within Bangladesh's national nutrition, food security, health, and agriculture policies. Although DBM is increasingly recognized as a policy priority, no previous study, to our knowledge, has systematically assessed Bangladesh's nutrition policy landscape using a structured, multidimensional framework aligned with international DBM guidance. As a result, policy gaps remain insufficiently identified, and their relevance to established best practices and implications for policy action are unclear. This study addresses this gap by applying an integrated analytical framework to evaluate national policy documents across multiple dimensions. This approach enables benchmark-based identification of policy gaps and provides clear, actionable, and time-bound recommendations. It also offers useful insights for other South Asian countries experiencing similar nutrition transitions.

Methods

Study design and conceptual framework.

This study employed a purposive policy document review to critically examine how Bangladesh's national nutrition policies address DBM. Our analysis was guided by an integrated framework drawing on three established approaches to addressing DBM. First, Hawkes et al.'s (2020) [16] double-duty actions framework, published in 'The Lancet,' identifies interventions that can simultaneously address both undernutrition and overnutrition. This framework emphasizes explicit recognition of coexisting forms, integrated service delivery, and life-course approaches linking childhood undernutrition to adult obesity risk. Second, WHO's Essential Nutrition Actions (2019) [20] provides operational guidance for integrating nutrition interventions across health service platforms and the life course. Third, the Global Nutrition Report (GNR, 2020) [17] identifies policy integration principles, including cross-sectoral coherence, food environment regulation, multisectoral coordination with accountability, and equity-focused targeting.

We operationalized core principles from these three sources into a structured assessment tool organized around three analytical dimensions (Fig. 1). First, dimension 1: Recognition and Framing, examines how policies conceptualize DBM, including whether both forms are explicitly acknowledged, how each is defined, recognition of nutrition transition dynamics, adoption of life-course perspectives, and policy goals and targets. Then, dimension 2: Intervention Content, assesses what policies propose, including comprehensiveness of interventions for each form, whether delivery platforms are integrated or separate, the presence of household-level strategies, food environment regulations, and operational guidance. Finally, dimension 3: Implementation Systems evaluates how policies enable implementation, including monitoring frameworks with indicators for both forms, surveillance systems, multisectoral coordination mechanisms, governance structures, human resource provisions, financing, and equity considerations.

This framework is particularly appropriate for assessing DBM policy integration in Bangladesh for several interconnected reasons. First, it provides an evidence-based foundation by anchoring assessment criteria in the most authoritative international guidance on DBM rather than relying on arbitrary or subjective standards. Second, the framework provides comprehensive coverage of the full policy cycle from problem definition through implementation. Third, the framework is methodologically appropriate for narrative policy analysis. Finally, the framework is specifically designed for gap identification, directly serving this study's aim of assessing policy integration and identifying areas requiring attention.

Policy document selection.

We purposively identified national policy documents governing nutrition and related sectors in Bangladesh through review of government and development partner websites. Documents were selected if they were: (1) national-level policies or strategic plans issued by Government of Bangladesh ministries, (2) primarily focused on nutrition, food security, or agriculture with substantial nutrition content, (3) publicly available, and (4) officially endorsed with authority over nutrition programming.

Five documents met criteria: National Nutrition Policy (NNP, 2015), Second National Plan of Action for Nutrition (NPAN2, 2016–2025), Bangladesh National Food and Nutrition Security Policy (BNFNSP, 2021–2030), National Agricultural Policy (NAP, 2018), and 8th Five-Year Plan (8th FYP, 2020–2025). These represent the core national policy architecture spanning health, food, agriculture, and planning sectors, with overlapping implementation timeframes enabling assessment of cross-sectoral coherence.

Analytical Approach.

Narrative policy analysis.

We employed narrative policy analysis, an interpretive approach examining policy content through systematic reading and structured synthesis [22]. Policy content was systematically extracted using a structured data extraction template organized around the three analytical dimensions and their component criteria (see Supplementary Table 1). For each policy document, the first author read the full text in its entirety and identified all sections relevant to each criterion, recording both direct textual evidence and interpretive notes within the template.

The coding process followed a deductive analytical approach: all coding categories were defined a priori from the integrated analytical framework rather than emerging inductively from the policy texts. This

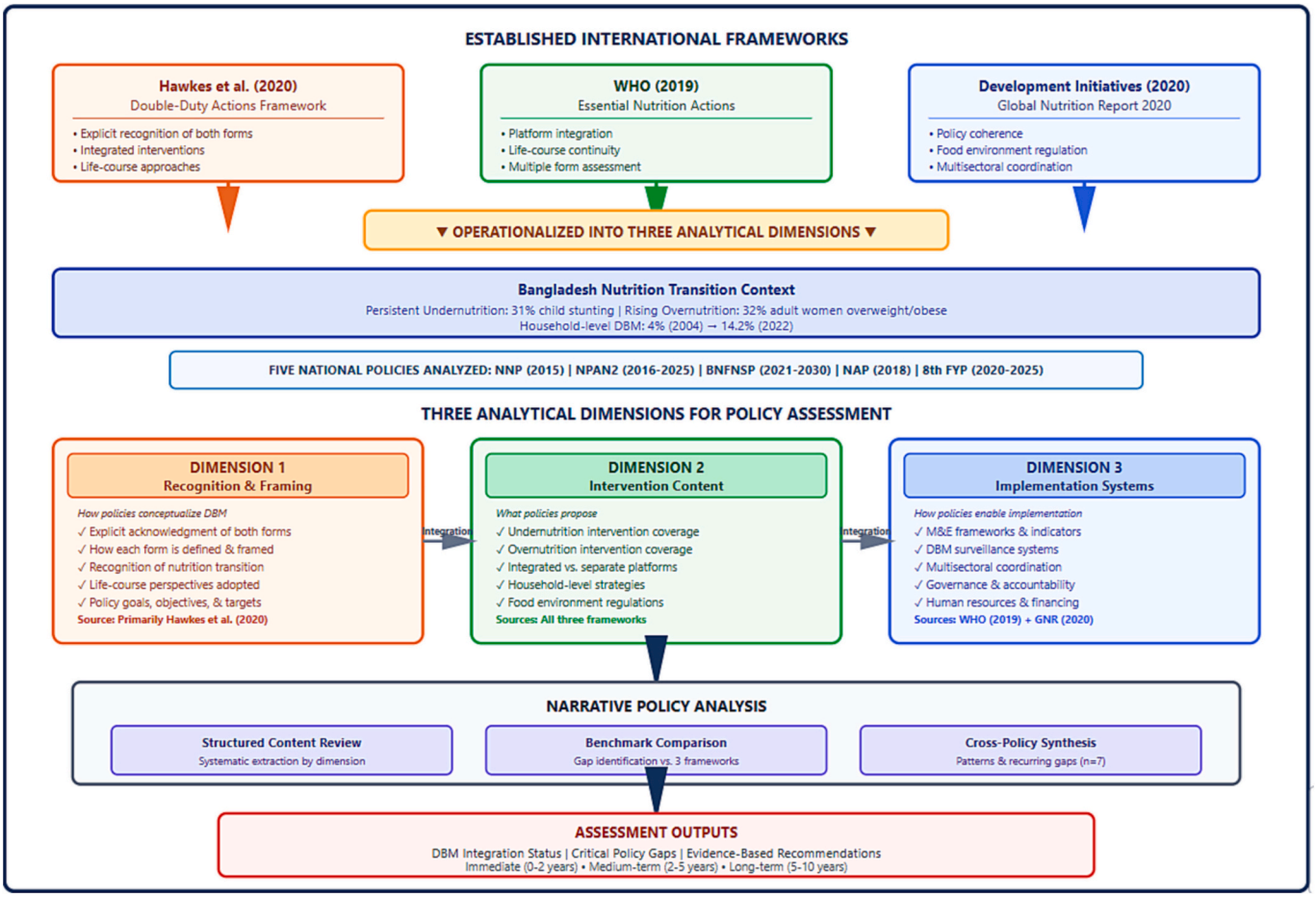

Fig. 1. Conceptual framework for assessing DBM policy integration in Bangladesh.
The framework synthesis three established international frameworks—Hawkes et al. (2020) double-duty actions, WHO Essential Nutrition Actions (2019), and Global Nutrition Report 2020 policy principles—into three analytical dimensions for systematic policy assessment. These dimensions operate within Bangladesh's nutrition transition context, where persistent undernutrition (31% child stunting) coexists with rising overnutrition (32% adult women overweight/obese). Five national policies are assessed across all dimensions through narrative analysis combining structured content review, benchmark comparison against international standards, and cross-policy synthesis to identify integration status, critical gaps, and evidence-based recommendations organized into immediate (0–2 years), medium-term (2–5 years), and long-term (5–10 years) timeframes.

choice was deliberate, as the study aim was to assess the degree to which existing policies aligned with established international standards for DBM integration, necessitating benchmark-defined categories against which policy content could be systematically compared. Nevertheless, where policy texts raised issues not anticipated by the framework (for example, references to emerging NCD-nutrition linkages), these were recorded as supplementary observations and considered during synthesis.

Coding categories within each dimension were operationalized as follows. Within Dimension 1 (Recognition and Framing), categories included: (i) explicit acknowledgment of DBM coexistence; (ii) definition of undernutrition and overnutrition; (iii) recognition of nutrition transition dynamics; (iv) adoption of a life-course perspective linking childhood undernutrition to adult obesity risk; and (v) policy goals and targets for both forms. Within Dimension 2 (Intervention Content), categories included: (i) comprehensiveness of undernutrition interventions; (ii) comprehensiveness of overnutrition interventions; (iii) service delivery platform integration; (iv) household-level DBM strategies; (v) food environment regulation; and (vi) dietary guidelines. Within Dimension 3 (Implementation Systems), categories included: (i) monitoring indicators for both forms of malnutrition; (ii) life-course surveillance systems; (iii) multisectoral coordination mechanisms; (iv) governance and accountability frameworks; (v) human resource capacity provisions; (vi) financing arrangements; and (vii) equity and targeting considerations. A full description of these categories with illustrative coding examples is provided in Supplementary Table 1.

To ensure consistency and transparency, the senior author independently reviewed all extracted content and verified that the evidence had been accurately identified and appropriately categorized according to the pre-specified criteria. In instances of divergent interpretations, for example, when determining whether a policy provision represented explicit acknowledgment of a criterion or only a conceptual mention, discrepancies were discussed and resolved through consensus. If consensus was not immediately achieved, the relevant policy text was re-examined, and a final classification was made based on the definitional criteria established within the analytical framework prior to data extraction. Each criterion was coded using a three-level classification: (1) explicitly addressed with operational detail, (2) conceptually mentioned without operationalization, or (3) absent. Items classified under categories (2) and (3) were subsequently treated as policy gaps.

Gap identification.

Building on the coding process described above, we systematically compared extracted content against the assessment criteria within each analytical dimension. Elements coded as category (2) or (3) were identified as gaps where policies fall short of international evidence-based guidance. Elements in categories (2) and (3) were identified as gaps where policies fall short of international evidence-based guidance.

Within Dimension 1 (Recognition and Framing), we assessed

whether policies explicitly acknowledged DBM, defined both forms of malnutrition, recognized nutrition transition dynamics, and adopted life-course perspectives linking childhood undernutrition to adult obesity risk. Within Dimension 2 (Intervention Content), we evaluated the comprehensiveness of interventions for each form, whether service delivery platforms were integrated or separate, the presence of household-level strategies and food environment regulations, and the availability of operational guidance. Within Dimension 3 (Implementation Systems), we examined monitoring frameworks and surveillance capacities, multisectoral coordination mechanisms, human resource provisions, financing arrangements, and equity and targeting considerations.

