

**Area-level variation in primary health care
service characteristics and the modifying effect
on individual-level socioeconomic variation in
receipt of care:
potential avenues for improving health equity**

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A thesis submitted for the degree of Doctor of Philosophy at the Australian
National University

August 2017

Declaration

Unless otherwise indicated, the work in this thesis is my own.

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9th August 2017

Word count: 72,017

Acknowledgements

First and foremost I wish to express my sincere gratitude to my primary supervisor and Chair of the Panel, Dr Rosemary J Korda. She has taught, trained and guided me in the pursuit of research inquiry and epidemiological excellence, and—possibly of equal importance—the art of communicating my research findings well. I am forever grateful for the many, many hours she has spent helping me unravel the complex challenges I faced, providing honest and constructive feedback, and being the voice of encouragement and reason during those hard times on the PhD journey. Her mentorship, insight, advice and friendship has been invaluable throughout this time.

I wish to offer my sincerest thanks to my other panel members. To Professor John Humphreys, an ardent scholar who has been a constant source of encouragement from the moment I first began in the field of health service research. Professor Humphreys has always afforded me wise words and helped me maintain the perspective between clinical practice, research and policy. To Professor Louisa Jorm, who offered her expertise in health policy research and the application of multilevel analyses; her guidance on undertaking rigorous research was invaluable. To Associate Professor Sarah Larkins, whose advice and direction, particularly in keeping the thesis true to the clinical context from which the idea first begun, helped me maintain my focus and motivation. And finally to Dr Wei Du, for his biostatistical expertise and knowledge, and his enduring patience in helping a clinician to keep up.

The transition from a rural General Practitioner, working mostly with disadvantaged communities, to engaging in health policy research to address the challenges faced in clinical settings such as these, would not have been possible without support of a number of key mentors and colleagues. I thank Professor Kirsty Douglas, who was critical in facilitating my early steps into research and embarking on the PhD program. I am incredibly grateful for the continued sound advice and technical expertise from Dr Ian McRae, who was always willing to review my work and offer thoughtful direction. I thank all of the members from the GRAPHIC collaboration, in particular Mr Paul Konings, Dr Soumya Mazumdar, Dr Nasser Bagheri, and Dr Federico Giroi, as well as the team across the ocean at HealthLandscape and the Robert Graham center, for creating the work environment and brains trust I was constantly able to draw upon, enabling me to complete this work. To my PhD buddies, Dr Tanisha Jowsey, Dr Jane Desborough and Ms Laurann Yen, I thank you for sharing this journey of many years, and for all the chats and cups of tea. My gratitude is also extended to all the staff from previous the Australian Primary Health Care Research Institute and currently at the Research School of Population Health, at the ANU.

This research was completed using data collected through the 45 and Up Study (www.saxinstitute.org.au). The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council NSW; and partners: the National Heart Foundation of

Australia (NSW Division); NSW Ministry of Health; NSW Government Family & Community Services – Ageing, Carers and the Disability Council NSW; and the Australian Red Cross Blood Service. I thank the many thousands of people participating in the 45 and Up Study.

I gratefully acknowledge the financial support of the Australian Government through the National Health and Medical Research Council Postgraduate Scholarship (GNT1038903).

I would also like to acknowledge Dr Guenter Plum, who provided professional proof-reading and formatting services of the thesis.

I am sincerely grateful to the many friends and family who have supported me over the years, for your encouragement and patience, and for being a willing ear. And last but far from least, to my incredible husband, Josh, whose belief in me never wavered, and my precious children, Beatrix and Max; this has been your journey as much as mine, and I cannot thank you all enough.

Abstract

The presence of a strong primary health care (PHC) system is crucial to improving not only the average levels of health of a population, but also health equity. While Australia has universal health care and a strong PHC system, service organisation and delivery characteristics vary according to the local context. However, the nature and extent of this variation and the way in which it modifies receipt of care in relation to a person's socioeconomic position (SEP) is not well characterised. This thesis aimed to address these evidence gaps and, in so doing, identify avenues for policy and practice intervention for improving the equity of health care use.

First, measures of service characteristics that reflect the core domains of strong PHC systems—accessibility (availability, affordability and accommodation), comprehensiveness and coordination—that can be viewed to operate at the small-area level were constructed. This was done using data available at the Statistical Area Level 3 for New South Wales, from a range of sources. There was marked geographical variation in these measures, and data and conceptual limitations warranted caution when applying some of them to PHC-related outcomes.

Second, variation in receipt of PHC and the association with PHC service characteristics were quantified using 2006–2008 survey data from the *45 and Up Study* linked to Medicare Benefits Schedule claims data and the constructed area-level PHC measures. Four outcomes were examined; frequency of GP use and three measures of quality—length of consultation, continuity of care and care planning. A series of two-level (individuals within areas) multilevel logistic regression models were run, separately by region (major cities, inner regional and outer regional/remote), and with cross-level interaction terms, to examine the effect of service characteristics on socioeconomic variation in receipt of care.

Both GP use and quality of care varied between areas, within each region. People living in areas where care was more affordable (that is, more bulk-billing or less out-of-pocket expenses), or that had more after-hours or chronic disease care, had greater GP use and better quality of care.

Generally, for a given level of need, persons of low SEP had more GP care (both GP use and quality of care) compared with their high-SEP counterparts. In major cities, increasing affordability or more after-hours services within an area was associated with a larger increase in GP care for persons of high SEP, compared with persons of low SEP. In contrast, in regional and remote areas, increasing affordability or more after-hours services within an area was associated with larger increases in use and a larger increase in long consultations for those who were low SEP compared with those who were high SEP; that is, these PHC characteristics were pro-low SEP.

Using the same data and analytical approach, use of specialist care was also shown to vary between areas; however, in contrast to GP care, specialist use was pro-high SEP.

The findings suggest that in major cities, PHC initiatives that promote affordability, accommodation and comprehensiveness of services within areas are working well from an equity perspective. On the other hand, in regional and remote areas there are clear opportunities for improving receipt of care for those who are disadvantaged through current policy initiatives. The inequitable use of speciality care sits in stark contrast to GP care, with significant potential for health gains by redressing this.

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List of Abbreviations

ABS	Australian Bureau of Statistics
ACCHO	Aboriginal Community Controlled Health Organisations
ACSC	ambulatory care sensitive conditions
ACT	Australian Capital Territory
AIHW	Australian Institute of Health and Welfare
ALSWH	Australian Longitudinal Study on Women's Health
AMPCo	Australian Medical Publishing Company
ANU	Australian National University
ARIA+	Accessibility/ Remoteness Index of Australia Plus
ASCO	Australia Standard Classification of Occupations
ASGC	Australian Standard Geographical Classification
ASGS	Australian Statistical Geographical Standard
AUD	Australian dollar
CCD	census collection district
CD	chronic disease
CHeReL	Centre of Health Record Linkage
CI	confidence interval
COB	country of birth
CSDH	Commission for the Social Determinants of Health
DALYs	disability-adjusted life years
DGP	Divisions of General Practice
DOH	Department of Health
DHS	Department of Human Services
DIC	Deviance Information Criterion
DVA	Department of Veteran Affairs
ED	Emergency Department
EPC	extended primary care
ERP	estimated resident population
FTE	full-time equivalent
FWE	full-time workload equivalent
FSE	full-time service equivalent
HC	health centre
GDP	gross domestic product
GISCA	National Centre for Social Applications of GIS
GIS	geographical information systems
GP	general practitioner

GPMP	general practice management plan
GRAPHIC	Centre for Geographic and Resource Analysis in Primary Health Care
GRHANITE	Generic Health Network Information Technology for the Enterprise
HC	health centre
HCC	health care card
HERO	Health Establishment Registration Online
ICC	intra-class coefficient
IQR	interquartile range
IRSD	Index of Relative Socioeconomic Disadvantage
LHD	Local Health District
MABEL	Medicine in Life: Balancing Employment and Life
MAGNET	Melbourne East Monash General Practice Database
MBS	Medicare Benefits Scheme
MCMC	Monte Carlo Markov Chain
MOR	median odds ratio
MOS	medical outcomes study
MP	medical practitioner
NHPA	National Health Performance Authority
NHS	National Health Survey
NPHCS	National Primary Health Care Strategic
NZ	New Zealand
NSW	New South Wales
NT	Northern Territory
OECD	Organisation for Economic Development and Organisation
OLS	ordinary least squares
OOP	out-of-pocket
OR	odds ratio
PBS	Pharmaceutical Benefits Scheme
PC	pension card
PCP	primary care physician
PCV	proportional change in variance
PHC	primary health care
PHI	private health insurance
PHIDU	Public Health Information Development Unit
PHN	Primary Health Networks
PQL	second order penalized quasi-likelihood
QLD	Queensland
QOF	Quality Outcomes Framework

QUALICOPC	Quality and Costs of Primary Care in Europe
RD	rate difference
RII	relative index of inequality
RR	rate ratio
SA	South Australia
SD	standard deviation
SDOH	Social Determinants of Health
SE	socioeconomic
SEIFA	Socioeconomic Indexes for Areas
SEP	socioeconomic position
SF-36	36-item MOS short form health outcome survey
SII	slope index of inequality
SA3	statistical area 3
SLA	statistical local area
SURE	Secure Unified Research Environment
TAS	Tasmania
TCA	team care arrangement
WHO	World Health Organisation
WA	Western Australia
URP	usual resident population
US	United States
VIC	Victoria

Chapter 1

The Role of the Primary Health Care System in Health Equity: Background and Rationale

The social, political and cultural contexts of the places where people live, work and play determine the social distribution of determinants of health and health behaviour. The health system is thought to play a key role in mitigating the differential exposure to health damaging factors and vulnerability to ill health, as well as the differential impact of illness, according to a person's socioeconomic position (SEP) [1]. The primary health care (PHC) system, in particular, is considered to be integral to this, in that equitable use—that is, equal use for equal need—of PHC services contributes to reducing socioeconomic variation in health [1-5]. This thesis seeks to explore the role of the PHC system in reducing socioeconomic variation in health. Specifically it aims to identify modifiable (that is, amenable to policy or practice change) characteristics of service organisation and delivery at the small-area level that are associated with equitable receipt of PHC services. In doing so, it may identify opportunities for policy and practice intervention to improve health equity.

It has been well documented in the literature that the presence of an effective PHC system is associated with higher average levels of health as well as an improved distribution of health across population subgroups [2, 6-9]. The importance of PHC as a means for improving health and health equity has been emphasised intermittently in Australian health policy discourse [3-5, 10]. The original vision of Alma Alta (1978) [11] placed health equity at the heart of PHC, where PHC is viewed as instrumental in addressing the upstream determinants of health through the provision of accessible, person-centred, comprehensive care provided within people's communities; promotion of community participation (as a citizen's right and duty); and inter-sectoral collaboration. While the cross-sectoral and advocacy role of PHC in addressing the social determinants of health is fundamental, ensuring equitable use and quality of care is the direct mechanism by which the PHC system can address socioeconomic inequalities in health.

Countries throughout the world have struggled to incorporate and imbed the ideals of Alma Ata in their health systems [3, 10, 12-14]. With a push towards a market-driven, disease-focused and biomedical view of health care delivery, the appeal to health equity and addressing root causes of ill health has been diverted and diluted [3-5, 15, 16]. Tackling the social distribution of health and health care access has become generalised to 'health for all' or targeted programs for disadvantaged populations only. The comprehensive, person-centred view of PHC, as described by Alma Ata and reiterated in 2008 [2], narrowed to a focus on efficiency and performance rather than on provision of whole-of-person care [3, 4]. Community participation has been reinterpreted

to frame people as consumers of health care services rather than a process for empowering communities to drive social and political change for the betterment of their health and well-being [3, 5].

Part of the challenge of implementing PHC through a social determinants or health equity lens is a lack of a detailed conceptual framework by which the PHC system can be understood to shape or mitigate socioeconomic inequalities in health. Literature directly examining the relationship of PHC systems with health equity is sparse [9, 17, 18]. Conceptually, and as supported by empirical evidence, the nature of where people live—from a macro level such as countries and states, to a meso level of a person's local neighbourhood or area of residence, and the micro level of households or workplaces—has been established to be important for health and, in particular, socioeconomic inequalities in health [19-22]. Similarly, the PHC system can be viewed to operate across these levels of contextual influence in determining use of services and thereby shape socioeconomic inequalities in health. This thesis will examine how the organisation and delivery of PHC within people's local context shapes socioeconomic variation in receipt of PHC services. It is expected that this will assist in identifying avenues within the PHC system for policy and practice interventions within people's communities that may contribute to reducing unwarranted socioeconomic variation in health care and, ultimately, contribute to reducing socioeconomic inequalities in health.

The subsequent sections of this chapter provide the broader context of the research. The international and Australian policy context, with respect to a social determinants perspective of health care and health care equity and the role of the PHC system therein, is summarised in Section 1.1. The relevant social epidemiology theory for understanding contextual influences on health and health behaviour is discussed in Section 1.2. An outline of the underpinning conceptual frameworks is provided in Section 1.3 to clarify the way in which the organisation of the PHC system within people's local context determines how they use care, which, in turn, shapes their health. This is followed, in Section 1.4, by an overview of the geographical organisation of Australia, with a focus on the main study area for the thesis (New South Wales) and as relevant to the organisation and delivery of health services. The chapter concludes with an outline of the thesis.

1.1 Health Policy Context

1.1.1 International Health Policy Context

In the face of increasing health inequities globally and the predominance of disease-focused and technology-based medical care, the World Health Organisation (WHO) established the Commission for the Social Determinants of Health (CSDH) [1] to refocus on the notion of health as a social phenomenon. At the core of the CSDH was the commitment to health equity and social

justice, where health equity is defined as ‘the absence of unfair and avoidable or remediable differences in health among population groups defined socially, economically, demographically or geographically’ (Solar and Irwin [1], p. 12).

In 2010, the CSDH put forward a conceptual framework [1] for understanding the causal pathways by which health inequities are produced, which identified entry points for policy intervention (see Figure 1). This framework places emphasis on the structural or root causes of health inequities whereby the social, economic and political contexts of populations configure and maintain the social stratification of populations (broadly represented by a person’s SEP), which leads to the unfair distribution of class, power and prestige. This, in turn, determines differential exposure of individuals to health damaging factors, and differential opportunities for health promoting factors (manifested as the social or intermediary determinants of health).

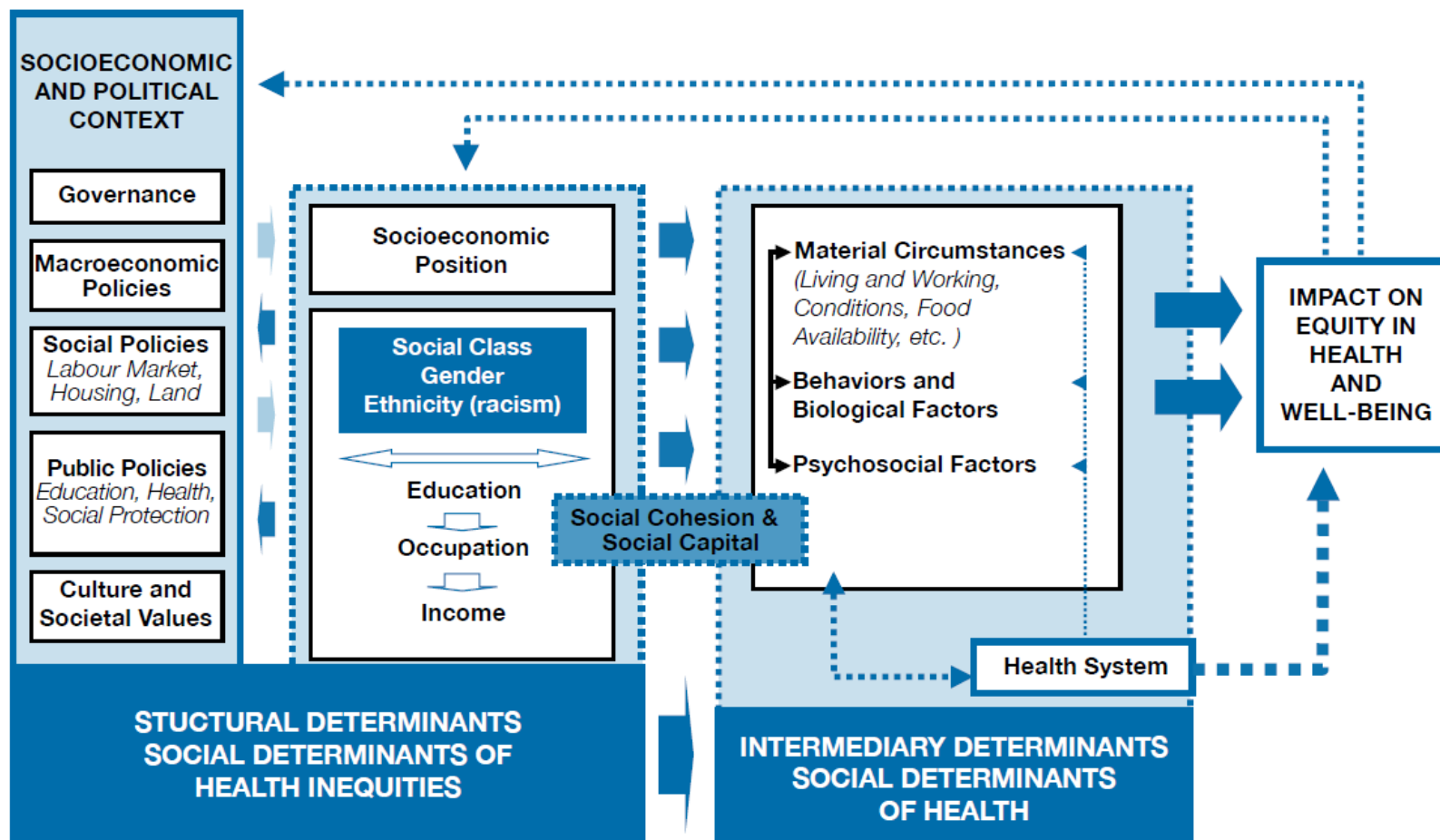


Figure 1. CSDH conceptual framework

Notes: CSDH, Commission for the Social Determinants of Health. Taken from Solar and Irwin [1], p.6

Of central importance to this thesis is the notion that in the CSDH framework the health system itself is an intermediary determinant of health. While addressing structural determinants (such as, governance, social and public policies) is key [23], the framework proposes that equitable use of health care can mitigate differences in vulnerability to ill health, as well as the differential consequences of illness in people's lives. In outlining their framework, the CSDH draws attention to the three obligations the health system can be viewed to have in confronting inequity [1]:

1. To ensure resources are distributed between areas in proportion to their relative needs
2. To respond appropriately to the health care needs of different social groups, and
3. To take the lead in encouraging a wider and more strategic approach to developing public health policies at both the national and local level to promote equity in health and social justice

It is the first two of these obligations that this thesis directly addresses, with the intention of contributing to the evidence base of the third.

The single most important contribution the CSDH framework makes for policy action is a focus on the unequal *distribution* of health determinants that result in health inequalities, rather than the health determinants *per se*. Addressing the latter without attention to the mechanisms of their social distribution may reduce the average level of health determinants within populations (for example, smoking rates or obesity) but fail to make an impact on differences between social groups and, at worst, may increase socioeconomic gradients [1]. Moreover, effective action requires attention on the social gradient, not just for the most disadvantaged, as inequalities are produced across the entire social hierarchy.

In concert with the development of the CSDH framework, the WHO reasserted the core values of PHC as originally envisioned in the Alma Ata declaration in 1978 [2, 4]. Over the intervening decades since Alma Ata, health systems had oriented more towards a biomedical, individually-focused, market-driven notion of care. This was at odds with the original imagination of PHC [4, 5], and undermined the capacity of health systems for addressing health equity [3]. Core PHC principles re-iterated were [2, 4]¹:

1. Universal coverage—access to health care according to need and regardless of ability to pay
2. People-centred services—providing comprehensive care within people's community
3. Healthy public policies—attention to the health impact in other policy sectors such as trade and education; and leadership—engaging all components of society

¹ Also referred to collectively as comprehensive PHC.

Reorienting health systems based on these core principles was viewed as the key mechanism by which health systems would become more coherent, effective, efficient and, most importantly, equitable [2, 4]. Critics have, however, noted the significant barriers in reorienting health systems to the core principles of PHC, given the ongoing inherently inequitable global economic policy environment and dominant neoliberal paradigms [3, 16].

In summary, the key themes emerging from this global policy discourse are a recognition of the nested hierarchies of contextual influences in determining the social distribution of health determinants and hence health inequities, and the role the health system has in mediating these differential impacts. The elimination of health inequities is a challenging task; however, the CSDH framework and others argue there is an ethical and human rights imperative to endeavour to do so [1, 23]. While acknowledging its minor part compared to the broader determinants of health inequities, primary health care has a role in redressing health inequities through accessible, comprehensive care that responds to the needs of people within their local contexts [23]. Countries throughout the world have attempted to re-align their health systems with these principles, with varying degrees of success [4, 10, 24-26]. With this in mind, a brief history of Australia's health system and recent health system reform is given next, with a particular focus on the way this aligns with a social determinants framework.

1.1.2 Australian Health Policy Context

1.1.2.1 Australia and socioeconomic health inequalities

The Commonwealth of Australia is a continent covering 7.69 million square kilometres. It comprises six States and two Territories, with a population of around 25 million in 2015 [27]. Australia has a stable, democratically elected government with powers divided between the central Commonwealth Federal Government and the six State governments (referred to in this thesis as 'the states') [28]. Australia's gross domestic product (GDP) per capita was A\$64,660 in 2013, with around 60% of this due to service industries [27]. Gross domestic product and income per capita in Australia are higher than the Organisation for Economic Cooperation and Development (OECD) average, with lower unemployment rates [29]. Income inequality in Australia is similar to the OECD average, while wealth inequality is slightly lower [30].