Finally, we synthesized findings across all three analytical dimensions and five policies through iterative comparison to identify consistent patterns in problem framing, variations in approach across sectors, and cross-cutting gaps appearing in multiple policies.

Development of recommendations.

Recommendations were developed by synthesizing identified gaps, reviewing international evidence on effective DBM interventions, and considering the Bangladeshi context, including health system capacity, resource constraints, and socio-cultural factors. Recommendations were organized into immediate (0–2 years), medium-term (2–5 years), and long-term (5–10 years) timeframes based on feasibility, resource requirements, and urgency.

Ethical Considerations.

This study analyzed publicly available policy documents and did not require ethical approval. No primary data collection involving human subjects was conducted.

Results

Overview of Policy Landscape.

Five national policy documents implemented between 2015 and 2030 form the foundation of Bangladesh's nutrition governance architecture (Table 1). These documents outline the country's strategic approach to addressing nutrition across multiple sectors. Analysis using the three framework dimensions—recognition and framing, intervention content, and implementation systems—showed how DBM is currently addressed within national policies and identified key gaps compared with international evidence-based guidance.

Dimension 1: Recognition and Framing of DBM.

Across all five policies, malnutrition was predominantly framed as undernutrition, with overnutrition receiving minimal recognition. Only the NNP (2015) [23] explicitly acknowledged DBM, stating that Bangladesh faces “the coexistence of undernutrition and overnutrition” and recognizing the need to “control both malnutrition and overweight.” This policy adopted a life-cycle approach covering all age groups and included separate targets for both stunting reduction and maternal overweight reduction. However, even this strongest recognition addressed the two forms as separate issues rather than through an integrated DBM framework.

The remaining four policies showed limited to no recognition of overnutrition as a policy problem. NPAN2 (2016–2025) [24] framed malnutrition almost exclusively as undernutrition, with its goal explicitly stating “to improve maternal and child nutrition and to accelerate the reduction of malnutrition”—operationalized entirely through undernutrition indicators. Overweight was mentioned briefly but not operationalized into targets or programs. The BNFNSP (2021−2030) [25] referenced “all forms of malnutrition” conceptually but without operational definition or differentiation. The NAP (2018) [26] and 8th FYP (2020–2025) [27] framed nutrition entirely as undernutrition and food insecurity, with no acknowledgment of rising overweight and obesity.

None of the policies explicitly recognized nutrition transition dynamics—the epidemiological shift from predominant undernutrition toward coexisting forms that Bangladesh is experiencing. Life-course perspectives linking childhood undernutrition to adult obesity risk, central to Hawkes et al.'s (2020) [16] framework and developmental programming evidence [24,25], were absent from all policies.

Gap Summary for Dimension 1.

Comparison against Hawkes et al. (2020) [16], who emphasize that effective DBM response begins with explicit recognition that both forms coexist, reveals fundamental framing gaps. Only one of five policies explicitly acknowledged DBM, and none operationalized this recognition into integrated targets or frameworks. The absence of nutrition-transition recognition and life-course perspectives linking early undernutrition to later obesity represents a critical missed opportunity for prevention-oriented policy approaches.

Dimension 2: Intervention Content and Design.

Undernutrition Intervention Coverage.

All five policies demonstrated comprehensive, well-specified interventions for undernutrition (Table 1). The NNP and NPAN2 included detailed maternal and child nutrition programs: exclusive breastfeeding promotion (0–6 months), complementary feeding guidance from 6 months, vitamin A supplementation every 6 months, iron-folic acid supplementation for pregnant women and adolescent girls, management of moderate and severe acute malnutrition, growth monitoring and promotion, zinc supplementation for diarrhea, micronutrient powder supplementation, and food fortification of salt and edible oil. NPAN2 set ambitious, time-bound targets: reduce stunting from 36% to 25%, reduce wasting from 14% to 8%, and increase exclusive breastfeeding from 55% to 70% by 2025 [26].

The BNFNSP emphasized nutrition-sensitive agriculture, including diversified production of pulses, vegetables, and fruits alongside continued micronutrient supplementation and fortification programs. The NAP focused on micronutrient-rich crop production, biofortification research, homestead vegetable gardening, and promotion of small fish, poultry, and livestock for dietary diversity. The 8th FYP prioritized scaling Community-based Management of Acute Malnutrition (CMAM) services and enhancing facility- and community-level nutrition services.

Overnutrition Intervention Coverage.

In stark contrast, overnutrition interventions were minimal or absent across all policies. Only the NNP explicitly addressed overweight and obesity prevention, including regulation of processed food marketing, behavior change communication to reduce excess salt, saturated fat, and trans-fat consumption, promotion of physical activity and exercise, targets to reduce maternal overweight (BMI >23), and prevention of overweight/obesity in educational institutions. However, operational guidance on implementing these interventions was limited.

NPAN2 mentioned physical activity promotion in schools and general dietary diversification messaging but provided no specific overnutrition prevention targets, programs, or resource allocation. School health programs included minimal focus on overweight prevention. The BNFNSP addressed overnutrition only implicitly through “promotion of balanced nutrition” and “dietary diversification beyond cereals,” with no specific targets or implementation guidance. The NAP and 8th FYP provided no direct focus on obesity or NCD prevention through nutrition, mentioning NCDs only as emerging issues separate from nutrition programming. It is worth noting, however, that certain NAP provisions—notably homestead vegetable gardening and diversified smallholder farming to promote dietary variety—could arguably function as double-duty actions in the sense described by Hawkes et al. (2020) [16], since promoting dietary diversity can simultaneously address micronutrient deficiencies and reduce reliance on energy-dense processed foods. These provisions were not, however, explicitly framed or operationalized as DBM interventions within the policy, representing a missed opportunity to leverage existing agricultural programming for integrated DBM outcomes.

Service Platform Integration.

A critical gap emerged regarding service delivery platform integration. WHO's Essential Nutrition Actions (2019) recommends that nutrition interventions be delivered through common health contact

Table 1
Summary Findings of National Policies with Framework-Referenced Gaps for DBM Policy Integration.

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
National Nutrition Policy [23]	**2015**	• **Goal:** To ensure proper nutritional care for all people, particularly women, children, and disadvantaged groups • **Objective:** Implement nutrition programs that address all forms of malnutrition	• Exclusive breastfeeding promotion (0–6 months) • Complementary feeding from 6 months • Vitamin A supplementation every 6 months • Iron-folic acid for pregnant women • Treatment of moderate/severe acute malnutrition • Growth monitoring and promotion • Zinc supplementation for diarrhea • Micronutrient powder (MNP) supplementation • Food fortification (salt, edible oil) • Reduction targets: stunting, wasting, underweight	• Regulation of processed food marketing • BCC to avoid excess salt, saturated fat, trans fat • Promotion of physical activity and exercise • Encourage healthy lifestyle and food habits • Target to reduce maternal overweight (BMI >23) • Prevention of overweight/ obesity in educational institutions • Control of unabated marketing of commercial foods • Awareness of avoiding processed foods	• Explicit DBM recognition in policy text • Acknowledgement of coexistence of under and over-nutrition • Addresses both forms but as separate issues • Life-cycle approach covering all age groups • Mentions need to control both malnutrition and overweight • Includes indicators for both undernutrition and overweight reduction	• **No integrated service delivery model:** Policy specifies separate interventions for undernutrition and overnutrition without integration at service delivery points. Gap relative to WHO (2019) Essential Nutrition Actions principle of "integrated service delivery platforms" where multiple forms of malnutrition should be addressed through common health contact points rather than parallel systems. • **Lack of household-level DBM strategies:** No operational guidance provided for health workers or families on how to simultaneously manage both forms within households where they coexist. Gap relative to Hawkes et al. (2020) emphasis on household-level strategies recognizing coexistence of multiple forms within families, and supported by evidence that 8–15% of Bangladeshi households experience DBM simultaneously (Kosaka & Umezaki, 2017). • **No DBM-specific targets:** Policy sets separate targets for undernutrition reduction and overweight reduction without integrated DBM targets at household or population level. Gap relative to Hawkes et al. (2020) double-duty actions framework requiring explicit dual recognition with integrated targets, not merely parallel targets for each form separately. • **Limited operational guidelines:** Policy does not specify how service providers should manage DBM simultaneously or how to design "double-duty" interventions with impact on both forms. Gap relative to Hawkes et al. (2020) operational guidance on implementing integrated interventions and WHO (2019) principle that health workers should be trained to assess and manage multiple forms simultaneously. • **Insufficient monitoring systems:** No DBM-specific surveillance system to track coexistence of both forms at household level or to monitor developmental pathways from childhood

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Table 1 (*continued*)

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
Second National Plan of Action for Nutrition (NPAN2) [24]	**2016–2025**	• **Goal:** To improve maternal and child nutrition and to accelerate the reductionof malnutrition • **Objective:** Strengthening nutrition programs in health, education, agriculture, and social safety nets	• **Stunting reduction:** 36% to 25% by 2025 • **Wasting reduction:** 14% to 8% by 2025 • **Exclusive breastfeeding:** increase to 55% to 70% by 2025 • Focus on increasing rate of early initiation breastfeeding within 1 h • CMAM services scale-up • Increasing focus on Vitamin A supplementation program • Provide iron-folic acid for adolescent girls • Nutrition counseling at ANC contacts • Promoting Deworming programs • Growth monitoring at community clinics • Homestead food production programs • Food fortification (iodized salt, fortified oil)	• Very limited explicit focus on overnutrition prevention • Physical activity promotion in schools • Healthy diet promotion through BCC • General dietary diversification messaging • School health programs (minimal focus on overweight/ obesity prevention)	• Minimal DBM integration • Policy predominantly frames malnutrition as undernutrition • No explicit DBM conceptual framework • Overweight mentioned but not operationalized • No strategies for preventing stunted children from becoming overweight adults	undernutrition to adult obesity. Gap relative to WHO (2019) life-course continuity principle requiring surveillance across life stages, and Development Initiatives (2020) recommendation for monitoring systems with indicators for all malnutrition forms. • **No overweight/obesity reduction targets:** Indicator framework completely omits targets for reducing overweight or obesity despite rising prevalence. Gap relative to Hawkes et al. (2020) requirement for explicit recognition of both forms with measurable targets, and Development Initiatives (2020) emphasis that policies must include indicators for all malnutrition forms. • **No DBM-specific indicators:** Monitoring framework focused exclusively on undernutrition indicators without household-level DBM indicators or life-course tracking. Gap relative to WHO (2019) life-course continuity principle requiring monitoring across the continuum, and Development Initiatives (2020) recommendation for surveillance systems tracking DBM at household and population levels. • **Lack of life-course DBM prevention strategies:** No strategies linking childhood undernutrition prevention to adult obesity prevention, missing critical developmental programming pathways. Gap relative to Hawkes et al. (2020) life-course approaches and substantial evidence that early-life undernutrition increases adult obesity risk (Barker, 2007; Victora et al., 2008). • **No ultra-processed food monitoring:** Consumption patterns of ultra-processed foods not tracked despite evidence of rapid proliferation and contribution to obesity. Gap relative to Development Initiatives (2020) food environment monitoring recommendations and evidence on ultra-processed food consumption driving obesity transition (Monteiro et al., 2013). • **Weak school nutrition standards:** No regulations on foods sold in schools or marketed to children, leaving obesogenic

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Table 1 (*continued*)