By comparison with international standards, Australia is a healthy country [31]². Life expectancy in Australia is 84 years for women and 80 years for men, with 82% of Australians reporting high levels of quality of life. Australia is ranked in the top third of OECD countries for life expectancy, mortality (all-cause and disease-specific), potential years of life lost, and smoking. By contrast, however, Australia ranks amongst the lowest third of OECD countries for obesity and alcohol

² A large part of the information on health and health inequalities in Australia is sourced from AIHW Australia's Health (2012). Only specific additional references are provided as relevant in this paragraph.

consumption. Despite overall high levels of good health, marked socioeconomic inequalities in health have persisted over time. Socioeconomic gradients have been documented for: risk factors such as physical inactivity, obesity [32] and smoking; health outcomes such as chronic disease [33] mortality [34, 35], lower cancer survival [36, 37], cardiovascular disease outcomes [38], poor oral health [39], end-stage kidney disease and mental health [33]; and measures of health status such as life expectancy and self-rated health [40, 41]. Significant gaps in health outcomes between Indigenous and non-Indigenous Australians have been documented [42, 43], with a difference in life expectancy estimated to be around 12 years. Only part of Indigenous health inequality can be attributed to differences in SEP.

Having provided a snapshot of Australia, its health and health inequalities, I now provide an overview of the health system in Australia followed by a brief discussion of recent health reforms, with a specific focus on how these reforms relate to health equity and a social determinants framework.

1.1.2.2 Overview of the health system in Australia

Australia's health system aims to give 'all Australians—regardless of their personal circumstances—access to adequate health care at an affordable cost or no cost' [31]. It is a complex system and comprises service providers across many health professions, in a number of different settings (private clinics, not-for-profit non-governmental agencies, public health centres and hospitals) with a range of funding mechanisms. The health system is underpinned by Medicare, Australia's universal public health insurance scheme, which provides free hospital services for public patients in public hospitals (through Australian Health Care agreements with the States), subsidises private patients for hospital services and provides benefits for out-of-hospital services such as consultations with general practitioners (GPs), specialists and in selected circumstances allied health practitioners (through the Medicare Benefits Scheme [MBS]). In addition Medicare provides significant subsidies for a large proportion of prescription medicines through the Pharmaceutical Benefits Scheme [PBS]. Unless otherwise indicated, the information in this section has been sourced from the Australian Bureau of Statistics (ABS), Australian Institute of Health and Welfare and relevant government websites and documentation [27, 28, 31, 44-46].

PHC is provided almost entirely through private general practice on a fee-for-service basis where an individual's first point of contact with the health system is typically with a GP. Access to specialist services, including pathology and radiology, require referral by a GP or other doctor. Individuals are free to choose their own GP, and are under no obligation to remain with one provider only. During 2015–2016 financial year, 82% of Australians visited a GP, a rate that has been relatively stable over the last seven years [44]. The average patient contribution per GP service (that is, out-of-pocket cost) for services that were not bulk-billed was A\$ 33.38 during the

2015–2016 financial year [44]. A limited number of PHC services are provided by publicly-funded Community Health Centres; these services usually relate to specific aspects of PHC such as aged care, maternal and child health programs, some allied health services, mental health services and community nursing [47]. Some of these services can be accessed directly without referral (aged care, for example) while others require referral by another health professional. In addition, Aboriginal Community Controlled Health Organisations (ACCHO) provide independently operated but federally funded comprehensive health services primarily for Aboriginal and Torres Strait Islander peoples. Rarely, in rural and remote areas where there are no community based services, PHC services may be accessed through public hospitals.

Other PHC providers in Australia include pharmacists, allied health providers (physiotherapy, dietetics, speech pathology, for example), psychological and dental services. These service are available in the private rather than public sector and, again, can be accessed directly without referral. According to the National Health Survey in 2007–2008, for each category of PHC provider other than a GP or dentist, between 3% and 18% of the population were seen in the preceding 12 months (depending on the service accessed). Optometrists, chemists (for advice only) and physiotherapists were the providers most commonly seen. Just under half of the Australian population sees a dentist in any one year; this has remained stable over the last six years.

Accessing ambulatory specialist medical care for the most part requires referral from a GP and is largely provided in the private sector. Approximately a third of the population sees a specialist in any one year. Additional services are also available through public hospital outpatient clinics, where patients cannot choose their doctor. Individuals may self-refer to hospital emergency departments; of these, 39% of presentations in 2010–2011 were estimated to be for GP-like problems [31]. Most emergency departments are public; however, there are an increasing number of providers emerging in the private sector.

Inpatient medical care is provided in public (three-fifths of inpatient care) and private hospitals. Admission is a formal process based on an assessment by a medical practitioner. Individuals may access this following assessment in the emergency department or by direct admission by a medical practitioner with admitting rights to a particular hospital (public or private). Patients can choose their doctor if they are a private patient in a public hospital or in a private hospital, but not if they are a public patient in a public hospital. There are a number of arrangements with respect to covering the costs of inpatient services, but in essence all care in public hospitals are provided at no cost (primarily funded by Medicare), while any gap above the Medicare schedule fee in private hospitals is generally covered by private health insurance. Public hospitals for the most part provide the most advanced treatment, specialised services and teaching facilities. However, this role is expanding in the private sector. In 2009–2010 there were 8.5 million hospitalisations, half

to two-thirds of which were for same-day procedures. The number of hospitalisations has been increasing steadily over the last seven years.

In addition to direct medical services, Australia's health system also includes public health programs focused on health promotion and disease prevention (screening programs, education programs and health policy), injury prevention, environmental health and disease control, as well as administration and research. These programs are also provided in a range of settings (government, schools, media, and universities) funded by a mixture of government and non-government organisations.

Australia's health system is funded through a mixture of government funding (two thirds of all health system funding, two-thirds of which is born by the Commonwealth in the form of Medicare and one-third by the States), private health insurance (8% of total health system funding in 2009–2010) and direct out-of-pocket payments (18% of total funding in 2009–2010)³. Approximately 80–85% of all GP services during the decade 2006–2015 had no additional co-payments (referred to as 'bulk-billed'), compared with 25–30% of specialist services in the same period [48].

Services accessed through community health centres and public hospitals are provided at no cost to the patient. Private health insurance, while optional, is encouraged by government rebates (income tested) and policies that reward uptake of insurance prior to age 30 [49]. Just over half of the population has private health insurance (57% in 2015–2016, up from 53% in 2007–2008) [44]. There are two main forms of cover, hospital and extras; the latter reimburses some of the costs of non-inpatient health services when not covered by Medicare, including optical, allied health and dental care.⁴

Safety net mechanisms are in place to limit out-of-pockets costs experienced by individuals for medical and pharmaceutical services. For MBS services, once a set yearly threshold of out-of-pocket costs is reached (this threshold is lower for those who are lower income), 80% of any additional out-of-pocket costs are covered by Medicare⁵. A similar arrangement is in place for PBS-listed medicines. Additional measures to limit costs to individuals include concession cards (generally for the elderly, those with a disability, unemployed persons and low income earners), which reduce costs for PBS-listed medicines and attract additional incentives for providing GP non-referred services without a co-payment (that is, when the service is bulk-billed).

In part reflecting the complex funding arrangements between Commonwealth, State and private sources, the tertiary, secondary and primary sectors of the health systems operate in relative silos with variable integration across the sectors depending on local arrangements. This is particularly

³ An additional 5% was sourced from the accident compensation scheme.

⁴ 48% have both hospital and extra cover, 6% have hospital cover only and 4% have extras only.

⁵ In 2011, the threshold was \$578.50 for concession card holder and families receiving Family Tax Benefit Part A, \$1,157.50 for all others.

so for the PHC sector and private specialist services. The impact of this on coordination, continuity, quality and efficiency of care has become of increasing focus in recent health policy, discussed further in the following section.

1.1.2.3 Recent Primary Health Care reform in Australia

Australia's health system underwent major review during the period 2007–2010. The main purpose of the review was to implement reforms to ensure the health system was better coordinated and able to meet the needs of an ageing population affected by chronic disease [50]. A consequence of this review, and evident in a number of key policy documents at the time, was a clear intent to incorporate a social determinants and health equity perspective in subsequent health system policy directions. The National Primary Health Care Strategic (NPHCS) framework (2013) [10], the main guiding document for reform of Australia's PHC system, asserted that PHC was at the centre of a high-quality and high-performing health system. Improving access to care and reducing health inequity was one of four main strategic outcomes identified for Australia's PHC. The first stated aim of the NPHCS framework was 'to improve health care for all Australians, particularly those who currently experience inequitable health outcomes' (Commonwealth of Australia [10], p. v).

The explicitly stated purpose of the third strategic outcome of the framework (increased focus on health promotion and prevention, screening and early intervention) was to tackle the social determinants of health and well-being. Medicare Locals (first launched in 2011) were viewed as the main vehicle for implementing the NPHCS framework, superseding the previous Divisions of General Practice⁶. These organisations had a geographically-defined area of responsibility and were tasked with the planning, coordination and delivery of PHC services based on local population health needs. Furthermore, it was expected that Medicare Locals would work across sectors (such as housing, education and employment) to address the social determinants of health affecting each community.

Overall, the reform process articulated a view of PHC that encompassed the core principles identified at Alma Ata. The language of the reform, and particularly the NPHCS framework, recognised that where people lived and their social, economic and cultural contexts influenced their use of PHC services and the quality of care received. However, strategies to address this focused on specific vulnerable groups (Aboriginal and Torres Strait Islander peoples, people living in rural and remote areas, the elderly, people with disability and people with lower socioeconomic status). Further, the focus was on intermediary determinants (such as smoking, diet, physical activity and housing) rather than upstream structural determinants, and

⁶ The divisions of General Practice had been established to support coordination and training of GP practices, with a role in coordination of services and multidisciplinary care within a specified area. These had subsequently been redesignated as General Practice Networks but continued to have a similar role. Medicare Locals were intended to have an expanded role, covering all primary health care services.

individualistic in its approach (that is, it provided specific pathways to address individuals' social and welfare needs, as well as their health needs). While addressing intermediary determinants and individual circumstances is clearly important, it fails to take into account that policies or the ways services are delivered may contribute to (or ameliorate) the unfair distribution of access and use of services across social groups.

Following a change of Federal Government in 2013 and the subsequent review of MLs, there was a substantial shift in the policy focus in the PHC sector [51]. Significantly larger PHC organisations, named Primary Health Networks (PHNs), with boundaries aligned with Local Hospital Networks were established in 2015, with a mandate focused on efficiency, effectiveness and improving coordination of services within a local area. There is no specific reference to health equity or a social determinants approach in the PHN Grant Program guidelines, although Aboriginal and Torres Strait Islander peoples and those with mental health conditions are identified as particular target groups [52]. PHNs and the integration with Local Hospital Networks is still in the early days of development. More recently, policy initiatives have focused on introducing 'health care homes', which involve voluntary enrolment of patients with chronic disease and new (albeit purportedly inadequate) funding arrangements [53-55]. While these models encompass core elements of PHC as set out by WHO and in the NPHCS framework, there is no specific mandate around health equity. Indeed, much of the policy discourse over the last three years has been dominated by concerns regarding a number of cost-saving measures proposed and the impact this is likely to have on overall use and equity within the PHC system [53, 56-58]. The conversation is no longer one where overcoming inequity is a priority, but rather one asking how inequity can be stopped from getting worse.

While Australian health policy has clearly recognised that the PHC system is central to maintaining overall population health and reducing health inequity, there has been a struggle to articulate this within a CSDH framework in policy documents, let alone in actual practice. Clarity about the mechanism by which the social distribution of PHC use and quality of care is produced is even more critical given current policy changes that have the potential to worsen existing socioeconomic inequalities (or even create new inequalities). To begin to understand how to examine this issue, Section 1.2 discusses key concepts and definitions within epidemiology and geography for understanding contextual influences on health (including health system organisation and delivery), with a focus on socioeconomic variation in health and health care. It also provides clarification around definitions of health inequalities and health equity.

1.2 Contextual Influences in Health and Health Equity: Key Concepts

1.2.1 Contextual Influences in Variation in Health

Over the last two decades there has been extensive work within social epidemiology investigating contextual influences on health internationally [19, 21, 22, 59-61] and within Australia [32, 34, 37, 43, 62], largely facilitated by improved methodological tools [63-66]. Increasingly, contextual influences on health care have been examined with a focus on hospital and tertiary level care [67-71]. The underlying premise is that the nature of where people live—physically, socially, culturally and politically—makes a difference to people’s health over and above who they are [22, 72]. Contextual effects are variously referred to as ‘area’, ‘place’, ‘neighbourhood’, ‘group’ and ‘ecological’ effects. The notion is that individuals can be seen to belong to a socio-cultural group or geographical location, where they are exposed to a range of determinants, shared by other members in that group (such as a neighbourhood or school), that can act within a nested hierarchy of influence (for example, neighbourhoods within countries, classes within schools) over time [21, 22, 60, 73]. Frequently this is a geographically-defined area (such as Census Tracts in the United States [US] or Census Collection Districts in Australia).

Epidemiology tends to be concerned more with the effect of membership of a particular context of influence, rather than a person’s precise location [73]. In geography, spatial or geographic variation in health and health services is generally more often of interest. This is understood in terms of geometric space, which is concerned with distance, proximity and location [73-75]. Inherent in this is the notion that socio-cultural and environmental processes play out over space (for example, availability of services or cultural aspects of one area is likely to be shaped by those areas nearby). In this view, membership to an area as well as spatial processes may matter for contextual effects on health service use. As Cummins and colleagues state:

Recognising that individuals can become relationally embedded in multiple health damaging and health promoting environments across time and space, and at multiple scales is crucial if we are to further understand the importance of ‘place’ in the generation of health inequalities. (Cummins et al. [21], p.1835)

For the purpose of this thesis, contextual influences refer to the physical, service organisation and socio-cultural aspects of the area within which people live. These influences are referred to in this thesis as ‘area effects’. While it is recognised that many contextual effects will have a spatial component (particularly with respect to service provision), it is membership of a particular geographical unit and the way this relates to socioeconomic variation in health service use that are of specific interest.

There are a range of methodological approaches for investigating area effects on health [19]. These include ecological [19, 21, 65, 76, 77], contextual [20], multilevel [60, 63, 65, 66] and

spatial analyses [74, 78-80]. In ecological studies, all variables are measured at the area level (often from aggregated individual-level data), while in contextual studies, area-level variables are included with individual-level variables in standard regression techniques. Multilevel models account for hierarchically-nested data, as well as allowing for and quantifying between-group (or area) variation [60, 63, 64]. Spatial techniques enable investigation of spatial processes and the way relationships may vary over space. These include clustering, hotspot and network analysis [81-84]; techniques for accounting for spatial nonstationarity in ecological and individual studies [78, 85, 86]; and combined multilevel and spatial analysis, which considers nested levels of influence as well as the way associations may change over space [70, 73, 87, 88]. In addition, qualitative studies are extremely valuable for providing richness of understanding of the dynamic between people and their contexts, and facilitate hypothesis generation [19].

A number of important conceptual considerations and definitions in the study of area effects relevant to the thesis require mention here.

Defining area-level constructs: Inherent in the study of area effects is the apparent false distinction between composition and context. As stated by McIntyre and colleagues [22], people make places and places make people, and the interaction between individual- and area-level processes need to be explicitly stated and included when modelling relationships (such as cross-level interactions in multilevel models) [21]. McIntyre and colleagues suggest that area effects act through either material or infrastructure resources (availability of services and local resources that are socially patterned) or collective functioning and practices (values, local norms, social cohesion and participation) [22]. In 2003, Leyland and Groenewegen, with specific reference to public health, frame area effects as opportunities and constraints for health and health behaviour [60]. Due diligence is required when defining variables in terms of whether they truly represent area characteristics and are not reducible to the individual level (global variables), are aggregate measures of people living in that area, or are somewhere in between (for example, the number or types of schools available versus overall educational levels) [65]. The application of these principles in constructing area measures of PHC service organisation and delivery characteristics is discussed in detail in Chapter 2.

Scale and unit of measurement: There are a range of scales at which different area-level processes may influence individual health [19-21, 60]. These include the small-area or neighbourhood level, regionally, nationally and globally. Determining an appropriate scale depends on the contextual phenomena intended to be examined [20, 60, 63]. For example, social relationships and connections that may influence people's health and health behaviour operate over small socially-homogenous areas. On the other hand, planning and delivery of health services near to where people live is frequently determined by administrative boundaries [60], which tend to be larger, more heterogeneous and not necessarily designed for the express purpose of understanding health

service use. Often the ‘ideal’ unit of analysis for the problem under investigation is not available, and caution is required in interpreting findings [19, 20]. In addition, there may be a range of nested and overlapping areas or contexts of effect that are relevant for certain outcomes [19, 60]. Relevant scale and unit of measurement for the Australian PHC system is outlined in a Section 1.4 of this chapter.

Multiple contexts over time and space: Over time, people move through a range of differing contexts in the course of their lives, all of which may influence health and health care use [19, 21, 63, 65]. Interpretation of findings, particularly from cross-sectional studies, needs to be considered with these caveats in mind.

1.2.2 Health and Health Care Equity

As defined by the CSDH, health inequity refers to differences in health across groups that are systematic (and hence socially produced), unfair and avoidable. There is an ethical and human rights imperative to address and eliminate these differences [89]. While social hierarchies may be inevitable, health differences related to this are not necessarily so [23]. It is this view of health equity which this thesis adopts. While the term ‘health inequalities’ is often used synonymously with “health equities”, referring to differences in health that are often viewed as unjust and avoidable (such as socioeconomic health inequalities), the term health inequalities may more broadly refer to differences in health or distribution of health determinants across population groups that are not necessarily unjust or unavoidable [90].

Vertical health care equity refers to the extent to which persons with unequal income pay unequal amounts for health care, but also have equal access to care for similar amounts of effort to reach this care [91, 92]. As mentioned earlier, horizontal health care equity is the receipt of equal care for equal need. It is this latter form of health care equity which is of specific interest in this thesis. Although not explicitly stated, horizontal health care equity is the implicit meaning within the Australian health reform documents [10, 14]. The NPHCS framework states:

For many individuals, the primary health care services they access and the quality of care they receive is influenced as much by where they live, their cultural background, and social and economic circumstances, as their specific health needs. (Commonwealth of Australia [10], p. 9)

While Australian health policy documents often refer to geographical inequity, this thesis is specifically concerned with inequalities in health care across socioeconomic gradients.

There is also extensive literature on the measurement of health and health care inequality and inequity. Details of this are provided in Appendix A, with a brief overview provided here. Most of the literature already discussed has considered health and health care inequity in terms of distribution across a socioeconomic gradient, or with specific reference to disadvantaged groups.

Generally, these are based on categorical SEP measures that can be ranked. A number of methods have been developed in order to capture the SEP gradient in health and health care, either in terms of absolute differences in quantifiable outcomes between socioeconomic groups, or relative differences; that is, the ratio of health outcomes between SEP groups.

There are two main approaches to doing this. The first approach is by pairwise comparisons, where the rates of each SEP group are compared with a reference group. The risk difference (RD), which is the difference in rates between the comparison groups, gives an absolute measure of inequality, while the risk ratio (RR) is the ratio of the rates of the comparison groups and gives a measure of relative inequality. In the second approach, a single summary measure of inequality is determined, where both size and ranking of SEP groups are accounted for in the estimate [93-96]. The slope index of inequality (SI: the difference between the hypothetical person at the top of the SEP hierarchy and the hypothetical person at the bottom of the SEP hierarchy) gives a measure of absolute inequality, while the relative index of inequality (RII: the ratio of the predicted rate at the hypothetical lowest end of the SEP continuum to the predicted rate at the hypothetical highest end of the SEP continuum) gives a relative measure of inequality. A related index, the concentration index, is also commonly used for investigating inequalities in health and health care. When estimates are adjusted for need, a measure of inequity (or need-adjusted inequality) is determined [94].

Having outlined the key concepts and definitions for understanding and measuring area effects on health and health behaviour, as well as key concepts relating to health and health care equity, this discussion now turns to addressing how this might be applied for investigating the influence of the PHC system on socioeconomic variation in receipt of PHC. Of specific interest is the way in which modifiable PHC service organisation and delivery characteristics of areas may shape socioeconomic variation in receipt of services, and therefore contribute to mitigating the differential exposure and vulnerability to health damaging factors and impact of illness. Section 1.3 outlines key framework and conceptual underpinnings in health services research relevant to the thesis and defines the final conceptual model for addressing the overarching research question.

1.3 Theoretical Underpinnings and Conceptual Model

In order to understand and interpret how area PHC service characteristics may shape socioeconomic variation in receipt of services, four conceptual frameworks are applied. As described in detail in Section 1.2, a social determinants of health framework gives the mechanism by which the social, cultural, economic and political context results in health inequities, and the role the health system (in particular PHC) has in mitigating this through ensuring equitable use of services. Consistent with area-effects theory, the CSDH framework posits that the upstream or structural determinants of health inequalities operate through nested levels of influence, which serve as points for strategic intervention. These are macro–public policies and governance, meso–

community level and micro–individual level [1]. The framework further outlines that, while policies relating to health system delivery may be implemented at the macro level, their impact in reducing unwarranted socioeconomic variation in health and health behaviours occurs at the meso and micro levels.

The framework does not, however, explicitly specify a causal pathway by which the health system (let alone the PHC system) may reduce health inequity, nor how this might be measured. Watson and colleagues' 2009 results-based logic model for PHC addresses this gap (see Figure 2) [97]. Their model provides a clear pathway by which the input and activities of the PHC system result in outputs (measured as frequency of use, quality of care and types of care provided) that, through direct outcomes (for example reduced hospitalisations, stable chronic disease) and indirect outcomes (efficiency, acceptability, appropriateness), result in an improved level and distribution of population health and wellness. The authors argue that it is only reasonable to measure performance based on factors for which PHC organisations and providers can be reasonably held accountable for, namely the actual services delivered and qualities of these services. Other downstream outcomes that the PHC system is thought to influence should only be applied for monitoring (for example, avoidable hospitalisations, prevalence of diseases).

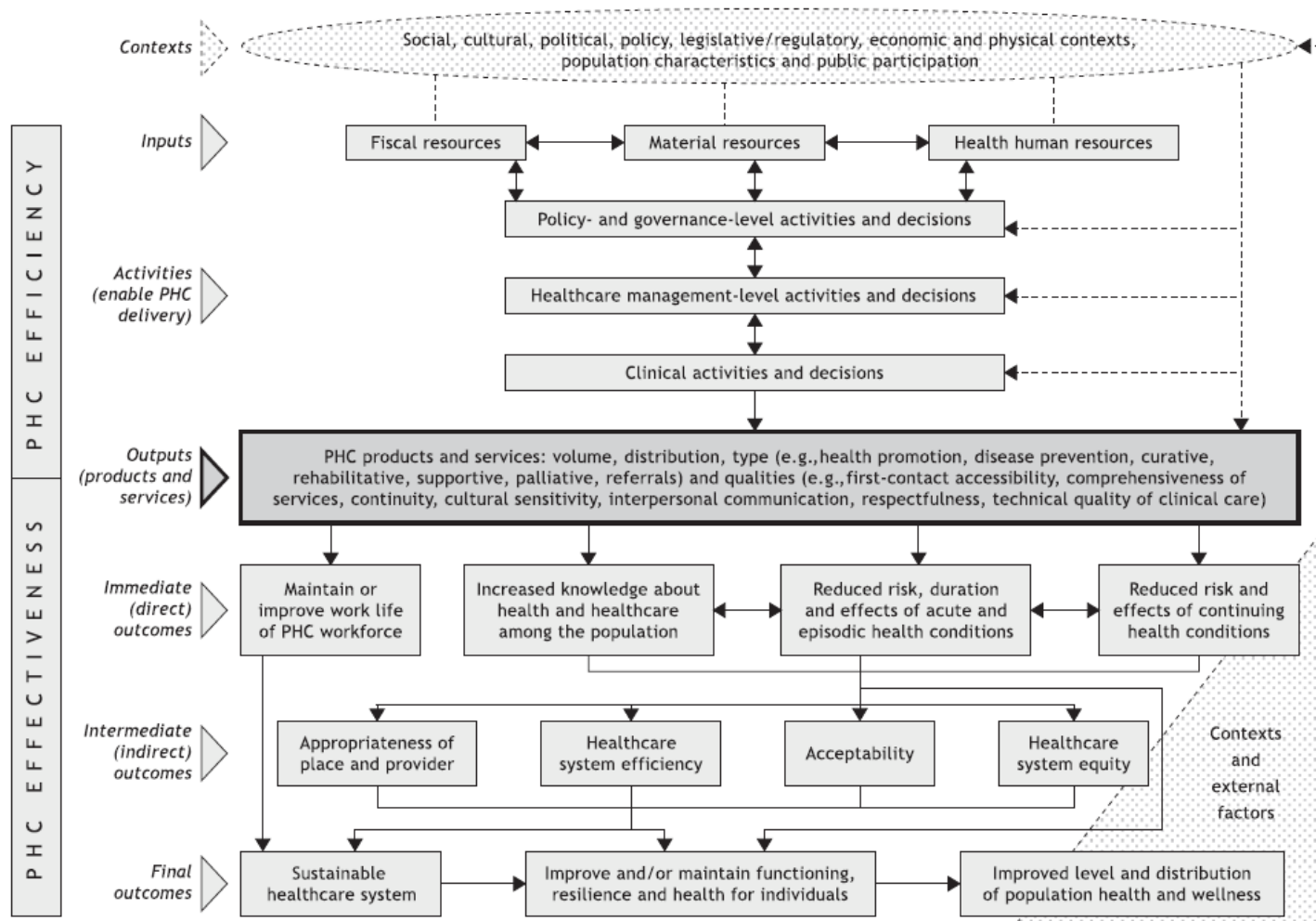


Figure 2. Results-based logic model of PHC

Notes: PHC, Primary Health Care. Taken from Watson and colleagues [97] p. 38

Watson and colleagues' model provides some clarification of the levels of structure and organisation of the PHC system which they term 'inputs' and 'activities'. Three levels of activities are described: the policy and governance level, the health care management level, and clinical activities. Specific details of what comprises these levels, how they may be measured, and how each component relates to each other is limited in Watson and colleagues' model. The work by Kringos and colleagues [17, 98] provides more depth in conceptualising the complexity of the PHC system, with specific reference to those aspects considered to be core principles or indicative of a 'strong' PHC system, as described in the seminal work by Starfield and colleagues [7, 8]. This conceptualisation of PHC systems by Kringos and colleagues is discussed in detail in Chapter 2 but is considered briefly here. This model conceptualises the PHC system on three levels: the structural level (governance and policy), the process level (with the dimensions of access, comprehensiveness and coordination) and the outcome level. Of specific interest for this thesis are those dimensions at the process level that represent modifiable characteristics of PHC service organisation and delivery within areas that determine how people use PHC (in terms of frequency, type and qualities of services) and therefore have the potential to influence the distribution of health outcomes; that is, health equity.

Anderson's behavioural model of health care access provides a schema for identifying a range of determinants of health service use (see Figure 3) [99]. While this model is limited with respect to detail of how the PHC system determines health service use and hence health outcomes, it does provide clarification of other primarily individual determinants of health. These include predisposing characteristics such as demographics, social structure and health beliefs, enabling resources (personal and community, the latter including health service resources) and need (both perceived and evaluated). These determinants operate in the context of the overarching influence of health system policies and governance structures. Based on this model, equitable access is defined as when need, rather than structural or social factors, determines use. Anderson's model lacks definition of the causal pathway by which structural and social factors may arise and determine health and health behaviour (including health service use)—a gap for which the CSDH framework [1] provides more nuanced detail.

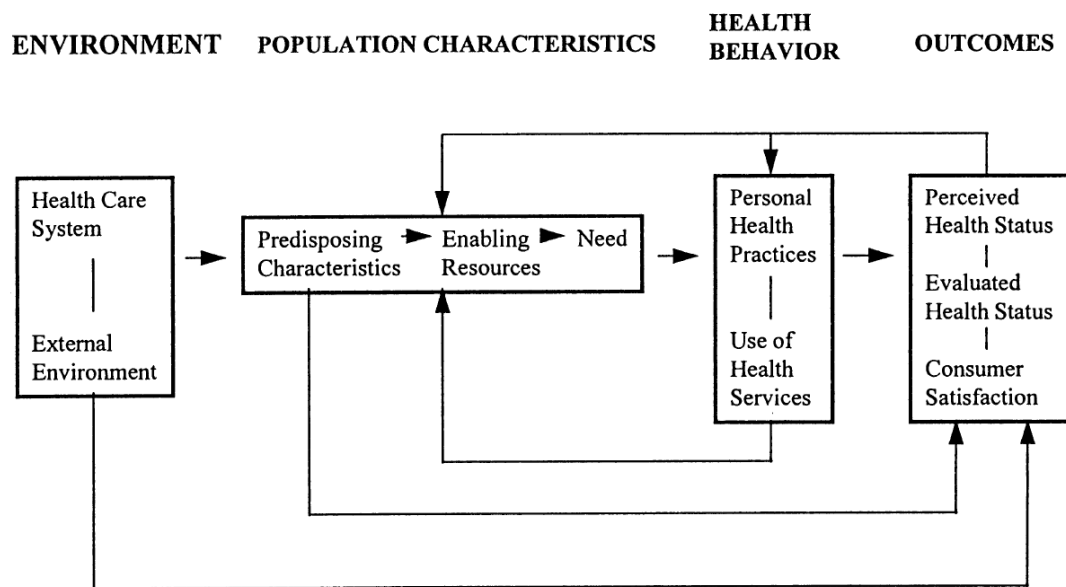


Figure 3. Anderson's behavioural model of health care access

Notes. Taken taken Anderson, [99] p.8

Figure 4 provides the broader conceptual framework applied in this thesis, incorporating the CSDH conceptual framework and Watson and colleagues' logic model. As shown in this figure, the upstream structural or social determinants of health inequities can be viewed as operating at the area and individual level. Individual predisposing factors, such as age, are additional determinants of health that are not socially produced. The intermediary determinants of health (for example, material resources) produce, and in turn are further shaped by, individual need factors. These, in turn, determine use of the PHC system. The PHC system is represented on the right side of the diagram, where resources, organisation and delivery of the system determine use, as well as influencing the effect of intermediary determinants and need factors on use. As outlined by Watson and colleagues, the output of interaction with PHC services results in health outcomes, as shown in Figure 4.

Figure 5 illustrates a detailed model for specifically examining the influence of modifiable area-level characteristics of PHC service organisation and delivery on socioeconomic variation in receipt of PHC (frequency of use, quality and types of services). In this figure, factors determining use of PHC services are represented as those operating at the area level (meso level) and those that act at the individual level (micro level). The socioeconomic and political context straddles these levels as it is understood that, while this operates within society, social stratification manifests at the individual level (as measured by individual SEP). Further detail is given with respect to the levels of organisation within the PHC system. This thesis is concerned specifically with the meso level, where it is proposed that inputs and enabling factors, as represented by the organisation and delivery of services within areas, shape the relationship between an individual's SEP and their receipt of PHC.

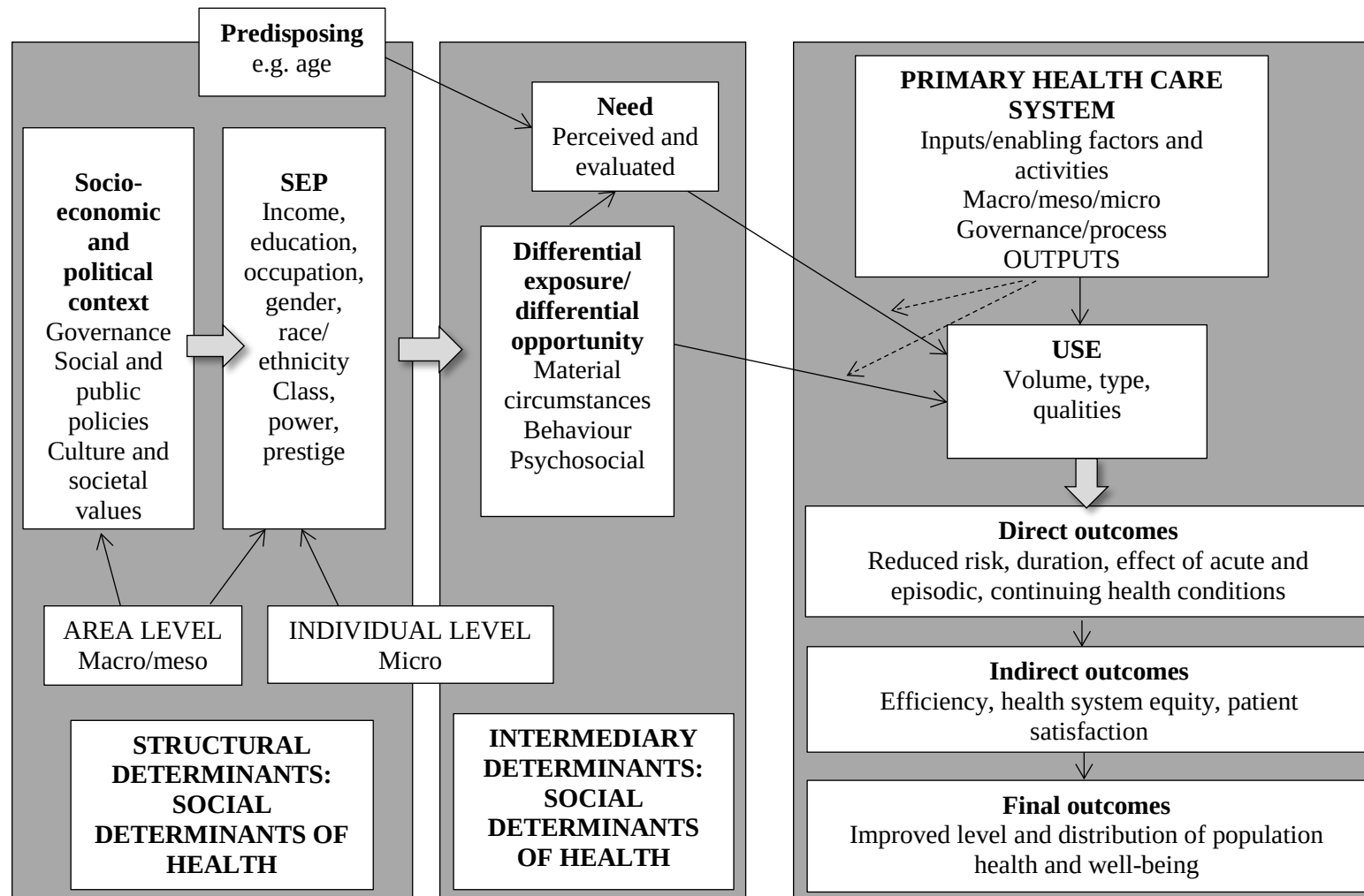


Figure 4. Conceptual framework incorporating a social determinants conceptualisation and causal pathway by which equitable use of primary health care may reduce health inequalities

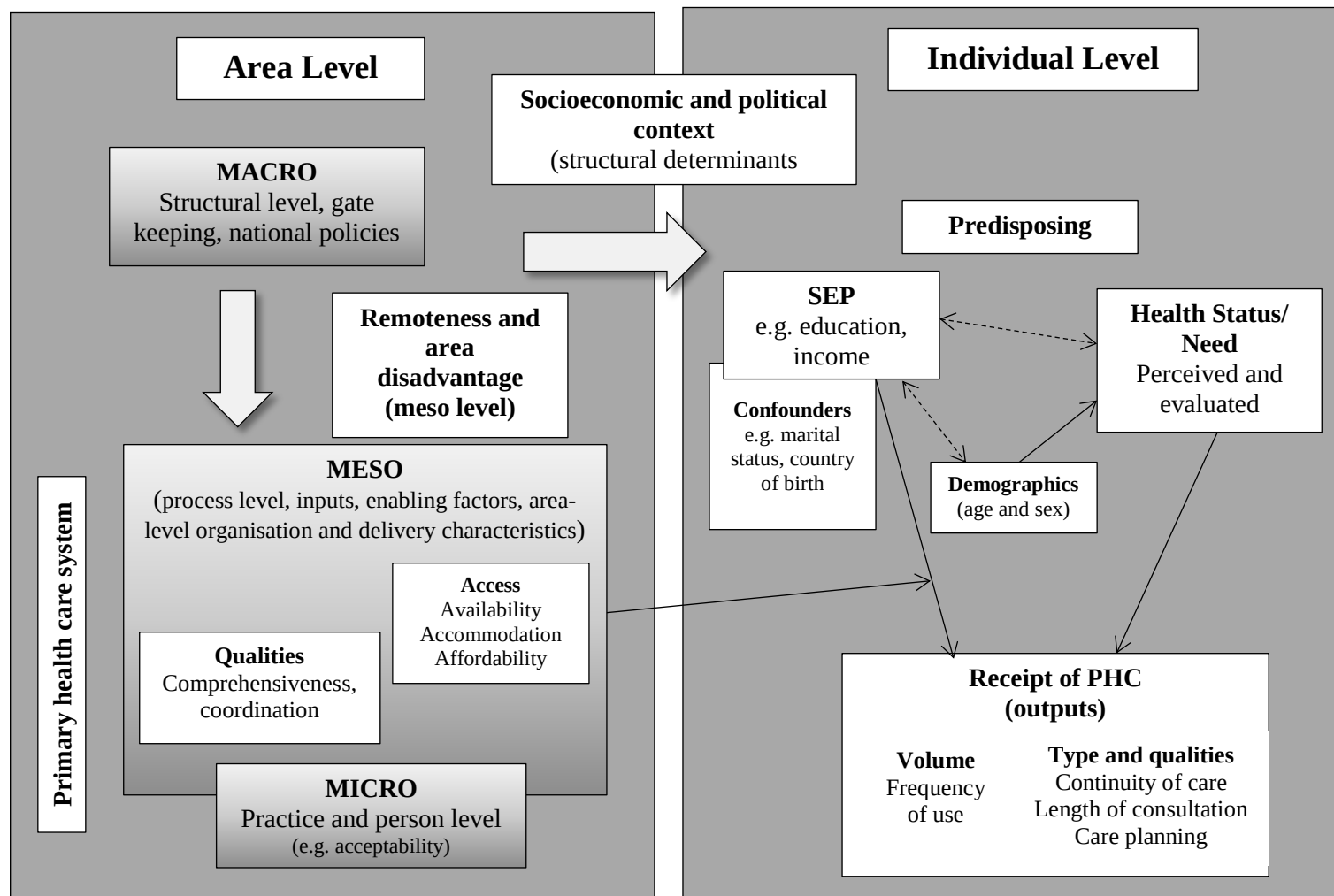


Figure 5. Main conceptual model for examining the influence of modifiable area PHC organisation and service delivery characteristics on socioeconomic variation in PHC use

1.4 Population Characteristics and Geographical Organisation of Health Care in Australia

Having described in detail the international and Australian policy context, the epidemiological theory, conceptual frameworks and definitions for understanding how organisation and delivery of the PHC system as a contextual influence may shape socioeconomic variation in receipt of services, further consideration is given to the study area—the Australian state of New South Wales. This section briefly reviews the population characteristics and geographical organisation of Australia as they pertain to the structure and delivery of the PHC system, with specific reference to New South Wales.

As shown in Figure 6, Australia comprises six states (New South Wales [NSW], Queensland [QLD], South Australia [SA], Tasmania [TAS], Victoria [VIC] and Western Australia [WA]) and two mainland Territories (Australian Capital Territory [ACT] and Northern Territory [NT]). The population of NSW in 2006 (the first year of the study period) was 6,549,177, 49% of whom were male, and the median age was 37 (interquartile range 18–54 years) [100]. As can be seen in Figure 6, much of the population across Australia, and particularly NSW, is concentrated along the coastline and metropolitan areas. New South Wales is relatively more densely populated than the rest of Australia, with most of the population living in major cities, but it also includes populations in small and remote communities.

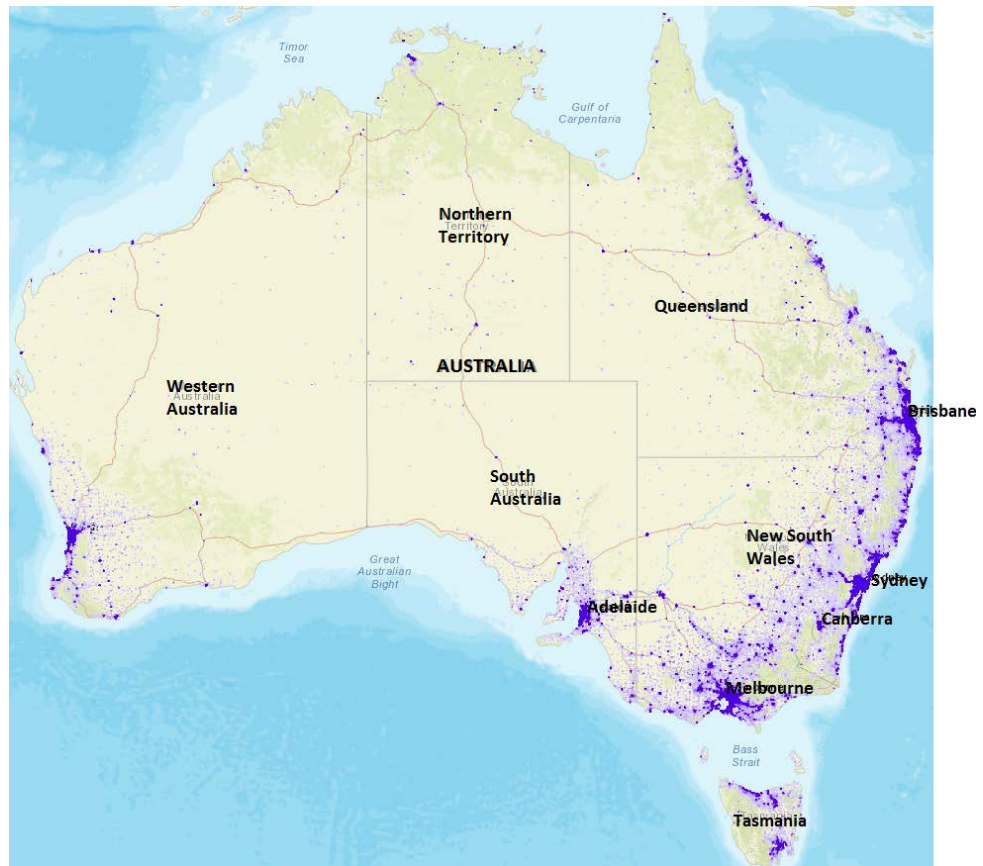


Figure 6. Map of Australia with state and territory boundaries shown

Notes:

1. Population density represented by purple bubbles. Increasing size and colour depth indicative of increasing population.
2. Sourced from HealthLandscape Australia via GRAPHIC, ANU.