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
						environment unaddressed. Gap relative to Development Initiatives (2020) food environment regulation principles requiring marketing restrictions and school food standards, demonstrated effective in other contexts (Taillie et al., 2020). • **Limited urban-slum focus:** Minimal attention to urban slums where DBM prevalence is highest due to coexistence of food insecurity and obesogenic environments. Gap relative to Development Initiatives (2020) equity principle requiring explicit targeting of populations and areas with highest DBM burden. • **No DBM-specific governance structure:** Coordination mechanisms don't explicitly address DBM; sectoral coordination lacks integrated DBM mandate. Gap relative to Development Initiatives (2020) multisectoral coordination principle requiring governance mechanisms with clear authority and accountability for addressing all malnutrition forms, and WHO (2019) emphasis on coordinated platforms. • **Missing fiscal policies for nutrition:** No taxation of unhealthy foods or subsidies for healthy foods despite food system mandate. Gap relative to Development Initiatives (2020) food environment regulation requiring fiscal measures, with evidence from Mexico and Chile showing sugar-sweetened beverage taxes reduce consumption (Colchero et al., 2017; Taillie et al., 2020). • **Insufficient food labeling requirements:** Consumers lack information to make informed choices; no front-of-package warning labels. Gap relative to Development Initiatives (2020) food environment regulation requiring labeling, with evidence that warning labels improve consumer choices (Taillie et al., 2020). • **No agricultural incentives for nutrition-dense crops:** Continued emphasis on calorie production without explicit incentives for nutrient-dense foods over calorie-dense foods. Gap relative to Hawkes et al. (2020) food systems action area requiring agricultural
Bangladesh National Food and Nutrition Security Policy [25]	**2021–2030**	• **Goal:** To improve food and nutrition security status to achieve SDG targets and fulfill related national and international commitments by 2030 • **Objective:** Strengthen cross-sectional governance and improve access to nutrition-sensitive social protection	• Promote nutrition-sensitive agriculture • Diversified food production (pulses, vegetables, fruits) • Micronutrient supplementation programs • Food fortification initiatives • Social safety nets for vulnerable groups • Maternal and child nutrition programs • WASH interventions for reducing infection • Homestead food production • Nutrition education and BCC	• Promotion of balanced nutrition • Food system approach addressing dietary quality • Dietary diversification beyond cereals • Awareness of food choices • Healthy eating promotion	Implicit DBM consideration through addresses "all forms of malnutrition" conceptually	

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Table 1 (*continued*)

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
National Agricultural Policy [26]	**2018**	• **Goal:** Achieve safe, affordable, sustainable food and nutrition security • **Objective:** Increase the productivity of crops through research and technological innovation	• Production of micronutrient-rich crops • Biofortification research (zinc-enriched rice, Vitamin A crops) • Homestead vegetable gardening • Small fish cultivation for animal protein • Poultry and livestock for dietary diversity • Pulse production for protein • Fruit and vegetable production • Nutrition-rich crop varieties development	• Minimal direct focus • General food production for adequate nutrition • No explicit obesity/NCD prevention strategies in agricultural policy	• No DBM integration • Policy focuses on increasing food production • Nutrition framed only as undernutrition/food insecurity • No consideration of over-nutrition risks from agricultural policies	policies aligned with nutrition goals, and Development Initiatives (2020) cross-sectoral policy coherence principle. • **No link to healthy eating patterns:** Agricultural production outputs not explicitly connected to dietary recommendations for DBM prevention; focus remains on production volume rather than nutrition quality. Gap relative to Hawkes et al. (2020) food systems action area requiring agriculture-nutrition linkages, and Development Initiatives (2020) cross-sectoral policy coherence requiring agricultural policies aligned with health nutrition goals. • **Missing nutrition education integration:** Agricultural extension workers not trained in nutrition despite their direct contact with farming households; missed opportunity for nutrition counseling. Gap relative to WHO (2019) principle that multiple sectors should contribute to nutrition service delivery, and Development Initiatives (2020) multisectoral coordination requiring capacity building across sectors. • **Insufficient promotion of nutrient-dense foods:** Continued policy emphasis on rice production without commensurate emphasis on fruits, vegetables, and pulses for dietary diversity. Gap relative to Hawkes et al. (2020) double-duty actions requiring promotion of dietary diversity benefiting both forms, and evidence that dietary diversity prevents both undernutrition and obesity. • **No consideration of ultra-processed food supply chains:** Agricultural policies don't address food processing industry despite its role in obesity transition; no regulations or guidance on processing that maintains nutritional quality. Gap relative to Development Initiatives (2020) food environment focus on ultra-processed foods, and evidence linking ultra-processed food consumption to obesity (Monteiro et al., 2013). • **Lack of urban agriculture strategies:** No specific provisions for urban and

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Table 1 (*continued*)

Policy Document	Year	Primary Focus & Objectives	Undernutrition Coverage	Overnutrition Coverage	DBM Integration	Gaps Identified for DBM Policy Integration
8th Five-Year Plan (FYP) [27]	**2020–2025**	• **Goal:** Increase the program's quality improvement for wasting prevention andtreatment as well as other facility-level nutrition services. • **Objective:**Enhance essential nutrition services and address wasting among children	• Vitamin A supplementation and deworming at vaccination • Dietary fortification (Vitamin A, iron, iodine) • IYCF counseling for mothers • Micronutrient supplementation • CMAM program expansion • Community clinic nutrition services • Growth monitoring • Management of wasting at facility and community levels	• Very limited focus • Mentioned as emerging issue • Linked to NCDs	• No DBM integration • Nutrition section predominantly focused on undernutrition • NCDs mentioned separately without integration with nutrition	peri-urban agriculture despite highest DBM burden in urban areas and potential for urban food production to improve dietary diversity. Gap relative to Development Initiatives (2020) equity principle requiring targeting of high-burden areas. • **Nutritional framing limited to undernutrition:** National planning document frames nutrition exclusively as undernutrition despite rising overweight/obesity; missed opportunity to position DBM as national development priority. Gap relative to Hawkes et al. (2020) explicit recognition principle that effective responses require acknowledging both forms coexist, and Development Initiatives (2020) emphasis on policy framing addressing all forms. • **Weak linkage between nutrition and NCD sections:** Nutrition and NCDs discussed as separate development challenges without recognizing their interconnection through DBM and shared food system determinants. Gap relative to Hawkes et al. (2020) integrated interventions principle and WHO (2019) life-course continuity requiring linkages between maternal-child health and adult NCD prevention. • **Lack of innovation in service delivery**: Traditional undernutrition-focused approaches maintained without piloting integrated platforms or new models appropriate for DBM context. Gap relative to WHO (2019) integrated service delivery platform principle recommending innovation in service models, and evidence that integrated approaches are more cost-effective (Shekar et al., 2017). • **No urban nutrition strategy:** Despite highest urban DBM burden and rapid urbanization, no urban-specific nutrition strategy addressing unique urban challenges of food insecurity amid obesogenic environments. Gap relative to Development Initiatives (2020) equity principle requiring geographic targeting of high-burden areas, and evidence of concentrated urban DBM burden (Kimani-Murage et al., 2015).

points, with health workers trained to assess and manage multiple malnutrition forms simultaneously. None of the five policies specified integrated service platforms. Instead, all maintained separation: undernutrition interventions delivered through maternal-child health services (ANC, immunization, growth monitoring) and overnutrition/NCD interventions delivered through separate adult NCD services. This creates parallel rather than integrated systems.

None of the policies included household-level strategies, recognizing that both forms may coexist within families, a critical gap given evidence that in 2022, 14.2% of Bangladeshi households experienced DBM at the household level [9]. Policies designed interventions at the individual level without guidance for managing families where, for example, a stunted child and overweight mother require simultaneous but different nutritional support.

Food Environment Regulations and Dietary Guidelines.

Food environment regulation, emphasized by the GNR (2020) as essential for addressing both forms of malnutrition, was largely absent. Only the NNP mentioned "regulation of processed food marketing" and "control of unabated marketing of commercial foods," but provided no operational details or enforcement mechanisms. None of the policies included front-of-package labeling requirements, fiscal measures such as sugar-sweetened beverage taxation, or comprehensive school food standards—all evidence-based approaches identified in the Global Nutrition Report. The existing Breastmilk Substitutes Act was not referenced in any policy, nor was its enforcement addressed.

Gap Summary of Dimension 2.

Comparison against all three frameworks reveals profound asymmetry. While undernutrition interventions are comprehensive and well-operationalized, overnutrition interventions are minimal. Hawkes et al. (2020) emphasize "double-duty" interventions addressing both forms simultaneously; no such interventions were identified. WHO (2019) calls for integrated platforms; policies maintain separation. GNR (2020) highlights food environment regulation; policies lack operational approaches. The absence of household-level strategies represents a critical gap given household-level DBM prevalence.

Dimension 3: Implementation Systems and Enablers.

Monitoring and Evaluation Frameworks.

Monitoring frameworks demonstrated the same asymmetry observed in interventions. All policies included detailed undernutrition indicators: stunting, wasting, underweight, exclusive breastfeeding rates, vitamin A supplementation coverage, and iron-folic acid supplementation coverage. The NNP included maternal overweight (BMI >23) as an indicator, making it the only policy with any overnutrition monitoring provision.

However, no policy included household-level DBM indicators that would track the coexistence of both forms within families, a critical monitoring gap given that household DBM is the most policy-relevant manifestation of the double burden. Adult obesity surveillance beyond pregnant women was not specified in any policy. Diet quality indicators assessing nutrient adequacy and dietary patterns, as opposed to simple food security or dietary diversity measures, were absent. Ultra-processed food consumption, despite rapid increases in Bangladesh, was not included in any monitoring framework.

None of the policies specified surveillance systems capable of tracking nutrition status across the life course, following individuals from childhood through adulthood to monitor stunted children's obesity risk, as developmental programming evidence suggests is necessary [24,25].

Multisectoral Coordination Mechanisms.

All policies acknowledged the importance of multisectoral coordination, with NPAN2 involving more than 17 ministries and establishing the Bangladesh National Nutrition Council (BNNC) as the apex coordination body. However, structural weaknesses in coordination mechanisms were evident. The BNNC, while established as a coordination body, lacks binding authority to enforce coordination across ministries. Policies specified coordination structures but not accountability mechanisms, shared budgeting frameworks, or performance indicators—elements the GNR (2020) identifies as essential for effective multisectoral governance.

Joint planning and budgeting for DBM were absent. Ministries received separate allocations for nutrition activities without integrated DBM programming. Linkages between agriculture and health sectors were weak, with agricultural policies focusing on production without connection to nutrition consumption goals and health policies focusing on supplementation without addressing food systems. Education sector engagement was minimal despite schools being critical platforms for adolescent nutrition. Private sector roles in both creating obesogenic environments and potentially supporting solutions remained unaddressed.

Human Resource Capacity.

Human resource provisions focused entirely on undernutrition management. Shortages of trained nutritionists at all levels were acknowledged, but capacity building provisions emphasized undernutrition topics. No policy specified training for health workers in simultaneous DBM assessment and management, or integrated counseling approaches. Medical and nursing pre-service curricula, where mentioned, focused on undernutrition. Agricultural extension workers, teachers, and social workers—all potentially important for nutrition education—were not included in nutrition training provisions.

Equity and Targeting.

While all policies mentioned "vulnerable groups," specific populations bearing high DBM burden remained underserved. Urban slum populations, where DBM prevalence is highest due to simultaneous food insecurity and obesogenic environments, received limited attention despite rapid urbanization. Adolescents, navigating critical growth and lifestyle transitions, were insufficiently targeted beyond school feeding programs. Elderly populations facing both undernutrition and NCD comorbidities were not addressed. Working women with limited time and access to nutritious foods were not specifically targeted despite their dual roles as primary caregivers and income earners.

Gap Summary of Dimension 3.

Comparison against WHO (2019) and GNR (2020) reveals fundamental implementation system gaps. Monitoring frameworks lack DBM-specific indicators and life-course tracking capabilities that WHO guidance emphasizes. Governance mechanisms lack the binding authority and shared accountability frameworks that the Global Nutrition Report specifies as necessary. Human resources are trained only in undernutrition management, creating capacity gaps for integrated service delivery. Targeting approaches do not address populations and geographies where DBM is concentrated.