Since 2011, the Australian Statistical Geography Standard (ASGS) has been the main geographical classification used by the Australian Bureau of Statistics (ABS) for collecting and disseminating geographically classified statistics. The smallest geographical units are meshblocks (representing approximately 30–60 dwellings) from which all larger geographies are built. Statistical Area Level 2s (SA2s) are medium-sized general purpose areas (built from aggregated SA1s, which are derived directly from meshblocks) that are viewed to represent a community that interacts together socially and economically and are most representative of neighbourhoods. Statistical Area Level 3s (see Figure 7a) are built from SA2s that have similar regional characteristics, and are the most common geography for which health data are publicly available. Statistical Area Level 3s generally have a population of 30,000–130,000 people and are often the functional areas of regional cities and large urban transport and service hubs. As such, these areas represent a reasonable approximation of an area theoretically relevant to the organisation and delivery of PHC services (see Chapter 3 for a more detailed discussion), and were used in this thesis as the main geographical unit for analysis of area effects. New South Wales has 93 SA3s, including offshore and migratory regions.

It is important to note that prior to 2011 a different geographical classification was used for census statistics and for collating and disseminating a range of health-related data. The geography approximately equivalent to SA3s, the Statistical Local Area (SLA), was the main unit of analysis in epidemiology and health services research when investigating area-level relationships. In NSW in 2006, there were 200 SLAs, including offshore and migratory regions, with populations of 3,000–130,000 persons. As the study period for the thesis was prior to 2011, many of the data were available at the SLA level and required aggregation to SA3. The details of this are provided in Chapter 3.

In NSW, the geographical boundaries of health care administrative areas have generally been historical in their definition and do not necessarily align with statistical areas. There are eight metropolitan and seven rural and regional local hospital networks (known as Local Health Districts or LHDs) in NSW. The LHDs provide public hospital services in accordance with the National Health Reform Agreement and contain one or more hospitals in their region. Primary Health Networks are the recently-formed geographical organisational unit of PHC which align with LHD boundaries, and in a number of cases encompass a number of LHDs. There are ten PHNs in NSW (see Figure 7b). As described in the preceding sections, the boundaries of PHNs were established with the view to maximising their capacity to negotiate coordination of care with other service providers, particularly LHDs, through economies of scale as well as mutual geographical areas of responsibility. As such, the areas and communities covered are heterogeneous in terms of their population and service organisation as well as often being physically distant from each other. This represents a significant challenge for PHNs in meeting the needs of *all* of the population, let alone addressing inequity of health care. To do so requires

an understanding of how health needs and health service use varies between-areas *within* these much larger administrative geographical units.

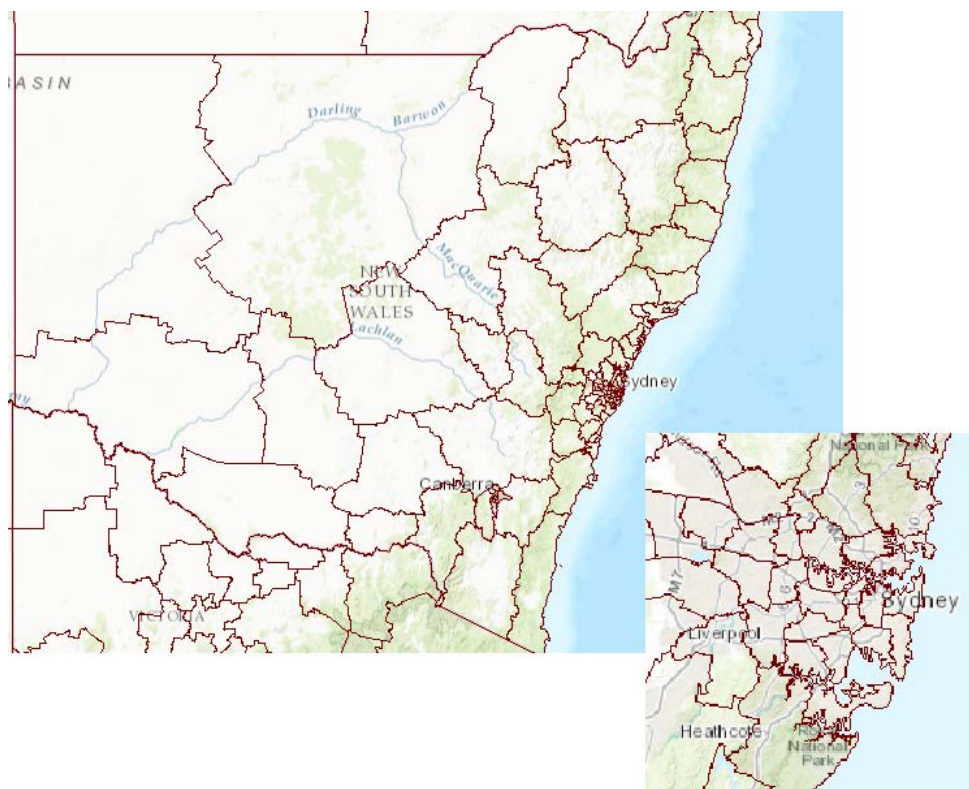


Figure 7a. Geographical boundaries (NSW, Greater Sydney area magnified): SA3s



Figure 7b. Geographical boundaries (NSW, Greater Sydney area magnified): PHNs

1.5 Summary and Thesis Outline

Internationally, there has been a ‘call to arms’ to recognise and address the upstream social, economic, political and cultural contextual influences in the distribution of the determinants of health in order to overcome health inequity. While acknowledging the preeminent role of the upstream structural determinants of health inequities, the health system is viewed as an intermediary determinant of health with a key role (particularly for the PHC system) in mitigating the unfair distribution of exposure and vulnerability to ill health and the consequences of illness. Australia’s health reform over the last decade has struggled to incorporate these ideals, but has articulated the priority that all Australians should have equal access to care relative to their needs, within their own local context. Social epidemiology has built the empirical evidence, conceptual frameworks and methodology for understanding how the nature of where people live influences their health and health behaviour over and above who they are. Perhaps, through similar mechanisms, the local structure and delivery of PHC services of areas may modify socioeconomic variation in receipt of services, and thereby contribute to health equity. Health services research theory provides a framework by which to understand and measure the way in which the PHC system may contribute to overall health of and the distribution of health within populations.

This thesis aims in the first instance to identify area-level characteristics of PHC service organisation and delivery that are modifiable; that is, service characteristics of areas that reflect core PHC principles and can be changed by policy or practice. The second aim of the thesis is to determine whether these area characteristics shape variation in receipt of the PHC services according to an individual’s SEP, and, thereby, identify avenues for policy or practice intervention for improving equity of health care. Figure 8 provides a schematic overview of the structure of the thesis.

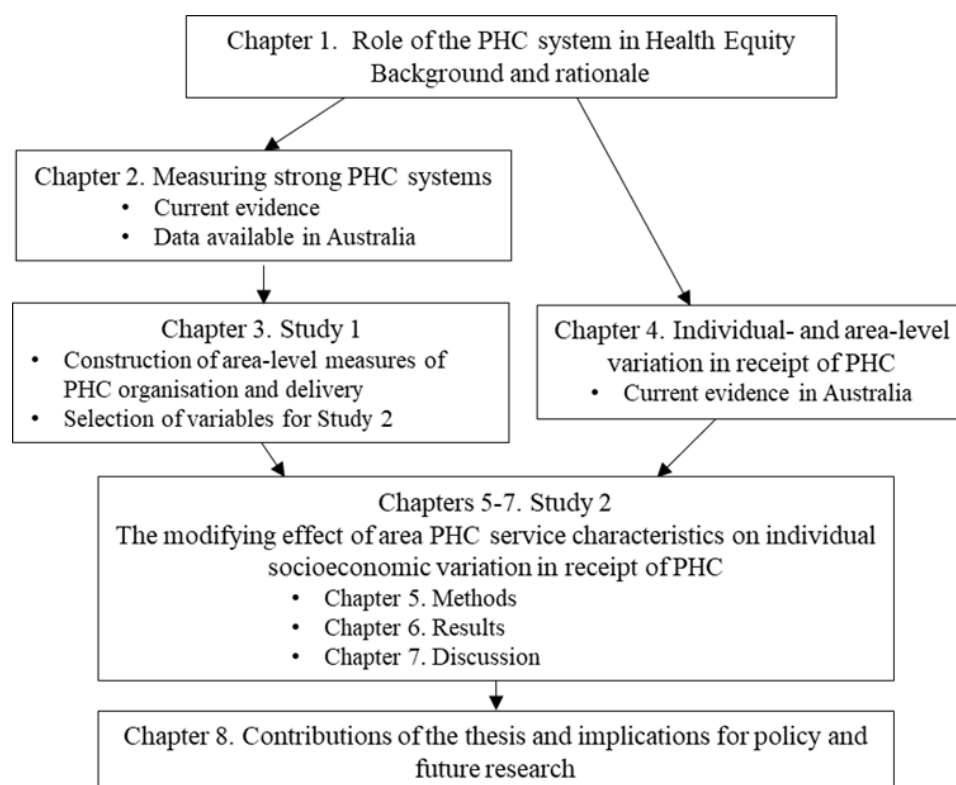


Figure 8. Schematic overview of structure of the thesis

The thesis presents two main projects to address these aims. Using available data, the first project (Study 1) constructs area-level measures of PHC service characteristics representative of the core principles or domains of a ‘strong’ PHC system. It also examines geographic variation in these measures and how they relate to each other. The second project (Study 2) applies these measures to investigate whether area PHC service characteristics modify the relationship between individuals’ SEP and receipt of PHC. In order to obtain a more complete picture of access to care relevant to the PHC system, socioeconomic and area variation in specialist services as an important secondary supportive tier of care are also investigated.

Chapter 2 reviews the foundational and more recent work with respect to defining and measuring essential features of an effective or ‘strong’ PHC system. The domains of a strong PHC system that can be viewed to operate at the area level (meso level)—that is, in the more immediate vicinity of where people live rather than at a national or larger regional scale—and that are amenable to policy and practice change, are described in detail with respect to definitions, measurement, knowledge gaps and data availability in Australia. The core domains identified are accessibility (with the subdomains of availability, affordability and accommodation), comprehensiveness and coordination.

Having identified the knowledge gaps in Chapter 2, Chapter 3 presents the first project (Study 1) of the thesis. This project uses data from a range of sources in Australia to develop measures of modifiable area PHC service characteristics in NSW. The geographical distribution of these

measures and how they vary according to remoteness and area disadvantage (as other important determinants of health service use in Australia) is examined, in order to clarify how these measures may be applied to examine variation in use of PHC services. Given the lack of empirical evidence internationally and within Australia, the relationship between measures within domains and across domains is investigated to better understand how specific service organisation and delivery aspects of services within areas may relate to each other.

The second project (Study 2) is presented in Chapters 4–7. This project investigates whether area PHC service characteristics modify socioeconomic variation in receipt of PHC. Chapter 4 presents a review of the literature regarding methodological approaches specific to examining socioeconomic variation in health and health care, and a review of the studies to date investigating socioeconomic variation in receipt of PHC and specialist services, with a focus on Australia. This second project uses data from the *45 and Up Study* linked to Medicare utilisation data and to the area measures developed in Chapter 3. Four main outcomes are examined; one relating to frequency of use of GP services, as the focal point where the majority of Australians receive their PHC, and three relating to quality of GP care. For each outcome the following are undertaken: variation at the area and individual level is quantified; the extent of area-level variation explained, as well as the strength of association between each area PHC characteristic and outcome, is quantified; the degree of variation in receipt of services according to individual SEP is determined (having adjusted for need and between-area variation) and, finally, cross-level effect modification by area characteristics on the relationship between individual SEP and receipt of services is tested. Additionally, as access to supporting secondary-level care is integral to an effective PHC system, individual-level socioeconomic and area-level variation in receipt ambulatory specialist care is also quantified. The methods, results and discussion for the second study are presented in Chapters 5, 6 and 7, respectively.

The final chapter, Chapter 8, brings the findings of the thesis together to summarise the main contributions to new knowledge and the implications for policy and future research.

Chapter 2

Defining and Measuring Primary Health Care Systems: A Review of the Literature and Data Available in Australia

Chapter 1 outlined the policy context and theoretical underpinnings supporting the notion that organisation and delivery of PHC services can modify the distribution of receipt of care according to an individual's SEP. In doing so, the PHC system can contribute to health equity by mitigating the differential exposure to ill-health and opportunities for health promoting factors, as well as the differential impact of illness. This chapter examines in further depth the specific organisational and delivery aspects of the PHC system that are viewed as operating at the area level and that are thought to shape socioeconomic variation in receipt of PHC, with a focus on describing how this can be measured and tested in an Australian setting.

There are three levels through which the PHC system can be viewed to shape the social distribution of receipt of health care. These are macro or structural level, examples of which include national policies on universal access and first point of contact; meso level, which reflects process characteristics⁷ of how PHC services may be organised and delivered; and micro level, relating to the practice/provider and patient interface [4, 7, 17, 101, 102]. Meso-level process characteristics include access (availability, geographic accessibility, affordability and accommodation), continuity, comprehensiveness and coordination [7, 17, 101-103]. It is these meso-level process characteristics that are of particular interest in this study, because they are modifiable (that is, amenable to policy or practice change) at the small-area level and thus have the potential to influence the health and health behaviours of many individuals residing near these services. For the purposes of this thesis, meso level is defined geographically as an area that can be reasonably thought to be representative of a neighbourhood or community sharing similar characteristics in terms of the health services available (and is hereafter referred to as 'area level'). The specific geographical unit best representing the organisation of PHC in the Australian context was covered briefly in Chapter 1, and is discussed in detail when the first project is presented in Chapter 3.

Despite the definitions put forth in Alma Ata and by the WHO in 2008 [2, 11], the wealth of divergent literature points to conceptual challenges in defining and measuring the core principles of a 'strong' or effective PHC system. The objective of this chapter is to explore in depth available

⁷ The process level is later referred to as 'service delivery level' in later publications (see Kringos, D., et al. [2013]. "The strength of primary care in Europe: an international comparative study." *Br J Gen Pract* 63[616]: e742-750). While this term better reflects the characteristics in this domain, the original terminology is retained in this thesis for consistency.

measures of service delivery characteristics of PHC systems that can be viewed to influence health service use behaviour at the area level. This chapter will:

1. Define PHC process characteristics
2. Review the literature regarding evidence of these characteristics as indicative of strong or effective PHC systems, how they vary geographically, particularly with regard to rurality and area socioeconomic disadvantage as other important determinants of receipt of health care in Australia, and how they relate to each other and
3. Describe how these characteristics are measured internationally and in Australia.

Key knowledge gaps and the rationale for the first project presented in Chapter 3 are outlined in section 2.3.

2.1 Defining and Measuring PHC Systems

There is a wealth of literature attempting to disentangle the complexity of a PHC system in terms of: i) defining the core features of PHC systems and postulating how these can be operationalised; ii) identifying relevant outcome measures; and iii) hypothesising the mechanism by which the PHC system may influence health inequalities [3, 7, 17, 97, 101, 102, 104, 105]. No single, clear conceptual model of the PHC system has emerged. However, there are some fundamental and consistent concepts. Early work by Starfield, Shi and Macinko has laid the foundation for what comprises a ‘strong primary health care system’ and the evidence in support of this [6, 7, 9, 103, 106, 107]. Based on this work, the key characteristics of PHC systems associated with better health outcomes (such as mortality and low birth weight) [6, 8, 103, 106, 107], increased preventative care [7] and reduced health care costs [6, 7] are:

1. First point of contact for health care (access)
2. Long-term person-focused care (continuity)
3. Comprehensive care for most needs (scope of care, chronic disease, preventative care, maternal child health, health promotion)
4. Coordinated care when it must be sought elsewhere (this primarily refers to coordination with specialist medical care)

It is important to note that while most of these early studies found that strong PHC systems were associated with better health outcomes, they were also associated with less patient satisfaction [7, 17], and the relationship with health equity inconclusive [9, 18]. Further, much of this work was based on United States (US) data and, given the differing health systems, the findings may not be generalisable to Australia.

Mostly citing the same studies, more recently a group examining variation of PHC systems across Europe has extended the conceptual work of Starfield and colleagues [17, 98]. This group identified three components of PHC systems, including ten core domains⁸:

1. The *structure* of a PHC system, with domains of governance, economic conditions, and workforce development
2. The *process* of a PHC system (later referred to as the PHC service delivery level), with domains of access, continuity, coordination and comprehensiveness and
3. The *outcomes* of a primary care system with domains of quality of care, efficiency of care and equity in health

This conceptualisation improves on the earlier work of Starfield and colleagues, as it recognises the different levels at which the PHC system operates (with the relevant varying determinants and mechanisms for policy or practice change) and attempts to provide some appropriate outcome measures by which the system can be evaluated. This conceptualisation also formed the analytical framework for the most recent and largest cross-country comparative study examining the strength of PHC systems on health system performance, Quality and Costs of Primary Care in Europe (QUALICOPC) [101, 102].

The process level can be viewed as occurring at the area level (meso), as well as the practice or patient–health professional interface (micro). It is those domains of the process level—access, continuity, comprehensiveness and coordination—that can be operationalised at a geographic scale relevant to the organisation and delivery of PHC services that this chapter explores and describes in detail. For the purposes of this thesis, these are referred to as area PHC service characteristics.

Access is considered in terms of availability, geographic accessibility, accommodation, affordability, acceptability, utilisation and equality in accessibility. This clearly borrows from Penchasky and Thomas' [108] conceptualisation of access that has been reiterated in the literature subsequently [74, 104, 109, 110]. These features of access also relate to Anderson's enabling factors (see Figure 3 in Chapter 1) [99], with some relating to Watson and colleagues' inputs (availability, geographic accessibility, affordability) and others to outputs, such as utilisation (see Figure 2 in Chapter 1) [97].

The second domain, coordination, extends Starfield's conceptualisation and relates to skill mix, a team-based structure and the interface with secondary-level care or public health. Comprehensiveness refers to scope of care, as previously defined by Starfield and colleagues. The domain of comprehensiveness, generally considered a process or organisational characteristic

⁸ While the authors refer to these as 'dimensions', for the purposes of consistency and clarity they are referred to as 'domains' in this thesis.

of PHC that determines how and what care is received, is viewed by some authors as an output, in that it represents the type of care received [97]. This resultant circularity and lack of conceptual clarity is considered in further detail in this chapter.

In terms of the outcome level in the conceptualisation proposed by the European group, quality of care has been measured primarily in terms of ambulatory care sensitive condition (ACSC) hospitalisations, emergency department admissions and prescription and referral rates, rather than the intrinsic qualities of services received. Using this conceptualisation of PHC systems, cross-country analyses within Europe have shown that countries that score highly on the process-level domains described above have better population health levels as measured by potential years of life lost for diabetes, ischaemic heart disease, stroke and chronic obstructive lung conditions; lower ACSC hospitalisations (chronic pulmonary obstructive disease and asthma); and lower socioeconomic inequality in self-rated health—but higher total health care expenditure [111]. This was more so for those countries that scored highly across all process domains (access, comprehensiveness and continuity) rather than on one single aspect [112]. Further outcome measures, with a specific focus on those used in the second project for this thesis, will be discussed in detail in Chapter 4.

QUALICOPC, the most recent cross-country comparative study of PHC systems (31 European and 4 non-European countries), also applied the European conceptualisation discussed above [101, 102]. A further distinction was made with regards to the process level of strong PHC systems. Firstly, there are generic dimensions relevant to all health service provision such as accessibility and user friendliness of services. Secondly, there are dimensions specific to PHC such as comprehensiveness, coordination, continuity of care and community orientation [101, 102]. Further, access was considered from the perspective of service providers and service users [113]. Data were collected between 2011 and 2013 at the country, practice/provider and patient level to examine how the structure of PHC at the national level and the organisation of PHC at the practice level related to three outcomes—overall system goals, indicators of process quality of service provision and indicators of the quality of PHC as perceived by users of services [114–119]. While measured at the practice (micro) rather than the area (meso) level, studies using QUALICOPC data found that process-level characteristics were associated with lower self-reported ED admissions [118], better patient perceived quality of care [116], and more preventative care [102]), but higher rates of hospitalisations for diabetes [119].

As discussed in Chapter 1, another body of work views the PHC system as articulated in the declaration of Alma Ata [3, 4]. Baum and colleagues refer to this as comprehensive PHC (as opposed to selective PHC) [5]. While the latter encompasses the key characteristics outlined in this section, the definition of comprehensive PHC also includes a cross-sectoral approach, citizen participation and social empowerment as core components. While it is recognised that these

aspects are critical to the original vision of PHC and, in particular, for addressing health equity, for the purposes of this thesis the focus has been on those characteristics highlighted most commonly across the literature that can be considered to operate at an area level and can be viewed to shape receipt of health care directly.

In Section 2.2, the specific area PHC service characteristics covering the domains of access—availability, affordability and accommodation—as well as coordination and comprehensiveness are examined in further detail. First, to provide background, each subdomain characteristic is defined and the way they are measured internationally described. The evidence is then reviewed with respect to the way these characteristics relate to a strong PHC system; how they vary in Australia, geographically, with respect to rurality and area disadvantage (as other important determinants of health care); and how they relate to each other. Second, data available for these measures in Australia are described in detail.

2.2 Specific Area PHC Service Characteristics: Background and Sources of Data in Australia

2.2.1 Availability

2.2.1.1 Definition and relevance to a strong PHC system

Availability refers to the available supply of primary care providers (PCPs) for the population. Most commonly this is measured as the number of PCPs per population [7, 17, 120], while other measures include full-time equivalents (FTE) accounting for the number of hours per week a provider may work [120-122]. This is in contrast to geographic accessibility, which considers the geographical spread and spatial accessibility of services and providers [74, 84, 123], thus taking into account the distance a patient needs to travel in order to avail themselves of a service. In Australia, counts of PCPs are restricted to GPs in contrast to the US, where any combination of family physicians, paediatricians, obstetricians and gynaecologists, medical internists and physician assistants may be included [7, 106].

The evidence for availability as indicative of a strong PHC system is predominantly based on US studies. These have shown that increasing per capita supply of PCPs is associated with improvements in a range of health outcomes (all cause and specific cause mortality, infant mortality, low birth weight, life expectancy and self-reported health), having controlled for a range of sociodemographic and lifestyle factors, including income inequality [7, 67, 106, 107]. A later study disaggregating PCPs into their specialty groups (that is, family physicians, medical internists, paediatricians etc.), found that only the availability of family physicians was associated with reduced mortality [106]. PCP supply has also been shown in the US to be associated with lower smoking rates, less obesity and higher seatbelt use, earlier detection of cancers (breast, colon, cervical, melanoma) [7], improved quality of care (as measured by hospitalisation rates)

[7, 67], reduced costs and reduced health inequalities (for stroke mortality, self-reported health, and infant mortality for example) [7, 17, 103, 106]. Full-time equivalency rather than headcounts have been found to have a stronger association with ACSC hospitalisations and mortality [67]. A study in the United Kingdom (UK), however, found that GP supply was not associated with mortality or hospitalisations once long-term illness, population need (measured by rural and elderly patients) and practice size was taken into account [124, 125]. The recent work comparing PHC systems across Europe has shown that countries that score highly on the access domain (covering availability, accommodation, affordability and acceptability) have lower ACSC hospitalisations for diabetes [111]. In Australia, ecological bivariate analyses showed that increased headcounts of generalist medical practitioners (including GPs and doctors in training) was associated with better health outcomes (measured by diabetes prevalence, behavioural risk factors and avoidable mortality) [126], while a recent multilevel analysis found no association between area GP FTE and preventable hospitalisations [69].

2.2.1.2 Variation in Australia

In Australia, there is on average one FTE (where FTE is capped at one) or headcount GP per 1000 population; this has remained relatively stable over the last decade [122, 127]. These figures are higher than estimates in the US [67, 128] and the UK [128, 129]. Geographic variation in supply and workload of GPs in Australia has been well documented [120-122, 126, 127, 130, 131]. In 2005, there were fewer FTE GPs in regional Australia, compared with major cities (100 FTE per 100,000 in major cities, 88 in inner regional, 94 in outer regional, 92 in remote/very remote areas) [121]. A similar pattern was observed in 2007 [122] and 2009 [132], with slightly increased per capita FTE in remote/very remote areas compared to all other areas. However, in 2011 FTE rates increased slightly with increasing remoteness (107 in major cities, 112 in inner regional, 113 in outer regional and 130 in remote/remoteness) [122]. It should be noted, however, that the number of hours worked per week increases with increasing remoteness [122] and decreasing population centre size [130], possibly reflecting the increased need for care relative to supply in more remote areas [31, 133]. Further, due to low numbers and the greater likelihood of locums and fly in/fly out services, estimates for remote and very remote areas need to be interpreted with caution. Supply may also vary by area disadvantage. A study using data from 1996 demonstrated that there were fewer doctors in disadvantaged areas. However, while there were fewest GPs in remote disadvantaged areas, there was no association between area SES and GP supply when stratified by remoteness⁹ [134]. This has not been examined with more recent data, but there is some evidence that metropolitan disadvantaged areas have lower spatial accessibility [123]. A correlation analysis using data from 2006 showed that disadvantaged areas had fewer doctors per

⁹ As determined by the ARIA classification used to differentiate geographical isolation or remoteness. Described in detail in Chapter 3.

population, but this was based on headcounts of all generalists doctors (including doctors in training), not solely on GPs [126].

2.2.1.3 Relationship with other PHC service characteristics

There has been limited work examining the relationship between availability and other PHC service characteristics, and none explicitly investigating this at the area level. Cross-country comparisons in Europe have found no association between the access, comprehensiveness and coordination aspects of a country's PHC system, although the subdomains within access (such as availability) has not specifically been examined [135]. In Australia, increasing GP availability has been shown to be associated with decreased affordability (as measured by a positive association between the number of (headcount) GPs per 1000 population and average gross price per SLA), suggesting that GPs locate in areas where they can charge more [127]. Specific international findings relating to the relationship between availability and PHC service characteristics are discussed in the subsequent sections once each characteristic is defined.

2.2.1.4 Data sources in Australia

There are a number of potential data sources in Australia for measures of availability [120], each with advantages and disadvantages (see Table 1). The Department of Health (DoH) provides what can be considered the official estimates of FTE (capped at one FTE per provider) and full-time workload equivalent (FWE; not capped), calculated from Medicare billing claims (more recently replaced by the full-time service equivalent [FSE], see Table 1 for definition). These figures are only available at the state/territory or ASGC remoteness areas. The three sources of data for availability of GPs at a geographical scale below remoteness areas are the Australian Medical Publishing Company (AMPCo), the Australian Institute of Health and Welfare (AIHW) and the Public Health Information Development Unit (PHIDU).

AMPCo data are available at address level; however this is sourced from doctor lists for the purposes of distributing commercial material, journals and medically related magazines. As such, an unknown number of GPs are recorded by their place of residence rather than by place of practice. Only full time/part time status is recorded; hence FTEs are an estimate. The AIHW has been the data custodian for a national health workforce survey, conducted every three years, which identifies main place of work and hours worked. The main limitations of these data are variable response rates across areas and data suppression due to small cell counts, and confidentiality concerns when aggregated to small areas such as SLAs or SA3s. The PHIDU data provide an approximation of FWEs determined from Medicare data. The limitation of this FWE measure is that it assumes a certain activity level per provider, and counts are based on this. As such, those who provide the equivalent of 1.5 FWE are counted as 1.5 persons when in fact only a single provider is available. While this is a good measure of services provided in the area, it

does not necessarily accurately reflect workforce supply; a particular concern in rural areas where an undersupply is common. In addition, if services are not provided privately (as often occurs in rural areas because services are frequently provided through public hospitals), this does not attract a Medicare rebate and hence is not included in this count.

Mazumdar and colleagues examined, in detail, the geographical distribution of Australian measures of GP availability and how well they correlated with each other [120]. There was good correlation at the SLA and Division of General Practice (DGP) level between measures sourced from AMPCo, AIHW and PHIDU (range 0.77–0.98), although coefficients were lower when measured at the smaller SLA geographical scale and decreased with increasing remoteness (for example, the correlation between AIHW FTE and AMPCo FTE was 0.58 and 0.52 for remote and very remote SLAs, respectively). In general, the PHIDU FWE measure tended to overestimate availability compared with the other measures. Further, the AMPCo measures overestimated FTE compared with national estimates provided by the DoH in all remoteness areas except very remote areas, suggesting that for AMPCo data either not all GPs have their part-time status recorded or a 0.5 FTE assumption is an overestimation of average part-time hours.

Table 1. Data sources for measures of GP availability in Australia

Data Source	Measure/s	Strengths	Limitations
Department of Health	FSE, modelled from Medicare claims where total hours worked is estimated from the number of days worked, volume of services and scheduled fees. One FSE equals a workload of 7.5 hours per day per week. Each practitioner capped at 2.5. Replaces previously published FTE based on a 40-hour working week capped at one FTE per provider.	Takes into account workload (i.e. full time or more, part time), complete coverage of all providers. Can be viewed as an 'authoritative' measure of supply.	Actual hours worked per practitioner unknown, relies solely on Medicare billing. Therefore, if hours are worked outside of Medicare (for example in public hospitals in rural areas) then this is not counted. Further, doctors that are providing more services than average are counted as more than one FSE provider. Therefore can overestimate workforce supply. Not available below state or remoteness area geographical scale.
Australian Bureau of Statistics	Headcount of 'generalist' medical practitioners by place of work.	Complete census, available to smallest geographical scale (currently meshblock).	Not specific to general practitioners or primary care providers. Includes interns, residents, and all doctors in training. Results in an overestimation of 20,000 providers nationally.
Australian Medical Publishing Company	Headcount (AMPCo count) by street address; FTE (AMPCo FTE) can be estimated based on whether a provider identifies as part time or full time.	Located to street addresses, therefore can be assigned to any geographic scale; regularly updated when providers change address.	Actual hours worked unknown, so part time status is estimated. Address may be residential or practice address. Data is for commercial purposes, therefore degree of inaccuracies of addresses is dependent on individuals notifying of change of address.
Health Workforce Survey, Australian Institute of Health and Welfare	Headcount, FTE (AIHW FTE), derived from self-reported survey.	Survey of all medical practitioners registered with the national registration body; includes self-reported main area of work and hours worked.	Poor response rates in some areas (<20%). Not available below SLA/SA3 due to confidentiality concerns; data suppressed if persons less than three in that cell.
Public Health Information Development Unit	FWE derived from Medicare claims for each area. The number of services claimed in that area is divided by the average number of services by the average FWE GP in that year.	Available at the SLA level; includes all workload (services) provided.	An approximation of FWE, as defined by DoH. A provider who provides more services than average is counted as more than one provider, resulting in inflated estimates of actual personnel.

2.2.2 Affordability

2.2.2.1 Definition and relevance to a strong PHC system

Affordability broadly refers to financial barriers to receiving PHC services that patients may experience [17]. This has also been defined as the economic capacity for people to spend resources and time to use services, reflecting direct costs of services as well as opportunity costs associated with accessing services [104]. Indicators of affordability include price of services [104, 127]; out-of-pocket costs (in total or as a proportion of household expenditure/income) [136, 137]; presence of mechanisms intended to limit cost sharing (for example, private health insurance or having a health care card) [94, 96] and proportion of population reporting deferring services due to costs [133, 136, 137]. Cross-country comparisons and observational studies examining the impact of PHC reform clearly demonstrated that low or no co-payments were associated with better health outcomes, fewer inequalities and lower total health care costs [6, 8, 136]. More recently in Europe, as mentioned above for availability, countries that scored highly on the access domain had lower hospitalisations for diabetes [111]. Using data from QUALICOPC, a recent multilevel analysis found that patients who postponed or abstained from visiting primary care for financial reasons were more likely to report visiting an ED in the past year, having accounted for between-practice and between-country variation [118]. Based on these studies, affordability is viewed to be integral to a strong PHC system.

2.2.2.2 Variation in Australia

Australia has national policies to limit patient cost sharing, as described in Chapter 1. In NSW in the period 2007–2010, 77% of patients had no out-of-pocket costs (that is, they were bulk-billed) for GP services. Recent national estimates for bulk-billing are around 78–83% [138]. As such, Australia's PHC system appears to perform well in terms of affordability. However, there is evidence that affordability varies across certain groups. A relatively high proportion of Australians report forgoing treatment due to cost, with 30% of those with below-average incomes going without treatment, compared with 22% of those with above-average incomes (Australia is the third highest of OECD countries) [136]. However, a recent study of older Australians found that only 4% of those surveyed reported that they were unable to afford out-of-pocket costs in at least one category of health care expenses (medical, medications, dental, allied health) [137]. Interestingly, in this study the amount of household equivalised income spent on out-of-pocket health expenses was not associated with self-reported inability to afford these costs, suggesting that these measures capture different aspects of the construct of affordability. Unsurprisingly, in this study those with private health insurance were more likely to be able to afford out-of-pocket costs (most likely reflecting disposable income more generally), while there was no relationship to possession of government or veterans' health care concession cards (an equity measure intended to minimise cost barriers).

There is also evidence that, in Australia, affordability varies between areas. A national study reported that the proportion of people deferring GP care due to cost varied from 1–13% across Medicare Locals [133]. Rural disadvantaged areas had the highest rates (10% on average), while metropolitan least disadvantaged areas had the lowest rates (5%) [133]. Bulk-billing percentages ranged from 50–96% across Medicare Locals, with the highest rates in metropolitan disadvantaged areas (close to 92%). Both of these findings were based on descriptive statistics and graphical representation of percentages by Medicare Local stratified by region and area disadvantage, rather than on statistical analysis of variation across areas.

2.2.2.3 Relationship with other PHC service characteristics

Other than the relationship with supply discussed above, there is no literature on the relationship between affordability and other area-level PHC service characteristics in Australia (specifically, accommodation, comprehensiveness and coordination).

2.2.2.4 Data sources in Australia

Potential measures of affordability in Australia include bulk-billing percentages, health care cards/pension cards, private health insurance and total out-of-pocket expenditure per visit¹⁰, all of which influence, or are indicators of, affordability but do not measure affordability directly. Measured at the area level, these indicators can be viewed to, at least in part, reflect how services in that area have organised themselves in order to be affordable to the population they serve (such as bulk-billing percentages and out-of-pocket costs) or represent a potential characteristic of that community that will influence affordability overall (private health insurance and health care cards).

Bulk-billing proportions give an approximation of the extent to which no co-payment is required for services within that area. While bulk-billing data are available through the Medicare division of the Department of Human Services (DHS), they are not routinely available publicly other than at state level. Only recently have they been released at the SA3 level, with data available from 2011 onwards¹¹. Total out-of-pocket expenditure per service gives an additional measure of affordability in an area in terms of what people actually have to pay. Estimates for this can also be derived from Medicare data, calculated as the difference between the total charge and the total benefit paid for a service, and are also available at SA3 level.

Health care cards (predominantly for low income earners) or pension cards (generally for the elderly or those with a long-term disability) are also potential measures of affordability at the area

¹⁰ This can be measured as either the average out-of-pocket costs each person pays when there is a co-payment or the total out-of-pocket expenditure across all services. The former is currently not available below state level, as only total costs and total benefits paid at the SA3 level are made available (on request only).

¹¹ At the time of analyses these data were available through the NHPA. This agency has subsequently been closed and data are now available through the AIHW.

level. These are available at the SLA level through the Social Health Atlas of Australia published by PHIDU. Individuals who hold these cards and are bulk-billed for a service (that is, there is no co-payment) attract an additional payment directly to the GP providing the service. Even if practices do not bulk-bill such individuals they will often charge them a reduced fee for services. It can be argued that, in areas where there is a higher percentage of people hold a health care or pension card, services will adapt their billing structures to be more competitive for their local clientele (as people may travel to other areas that are relatively less expensive); for example, by offering bulk-billing or reduced fees for concession or pension card holders.

2.2.3 Accommodation

2.2.3.1 Definition and relevance to a strong PHC system

Accommodation is primarily defined in the literature as the manner in which resources or services are organised to accept clients, including appointment systems, hours of operations, walk-in facilities and telephone and email services [104, 105, 108]. In the review by Kringos and colleagues, much of the evidence cited regarding accommodation as a measure of a strong PHC system uses length of consultation as a measure. However, consultation length can be considered a consequence of how a service is organised in terms of accommodation, comprehensiveness and coordination and, arguably, availability in terms of workforce supply. Hence length of consultation is better viewed as an output rather than a process of care (as discussed in further detail in Chapter 4).

Studies have shown that some aspects of accommodation such as telephone triage, advice centres and cooperatives for after-hours care were associated with less workload and lower costs [17]. Much of the rationale for accommodation being indicative of a strong PHC system is based on the premise that better access will improve health outcomes; conceptually, accommodation is an essential component of access [104, 108, 111]. Further insight has been provided by the QUALICOPC study, which found that self-reported measures of accommodation (less restrictive opening hours, availability of home visits and out-of-hours care) were associated with lower ED visits [118]. However, a composite score of self-reported accessibility, which included these indicators as well as a measure of distance to the practice, was associated with higher rates of hospitalisations for diabetes [119]. In Australia, and in many other countries, service delivery models for increasing after-hours care for GP services have been prioritised as a means of improving accessibility, quality and efficiency of care [139, 140]. No studies in Australia have examined the effect after-hours care has on use and quality of care or on health outcomes directly.

2.2.3.2 Variation in Australia

As stated above, the main focus in Australian policy and literature with respect to accommodation has been the provision of after-hours PHC services, whether through extended hours by a practice,

specific after-hours clinics or home-visit services, or nurse-led clinics [140, 141]. There has been a recent emergence of telephone-based services (Health Direct and other private enterprises) as a means of providing alternatives for after-hours care. There are also a number of other arrangements to improve accommodation in Australian PHC services (such as 'walk-in' clinics and online booking). However, area variation in these arrangements have not been explicitly examined in the literature.

Nationally, rates for after-hours attendances have been reported to vary across Medicare Locals and SA3s. This ranged from 0.03 to 0.71 visits annually per person across Medicare Locals in 2010–2011 and from 0.05 to 0.79 in 2011–2012. The equivalent figures for SA3s were 0.02 to 0.98 and 0.02 to 1.01 for the respective years, demonstrating even greater variation at the smaller-area level. Rates were generally highest in metropolitan disadvantaged areas, with the lowest rates in regional disadvantaged and rural areas [142]. However, surveys suggest that GPs in regional areas are far more likely to participate in after-hours care. Further, they provide more hours of work (after hours) when compared with their city counterparts who also participate in after-hours care (based on self-reported survey data) [143].

2.2.3.3 Relationship with other PHC service characteristics

While it has been shown that the percentage of patients reported as bulk billed by a GP is positively associated with that GP participating in after-hours care [143], it is unknown whether bulk billing and after-hours care are associated at the area level. International studies have found that when out-of-hours care was delivered only within primary care, GPs reported providing more comprehensive care (in terms of their role in first contact for care, treatment of chronic diseases, minor technical procedures and preventative care) [144]. Again, whether this relationship is apparent at the area level is unknown. The relationship of after-hours care with other area PHC service characteristics such as availability, comprehensiveness or coordination has not been studied in Australia.

2.2.3.4 Data sources in Australia

Potential measures of accommodation relevant to the Australian context include the availability of after-hours services and their arrangement (by telephone or email consultations, cooperatives, practice-based with extended hours, emergency department supplied or nurse-led clinics), home visit rates and services for special groups. While many of these activities occur within the Australian PHC system, there are no data routinely collected in a cohesive manner. A number of Medicare Locals (many now transitioning to the new arrangement of PHNs), had begun routine collection of such data within their designated geographical areas of responsibility [145-150]. However, this had been piecemeal and generally not available outside of the organisations themselves. The Medicine in Life: Balancing Employment and Life (MABEL) survey includes questions on after-hours service provision at the provider level across all areas in Australia [143].

However, this is a limited sample and does not provide sufficient responses for a small-area measure.

What can be measured in Australia routinely is the number of after-hours care and after-hours urgent care MBS items that are claimed in an area. These are a series of specific item numbers for services provided after hours that are reimbursed by Medicare. Private GP clinics that provide extended hours on site, specific after-hours services that visit the patients in their home, and some public hospital-based services provided in very remote areas after hours can claim for these item numbers. These items can then be enumerated from MBS data to provide area-level estimates of after-hours services. The MBS does not capture telephone advice and triage service, nurse-led clinics or any after-hours service provided by GPs or other primary care health professionals in a hospital setting (as commonly occurs in rural and remote areas of Australia).

2.2.4 Coordination and Comprehensiveness

2.2.4.1 Definition and relevance to a strong PHC system

Coordination is considered to include the ability of primary care providers to coordinate use of other services (specialist and allied health), skill mix and diversity within the service and team-based care [7, 17, 103]. Examples of specific measures in the literature include the presence of a gatekeeping mechanism; solo/group/with specialist practice (shared practice); substitution (for example nurse led); specialist outreach (consultations, teaching) and public health integration (such as use of aggregated patient health data for population health monitoring) [17, 101, 102, 113].

Comprehensiveness refers to the concept that all problems are dealt within the PHC setting except those too unusual to be expected to be treated competently by PHC providers [7, 17, 103]. These include prevention, health promotion, curative and rehabilitative care, and maternal and child health [5]. Examples of specific measures in the literature include equipment; range of health problems managed; percentage of problems managed entirely by the GP/PCP; range of procedures; preventative care activities; maternal/child health problems managed and health promotion [17, 101, 102, 113]. There is some discord in the literature as to how comprehensiveness is viewed conceptually. While most authors refer to comprehensiveness as a process or service delivery characteristic of strong PHC systems, measures commonly used quantify the type and range of services received by individuals (outputs) [7, 97, 151]. Such measures can be viewed as a proxy for organisational structures that may be in place and that enable the delivery of a comprehensive range of services. For the purpose of this study, comprehensiveness is viewed as the way services collectively are organised within a local community to enable provision of an extended and as complete as possible range of services, rather than an output that any one individual may receive.

The inclusion of coordination and comprehensiveness as core components of a strong PHC system was initially based on face validity and findings from early cross-country comparisons [8, 103]. In a review of the literature in 2010, coordination was associated with continuity of care and higher quality of care (in terms of preventative activities and better diabetes clinical care) [17]. This review also found that specialist outreach was associated with guideline-consistent care, less inpatient use and improved outcomes, while shared care improved prescribing and medication adherence [17]. In cross-country comparisons using data from the early to mid 1990s, the degree of comprehensiveness of a country's PHC system was the main differentiating factor as to whether or not that country scored highly for a strong PHC system (which in turn was associated with better health outcomes) [6]. International studies examining the availability of community health centres or countries undergoing health centre reform (where comprehensiveness is a core feature of health centres) have shown that the presence of health centres was associated with less health inequalities, improved life expectancy and reduced infant mortality [7].