Discussion

This study provides a structured, framework-referenced assessment of how Bangladesh's five national nutrition policy documents address DBM. Organized across three analytical dimensions, such as recognition and framing, intervention content and design, and implementation systems, the analysis reveals a persistent gap between the country's evolving nutrition landscape and its policy responses. The following discussion contextualizes these findings within international literature and examines the political economy forces that sustain this misalignment.

The most fundamental finding of this study is that only one of five major national policies, the NNP 2015, explicitly acknowledges DBM, and even that recognition does not extend to an integrated operational framework. The remaining four policies continue to conflate malnutrition with undernutrition, effectively rendering overnutrition invisible as a policy problem. This pattern reflects a well-documented tendency among policymakers in LMIC countries to focus on undernutrition while the burden of overnutrition grows alongside undernutrition [28]. Addressing this policy-evidence gap requires nutrition frameworks that treat both forms of malnutrition as shared priorities rather than separate

problems [16,28,29]. Broad commitments to address "all forms of malnutrition," such as those outlined in the BNFNSP (2021–2030), are insufficient without explicit recognition of their coexistence. Effective policy responses require clear and targeted strategies that explicitly identify undernutrition and overnutrition as interconnected conditions occurring within the same households and address them through coordinated and integrated interventions [16].

Notably, none of the policies acknowledge nutrition-transition dynamics or adopt life-course perspectives linking childhood undernutrition to adult obesity risk through developmental programming, a pathway well established in the literature [11,25]. This absence is particularly consequential. Evidence suggests that stunted children exposed to increasingly obesogenic environments face disproportionate risk of overweight and non-communicable diseases in adulthood [11,12]. The failure to operationalize this understanding into prevention-oriented policy represents a missed window for upstream intervention.

The persistence of undernutrition-centric framing is not simply a knowledge gap. Undernutrition programming has well-established institutional champions, dedicated financing streams, and strong international support through multilateral agencies. Overnutrition prevention, by contrast, requires confronting commercially powerful food industry actors who benefit from weak regulatory environments [27]. Reframing national nutrition policy around DBM therefore demands deliberate political strategies alongside technical evidence.

Bangladesh's experience reflects a broader pattern across South Asia. India's POSHAN Abhiyan (2018) primarily focuses on undernutrition, including stunting, wasting, anemia, and low birth weight [30], with limited integration of overnutrition prevention despite rising obesity, particularly in urban areas [31,32]. Nepal's Multi-Sector Nutrition Plan III (2023 to 2030) takes a more advanced approach by outlining objectives such as reducing salt and sugar intake, promoting healthy food production, regulating marketing of unhealthy foods, and improving food labeling and dietary guidelines [33]. However, these remain largely aspirational and are not yet fully operationalized. Overall, all three countries continue to prioritize undernutrition, while food environment regulation and overnutrition prevention remain secondary, highlighting a shared regional challenge in adapting nutrition policies to the ongoing nutrition transition.

All five policies include well-specified, operationally detailed undernutrition interventions with measurable targets, while overnutrition interventions are limited to general health promotion messaging without programmatic detail or resource commitments. Comparison against the double-duty actions framework [16] reveals a complete absence of interventions explicitly designed to address both forms simultaneously, such as dietary diversity promotion structured to ensure both micronutrient adequacy and energy balance. No such integrated intervention logic appears in any reviewed policy.

Food environment regulation represents the most critical gap. The WHO Essential Nutrition Actions framework [20] and the GNR (2020) [17] both identify food environment policy as foundational for addressing the full malnutrition spectrum. Evidence from Chile demonstrates that mandatory front-of-package warning labels, combined with marketing restrictions and school food standards, meaningfully reduce purchases of high-sugar and high-fat products [28]. Mexico's sugar-sweetened beverage tax reduced consumption by approximately 7.6% overall and substantially more among low-income households [29]. A recent South Asian consensus statement on front-of-pack warning labels specifically highlights their relevance for contexts where diet-related NCDs and micronutrient deficiencies coexist [34]. Bangladesh's food policy architecture lacks all such instruments: no front-of-package labeling requirements, no fiscal measures on unhealthy foods, and no enforceable school food standards appear in any reviewed policy.

Multisectoral coordination represents an equally important structural weakness. Although the BNNC nominally coordinates across more than 17 ministries [24], it lacks binding authority, shared budgeting, and DBM-specific accountability frameworks. In practice, ministries often operate within institutional silos. For example, the health sector primarily focuses on supplementation and treatment, agriculture emphasizes production targets, and planning prioritizes economic growth, with limited coordination across sectors to address the common food system drivers of DBM. The GNR [17] identifies high-level governance with binding authority and shared accountability frameworks as essential for effective multisectoral nutrition coordination. However, current mechanisms do not meet this standard. Additionally, human resource capacity is similarly constrained, with training provisions across all policies focused exclusively on undernutrition management, leaving frontline workers without the skills to screen for or counsel on co-existing overnutrition. Agricultural extension workers, teachers, and social workers are entirely excluded from nutrition training frameworks.

Evidence-Based Conclusions and Priority Recommendations.

Three evidence-based conclusions emerge from this analysis. First, Bangladesh's policies are structurally misaligned with the DBM burden, comprehensively addressing undernutrition while providing negligible guidance for overnutrition prevention or integrated DBM management. Second, the food environment regulatory gap is a primary driver of accelerating overnutrition, and evidence from multiple settings confirms that fiscal measures, warning labels, and marketing restrictions can reduce unhealthy food consumption. Third, effective DBM management requires household-level strategies, life-course surveillance, and governance mechanisms with binding multisectoral authority—all absent from current policies.

On this basis, we propose a prioritized set of policy actions linked directly to identified gaps. In the immediate term (0–2 years):

- DBM indicators should be included in routine monitoring. This would provide a baseline to track DBM and support recommendations to expand nutrition surveillance [1].
- DBM screening should be included in antenatal care services. This would use Bangladesh's community clinics, which reach about 98% of the population but are currently underused for comprehensive nutrition services [35].
- A high-level DBM task force with cross-ministerial representation should be established to develop a national strategy with clearly assigned responsibilities. Evidence shows that strong political commitment and executive champions are essential for effective multisectoral nutrition coordination [18,36].

In the medium term (2–5 years):

- NPAN2 should be revised to include explicit DBM goals, targets, and dedicated resources. This ensures integrated programming is properly financed and can improve service delivery practices [16,27].
- Food labeling laws, including mandatory front-of-package warning labels, and fiscal measures on sugar-sweetened beverages should be introduced. Evidence shows these policies reduce unhealthy food purchases, especially among lower-income households [36–39].
- DBM topics should be included in pre-service medical, nursing, and public health education. Training a workforce across the full spectrum of malnutrition is critical to respond to the nutrition transition [40].

Over the next 5–10 years:

- Bangladesh should aim to achieve universal coverage of integrated DBM services, implement comprehensive food environment regulations, and establish sustainable financing linked to DBM performance indicators. These actions are essential to achieve SDG 2.2 (ending all forms of malnutrition) and SDG 3.4 (reducing premature NCD mortality) by 2030.

Bangladesh's strong record in health system innovation, including successful scaling of community-based nutrition programs, provides a solid foundation to lead effective DBM responses in South Asia [41,42]. Realizing this potential will require sustained political commitment and institutional reforms to integrate DBM across sectors [41,43,44].

Strengths and Limitations.

This study is strengthened by its consideration of major national policies across multiple sectors, use of an analytical framework grounded in three established international sources, and development of actionable recommendations aligned with feasibility timeframes. However, several limitations should be noted. Our analysis focused on policy intent as stated in documents rather than implementation fidelity or outcomes. Actual practice may differ substantially from written policies due to resource constraints, capacity limitations, or political factors. The national-level focus may not capture sub-national variations, local innovations, or implementation realities at district and community levels. We analyzed policy content through narrative interpretation structured by our analytical framework. However, different analysts might emphasize different aspects. Although our analysis was limited to publicly available documents, confidential government materials or unpublished draft policies were not accessed. Finally, formal engagement with implementing agencies, frontline workers, communities, and private sector actors was not undertaken, which may limit our understanding of on-the-ground implementation challenges and contextual factors influencing the translation of policy into practice.

Conclusion

Bangladesh is at a critical stage of its nutrition transition, with persistent undernutrition coexisting alongside rapidly increasing overweight and obesity. Our analysis indicates that while national policies effectively address undernutrition, they remain inadequate for managing DBM due to gaps in integrated service delivery, monitoring and surveillance, human resource capacity, dietary guidance, food environment regulation, and multisectoral coordination. Addressing DBM requires a shift from siloed, undernutrition-focused approaches to integrated, life-course strategies that simultaneously prevent and manage both forms of malnutrition. The phased recommendations outlined in this analysis provide a practical roadmap for strengthening policy integration. Urgent action is needed to establish coherent DBM frameworks, strengthen health systems, regulate unhealthy food environments, and operationalize multisectoral coordination. Without timely intervention, DBM will continue to drive preventable morbidity, rising non-communicable disease costs, and missed Sustainable Development Goal targets; however, Bangladesh's strong track record in health system innovation positions it well to lead effective DBM responses in the region.

CRediT authorship contribution statement

Ashis Talukder: Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Matthew Kelly:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Conceptualization. **Darren Gray:** Writing – review & editing, Visualization, Validation, Supervision, Conceptualization. **Haribondhu Sarma:** Writing – review & editing, Visualization, Validation, Supervision, Conceptualization.

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Ethical Considerations:

This study involved analysis of publicly available policy documents and did not require ethical approval. All documents analyzed were official government publications or publicly accessible policy materials. No primary data collection involving human subjects was conducted.

Disclosure of interest:

No potential competing interest was reported by the author(s).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Nutritional epidemiology and public health

The Double Burden of Malnutrition in Bangladesh: Policy Architecture, Implementation Realities, and Future Directions

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A B S T R A C T

Background: Bangladesh faces a growing double burden of malnutrition (DBM), where persistent undernutrition coexists with rapidly rising overweight and obesity. Although the country has a comprehensive National Nutrition Policy architecture, it remains unclear whether current policies address DBM as an integrated challenge.

Objectives: This study aimed to explore stakeholders' perspectives on the DBM in Bangladesh by examining how DBM is understood and framed, assessing the responsiveness of the current national nutrition policy architecture, identifying implementation challenges, and exploring policy and governance priorities for strengthening future nutrition outcomes.

Methods: This study employed a qualitative design conducted in Bangladesh between June and August 2025. A total of 12 purposively selected senior-level nutrition stakeholders participated in semistructured key informant interviews (KII), including representatives from government, international and national nongovernmental organizations, and research institutions. Participants were selected on the basis of their expertise and direct involvement in nutrition policy development and implementation. Interview data were analyzed using reflexive thematic analysis following Braun and Clarke, with themes generated inductively from participants' accounts. The integrated Health Policy Triangle–Centers for Disease Control and Prevention Policy Process Framework was used as an interpretive lens to contextualize and organize the emergent themes within established health policy frameworks.

Results: KII generated 4 themes that extend beyond policy description to illuminate implementation realities, causal explanations, and reform priorities: *1*) growing recognition of DBM among senior stakeholders that has not yet translated to frontline or community levels; *2*) stakeholder-confirmed undernutrition-focused policy architecture, with explanatory accounts of the cognitive and institutional barriers preventing DBM integration; *3*) implementation challenges characterized by symbolic multisectoral coordination, weak accountability systems without DBM-specific indicators, and limited subnational workforce capacity; and *4*) stakeholder-identified priorities including stronger multisectoral governance, food system regulatory reform, DBM-focused capacity building, and adaptation of existing programs as double-duty actions.