More recent international studies have confirmed these earlier findings. A US-based multilevel analysis (patients nested in physicians) of 2007–2011 data found that patients of family physicians who had high comprehensiveness scores (which measured scope of practice) were less likely to be admitted to hospital (that is, have better quality of care) and had lower costs of care when adjusted for a range of individual and physician characteristics [151]. In the cross-country comparison study in Europe in 2013 [111], scoring highly on the comprehensiveness domain was associated with slower growth in total per capita expenditure on health, lower hospital admissions for asthma, and fewer potential years of life lost for ischaemic heart disease and stroke. Coordination was associated with lower hospital admissions (for men only) and fewer potential years of life lost for chronic obstructive lung disease. Multilevel analyses (patients nested in GPs, nested in countries) using 2011–2013 data from the European based QUALICOPC study, found that patients of GPs with a broad service profile (that is, they provided comprehensive care) reported better quality of care (in terms of self-reported access and continuity), when adjusted for a range of GP and patient characteristics [116]. In summary, the findings suggest that the more coordination and comprehensiveness within a PHC system, the better the quality of care, health outcomes and capacity to contain costs. The only contrasting finding to this general pattern was a study also using QUALICOPC data, which found that in countries where GPs had broader service profiles, the incidence rate of uncontrolled diabetes hospital admissions was higher, when adjusted for diabetes prevalence and hospital bed supply [119]. This was not the case, however, for admissions for long- or short-term complications of diabetes.

2.2.4.2 Variation in Australia

In the Australian health system, the first point of contact for the vast majority of health care is with GPs. Aboriginal community controlled health services, and to a lesser degree state-based community health centres, generally include features of coordination such as multidisciplinary

team-based care, outreach specialist care, role substitution/complementation with nurses and Aboriginal health workers, and public health integration such as health promotion and community engagement [47, 152, 153]. Increasingly, there are mainstream private models of care that encompasses a number of these features of coordination. Generally, GPs in Australia provide comprehensive care as defined above (the full range of problems managed including acute, chronic, preventative, maternal/child health for the majority of health problems).

Literature in Australia examining coordination has been based predominantly on qualitative and small-scale studies at the practice level investigating implementation of coordination of care processes [154]. There is no work specifically examining area-level variation in coordination of care. With respect to comprehensiveness, literature in Australia has focused on the uptake and provision of extended primary health care or care planning MBS items (health assessments, completion of GP management plans and team care arrangements, cycles of care for diabetes and asthma) [95, 155-158]. These are specific MBS items that can be claimed (and hence counted) that broadly relate to the provision of complex and chronic disease care planning, preventative care and coordination of care with other primary health and specialist care providers [159].

Based on 2010–2011 data, the annual number of care planning items per person was reported to vary across Medicare Locals (0.05–0.35) and SA3s (0.02–0.59) [142]. Graphical representation of the rates by Medicare Locals suggested that metropolitan areas that were socioeconomically disadvantaged had higher rates, compared with less disadvantaged metropolitan areas, while regional non-metropolitan areas had the highest rates and rural areas the lowest (irrespective of area disadvantage). No formal statistical analyses were performed for these data, and the reference population for the report was total population, rather than the eligible population (that is, those with a chronic disease and requiring complex care). As such, the relative underlying need within an area was not accounted for. These findings were broadly consistent with studies from 1999–2001 measuring variation in uptake of these extended primary health care items across Divisions of General Practice [157, 158]. Using the same data, further analysis also found that rates of health assessments per GP FTE, adjusted for persons aged 75 years or more, were higher in rural areas than urban areas. Rates of health assessments per population were highest in the most socioeconomically disadvantaged areas [158].

2.2.4.3 Relationship with other PHC service characteristics

There is some international evidence that comprehensiveness is associated with supply. A positive association has been found between PCP supply and rates of detection of breast, cervical, colon cancer and melanoma seen in US studies, presumably in part due to more preventative (and hence comprehensive) services being provided [7]. UK studies have shown that increasing GP supply was associated with increased provision of specific services for diabetes and contraception (indicative of the comprehensiveness of services) [125]. A multilevel analysis (GPs nested within

countries) using QUALICOPC data (described in section 2.1 and section 2.2.4.1) found that GPs who collaborate more with other primary care providers (that is, coordinate more) have a broader service profile when adjusted for age and sex of the GP and overall strength of a country's PHC system [144]. As mentioned in section 2.2.3.3, this was also the case for GPs who provide out-of-hours care within primary care only. By contrast, and as mentioned previously, cross-country comparisons in Europe have found no association between the access, comprehensiveness and coordination aspects of a country's PHC system [135].

2.2.4.4 Data sources in Australia

Given that community health centres may include a number of features of coordination and comprehensiveness, this could be considered as proxy indicator of the presence of these characteristics within areas. However, it is more likely that the presence of a community health centre better represents additional support services within an area. There are a variety of reasons why a health centre may be located in an area (due to a lack of services, increased need and political reasons) that cannot be measured. Hence, hypothesising how this may relate to certain outcomes is difficult. Other measures listed above—such as skill mix, role substitution and scope of care—are not routinely collected at the community or small-area level (or, if they are at all, in a few practice-based studies).

Rates of MBS claims relating to care planning and preventative health (including health assessments and pap screening for under-screened women) may give some indication of how well services may be organised and delivered within an area to provide comprehensive care. As briefly mentioned above, care planning items reflects care that is not only chronic-disease focused but also considers multi-morbidity, is long-term focused and develops mutually important health care goals between the care provider and the patient [157, 159]. Further, they are a means (through the team care arrangement items) to facilitate coordination and collaboration with other care providers including allied health and specialist services. As such, they could be viewed to be a measure (albeit imperfect) of the comprehensiveness and coordination aspect of PHC services within areas.

Health assessments are items that can be claimed for specific groups (children aged 4, adults aged 45–49 years or over 75 years, refugees and humanitarian arrivals) intended to reimburse a comprehensive assessment covering acute health needs, chronic health needs, preventative care and behavioural health interventions [160]. Items relating to under-screened women having a Papanicolaou test receive additional payments. These items as such capture preventative care, which is considered fundamental to the comprehensive care domain of strong PHC systems.

The inherent difficulty in using MBS items as a measure of comprehensiveness and coordination of services within areas is that, while PHC organisations do need to be structured in a certain way

to be able to deliver care in order to claim these items, these items actually reflect the care received (that is, an output of the primary health care system). Specifically, they are a measure of the overall quality of care received by the population residing in that area. Hypothesising how this may relate to specific individual-level outcome measures of GP service use and type of care received results in conceptual circularity. A further consideration is that the number of services claimed for these items is relative to the underlying eligible population. Currently there are no publicly available estimates of the prevalence of chronic or long term conditions available at the small-area level below SA4 (100,000–300,000 persons in regional areas, 300,000–500,000 in metropolitan areas; 106 SA4 areas across Australia, 31 within NSW). This is too large a geographical scale to make reasonable inferences regarding variation of services at a local or community level (as discussed in Chapter 1). The number of disease-specific conditions by SLA are available as modelled estimates from PHIDU; this enables an estimate of the number of long term conditions by small area as an approximation of the eligible population [161].

An additional available measure of preventative care that may reflect variation in service organisation and delivery at the small-area level is cervical screening participation rates. Measured as the percentage of women aged 20–69 years who have had cervical screening in the preceding two years, these data have been collated and produced by the PHIDU at the SLA level for NSW from 2011 onwards [162]. However, similar to the issue with the MBS health assessment items, although it could be argued that the cervical screening participation rate reflects the overall organisation of services in an area, hypothesising the way in which changing percentages of screening will affect GP service use or quality of care is difficult.

2.2.5 Other Potential Area-level Measures of PHC Service Characteristics

The preceding sections have described in detail available measures of meso-level service delivery characteristics of PHC systems that can be viewed to influence receipt of care at the area level. There are additional process characteristics identified in the literature as integral to strong PHC systems that could be viewed as operating at the meso level. These are considered briefly here.

Acceptability in Kringos and colleagues' conceptualisation is viewed as a process characteristic [17]. This concept refers to the cultural and social factors determining a person's attitudes towards the characteristics of the service, as well as provider attitudes towards the person seeking care [104, 108]. This dynamic is more a feature at the practice/provider and patient interface, rather than one that is amenable to change at the area level. Specific measures of acceptability include patient satisfaction with services; whether services are congruent with patient health beliefs, culture and values; and provider attitudes regarding the acceptability of clients. As such this characteristic was not further considered for study in this thesis.

Continuity of care has been clearly identified in the literature as a core component of strong PHC systems [7, 98, 163], and was identified as a process characteristic of PHC by Kringos and colleagues [17]. Utilisation was also initially viewed as a process characteristic in conceptualisation by Kringos and colleagues, and is often considered a dimension of access ('realised access') [74, 99, 104]. Watson and colleagues, in their results-based logic model, view these characteristics as outputs of the PHC system [97]; that is, a consequence of the inputs (such as availability of health personnel) and activities that enable PHC delivery. For the purposes of this thesis, utilisation and continuity of care are viewed as outcome measures reflecting services received by individuals, rather than as organisational and delivery characteristic of PHC services within areas. Both measures are discussed in detail in Chapter 4.

2.3 Summary

There has been extensive work over the last few decades in attempting to define what a strong PHC system is and how it can be measured. Access (and its components), continuity, comprehensiveness and coordination are clearly identified as process characteristics of PHC services that can be viewed to operate in part at the area level and have a strong conceptual basis with face validity. However, there is inconsistency in how these are measured, and the empirical evidence for each specific measure is highly variable internationally and largely absent in Australia. More recently, work has investigated the organisation of PHC systems across European countries. These studies have examined variation in the domains of PHC across countries, the relationship between domains [135], the efficiency of countries in translating the process characteristics into quality of care outcome measures [112] and the relationship of these domains with health outcomes and health inequalities [111]. However, these previous studies have been based on composite scores across a number of indicators in each domain (access, comprehensiveness and coordination) rather than on examining the specific measures themselves. While this is helpful in comparing health systems across countries, it does not enhance understanding of the specific modifiable PHC service characteristics at the area level within countries that are suitable for policy or practice intervention. QUALICOPC has offered important insights into how the structure and organisation of PHC systems relate to the performance of health care systems [102, 116, 118, 119, 144]. These data have been used to investigate specific process characteristics from each domain with respect to variation between countries and practices [114], the relationship between characteristics [144], and the relationship with patient perceived quality of, [116] and access to, [118, 119] care. However, this work has focussed on process characteristics at the practice- or provider/patient- level (that is, the micro level). Relationships may differ at the area-level requiring an alternative policy approach. Further, such work has not specifically been undertaken in the Australian setting.

There is a range of potential sources of data in Australia across the domains of access, comprehensiveness and coordination that can be used at the small-area level. However, there are a number of caveats concerning how well available data in Australia can capture the domains of comprehensiveness and coordination as a process measure, rather than as an output of the PHC system. To date, there are limited studies specifically describing these potential measures in detail in terms of their geographical variation (generally and in relation to rurality and area socioeconomic disadvantage) and none investigating the relationship between the measures themselves—either within domains or between domains. Chapter 3 endeavours to address this knowledge gap by constructing and examining measures of organisation and delivery characteristics of PHC services that can be viewed to operate at the small-area level in Australia.

Chapter 3

Study 1: Primary Health Care Service Characteristics in NSW—Construction and Descriptive Analysis of Area-level Measures

The purpose of this chapter is to construct and describe area measures of modifiable organisational and delivery characteristics of PHC services. Chapter 2 described the definitions, relevant literature and available data sources in Australia of area PHC service characteristics. This review showed that the availability of relevant measures in Australia is piecemeal and characterised by several limitations with respect to their construction and suitable geographical scale. There have been no studies in Australia explicitly examining the geographical distribution of measures of modifiable PHC service characteristics across all domains (access, comprehensiveness and coordination). Nor have there been studies investigating the relationship between measures from the different domains. This has important implications for policy and service delivery in identifying aspects of the PHC system at the area level that may be modified in order to reduce unwarranted variation, and of primary importance to this thesis; socioeconomic variation, in PHC use and quality of care.

The area-level measures examined in this chapter were assumed to capture process characteristics of PHC services that are viewed to be indicative of strong and effective PHC systems (as discussed in Chapter 2). The measures included were based on data available in Australia at the small-area level across NSW. This included thirteen variables, covering the following domains:

1. Access, with the subdomains of availability, affordability and accommodation;
2. Comprehensiveness; and
3. Coordination.

To recall, as raised in section 2.2.5, while acceptability is recognised as an important subdomain of access, for the purposes of this thesis it is viewed to operate at the provider/patient interface and hence was not included in the current study.

3.1 Study Aims

The specific objectives of this study were as follows:

1. To describe the geographical distribution of these measures for the study area (NSW)
2. To examine the relationship between measures within domains/subdomains, in order to determine the extent to which they capture a similar underlying construct

3. To describe the relationship of these measures with area socioeconomic disadvantage and remoteness (well established in Australia as area determinants of health service use and access)
4. To examine the relationship between measures from the domains of access, comprehensiveness and coordination, in order to see how these core components of PHC systems relate to each other at the area level in Australia

It is hypothesised that there is marked geographical variation in these measures and that they vary according to rurality and area socioeconomic disadvantage, and areas that have a greater presence of one PHC service characteristic are more likely to have other services characteristics associated with a strong PHC system.

3.2 Methods

3.2.1 Data

3.2.1.1 Setting and data sources

The study used NSW data, covering the period from 2006 to 2012. Data sources included AMPCo doctor lists (2010); AIHW health workforce survey (2007); PHIDU Social Health Atlas of Australia (2010, 2011, 2014); MBS service claims data 2008–2012, DHS; ABS 2006 Census; Access and Remoteness Index of Australia + (ARIA+), 2006, National Centre for Social Applications of Geographical Information Systems (GISCA), Adelaide; National Health Performance Authority (NHPA); and Health Establishment Registration Online (HERO) data, Ministry of Health NSW. A summary of the thirteen variables considered and the corresponding data sources used to construct them is in Table 2.

Table 2. Area-level PHC service characteristic measures and data sources

Domain	Variable name	Measure	Data source	Aggregation
Access				
Availability	<i>AMPCo count</i>	Headcount per 1000 URP	AMPCo doctor list, 2010. Denominator URP Census 2006	SLA2006 to SA3 2011. Denominator CCD2006 to SA3 2011
	<i>AMPCo FTE</i>	Full time/part time equivalent per 1000 URP	AMPCo Doctor list (part time assigned 0.5 FTE), 2010. Denominator URP Census 2006	SLA2006 to SA3 2011. Denominator CCD2006 to SA3 2011
	<i>AIHW FTE</i>	Full time equivalent (hours) per 1000 URP	AIHW Health Workforce survey, 2007 Denominator URP Census 2006	SLA2006 to SA3 2011. Denominator CCD2006 to SA3 2011
	<i>PHIDU FWE</i>	Full time work load (services) equivalent per 1000 URP	MBS-derived, published by PHIDU (years 2009-2010), Social Health Atlas 2011 Denominator URP Census 2006	SLA2006 to SA3 2011. Denominator CCD2006 to SA3 2011
Affordability	<i>OOP expenses</i>	Out-of-pocket costs per service in dollar amounts	GP MBS service claims for the years 2009–2011, DHS	Provided at SA3
	<i>Bulk-billing</i>	Percentage of all non-referred GP attendances bulk-billed	MBS service claims for the years 2011–2012, supplied to NHPA by DHS	Provided at SA3
	<i>HCC holders</i>	Percent of 15-65 year olds with a HCC (2009)	Centrelink, June 2009; Denominator, ABS ERP June 2008. Compiled by PHIDU 2010	SLA2006 to SA3 2011
	<i>PC holders</i>	Percentage of over 15 year olds with a pension card (2009)	Centrelink, June 2009; Denominator, ABS ERP June 2008. Compiled by PHIDU 2010	SLA2006 to SA3 2011
Accommodation	<i>After-hours care</i>	Percentage of after-hours care and after-hours urgent care items claimed of total GP services	GP MBS services claimed for the years 2009-2011, DHS	Provided at SA3
Comprehensive-ness				
Chronic Disease Care	<i>CD care</i>	Number of items claimed for GP management plans, team care arrangements and cycles of care for diabetes and asthma per 100 long-term conditions	GP MBS service claims for the years 2009–2011, DHS; denominator, self-reported long-term conditions compiled by PHIDU 2011 from NHS 2007–2008, and ERP average of June 2007–2008	Provided at SA3; denominator aggregated from SLA2006 to SA3 2011

Domain	Variable name	Measure	Data source	Aggregation
Preventative care	<i>Cervical screening</i>	Percentage of 20–69 year old women who have participated in cervical screening in the last 2 years	NSW cancer registry data for 2011–2012; Denominator, ERP from ABS 2011–2012 (denominator). Variable compiled by PHIDU 2014	SLA2006 to SA3 2011
	<i>Health assessments</i>	Number of items claimed for health assessments per 100 eligible persons (3–5 year olds, 45–49 year olds, 75 years and over and all Aboriginal and Torres Strait Islander peoples)	GP MBS service claims for the years 2000–2011, DHS; ABS 2006 census	Provided at SA3; denominator CCD2006 to SA3 2011
Comprehensive-ness and coordination				
Community Health Centre	<i>Community HC</i>	Number of community health centres per 10,000 population	HERO Data, Ministry of Health, NSW. Denominator URP Census 2006	Geocoded from address to SA3
Remoteness	<i>Remoteness areas</i>	Major cities, inner regional, outer regional, remote and very remote	ARIA+ 2006, GISCA	Provided at SA3, aggregated from a 1km grid by data custodians
	<i>Region</i>	Major cities, inner regional, outer regional, remote	ARIA+ 2006, GISCA	Provided at SA3, aggregated from a 1km grid by data custodians
Area SE disadvantage	<i>Area SE disadvantage</i>	Quintiles 1–5, where quintile 1 is the most disadvantaged and 5 is the least disadvantaged	SEIFA indexes for small areas, census 2006. URP census 2006 used to estimate population weighted quintiles	CCD2006 to SA3 2011

Notes:

1. URP, usual resident population; ERP, estimated resident population; AMPCo; Australian Medical Publishing Company; FTE, full-time equivalent; FEW, full-time workload equivalent; SA3, Statistical Areas Level 3; SLA, statistical local area; CCD, census collection district; NHS, national health survey; DHS, Department of Human Services; ARIA, accessibility and remoteness index of Australia; HC, health centre; NSW, New South Wales; SE, socioeconomic; IRSD, index of relative socioeconomic disadvantage; SEIFA, socioeconomic indexes for small areas; HERO; health establishment registration online; NHPA; National Health Performance Authority; GP; general practitioner; MBS, Medicare Benefits Scheme; GISCA; National Centre for Social Applications of Geographical Information Systems
2. URP is used as denominator population for numerator data from census years; ERP is used as denominator population for numerator data from inter-census years.

All area PHC service characteristic measures for NSW were calculated at the SA3 level. Statistical Area Level 3s are designed to provide a standard framework for the analysis of ABS data at the regional level. These areas have populations between 30,000 and 130,000 persons. In major cities they represent the area serviced by major transport and commercial hubs; in regional areas, the area serviced by regional cities with a population of at least 20,000; and in outer regional and remote areas they represent areas that have a distinct identity and similar social and economic characteristics. New South Wales has 93 SA3s (including migratory and offshore, and shipping and no usual address areas). Only those SA3s relating to residential areas (n=91) were included in this study (other SA3s had no data for the variables of interest). Numerators and denominators for each variable represent a full census count for that area, except for long term conditions, which are modelled estimates as described in this section.

3.2.1.2 Data aggregation and merging of data files

Medicare Benefits Scheme and ARIA+ data were available from the data custodians geocoded to SA3 level. Medicare Benefits Scheme data were geocoded to SA3 from addresses, while ARIA+ data were aggregated by the data custodians from a 1km square matrix that nests wholly within an SA3. One NSW SA3 (12402 Blue Mountains south) had no MBS data and was missing from the source file; this was presumed to be due to an extraction error at source.

Health Establishment Registration Online data included physical addresses of all state-run community health centres in NSW and were geocoded to SA3 by the National Centre for Geographic Resources and Analysis in Primary Health Care (GRAPHIC), Australian National University. These data are reliant on the local health district maintaining an up to date and accurate address list, and there may be errors unknown to the data custodian. Seven of the community health care centres could not be assigned to an SA3 due to incorrect or insufficient address details. Six SA3s did not have any community health centre counts assigned to them (10702, 10803, 11503, 11504, 11602, and 12402). These SA3s were excluded from analyses, including the community health centre variable.

All other variables required aggregation from either SLA level (AMPCo, AIHW, PHIDU, specialist counts, Census 2006) or Census Collection District (CCD) level (Index of Relative Disadvantage and population counts, Census 2006). Census Collection Districts were the smallest geographical areas produced by the ABS for census data prior to 2011 (CCDs are nested in SLAs). Aggregation was based on population-weighted correspondence files. These were obtained from the ABS either as downloadable spreadsheets or directly from within the Statistics Division of the ABS. Concordance values were calculated by multiplying the contributing proportion of the population of the original area (CCD or SLA) to the new area (SA3) by the values in the original area. The calculated population-weighted values were then summed by SA3 to give a new total value for that SA3. In most instances, the CCD to SA3 concordance was a many-to-one

relationship. However, 331 CCDs (of a total of 12,254) were split between SA3s due to alteration in borders for statistical geographies between census years. More than half the SLAs were split between SA3s (103 of 199 SLAs).

3.2.2 Area-level PHC Service Characteristic Variables

3.2.2.1 Access

3.2.2.1.1 Availability

Three sources of data—AMPCo doctor list, AIHW health workforce survey and MBS-derived estimates by PHIDU—were used to construct four area-level measures of availability:

1. *AMPCo count*: headcounts of doctors per 1000 usual resident population (URP)
2. *AMPCo FTE*: full time equivalents estimated from full time/part time status per 1000 URP
3. *AIHW FTE*: full time equivalents by hours worked per 1000 URP
4. *PHIDU FTE*: full time workload equivalents per 1000 URP

AMPCo FTE was estimated by assigning part-time doctors a weight of 0.5 [120, 164]. Data for *AIHW FTE* were available at the SLA level. Due to confidentiality concerns, SLAs with fewer than three doctors residing in them had values suppressed and hence the count was missing (this occurred for a total of 34 SLAs in NSW). *PHIDU FTEs* were calculated from MBS claims data for each area (2009, from PHIDU, Social Health Atlas 2011) and average MBS services per GP across Australia published by Department of Health. The URP from the 2006 census was included as the base population.

3.2.2.1.2 Affordability

Four area-level measures of affordability were examined:

1. *Out-of-pocket (OOP) expenses*: average OOP cost per visit, in AUD
2. *Bulk-billing*: percentage of all GP attendances services bulk-billed
3. *Health care card (HCC) holders*: percentage of 15-65 year olds with an HCC
4. *Pension card (PC) holders*: percentage over 15 year olds with a PC

For the measure *OOP expenses*, data were sourced directly from the DHS for all GP MBS services claimed for the period January 2009–December 2011, aggregated by SA3. The specific item numbers included are presented in Table 3. This dataset represents a full census. The time period was selected on the basis that it was the earliest that was available that would be viewed as

representative of an appropriate time period of exposure for the study population¹². *OOP expenses* were calculated as the average dollar amount per visit, by SA3.

Data for *bulk-billing* were sourced from NHPA, aggregated by SA3. The specific item numbers included are not available, but include all item numbers relating to non-referred GP attendances. The earliest time period available which was sufficiently close to the study period was for claims during 2011 and 2012. The DHS provides the MBS data directly to NHPA, who then process the data for public use (by specific request, as at the time of analysis these data were not publicly available in any downloadable format).

Health care card (HCC) holders and *Pension card (PC) holders* were sourced from the PHIDU Social Health Atlas of Australia 2010. These data are compiled by PHIDU using data from Centrelink as agent for the Department of Families, Housing, Community Services and Indigenous Affairs (now known as DHS), June 2009 (numerator); and ABS Estimated Resident Population (ERP), 30 June 2008 (denominator). The ERP is produced by the ABS for intercensal years estimated from the natural increase in population from the baseline preceding census count, net migration overseas and net interstate migration. Briefly, people eligible for a HCC are those aged 0–64 years that are not on a pension card (PC) and are low income, are a primary carer (short term), under financial hardship or currently seeking work or undertaking studies (and experience financial hardship). Those eligible for PCs are predominantly people on the aged pension but also people aged 15 years and over who are a long term carer, single parent, or receiving disability support. (See Appendix B for a complete list of people eligible for an HCC or PC.)

3.2.2.1.3 Accommodation

After-hours care was calculated as after-hours items and after-hours urgent care items claimed as a percentage of total MBS items for GP services. The specific item numbers included are shown in Table 3. Data were sourced as per *OOP expenses*. This measure is not intended to be a comprehensive measure of accommodation but rather one indicator than can actually be measured with available data at this geographical scale.

3.2.2.2 Comprehensive care and coordination

Three measures for comprehensive care were constructed, based on available data and what best captured this domain; one measure for chronic disease care and two preventative care measures:

1. *Chronic disease (CD) care*: the number of chronic disease care MBS items per 100 eligible population per year

¹² Medicare data is only available from DHS for up to 5 years from the time of data extraction. The date of extraction for this study was June 2013.

2. *Cervical screening*: the percent of women aged 20–69 years who have participated in cervical screening in the last two years, excluding an estimate of those who had undergone a full hysterectomy
3. *Health assessments*: the number of health assessment MBS items claimed per 100 eligible population per year¹³

In addition, the number of community health care centres per 100,000 URP (*Community HC*) was examined as a measure of coordination and comprehensiveness. This was included given that community health care centres in NSW generally encompass coordination and comprehensiveness in their models of care (as discussed in Chapter 2).

Counts for chronic disease MBS items and health assessments MBS items were sourced as described above for *OOP expenses*. *Chronic disease care* included MBS item numbers for GP management plans, team care arrangements and cycles of care for diabetes and asthma (Table 3). Item numbers for *health assessments* are also listed in Table 3.

The number of women who have participated in cervical screening was compiled by PHIDU from data from the NSW Department of Health and NSW Central Cancer Registry, for 2011 and 2012. Cervical screening rates for NSW were unavailable prior to 2011. There may be differences in rates over time, but in the absence of specific state-wide public health initiative (for example, a cervical screening promotion campaign), these are expected to be minimal.

The eligible population for the *CD care* measure—those with a long term condition—was sourced from the PHIDU Social Health Atlas 2011. Actual counts of persons per area stating if and how many long-term conditions they have are currently unavailable. Modelled estimates of the number of people with a long-term condition by condition (or category of conditions, such as respiratory or musculoskeletal) were available by SLA compiled by PHIDU from the 2007–2008 National Health Survey (NHS) and the ABS ERP, averaged from the June 2007 and June 2008 estimate. Respondents to the NHS were asked whether they had been diagnosed with any long-term health condition (a condition that has lasted or is expected to last for six months or more), and were also asked whether they had been told by a doctor or nurse that they had a condition from a list of specific conditions. For mental health and behavioural problems, respondents were not specifically asked if that had been diagnosed and therefore could represent self-diagnosis rather than diagnosis by a health professional. The following conditions and groups of conditions were included: diabetes, high cholesterol, mental and behavioural problems, circulatory system diseases, respiratory system diseases, and musculoskeletal system diseases. It should be noted that these counts represent the number of people with that specific condition in each SA3 and are only available by condition group. Hence, when counts are aggregated across conditions for each

¹³ See Chapter 2 for details of care provided in order to claim a Health Assessment.

SA3 this represents the total number of conditions within that area, as a person who has, for example, diabetes and high cholesterol will be counted twice.

The eligible populations for health assessments were sourced from the 2006 census. Persons aged 3–5 years, 45–49 years and over 75 years old were included¹⁴. Counts of persons identifying as Aboriginal and/or Torres Strait Islander were also included in the eligible population (as eligible for one health assessment annually). Due to the age brackets there may be some double counting, having included all Aboriginal and Torres Strait Islander people. Some groups, such as recently arrived humanitarian immigrants, were not included in the eligible population due to a lack of available data. As these groups comprise a small population overall for NSW (humanitarian immigrants were 0.62% of the total NSW population in 2008¹⁵), excluding them is not expected to influence overall proportions at the SA3 level.

The eligible population (also compiled by PHIDU) for cervical screening was derived from the average of the ABS ERP, from 30 June 2011 and 30 June 2012, with hysterectomy fraction data derived from the 2007–2008 National Health Survey.

3.2.3 Remoteness and Area Socioeconomic Disadvantage

3.2.3.1 Remoteness

In Australia, the main classification of urban, rural and remote areas is based on the ARIA+ classification of areas. For this study, ARIA+ 2006 scores for each SA3 were obtained from the GISCA (Adelaide). The Access and Remoteness Index of Australia + is a continuous index with values ranging from 0 (high accessibility) to 15 (high remoteness). It is based on road distance measurements from over 12,000 populated localities to the nearest service centres in five size categories based on population size. These service centre categories are: A, 250,000 persons or more; B, 48,000–249,999 persons; C, 18,000–47,999 persons; D, 5,000–17,999 persons; E, 1,000–4,999 persons. An interpolation procedure is then used to derive the index values for each of the localities to a 1 km grid so that all areas of Australia are able to be assigned an index value. Using the interpolated grid surface, scores for larger areas such as SA3s can be derived. The ARIA+ scores for each SA3 were categorised into five remoteness areas as per the ABS standard used in Australia [165]. These categories were ‘major cities’ (0–0.2), ‘inner regional’ (0.2–2.4), ‘outer regional’ (2.4–5.92), ‘remote’ (5.92–10.53) and ‘very remote’ (10.53–15). These remoteness areas were then aggregated into three regions: major cities, inner regional and outer regional/remote (outer regional, remote and very remote) areas. This categorisation was chosen as there are very few remote and very remote SA3s in NSW (only 1.85% of the population for

¹⁴ 3–5 year olds and 45–49 year olds are eligible for one health assessment only; over 75 year olds are eligible for one health assessment per year.

¹⁵ Sourced from settler arrivals 2007–2008, Department of Immigration and Citizenship, Australian Government and ABS ERP 2008.

remote and very remote areas combined) and hence were combined with outer regional areas to ensure sufficient power for analyses.

3.2.3.2 Area socioeconomic disadvantage

The ABS produce four measures of social and economic status at the small-area level. One of these, the Index of Relative Disadvantage (IRSD), comprises a number of census variables reflecting socioeconomic disadvantage [166]. A score from principal components analysis of these variables is developed for all areas across Australia and standardised to a mean of 1000 and a standard deviation of 100. As this is an ordinal scale, a five-category variable, *Area socioeconomic (SE) disadvantage*, was created based on population-weighted quintiles ranging from most disadvantaged to least disadvantaged. To do this, population-weighted scores were first aggregated from CD to SA3 (as described in Section 3.2.1.2 then ranked from the lowest to the highest and given a quintile number (between 1 and 5) based on the population distribution across the ranked SA3s (that is, the SA3s that contained the first 20% of the population were assigned a quintile of 1, the SA3s containing the next 20% of the population were assigned quintile 2, and so on), as per recommended by the ABS for aggregating Socioeconomic Indexes for Small Areas (SEIFA) [167]. Areas in quintile 1 are the most socioeconomically disadvantaged, while those in quintile 5 are the least socioeconomically disadvantaged.¹⁶

Table 3. Non-referred GP attendance MBS item numbers included in the analysis

Item Group Description	Item Numbers
Brief consultations	3 and 52
Standard consultations	23 and 53
Long consultations	36 and 54
Prolonged consultation	44 and 57
Remainder A1 and A2	4, 20, 24, 35, 37, 43, 47, 51, 58–60, 65, 92, 93, 95, 96
After-hours services (urgent and non-urgent)	597, 598, 559, 600, 5000, 5003, 5010, 5020, 5023, 5028, 5040, 5043, 5049, 5060, 5063, 5067, 5200, 5203, 5207, 5208, 5220, 5223, 5227, 5228, 5260, 5263, 5265, 5267
Heath assessments	701, 703, 705, 707, 715
GP management plans	721, 723, 729, 731, 732
Cervical screening (for unscreened or significantly underscreened women)	2497, 2501, 2503, 2504, 2506, 2507, 2509, 2598, 2600, 2603, 2606, 2610, 2613, 2616
Asthma cycle of care	2546, 2547, 2552, 2553, 2558, 2559, 2664, 2666, 2668, 2673, 2675, 2677
Diabetes cycle of care	2517, 2518, 2521, 2522, 2525, 2526, 2620, 2622, 2624, 2631, 2633, 2635

Note:

Remainder A1 and A2 refers to non-referred general practice services provided by vocationally and non-vocationally registered medical practitioners at a residential care facility or at other than consulting rooms or residential aged care facility.

¹⁶ In 2006, 99 CDs in NSW did not have an IRSD score. Approximately 3% of all CDs across Australia for the 2006 census do not have a score due to insufficient responses in that area.

3.2.4 Analyses

All area-level primary health care service characteristics were examined as categorical and continuous variables. Categorical variables were constructed using the ranked quartile population distribution breakpoints determined from the total dataset available for all SA3s. That is, after ranking SA3s from lowest to highest on the continuous score, SA3s comprising the first 25% of the cumulative population were assigned the first quartile for that variable, SA3s contained in the subsequent 25% of the cumulative population were assigned to the second quartile and so on.

In order to describe the study area (NSW), number of areas and demographic characteristics including population size, distribution by regional and area SE disadvantage were quantified. To examine the distribution of area SE disadvantage within regions, the number and percentage of SA3s, and the total and percentage of population by SA3, were calculated stratified by region and by quintile of disadvantage. Means and standard deviations are reported in the results section of this chapter for continuous variables and proportions for categorical variables.

To describe the geographical variation of area-level measures of PHC service characteristics within NSW, means and standard deviations and median and interquartile ranges for continuous variables, and proportions for categorical variables, were calculated. Categorical variables were mapped by SA3 in order to visually represent the geographical distribution of the PHC service characteristics across the state.

To examine the relationship between variables within domains and subdomains (Objective 2), pairwise Pearson's correlation analyses were undertaken between variables of each domain and subdomain. Correlation coefficients and significance tests are reported here. Tests of trends for categorical variables within domains and subdomains were determined by Chi squared tests.

In order to examine how each of the area-level PHC service characteristics varies with rurality and area SE disadvantage, means and standard deviations of continuous PHC service characteristic variables were calculated separately for each category of rurality and area SE disadvantage. Given that *a priori* the relationship of area SE disadvantage with some PHC service characteristics was expected to vary according to remoteness, the means and standard deviations of each PHC service characteristic variable by quintile of area SE disadvantage were also calculated after stratifying by region. Tests for trends were performed with bivariate linear ordinary least squares regression.

Finally, in order to better understand how area measures of PHC service characteristics capturing different domains and subdomains of strong PHC systems relate to each other in the Australian context, pairwise Pearson's correlation analyses were performed between variables from each domain and subdomain (availability, affordability, accommodation, comprehensiveness and

coordination). Correlation coefficients and significance tests are reported. Tests for overall trend between categorical variables were also performed using Chi squared tests.

3.3 Results

3.3.1 Demographic Characteristics

Across the study area of NSW, SA3s have a mean population of 71,467 (standard deviation [SD] 40,484) and median of 65,142 (IQR 63,713; Table 4). Table 4 shows the distribution of SA3 areas and population by region and area SE disadvantage.

Table 4. Distribution of SA3s and population by remoteness and SE disadvantage

	No. SA3s	% SA3s	URP mean (SD) median (IQR)
Study area	91	100	71,489 (40,484) 65,142 (63,713)
Remoteness	No. SA3.	% SA3s	% Total URP
Major cities	40	44.0	58.4
Inner regional	28	30.8	26.6
Outer regional	18	19.8	13.7
Remote	2	2.2	0.6
Very remote	3	3.3	0.7
SE disadvantage			
1st quintile (most disadvantaged)	18	19.8	18.9
2nd quintile	18	19.8	19.6
3rd quintile	20	22.0	20.9
4th quintile	16	17.6	20.4
5th quintile (least disadvantaged)	19	20.9	20.2

Notes:

SA3, Statistical Area 3, URP, usual resident population, SE, socioeconomic; No., number; %, percentage; SD, standard deviation; IQR, interquartile range.

Table 5 shows the distribution of SA3 areas and their population across regions stratified by SE disadvantage. There were more SA3s in urbanised areas than more remote areas across NSW, with an even greater proportion of the population living in SA3s in urbanised areas than in more remote areas. Generally, in major cities there were more areas and more people who lived in areas of least disadvantage, whereas in outer regional/remote areas there was a far greater percentage of areas and people in the most disadvantaged SA3s. In inner regional areas, both the number of areas and population tended to be largest in areas of middle SE disadvantage. Overall, there was a clear trend that SA3s and people living in SA3s that were more disadvantaged were also more remote ($p < .001$).

Table 5. Distribution of SA3s and population by remoteness, separately by quintile of SE disadvantage

	Major cities		Inner regional		Outer regional/remote	
Area's SE disadvantage	% of SA3s (n)	% of total URP (n)	% of SA3s (n)	% of total URP (n)	% of SA3s (n)	% of total URP (n)
1 (most disadvantaged)	17.5 (7)	20.8 (789,054)	7.14 (2)	5.6 (96,905)	39.1 (9)	35.5 (348,562)
2	12.5 (5)	10.6 (400,443)	14.3 (4)	22.1 (381,069)	43.5 (10)	50.3 (493,005)
3	15.0 (6)	15.2 (576,188)	35.7 (10)	38.2 (660,451)	8.7 (2)	12.3 (120,469)
4	22.25 (9)	25.1 (951,711)	21.4 (6)	20.7 (357,490)	8.7 (2)	1.9 (19,074)
5 (least disadvantaged)	32.5 (13)	28.4 (1,078,486)	21.4 (6)	13.5 (232,594)	0.0 (0)	0.0 (0)
Total	100 (40)	100 (3,795,882)	100 (28)	100 (1,728,509)	100 (23)	100 (981,110)

Notes:

IRSD, Index of Relative Disadvantage; SE, socioeconomic; URP, usual resident population; SA3, statistical area 3; %, percentage; n, number.

3.3.2 PHC Service Characteristics

The geographical variation of the area PHC service characteristics across the study area was also examined. Table 6 summarises each category of the PHC characteristic variables, reporting the SA3 compositions, the means and standard deviations. The mean, standard deviation, median and interquartile range for each area's PHC characteristic variable are also reported. The average number of non-referred GP services for the period 2009–2011 was 445,217 (SD 317,838), with a median of 354,053 (IQR 489,388). Across NSW, there was approximately 1 GP per 1000 URP by each of the four measures. The average *OOP expense* was \$4.20 (SD \$3.40) per service, 83.1% (SD 10.6%) of services were bulk-billed, 8.0% (SD 3.0%) of people aged 15–65 years held a health care card, 20.3% (SD 7.0%) of people over 65 years old held a pension card, and 4.4% (SD 3.6%) of all services were after-hours. Furthermore, there were 22.3 (SD 9.3) CD care items per 100 long-term conditions, 9.3 (SD 3.6) health assessments per 100 eligible persons, 56.4% (SD 5.6%) of women aged 20–69 years had participated in cervical screening and there were 8.0 (SD 5.5) community health centres per 100,000 URP. The proportion of SA3 areas in each population-weighted PHC service characteristic quartile was 20–30%.

The geographical variation of PHC service characteristic quartiles is shown in Figure 9.

Table 6. Area PHC service characteristic quartiles: SA3 composition and mean (SD) and median (IQR) values

PHC service characteristic by quartile	Definition	SA3 composition		Values	
		No. SA3s	% all SA3s	Mean (SD)	Median (IQR)
<i>AMPCo Count</i>	No. GPs/1000 URP				
1st quartile		25	27.5	0.7 (0.1)	–
2nd quartile		24	26.4	0.9 (0.1)	–
3rd quartile		23	25.3	1.2 (0.1)	–
4th quartile		19	20.9	1.8 (0.4)	–
Total		91	100	1.1 (0.5)	1.0 (0.5)
<i>AMPCo FTE</i>	FTE GPs/1000 URP				
1st quartile		27	29.7	0.7 (0.1)	–
2nd quartile		22	24.2	0.9 (0.0)	–
3rd quartile		23	25.3	1.1 (0.1)	–
4th quartile		19	20.9	1.7 (0.4)	–
Total		91	100	1.1 (0.4)	0.9 (0.5)
<i>AIHW FTE</i>	FTE GPs/1000 URP				
1st quartile		31	34.1	0.6 (0.2)	–
2nd quartile		20	22.0	0.8 (0.0)	–
3rd quartile		19	20.9	0.9 (0.0)	–
4th quartile		21	23.1	1.1 (0.2)	–
Total		91	100	0.8 (0.2)	0.9 (0.3)
<i>PHIDU FWE</i>	FWE/1000 URP				
1st quartile		27	29.7	0.8 (0.1)	–
2nd quartile		22	24.2	1.0 (0.0)	–
3rd quartile		25	27.5	1.1 (0.0)	–
4th quartile		17	18.7	1.3 (0.1)	–
Total		91	100	1.0 (0.3)	1.0 (0.3)

PHC service characteristic by quartile	Definition	SA3 composition		Values	
		No. SA3s	% all SA3s	Mean (SD)	Median (IQR)
<i>OOP expenses</i>	OOP costs/service (AUD)				
1st quartile		17	18.7	0.3 (0.3)	–
2nd quartile		28	30.8	2.3 (0.8)	–
3rd quartile		22	24.2	4.9 (0.7)	–
4th quartile		23	25.3	8.6 (2.9)	–
Missing		1	1.1	–	–
Total (non-missing)		90	100	4.2 (3.4)	3.7 (4.9)
<i>Bulk-billing</i>	% all GP services bulk-billed				
1st quartile		24	26.4	69.5 (5.9)	–
2nd quartile		21	23.1	80.6 (2.0)	–
3rd quartile		27	29.7	89.0 (2.7)	–
4th quartile		16	17.6	97.0 (1.5)	–
Missing		3	3.3	–	–
Total (non-missing)		90	100	83.1 (10.6)	83.2 (15)
<i>Holders of HCC</i>	Percentage of 15–65 yo with an HCC				
1st quartile		19	20.9	3.7 (0.7)	–
2nd quartile		25	27.5	6.8 (0.7)	–
3rd quartile		22	24.2	8.8 (0.7)	–
4th quartile		24	26.4	11.8 (1.1)	–
Missing		1	1.1	–	–
Total (non-missing)		90	100	8.0 (3.0)	8.0 (4.3)

PHC service characteristic by quartile	Definition	SA3 composition		Values	
		No. SA3s	% all SA3s	Mean (SD)	Median (IQR)
<i>Holders of PC</i>	Percentage of ≥ 15 yo with a pension card				
1st quartile		21	23.1	11.2 (2.2)	–
2nd quartile		24	26.4	17.5 (1.5)	–
3rd quartile		20	22	22.4 (1.2)	–
4th quartile		26	28.6	28.8 (3.6)	–
Total		91	100	20.3 (7.0)	20.2 (9.4)
<i>After-hours care</i>	Percentage of all GP services claimed after hours				
1st quartile		31	34.1	0.7 (0.5)	–
2nd quartile		22	24.2	3.5 (1.0)	–
3rd quartile		18	19.8	6.8 (0.8)	–
4th quartile		19	20.9	9.8 (1.8)	–
Missing		1	1.1	–	–
Total (non-missing)		90	100	4.4 (3.6)	3.7 (6.5)
<i>CD care</i>	Number of CD items claimed/100 eligible population ²				
1st quartile		26	21.98	11.5 (3.9)	–
2nd quartile		23	25.27	20.0 (1.9)	–
3rd quartile		19	27.47	26.8 (1.6)	–
4th quartile		21	25.27	34.1 (5.8)	–
Missing		2	1.2	–	–
Total (non-missing)		89	100	22.3 (9.3)	21.9 (13.5)

PHC service characteristic by quartile	Definition	SA3 composition		Values	
		No. SA3s	% all SA3s	Mean (SD)	Median (IQR)
Health assessments	No. health assessments claimed/100 eligible population ³				
1st quartile		24	26.4	5.5 (1.8)	—
2nd quartile		19	20.9	7.8 (0.4)	—
3rd quartile		22	24.2	9.7 (0.8)	—
4th quartile		25	27.5	13.8 (2.6)	—
Missing		1	1.1	—	—
Total (non-missing)		90	100	9.3 (3.6)	6.7 (4.3)
Cervical screening	% of women aged 20–69 who received a Pap smear in the last 2 years				
1st quartile		20	22.0	49.6 (2.1)	—
2nd quartile		23	25.3	53.9 (1.0)	—
3rd quartile		25	27.5	57.6 (0.8)	—
4th quartile		23	25.3	63.6 (4.3)	—
Total		91	100	56.4 (5.6)	56.1 (6.8)
Community HC	No. CHC/100,000 URP				
1st quartile		17	18.7	2.7 (0.8)	—
2nd quartile		20	22	4.9 (0.6)	—
3rd quartile		21	23.1	7.2 (0.9)	—
4th quartile		27	29.7	14.3 (5.4)	—
Missing		6	6.6	—	—
Total		85	100	8.0 (5.5)	6.4 (5.1)

Notes:

1. PHC, primary health care; SA3, statistical area 3; SD, standard deviation; IQR, interquartile range; No., number; %, percentage; yo, years old; OOP, out-of-pocket; HCC, health care card; CD, chronic disease; HC, health centre.
2. Persons aged 3–5 years, 45–49 years, 75 years and over, Aboriginal and Torres Strait Islander peoples.
3. Persons reporting a long-term condition. All categories population weighted using 2006 usual resident population (URP).