Conclusions: Recognition of DBM in policy is necessary but insufficient without broader reforms in governance, program design, and resource allocation. The ongoing revision of Bangladesh's Third National Plan of Action for Nutrition provides a timely opportunity to incorporate operational DBM indicators, adapt existing programs as double-duty actions, and strengthen accountability systems to track progress across multiple forms of malnutrition. These findings may also inform policy responses in other low- and middle-income countries undergoing similar nutrition transitions.

Keywords: double burden of malnutrition, nutrition policy, double-duty actions, Bangladesh, qualitative research

Abbreviations: BCC, behavioral change communication; BNNC, Bangladesh National Nutrition Council; CDC, Centers for Disease Control and Prevention; DBM, double burden of malnutrition; HPT, Health Policy Triangle; LMIC, low- and middle-income country; NGO, nongovernmental organization; NNP, National Nutrition Policy; NPAN-2/NPAN-3, (Second/Third) National Plan of Action for Nutrition; UN, United Nations.

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Introduction

In recent decades, low- and middle-income countries (LMICs) have confronted an increasingly complex nutrition challenge: the simultaneous coexistence of undernutrition and overnutrition within the same populations, households, and even individuals across the life course, a phenomenon known as the double burden of malnutrition (DBM) [1,2]. Driven by rapid economic development, urbanization, and shifts in dietary patterns, this transition has progressed rapidly in many countries across Asia and Africa, placing mounting pressure on policy systems designed primarily for single-burden responses [3,4]. Traditional policy approaches that address undernutrition and overnutrition separately are increasingly inadequate because both forms of malnutrition share common upstream determinants, including poverty, food insecurity, poor dietary quality, and inequitable food environments [5]. Moreover, the consequences of early-life undernutrition can increase the risk of obesity and diet-related noncommunicable diseases later in life, highlighting the need for coordinated, life-course policy responses [6]. Fragmented policy frameworks may therefore generate unintended consequences, such as nutrition programs that increase caloric intake without improving diet quality, potentially accelerating the transition toward overnutrition [7–9].

The presence of DBM is particularly evident across LMICs. Globally, >45 countries experience both high levels of child stunting (>20%) and adult overweight (>35%), illustrating the extensive and simultaneous presence of undernutrition and overnutrition within populations [10]. In South Asia, the proportion of households affected by both forms of malnutrition ranges from 6% to 20%, demonstrating that DBM occurs not only at the population level but also within households [11]. In response to this growing challenge, global health agencies increasingly advocate for integrated actions that address the shared determinants of undernutrition and overnutrition simultaneously. These include promoting breastfeeding, improving maternal and child nutrition during the first 1000 d of life, creating healthier school food environments, and regulating the marketing of unhealthy foods to children. Such interventions have the potential to reduce undernutrition while also preventing overweight, obesity, and diet-related noncommunicable diseases [1,12,13].

Bangladesh provides a compelling example of DBM during a rapid nutrition transition. Despite substantial progress in reducing child undernutrition over the past 2 decades, undernutrition remains a major public health challenge. According to the most recent Bangladesh Demographic and Health Survey 2022, 22.5% of children aged <5 y were stunted and 9.7% were wasted, with the prevalence of wasting remaining nearly double the global target of <5% [14–16]. Micronutrient deficiencies also remain widespread, with anemia affecting children, adolescent girls, and women of reproductive age, and deficiencies in vitamin A, iron, iodine, zinc, vitamin B12, and folate reported among young children, pregnant women, and lactating mothers [17]. These forms of undernutrition are concentrated among young children, adolescent girls, and poorer rural populations [18,19]. At the same time, overweight and obesity have risen sharply, with 36.5% of women aged 15 to 49 y classified as overweight or obese in 2022, compared with only 9% in 2004 [14,20]. This increase has been most pronounced among older, wealthier, and urban women, contributing to growing socioeconomic and rural–urban inequalities in nutritional outcomes [21]. The simultaneous presence of persistent undernutrition and micronutrient deficiencies alongside rapidly increasing overweight and obesity illustrates the complex nature of malnutrition in Bangladesh and highlights the need for integrated policy responses that address all forms of malnutrition simultaneously [22].

Bangladesh's nutrition policy architecture is guided by several key policy instruments. The National Nutrition Policy (NNP) (2015) [23] provides the overarching strategic framework, whereas the Second National Plan of Action for Nutrition (NPAN-2) [17] translates this framework into action through a multisectoral implementation strategy involving 17 ministries across areas such as life-course nutrition, agriculture and dietary diversification, and social protection. The Bangladesh National Nutrition Council (BNNC) is responsible for coordinating nutrition-related activities across 22 ministries [17,22]. NPAN-2 established specific targets for reducing undernutrition and overnutrition, including reducing stunting among children aged <5 y to 25% and limiting overweight and obesity among women of reproductive age to 30% by 2025 [17]. Although the stunting target has been achieved, the target for overweight and obesity has not been met. Complementing these efforts, the National Food and Nutrition Security Policy (2020) and its associated Plan of Action (2021–2030) [24] adopt a broader food systems approach aimed at improving dietary quality and promoting dietary diversification. As part of this strategy, the policy seeks to reduce the contribution of cereals to total dietary energy intake to <60% by 2030 [24].

Despite this comprehensive policy architecture, implementation priorities have historically remained focused on reducing undernutrition, particularly among children and women, with comparatively limited operational attention to overnutrition [22]. Although global evidence increasingly promotes integrated "double duty" actions that simultaneously address undernutrition and overnutrition [5], it remains unclear to what extent such approaches are operationalized within national implementation in Bangladesh. In addition, there is limited empirical evidence on how key stakeholders interpret and translate these policies in practice. To the best of our knowledge, no previous study has systematically examined how policymakers, program implementers, and technical experts understand DBM, assess existing policy responses, identify implementation barriers, and propose future policy directions in Bangladesh. Addressing this gap is essential for developing more coherent and effective strategies to strengthen nutrition policy implementation and tackle the growing prevalence of DBM.

This study addresses these gaps by investigating the perspectives of senior-level key stakeholders on DBM policy in Bangladesh. This study specifically explores the following: *1*) how stakeholders understand and frame DBM within Bangladesh's nutrition transition context; *2*) how stakeholders perceive and assess current NNP architecture in relation to DBM; *3*) what implementation challenges constrain the translation of policy commitments into effective action; and *4*) which policy and governance strategies stakeholders consider most important for improving future nutrition outcomes. By answering these questions, we aim to generate stakeholder-grounded evidence to

inform the strengthening of nutrition governance and integrated policy responses to DBM in Bangladesh.

Methods

Study setting

This study was conducted in Bangladesh between June and August 2025, coinciding with the final implementation phase of NPAN-2 and the preparatory period for its successor Third National Plan of Action for Nutrition (NPAN-3). As an LMIC experiencing DBM and undertaking a revision of its national nutrition plan, Bangladesh provided a timely context for capturing stakeholder perspectives on current nutrition policy challenges and priorities for future reform.

Conceptual framework

This study adopted an integrated conceptual framework combining Walt and Gilson's [25] Health Policy Triangle (HPT) with the Centers for Disease Control and Prevention (CDC) Policy Process Framework (HPT–CDC) [26] (Figure 1). The HPT examines how context (Bangladesh's nutrition transition, governance structures, and institutional environment), actors [government agencies, United Nations (UN) organizations, nongovernmental organizations (NGOs), researchers, and community stakeholders], policy content, and policy processes interact to shape national DBM responses. The CDC Policy Process Framework operationalizes the HPT's "process" component through 5 core domains: *1*) problem identification, *2*) policy analysis, *3*) strategy and policy development, *4*) policy enactment, and *5*) policy implementation, with 2 overarching domains, such as stakeholder engagement and education, and evaluation, operating continuously throughout the process.

This integration addresses each framework's limitations. The HPT provides contextual depth but lacks detailed process guidance, whereas the CDC framework offers clear process delineation but limited attention to contextual and actor-related factors [26,27]. Together, the frameworks enable systematic examination of both structural determinants (context, actors, and content) and dynamic processes (from problem identification to implementation) that shape DBM policy responses. This integrated approach is particularly relevant for DBM, which requires coordinated multisectoral action, engagement of diverse stakeholders with competing priorities, and navigation of complex contextual factors, including nutrition transition, institutional legacies, and resource constraints.

Participant selection and recruitment for key informant interviews

Participants were selected using purposive sampling to obtain a range of perspectives from stakeholders involved in

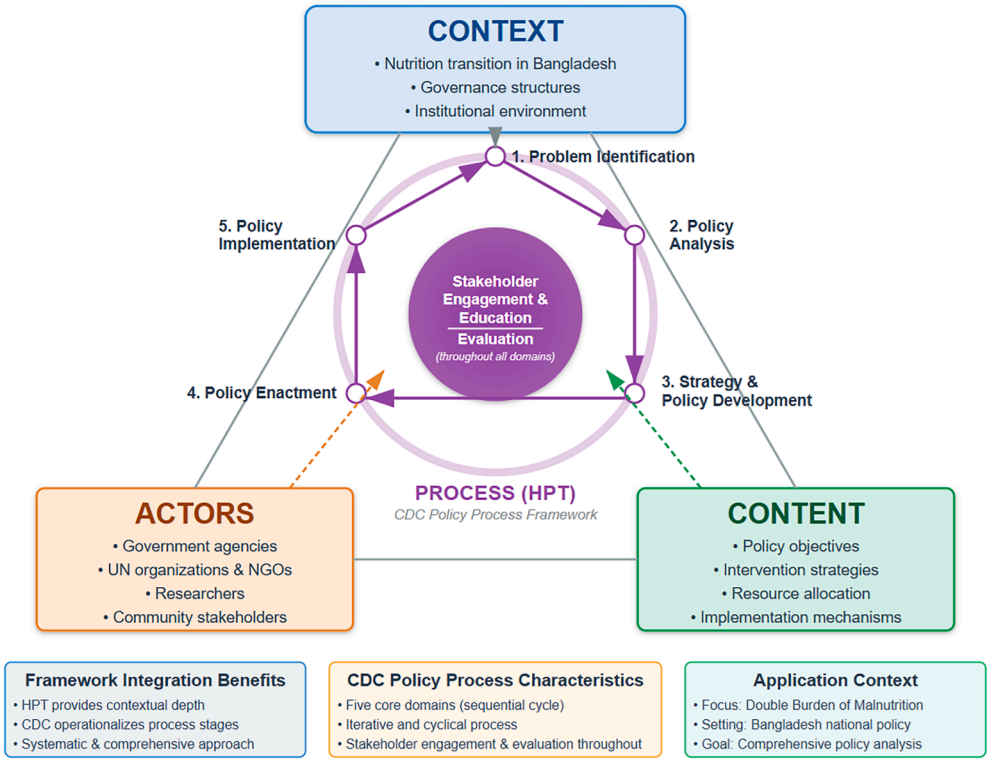

FIGURE 1. Integrated conceptual framework combining the Health Policy Triangle (HPT) and CDC Policy Process Framework for DBM policy analysis in Bangladesh. Note: The triangle represents the 3 HPT dimensions (context, actors, and content) that interact with the central process component, operationalized through 5 CDC framework core domains. Arrows indicate dynamic interactions between components. The framework acknowledges that policy processes are iterative and cyclical, continuously shaped by contextual factors, actor dynamics, and policy content. CDC, Centers for Disease Control and Prevention; DBM, double burden of malnutrition; NGO, nongovernmental organization.

nutrition policy and programming in Bangladesh. Although effective responses to DBM require coordinated action across multiple sectors, this study focused specifically on stakeholders working within the nutrition sector because its primary aim was to examine how DBM is understood, prioritized, and addressed within Bangladesh's nutrition policy and program architecture. The implications of not including stakeholders from other sectors are discussed in the "study limitations" section.

Eligible participants had the following: *1*) current or recent involvement in nutrition policy development, program implementation, or technical advisory roles; *2*) ≥5 y of experience working on nutrition issues in Bangladesh; and *3*) the ability to provide informed perspectives on policy responses to malnutrition. To ensure variation across key stakeholder groups within the nutrition sector, participants were recruited from 4 categories: government nutrition authorities, international NGOs, national research and academic institutions, and subnational health and nutrition service providers. This approach enabled the inclusion of perspectives from individuals involved in policy development, technical advice, program coordination, and frontline implementation at both national and subnational levels. Initial participants were identified through a review of nutrition policy documents, national coordination meeting records, and relevant literature, with additional participants recruited through snowball sampling [28,29]. Potential participants were contacted by e-mail and provided with study information before providing informed consent. Individuals who were approached but declined to participate or did not respond were not formally logged. All individuals who agreed to participate completed an interview.

Data collection

A semistructured interview guide was developed to explore participants' perceptions and experiences of DBM policy in Bangladesh. The guide was initially developed by the first author (AT) following a review of relevant literature and informed by the integrated HPT–CDC conceptual framework (Figure 1). It was further refined through iterative discussions within the research team to ensure conceptual alignment with study objectives, clarity of wording, and logical sequencing of questions. Attention was given to ensuring that questions were clearly structured and that probes were appropriate to elicit detailed and in-depth responses from participants. The final version of the interview guide is provided in Supplementary Table 1 (File 1).

The interview guide included open-ended questions organized into 4 main domains: *1*) participants' awareness and perceptions of DBM within the context of Bangladesh's nutrition transition; *2*) perspectives on existing NNPs, including their scope in addressing undernutrition and overnutrition, and perceived policy gaps; *3*) stakeholder roles, coordination mechanisms, and multisectoral governance arrangements; and 4) experiences of policy implementation, monitoring and evaluation processes, and views on future policy directions. The use of open-ended questions allowed participants to introduce additional issues not anticipated a priori, in line with the flexible and exploratory nature of semistructured interviews. The guide was designed to ensure comprehensive coverage of relevant policy domains while maintaining consistency across interviews.

Face-to-face interviews were conducted by the first author (AT) between June and August 2025. AT had prior experience conducting research on nutrition and health-related topics in Bangladesh. Before data collection commenced, AT received training and mentorship in qualitative interviewing techniques, including probing, active listening, reflexive note-taking, and management of interviewer bias, from the senior author (HS), who has extensive experience in qualitative health policy research in low- and middle-income settings. HS also provided ongoing methodological oversight throughout the study. AT was not affiliated with any of the participating institutions and had no prior professional, supervisory, or working relationships with the participants. This independent position helped minimize the potential influence of existing organizational relationships, professional hierarchies, or perceived conflicts of interest on participant responses. After the first 2 interviews, HS reviewed the transcripts and field notes and provided structured feedback on question framing and probing depth, which informed minor refinements to the interviewing approach for subsequent interviews. Reporting of the qualitative methods follows the Consolidated Criteria for Reporting Qualitative Research checklist [30], provided in Supplementary Table 2 (File 2). All participants, including those representing international organizations, were Bangladeshi nationals based in Dhaka and fluent in Bangla. Consequently, all interviews were conducted in Bangla. Only the participant and the interviewer (AT) were present during each interview. Interviews were audio recorded with participant consent and lasted ~40 to 60 min. AT used flexible probing throughout the interviews to encourage participants to elaborate on issues they considered important and to explore emerging topics in greater depth [29]. Field notes were maintained to document contextual observations, interview dynamics, and preliminary analytical reflections. All interviews were transcribed verbatim in Bangla and subsequently translated into English by AT, a native Bangla speaker with professional proficiency in English. After each interview, AT reviewed the findings and tracked their alignment with the research questions and objectives.

Data collection concluded after 12 interviews. This decision was informed by the principle of information power [31], which suggests that the sample size required in qualitative research depends on factors such as the specificity of the study aim, the richness and relevance of information provided by participants, and the analytical approach employed. In this study, participants occupied senior policy, program, and technical roles within Bangladesh's nutrition sector and were selected for their direct experience with nutrition policy and implementation. Given the focused research objectives and the use of reflexive thematic analysis, the interviews generated sufficient depth and richness of information to address the study's aims. Data collection concluded when successive interviews yielded no substantively new insights. Nevertheless, the relatively small sample size should be considered when interpreting the findings and is discussed further in the "study limitations" section.

Data analysis

Data were analyzed using reflexive thematic analysis following the approach described by Braun and Clarke [32]. Analysis proceeded inductively, allowing themes to be generated from the data. The process followed 6 phases:

familiarization with the data through repeated reading of transcripts; generation of initial codes; development of themes; review and refinement of themes; definition and naming of themes; and production of the final analytic narrative.

The integrated HPT–CDC conceptual framework served as an interpretive lens during the analysis. Although themes were generated inductively from participants' accounts, the framework guided their interpretation with respect to the policy context, actors, content, and process. This approach allowed themes to emerge from participants' accounts while ensuring that findings were systematically connected to the established health policy framework. The first author (AT) conducted the coding, whereas the senior author (HS) reviewed the coding framework and thematic interpretations to ensure consistency and credibility. Emerging themes were discussed iteratively with all coauthors to refine interpretations and strengthen the trustworthiness of the analysis. The themes were mapped onto the HPT–CDC domains. All analyses were performed using NVivo 15 (QSR International Pty Ltd., 2023).

TABLE 1
Study participant distribution by stakeholder group and engagement level

Stakeholder group	Number of participants	Level of engagement
International NGOs (including 2 United Nations agency representatives)	4	National
National Research and Academic Institutions	3	National
Government Nutrition Authorities	3	National
Subnational Health and Nutrition Services	2	Subnational

Abbreviation: NGO, nongovernmental organization.

Results

Overview of study participants

A total of 12 participants were included, representing 4 stakeholder groups (Table 1): international NGOs working on nutrition ($n = 4$), national research and academic institutions ($n = 3$), government nutrition authorities ($n = 3$), and subnational health and nutrition service providers ($n = 2$). Ten participants worked primarily at the national level in policy formulation, technical advisory, and program coordination roles, whereas 2 provided subnational perspectives from district-level implementation contexts.

Thematic structure

The analysis generated 4 major themes that capture participants' accounts of Bangladesh's policy response to DBM (Table 2). Theme 1 examines how DBM is understood and framed at the policy level. Theme 2 explores the current nutrition policy landscape and its responsiveness to DBM. Theme 3 identifies implementation challenges constraining effective policy response. Theme 4 captures stakeholder perspectives on policy strengthening and future directions. Table 2 maps each theme and its subthemes to the corresponding dimensions of the integrated HPT–CDC conceptual framework, illustrating how identified themes connect to the framework's domains and CDC policy stages.

Theme 1: understanding and framing DBM

Subtheme 1.1: shifting the meaning of malnutrition from undernutrition to dual burden

Participants consistently described a fundamental shift in how malnutrition is conceptualized in Bangladesh, moving from a historically dominant focus on undernutrition to a growing

TABLE 2
Thematic structure mapped to the integrated HPT–CDC framework

Theme	Subthemes	Framework dimension(s)	CDC policy stage(s)
Theme 1: understanding and framing DBM	1.1 Shifting the meaning of malnutrition from undernutrition to dual burden 1.2 Ongoing challenges in defining and conceptualizing DBM	• Context (nutrition transition, historical focus) • Actors (expert vs. community understanding)	• Problem identification
Theme 2: current nutrition policy landscape and responsiveness to DBM	2.1 Comprehensive multisectoral nutrition policies with a persistent focus on undernutrition 2.2 Absence of integrated DBM-specific frameworks and double-duty action approaches	• Content (policy substance) • Actors (multisectoral engagement) • Context (institutional arrangements)	• Policy analysis • Strategy and policy development
Theme 3: policy implementation challenges	3.1 Weak multisectoral coordination and policy implementation gaps 3.2 Weak monitoring, evaluation, and accountability systems 3.3 Insufficient human and institutional capacity for implementation	• Process (implementation mechanisms) • Actors (capacity, coordination) • Context (resource environment)	• Policy implementation • Evaluation
Theme 4: policy strengthening and future directions	4.1 Enhancing multisectoral governance, food system transformation, and regulatory interventions 4.2 Strengthening implementation capacity, monitoring systems, and institutional mechanisms 4.3 Behavior change communication and awareness programs	• All dimensions (comprehensive strengthening) • Context (governance reform) • Actors (capacity building) • Content (policy revision) • Process (implementation systems)	• Strategy and policy development • Stakeholder engagement and education • All stages (iterative improvement)

Abbreviations: CDC, Centers for Disease Control and Prevention; DBM, double burden of malnutrition; HPT, Health Policy Triangle.

recognition of a dual burden encompassing both undernutrition and overnutrition. This shift was linked to broader socioeconomic changes, including improvements in food security, reductions in poverty, and rising purchasing power, which have altered dietary patterns and nutritional risk profiles. As 1 government nutrition official explained:

> "As food security has improved, poverty has declined, and purchasing power has increased, undernutrition has gradually fallen. However, this progress has been accompanied by a rise in overnutrition due to shifts in dietary patterns" (P1, Government nutrition authority).

Several participants noted that malnutrition was previously understood almost exclusively as undernutrition, with limited recognition of overnutrition as a public health concern. Reflecting this evolving perspective, another government official stated:

> "Previously, our general understanding of malnutrition was limited to undernutrition only. However, both undernutrition and overnutrition fall under the category of malnutrition" (P7, Government nutrition authority).

Participants further emphasized that this transition is evident at both population and household levels. They described declines in stunting and undernutrition alongside a rapid increase in overweight and obesity, particularly in urban areas (P12; Supplementary Table 1). Participants also highlighted that the dual burden of malnutrition is increasingly observed both within and across households. Within households, undernutrition and overnutrition may coexist simultaneously, for example, where an overweight mother and an undernourished child live together. Across households in the same community, food-secure households were reported to experience overweight, whereas economically disadvantaged neighboring households continued to face undernutrition (P9; Supplementary Table 1).

Despite growing recognition of the dual burden among policy-level and technical actors, participants identified persistent gaps in community-level understanding. A senior researcher highlighted the disconnect between expert discourse and public awareness:

> "The concept of double burden of malnutrition does not actually exist in Bangladesh. It is neither recognised nor understood at the individual or household level" (P4, National research institution).

Subtheme 1.2: ongoing challenges in defining and conceptualizing DBM

Participants reported persistent conceptual ambiguities that complicate problem identification and policy formulation for DBM in Bangladesh. The absence of a universally accepted definition creates uncertainty among policy actors about what constitutes DBM and what should be prioritized in interventions. As 1 government official explained:

> "To be honest, there is still no globally accepted definition. There is only a working definition provided by WHO, which we generally follow" (P7, Government nutrition authority).

Participants also attributed definitional ambiguity to both historical context and evolving scientific understanding. Malnutrition discourse in Bangladesh has long been dominated by undernutrition, dating back to a time when overnutrition was viewed as a problem confined to Western countries. This historical framing creates enduring path dependencies continuing to shape how DBM is defined and understood (P3; Supplementary Table 2).

Although participants acknowledged that DBM understanding has expanded, they emphasized that prevailing definitions remain limited in scope. An international NGO representative highlighted that micronutrient deficiencies are often excluded from the conceptualization of DBM:

> "By double burden of malnutrition, we generally mean 2 things: overnutrition and undernutrition. One is malnutrition and the other is overnutrition—that is what we understand. But along with this double burden, there is another thing that is very important, and that is micronutrient deficiency" (P8, International NGO representative).

Participants also reported persistent uncertainty regarding DBM conceptualization across age groups and life stages, highlighting the importance of a life-course perspective, noting that individuals may experience underweight and overweight at different life stages (P7; Supplementary Table 2).

The 2 subthemes above indicate persistent challenges in DBM understanding and framing. Recognition remains largely limited to expert levels, with limited community awareness. Conceptual ambiguities, including roles of micronutrient deficiencies and life-course considerations, leave policy actors working with incomplete frameworks. Historical undernutrition-focused policies further constrain the adoption of a dual-burden perspective. These problem-identification gaps extend throughout the policy process, contributing to content gaps and implementation challenges described in themes 2 and 3.

Theme 2: current nutrition policy landscape and responsiveness to DBM

Subtheme 2.1: comprehensive multisectoral nutrition policies with persistent focus on undernutrition

Bangladesh's NNP architecture formally acknowledges both malnutrition forms but with markedly different emphasis: undernutrition receives considerably more attention and detailed intervention guidance, whereas overnutrition is addressed only through generic behavior change communication and without programmatic specificity. Stakeholders confirmed this structural pattern and, critically, offered explanatory accounts of why it has persisted despite growing epidemiologic awareness of overnutrition.

Participants observed that although DBM is increasingly recognized in principle, policy guidance remains uneven in depth and specificity. As 1 government official explained:

> "In the process of formulating the new policy, there is an initiative to address DBM, although the work has not yet begun" (P6, Government nutrition authority).

Despite comprehensive multisectoral frameworks, participants reported that historical undernutrition focus continues to

shape policy priorities and implementation. Undernutrition dominates across ministries, influencing program design and operational practices. As 1 government official summarized:

> "Unfortunately, everything is still undernutrition-centric. Whether we talk about programs or policies, the main focus remains undernutrition" (P7, Government nutrition authority).

Although policies acknowledge rising overweight and obesity, interventions, training, technical guidance, and communication materials remain largely undernutrition-focused, leaving frontline workers less equipped to respond to overnutrition across population groups (P2, P7, P8; Supplementary Table 3).

Subtheme 2.2: absence of integrated DBM-specific frameworks and double-duty action approaches

Participants reported that Bangladesh lacks a formal, integrated policy framework specifically designed to address DBM. This gap was attributed not only to structural limitations but also to prevailing mindsets among policymakers. A government nutrition official reflected on this evolving policy awareness, stating:

> "The main reason it has not been included in the policy is that our mindset has not yet fully evolved. I have been emphasising this for the past two to three years. Our discourse has focused heavily on stunting—an issue we have been addressing for the last 20 years" (P7, Government nutrition authority).

Participants described this as a lag between epidemiological reality and policy cognition. Representatives from international NGOs and the government noted:

> "Effective interventions, links, or strong separate policies for overnutrition are not there. That part is missing" (P8, International NGO representative).

> "If you go to programmatic level… whether there is anything that specifically addresses the double burden of malnutrition with a double duty action approach, the answer is no" (P7, Government nutrition authority).

Additional perspectives from other participants further corroborated the absence of overnutrition-specific policy mechanisms within the existing national nutrition framework (Supplementary Table 4).

Theme 3: policy implementation challenges

Subtheme 3.1: weak multisectoral coordination and policy implementation gaps

Participants identified a critical disconnect between formal structures and functional operationalization. Although comprehensive frameworks exist with explicit coordination mandates, on-the-ground translation was described as weak. An international NGO representative noted:

> "Bangladesh performs well in policy adoption, comparable to many countries. But when it comes to implementation, we face significant challenges" (P9, international NGO representative).

This assessment was echoed across stakeholder groups. A UN agency representative and academic institution participants emphasized that although policies are well-developed, implementation falls short of the original intent, with implementation challenges rather than policy design identified as the primary constraint (P2, P5; Supplementary Table 5). Nutrition is inherently multisectoral, yet sectors operate largely in silos with limited functional coordination despite formal structures. As a UN agency representative explained:

> "Nutrition is a multisectoral issue, not the responsibility of a single ministry. The Bangladesh National Nutrition Council (BNNC) under the Ministry of Health is supposed to coordinate across 22 ministries, but it lacks the mechanisms to regularly monitor or review progress" (P2, UN agency representative).

Weak coordination challenges extend beyond organizational structures to accountability gaps. Participants noted the absence of effective mechanisms to ensure that nonhealth sectors fulfill their nutrition-related responsibilities, limiting accountability and cross-sectoral commitment to nutrition objectives (P8; Supplementary Table 5).

Subtheme 3.2: weak monitoring, evaluation, and accountability systems

Despite formal provisions, participants identified persistent weaknesses in the functioning of monitoring, evaluation, and accountability mechanisms. Although monitoring policies formally exist, they lack rigorous mechanisms for effective oversight. As a government nutrition authority explained:

> "The monitoring mechanism is very weak" (P6, Government nutrition authority).

Government monitoring lacks adequate strength because routine activity tracking fails to capture service quality or verify information accuracy provided to beneficiaries (P8; Supplementary Table 6). Participants reported gaps between formal monitoring systems outlined in policies and their practical application. A researcher highlighted this deficit:

> "There is a monitoring policy, but in practice, it is not fully implemented" (P3, National research institution).

Participants identified critical gaps related to routine data collection and systematic evaluation. Key nutrition indicators, particularly anthropometric measurements, are not consistently tracked across service delivery points (P1, P3; Supplementary Table 6). Systematic weaknesses in evaluation compound this data gap, with agencies often lacking basic information on policy outcomes and unable to demonstrate implementation progress or impact (P10; Supplementary Table 6).

Subtheme 3.3: insufficient human and institutional capacity for implementation

Interviewed participants identified critical shortages of trained, dedicated personnel as major constraints affecting policy implementation and scale-up. Workforce limitations extend from national coordination bodies to frontline service delivery. At the national level, institutional capacity constraints are particularly evident in coordinating bodies. Despite formal

mandates, BNNC was described as underresourced and lacking authority. A UN agency representative explained:

> "BNNC is expected to coordinate across 22 ministries, but it has limited manpower and authority. Even though the government has given them a mandate, a small and weak directorate-level institution cannot effectively supervise so many ministries" (P2, UN agency representative).

Capacity constraints within technical institutions compound these challenges. Institutions like Institute of Public Health Nutrition (IPHN) lack the manpower required even for limited geographical implementation (P6; Supplementary Table 7). These institutional capacity deficits restrict the system's ability to provide oversight, technical guidance, and quality assurance for nutrition programming.

At the frontline level, participants described substantial human resource gaps limiting nutrition service delivery. No specific nutrition workers exist at the field level, and family planning workers already carrying multiple priorities leave nutrition competing for attention (P8; Supplementary Table 7). Nutrition activities are often carried out by workers whose primary responsibility is not nutrition. A government nutrition authority explained:

> "The primary problem is human resources. Nutrition has no dedicated human resources and depends on proxies who do not consider it their main task" (P7, Government nutrition authority).

Beyond workforce numbers, available personnel often lack the skills and training needed to implement nutrition interventions effectively. This skills gap reflects inadequate training, leaving workers unable to operationalize policies, even when they are explained. A UN agency representative highlighted:

> "They have not been trained... even if you explain the policy, they cannot implement it because they are unaware" (P10, UN agency representative).

Theme 4: policy strengthening and future directions

Subtheme 4.1: enhancing multisectoral governance, food system transformation, and regulatory interventions

Participants highlighted the need to strengthen multisectoral governance mechanisms and to expand policy responses beyond the health sector. Current coordination bodies face persistent institutional weaknesses, particularly regarding the capacity to fulfill coordination mandates effectively (P11; Supplementary Table 8). Stronger governance requires clearer role definitions, improved accountability, and broader stakeholder engagement. As an international NGO representative stated:

> "It must clearly state the responsibilities of each stakeholder… otherwise there will be a big gap" (P8, International NGO representative).

Participants also highlighted the need to engage private-sector actors in nutrition governance as a critical strategy addressing emerging nutrition challenges (P10; Supplementary Table 8).

Stakeholders recognized healthy diets as a central component of efforts to address DBM and emphasized the need to move beyond a traditional focus on food security toward improving dietary quality. As an international NGO representative noted:

> "Food security alone is not enough; attention must be given to food quality" (P9, International NGO representative).

A prominent regulatory concern raised was the sale of unregulated, unhealthy food near schools. Participants described widespread availability of highly processed, energy-dense snacks within school vicinities, emphasizing the need for enforceable restrictions. As 1 subnational health and nutrition service provider noted:

> "In front of every school… there's always a fast-food shop. If they could be fined or restricted, it would help" (P11, Subnational health and nutrition services).

Subtheme 4.2: strengthening implementation capacity, monitoring systems, and institutional mechanisms

Building on implementation and monitoring gaps identified in theme 3, participants identified strategies enhancing Bangladesh's ability to operationalize nutrition policies and respond effectively to DBM. Strengthening implementation was repeatedly highlighted as a priority, with participants noting that policies are strong but lack proper follow-through (P2; Supplementary Table 9). Systematic project assessment is essential for learning and improvement. As a district health education officer stated:

> "If a three-month pilot is done but not evaluated, nothing improves" (P11, Subnational health and nutrition services).

Strengthening monitoring and verification systems is essential for accountability. Participants identified the need for functional surveillance systems enabling evidence-based decision-making. Proper record-keeping allows early problem identification and rapid response (P8; Supplementary Table 9).

Building human and institutional capacity emerged as a key priority to directly address workforce constraints. Frontline workers often lack specific skills in implementing nutrition policies effectively (P10; Supplementary Table 9). Strengthening coordination structures and ensuring adequate local-level resources were also recommended:

> "The District Nutrition Coordination Committee needs to be made functional with proper support" (P11, Subnational health and nutrition services).

Participants highlighted emerging positive developments, such as research partnerships and digitized reporting systems that have the potential to be scaled up. Research on trans-fat was reported to have already contributed to the establishment of new national laboratory capacity (P9; Supplementary Table 9).

Subtheme 4.3: behavior change communication and awareness programs

Behavioral change communication (BCC) is widely recognized as a fundamental strategy for addressing both undernutrition and overnutrition in Bangladesh. Interviewed participants emphasized the central role of systematic communication and knowledge dissemination across stakeholder groups. A government nutrition official noted:

"The main strategy is counselling and communication aimed at changing behaviour" (P1, Government nutrition authority).

Participants highlighted mass media campaigns as key mechanisms for reaching wide audiences, drawing lessons from successful initiatives, such as oral rehydration solution awareness programs (P2; Supplementary Table 10). This example demonstrated how consistent public education translates into widespread knowledge and behavior change at the community level, providing a potential model for DBM-related nutrition messaging.

Health professionals play a critical role in initiating and sustaining BCC, even in the absence of formal policies or programs (P10; Supplementary Table 10). The absence of comprehensive overnutrition policies limits the development of structured BCC programs. A senior researcher explained:

"First, we don't have a comprehensive policy on overweight and obesity. Without it, awareness campaigns and training cannot be properly implemented" (P3, National research institution).

Discussion

This study identified a range of conceptual, policy, and implementation challenges that stakeholders perceived as constraining effective responses to DBM in Bangladesh. Findings suggest that limitations in how DBM is understood, prioritized, and translated into policy and practice continue to hinder effective responses. Stakeholders highlighted challenges related to conceptual clarity, competing policy priorities, multisectoral coordination, and implementation capacity, which may impede the translation of growing awareness of DBM into coherent and sustained action. Addressing these challenges will require stronger alignment between policy objectives and implementation realities, as well as greater attention to how DBM is incorporated into policy planning, program design, and service delivery. Drawing on the perspectives of 12 senior nutrition stakeholders, this study contributes empirical evidence on perceived gaps in current policy responses and identifies stakeholder priorities for strengthening future efforts to address DBM in Bangladesh.

Themes 1 and 2 help explain why Bangladesh's nutrition policies remain undernutrition-centric despite growing recognition of overnutrition. Stakeholders described a persistent "path dependency" [33], in which priorities established during decades of undernutrition programming continue to shape policy cognition, funding flows, and institutional culture. In this "adding on" dynamic, overnutrition concerns are appended to existing frameworks without meaningful reorientation, reflecting a lag between epidemiological reality and policy understanding [33,34]. The lack of a widely operationalized DBM definition further compounds this challenge, with ongoing ambiguity around what constitutes DBM, which age groups should be prioritized, and how micronutrient deficiencies fit within the dual burden framework. These conceptual gaps help explain the structural policy limitations identified in theme 2. Overnutrition remains insufficiently integrated into policy, highlighting that the absence of double-duty actions stems from institutional and cognitive factors that require engagement at the actor level, rather than simple policy revision [5].

Findings from theme 3 highlight implementation gaps as a central challenge in Bangladesh's nutrition policy, reflecting a broader disconnect between policy intentions and practical realities in global nutrition governance [35,36]. Three interrelated barriers were identified: weak multisectoral coordination, insufficient monitoring and accountability systems, and persistent resource and workforce constraints. Although formal structures such as the BNNC exist, stakeholders described multisectoral coordination as largely symbolic, with nutrition often viewed by nonhealth sectors as outside their remit. This underscores the absence of a truly operational multisectoral approach, which is essential for effectively addressing DBM [37]. Coordination challenges were also apparent at subnational levels, in which platforms experienced irregular meetings and limited logistical support, indicating that gaps extend beyond national structures to the frontline settings in which interventions are delivered. These findings align with prior evidence that effective multisectoral nutrition action requires functional coordination at district and community levels, supported by adequate resources, clear mandates, and robust accountability frameworks [35,37,38].

Monitoring and accountability gaps were identified as a major constraint in subtheme 3.2. Although policy documents outline monitoring mechanisms, participants reported that their implementation remains weak. Existing data systems do not adequately capture service quality or provide timely information to guide decision-making. In particular, the lack of routine anthropometric measurements and the absence of DBM-specific indicators were highlighted as critical shortcomings. The 2020 Global Nutrition Report notes that when monitoring systems focus primarily on undernutrition while neglecting overweight, obesity, and diet-quality indicators, implementation tends to default to traditional undernutrition-focused interventions [10]. Accountability for nutrition outcomes is also limited, with few consequences for poor performance, reducing incentives for implementers to maintain high-quality service delivery [10,39,40].

Subtheme 3.3 highlighted human resource constraints as one of the most critical barriers to effective policy implementation. Participants described the absence of a dedicated nutrition workforce at the frontline, with existing staff already overburdened and nutrition responsibilities often treated as secondary tasks. Capacity is further constrained by a lack of DBM-specific skills, as most personnel are trained primarily in undernutrition-focused approaches. These findings align with previous evidence showing that inadequate workforce capacity undermines the effectiveness of nutrition programs across LMICs [41–44]. Limited budget allocations for nutrition-specific interventions further exacerbate the challenge, indicating that fiscal commitments have not kept pace with policy rhetoric on DBM [10,45].

Reflecting the reform priorities highlighted in theme 4, participants identified several key areas for strengthening nutrition policy, including enhancing multisectoral governance, advancing food system reforms through regulatory measures, improving implementation capacity and monitoring, and

expanding BCC initiatives. They emphasized the importance of functional, rather than symbolic, coordination mechanisms, echoing previous evidence that successful nutrition action requires clearly defined roles, robust accountability structures, and active engagement across sectors beyond health [46]. The call to strengthen subnational coordination is consistent with experiences from the "Nutrition Officers in Tanzania" initiative, in which effective implementation relied on empowered district-level platforms and clearly defined authority [47].

Emphasis on food system approaches—including trans-fat regulation, sodium reduction, nutrient profiling, and restrictions on unhealthy foods near schools—reflects alignment with global evidence on obesity prevention [48,49]. However, participants noted that although such regulations exist, enforcement remains weak, highlighting the need for implementation infrastructure, including laboratory capacity, inspection systems, and clear enforcement authority. Expanding the definition of food safety to encompass nutritional harm represents an important conceptual shift, with the potential to strengthen regulatory action [49,50].

The emphasis on implementation capacity and monitoring reflects recognition that Bangladesh's primary challenge lies in execution rather than policy formulation. Participants stressed the importance of evaluation and learning, noting that "if a pilot is done but not evaluated, nothing improves," underscoring the role of learning systems in adapting policies. Emerging research partnerships and digitized reporting systems provide a foundation for continuous quality improvement, but these mechanisms require further scaling and institutionalization. Participants also highlighted BCC as a critical component of effective nutrition policy because it shapes dietary knowledge, attitudes, and practices that influence nutritional outcomes. However, they noted that BCC efforts in Bangladesh remain heavily focused on undernutrition, with comparatively limited and less developed initiatives targeting overnutrition and unhealthy diets [8,51,52].

Taken together, the 4 themes of this study highlight that a DBM-responsive policy architecture is not simply a matter of appending overnutrition programs to existing undernutrition frameworks. Instead, it requires what Hawkes et al. [5] describe as "double-duty actions": interventions, programs, and policies deliberately designed or adapted to address the shared drivers of undernutrition, overweight, obesity, and diet-related noncommunicable diseases within the same populations or households [5]. The *Lancet* series on DBM further identifies such actions with strong evidence potential, categorized around 4 key domains: early-life nutrition, diet diversity, food environments, and socioeconomic factors [5].

Bangladesh has existing platforms that could be adapted for double-duty purposes. Breastfeeding promotion already features in the NNP [23] and NPAN-2; enhancing enforcement of the International Code of Marketing of Breast-milk Substitutes and expanding community lactation support could strengthen both undernutrition and obesity prevention [5]. The National School Feeding Policy [53,54] could be adapted to emphasize dietary diversity, locally sourced foods, and limits on added sugar, salt, and saturated fat, simultaneously addressing micronutrient deficiencies and unhealthy dietary exposure [55,56]. Social protection programs such as the Mother and Child Benefit Programme can act as double-duty interventions if paired with BCC focusing on diet quality [57]. Finally, food environment interventions such as front-of-pack labeling [58,59] and marketing restrictions on unhealthy foods would reduce exposure to ultraprocessed foods, benefiting both undernourished and overweight populations [53]. These examples highlight that Bangladesh does not need to develop a DBM policy from scratch; rather, existing programs can be systematically adapted, monitored, and integrated through a double-duty lens, using combined indicators to capture co-benefits and manage potential trade-offs.

Implications for policy and practice

Our findings have several important implications for nutrition policy in Bangladesh and similar contexts. First, although existing programs provide opportunities for double-duty interventions, addressing DBM ultimately requires moving beyond "policy add-ons" toward a broader reorientation of nutrition governance, including integrated policy frameworks, stronger multisectoral coordination, and balanced resource allocation. Second, strengthening implementation must be prioritized alongside policy formulation, with particular emphasis on improving multisectoral coordination, establishing functional monitoring and accountability systems, and building adequate workforce capacity. Third, conceptual clarity around DBM definitions and operationalization is essential for translating recognition into action. Fourth, greater emphasis is needed on food system approaches, including regulatory measures and environmental modifications, to complement individual-level interventions.

For policymakers, ongoing revisions such as NPAN-3 provide an opportunity to integrate DBM into national frameworks, clarify implementation processes, strengthen monitoring indicators for both forms of malnutrition, and align resource allocation with current nutrition trends. For program implementers, the findings highlight the need for workforce training on integrated approaches, strengthened supervision systems, and adaptation of intervention packages to address risk factors associated with both forms of malnutrition.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, although DBM is inherently a multisectoral issue and participants frequently emphasized the importance of engagement beyond the nutrition sector, all participants were recruited from nutrition-sector organizations. Consequently, perspectives from stakeholders in other sectors relevant to DBM, such as agriculture, education, food systems, trade, and urban planning, were not captured. Future research could extend this work by examining how actors across these sectors understand and respond to DBM. Second, the sample size was relatively small. Although participants were purposively selected for their direct involvement in nutrition policy and implementation, and the sample size was guided by the principle of information power, the findings may not reflect the full range of perspectives present within Bangladesh's broader nutrition and policy landscape. Relatedly, data collection was conducted over a 3-mo period (June–August 2025), which limited the time available for more participants' recruitment. A longer recruitment period may have facilitated

engagement with additional senior stakeholders, particularly from academic and research institutions.

Third, the cross-sectional design captured stakeholder perspectives at a single point in time during ongoing policy review and implementation processes. As nutrition policies, governance arrangements, and programmatic priorities continue to evolve, stakeholder perspectives may also change over time. Longitudinal research could provide further insights into how understandings of DBM and policy responses develop in response to evolving policy contexts. Fourth, transcripts were not returned to participants for comment or correction, and member checking of emergent themes was not conducted because of time and scheduling constraints that limited the feasibility of a second round of stakeholder consultation. Finally, participant responses may have been influenced by social desirability bias, particularly when discussing politically sensitive issues such as policy implementation challenges, institutional constraints, and resource allocation. Efforts were made to minimize this risk by assuring participants of confidentiality and encouraging open discussion during interviews.

Conclusions

Drawing on the perspectives of 12 senior stakeholders within Bangladesh's nutrition sector, this study provides timely, stakeholder-informed evidence to inform nutrition governance during a critical policy revision period. We recommend 3 priority actions for policymakers: *1*) operationalize DBM definitions within NPAN-3 with clear indicators and resource allocations; *2*) establish effective multisectoral coordination mechanisms with dedicated budgets and robust accountability systems at both national and subnational levels; and *3*) invest in workforce capacity to support integrated approaches that address both undernutrition and overnutrition. Development partners can reinforce these efforts by aligning technical assistance with double-duty action frameworks, improving monitoring systems that capture the full spectrum of malnutrition, and facilitating evidence exchange with countries navigating similar transitions. It is evident that recognizing DBM in policy is necessary but insufficient without deeper reforms in governance, implementation, and resource allocation—an emerging challenge for many LMICs undergoing rapid nutrition transitions.

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Author contributions

The authors' contributions were as follows – AT, HS: conceptualized and designed the study. AT: conducted the key informant interviews (KII), collected the data, led the data analysis, and drafted the manuscript; AT, SKC: contributed to the interpretation of the results; HS, MK, DG: supervised the analytical process; HS, MK, SKC, DG: critically revised the manuscript for intellectual content; and all authors: reviewed and edited subsequent drafts, read and approved the final version, and contributed to the decision to submit the manuscript for publication.

Conflict of interest

The authors report no conflicts of interest.

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Data availability

The data are available from the corresponding author upon reasonable request.

Ethical considerations

Ethical approval was obtained from the Human Research Ethics Committee, Australian National University, Australia (Project H/2025/0278) and the Research and Innovation Centre, Khulna University, Bangladesh (KUECC-2025-04-32). All participants provided oral informed consent and were informed of their right to withdraw at any time. To ensure confidentiality, participants were assigned alphanumeric codes (P1–P12). Audio recordings and identifying information were stored separately in password-protected files accessible only to the first author. Data will be retained for 5 y and then securely destroyed in accordance with institutional guidelines.

Declaration of Generative AI and AI-assisted technologies in the writing process

The author(s) declare that no generative AI or AI-assisted technologies were used in the writing of this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cdnut.2026.109433.

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