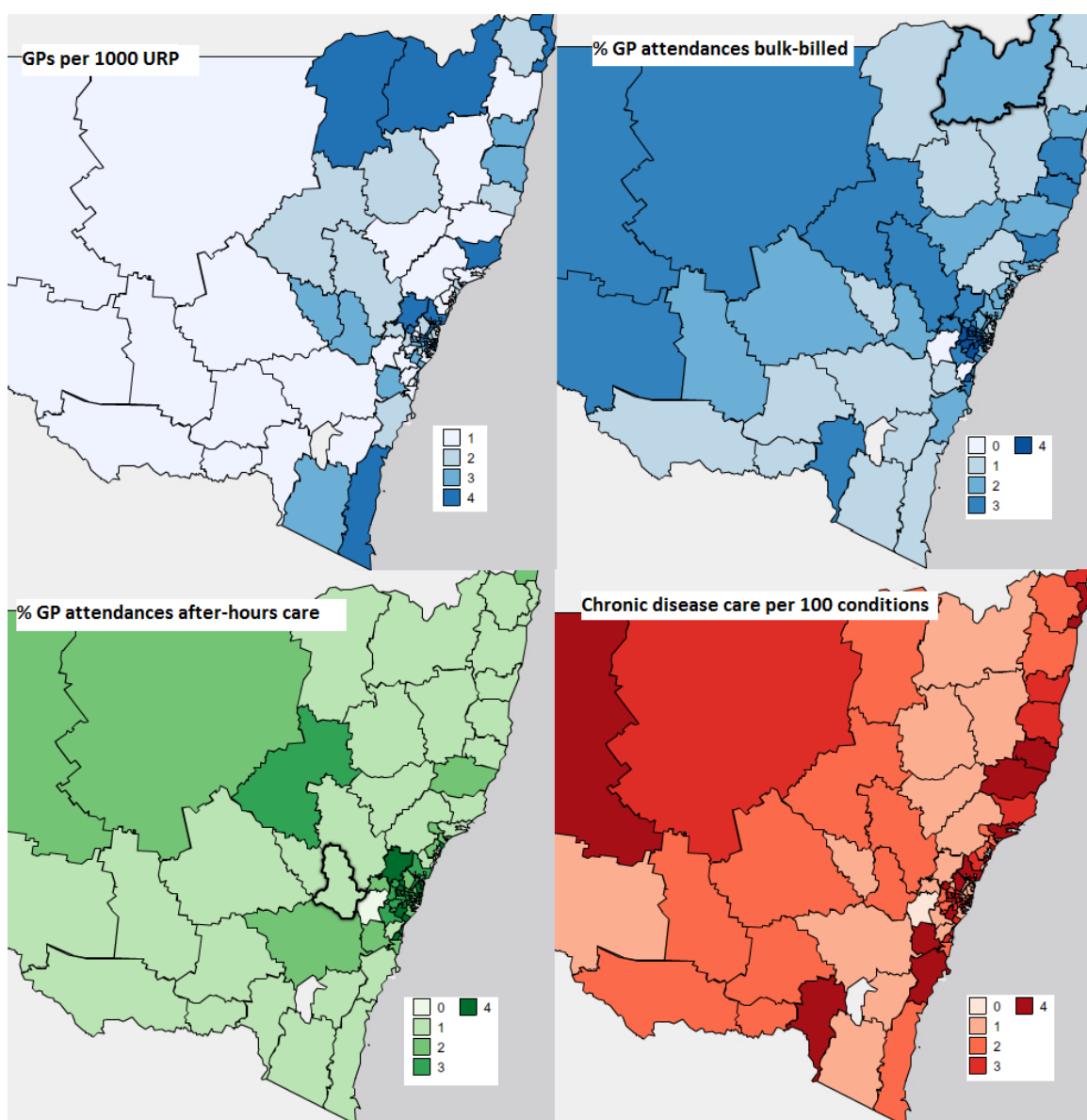


Figure 9. Geographical distribution of area PHC service characteristic quartiles from each domain and subdomain of PHC systems, by SA3

Notes:

1. PHC, primary health care; SA3, Statistical Area Level 3; GP, general practitioner; URP, usual resident population; %, percent.
2. Legend gives population-weighted quartile categories for each area PHC characteristic, where 1 is the first and lowest quartile and 4 is the fourth and highest quartile. Zero (0) refers to SA3 for which data were missing.

3.3.3 Relationship Between Measures Within Domains and Subdomains

Pairwise correlations generally found that variables from within domains and subdomains of the area PHC service characteristics were correlated. The strength of correlation depended on the specific variable pairs examined, and surprisingly there were some variable pairs that demonstrated no correlation (see Table 7). While there was fair correlation between availability measures from the AMPCo (count and FTE) and the AIHW data source (0.33 and 0.30, respectively), neither of these measures was correlated with the PHIDU measure. Possible reasons

were explored in further detail in subsequent analyses. *OOP expenses* and *bulk-billing* were highly correlated (-0.93), not unexpectedly, given how these measures are calculated. As anticipated, the proportion of *HCC holders* was positively associated with *bulk-billing* and negatively associated with *OOP expenses*. Correlations between measures within the comprehensiveness/coordination domain were weaker than between measures in the access subdomains. *Health assessments* and *CD care* were positively correlated (0.53), while *CD care* was negatively associated with *cervical screening* (-0.28). These relationships were generally confirmed with Chi squared tests for trends between categorical variables. It was expected that some of the observed associations reflected an underlying relationship with either region or area SE disadvantage. This was further investigated and described below in Section 3.3.4.

Table 7. Correlation between measures within domains—availability, affordability and comprehensiveness/coordination

Availability	AMPCo Count		AMPCo FTE		AIHW FTE	
	r	p	r	p	r	P
<i>AMPCo FTE</i>	1.00	<.001	–	–	–	–
<i>AIHW FTE</i>	0.33	0.002	0.30	0.004		–
<i>PHIDU FWE</i>	-0.07	0.529	-0.03	0.755	0.07	0.781
Affordability	OOP		Bulk-billing		HCC	
	r	p	r	p	r	P
<i>Bulk-billing</i>	-0.93	<.001	–	–	–	–
<i>HCC holders</i>	-0.35	<.001	0.31	0.004	–	–
<i>PC holders</i>	-0.21	0.044	0.14	0.187	0.87	<.001
Comprehensiveness/ Coordination	CD care		Health Assessments		Cervical screening	
	r	p	r	p	r	p
<i>Health assessments</i>	0.56	<.001	–	–	–	–
<i>Cervical screening</i>	-0.28	0.008	-0.09	0.376	–	–
<i>CHC</i>	-0.17	0.127	0.04	0.695	-0.09	0.437

Notes:

FTE, full-time equivalent; FWE, full-time workload equivalent; OOP, out-of-pocket expenses; HCC, health care card; CD, chronic disease; CHC, community health centre; r, Pearson's correlation coefficient; p, p-value for coefficient.

3.3.4 Variation with Remoteness and Area Socioeconomic Disadvantage

Nearly all area PHC service characteristics varied significantly according to region and area SE disadvantage (see Table 8 and Figure 10). However, the relationship of each measure with area disadvantage did depend on the region (this is shown in Table B3 in Appendix B). The details regarding un-stratified bivariate analyses are discussed first, followed by a brief comparison with bivariate analyses with area SE disadvantage stratified by region.

Table 8. Area PHC characteristics by region and area SE disadvantage, mean (SD)

Region	AMPCo count	AMPCo FTE	AIHW FTE	PHIDU FWE	OOP expenses	Bulk- billing	HCC holders	PC holders	After- hours care	CD care	HA	Cervical screening	CHC
Major cities	1.3(0.5)	1.2(0.4)	0.9(0.2)	1.1(0.2)	3.5(4.2)	87(11.5)	6.7(2.9)	16.1(5.1)	7.2(2.9)	233.8(8.2)	8.5(2.2)	55.7(6.4)	6.1(3.8)
Inner regional	1.0(0.3)	0.9(0.2)	0.8(0.2)	1.0(0.1)	4.6(2.9)	79.4(9.3)	7.7(2.6)	21.58(6.6)	3.3(3.0)	19.8(9.8)	9.2(4.3)	57.8(4.1)	8.0(5.6)
Outer regional/remote	1.0(0.5)	1.0(0.5)	0.7(0.2)	0.9(0.1)	4.8(2.0)	80.4(7.9)	10.6(2.1)	25.9(5.9)	1.4(1.8)	22.6(10.4)	11.0(4.2)	55.8(5.47)	11.4(6.5)
Total	1.1(0.5)	1.1(0.4)	0.8(0.2)	1.0(0.2)	4.2(3.4)	83.1(10.6)	8.0(3.0)	20.3(7.0)	4.5(3.7)	22.3(9.3)	9.3(3.6)	56.4(5.6)	8.0(5.5)
Test for trend	0.008	0.011	p<.001	p<.001	0.100	0.007	p<.001	p<.001	p<.001	0.462	0.008	0.858	p<.001
Area disadvantage													
Most disadvantaged	0.9(0.2)	0.9(0.2)	0.8(0.2)	1.1(0.3)	2.7(2.6)	88.2(9.7)	11.6(1.4)	27.2(5.6)	4.8(4.9)	26.0(6.7)	10.3(4.0)	52.5(3.6)	9.3(6.5)
2	0.9(0.3)	0.85(0.3)	0.8(0.2)	1.0(0.2)	3.6(2.5)	84.8(9.7)	9.6(1.9)	24.4(4.9)	3.1(3.8)	24.7(9.8)	10.3(3.6)	54.3(4.0)	10.2(6.0)
3	1.0(0.2)	1.0(0.2)	0.8(0.2)	1.0(0.2)	4.5(2.5)	80.9(8.9)	8.3(1.1)	22.0(3.5)	3.6(2.8)	23.8(9.4)	10.6(2.5)	56.9(4.5)	6.2(5.2)
4	1.3(0.6)	1.2(0.6)	0.9(0.3)	1.0(0.1)	3.9(3.4)	84.6(11.4)	6.2(1.1)	16.4(3.4)	5.0(2.5)	21.0(7.9)	7.6(2.5)	56.1(5.8)	7.2(3.2)
Least disadvantaged	1.5(0.6)	1.3(0.5)	0.9(0.2)	1.0(0.1)	6.0(4.8)	77.4(10.9)	4.0(1.3)	11.8(3.4)	6.2(3.1)	15.9(9.3)	7.7(4.0)	62.2(4.7)	6.7(4.9)
Total	1.1(0.5)	1.1(0.4)	0.8(0.2)	1.0(0.2)	4.2(3.4)	83.1(10.6)	8.0(3.0)	20.3(7.0)	4.5(3.7)	22.3(9.3)	9.3(3.6)	56.4(5.6)	8.0(5.5)
Test for trend	p<.001	p<.001	0.076	0.128	0.005	0.004	p<.001	p<.001	0.07	p<.001	0.004	p<.001	0.048

Notes:

1. SD, standard deviation; PHC, primary health care; SE, socioeconomic; OLS, ordinary least squares; IRSD, index of relative disadvantage; FTE, full-time equivalent; OOP, out-of-pocket expenses; HCC, health care card; PC, pension card; CD, chronic disease; HA, health assessment; CHC, community health centre.
2. Test for trend for bivariate analyses, OLS regression.

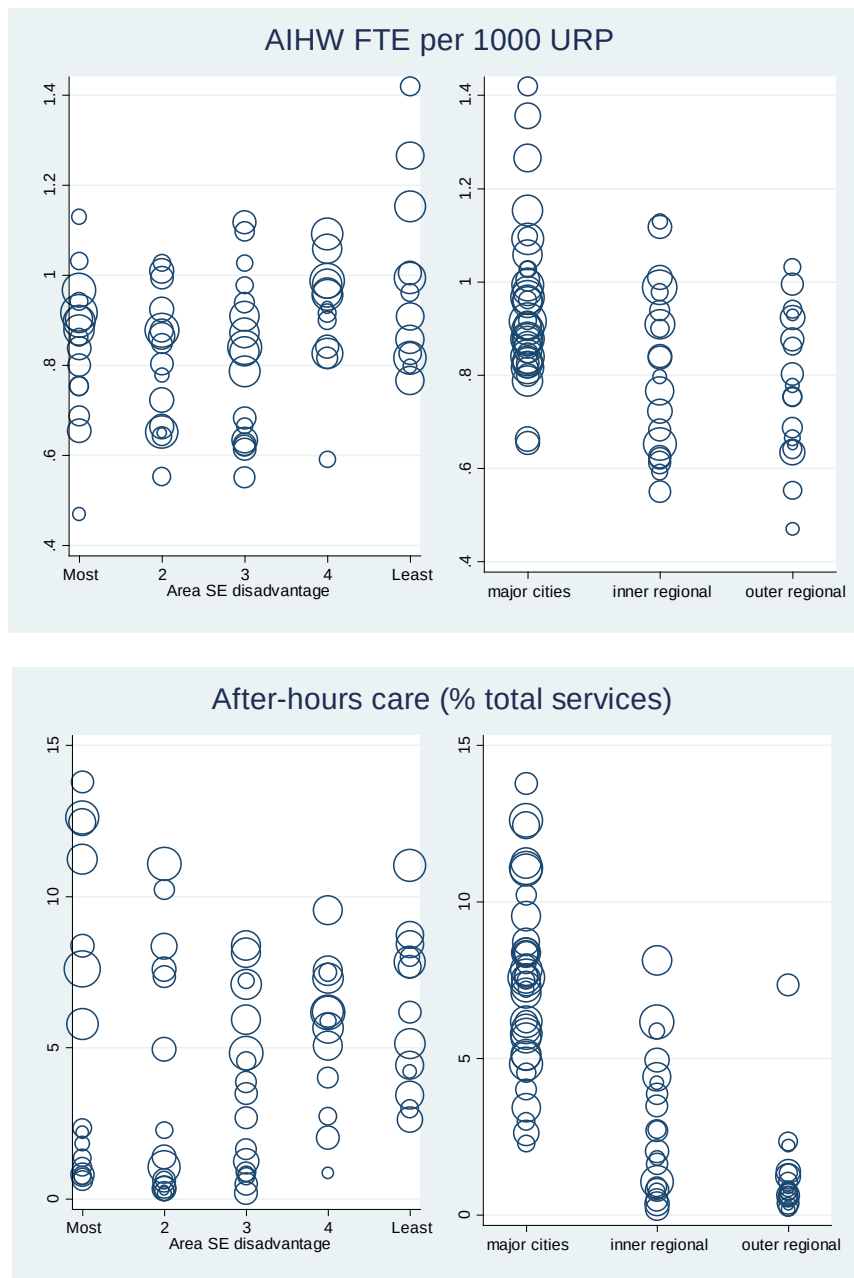


Figure 10(a). Scatterplots of region and area disadvantage with area PHC service characteristic measures – Availability and accommodation

Notes:

1. Size of circle is proportional to population of the SA3 plotted; that is, a larger circle indicates a larger population in that SA3.
2. SE, socioeconomic; AIHW, Australian Institute of health and Welfare; FTE, full-time equivalent; URP, usual resident population; OOP, out-of-pocket expenses; GP, general practitioner; %, percentage.
3. Eligible population for health assessments: persons aged 3–5 years, 45–49 years, 75 years and over, Aboriginal and Torres Strait Islander peoples.

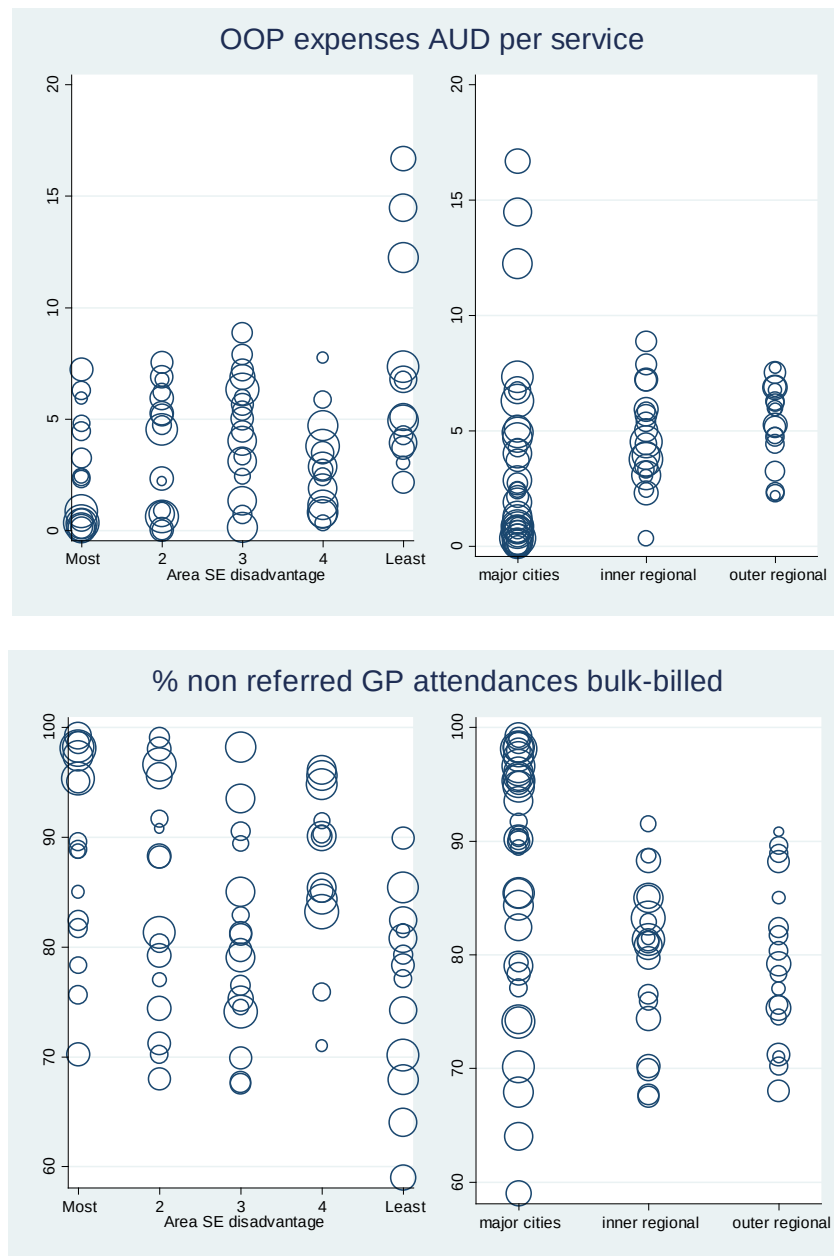


Figure 10(b). Scatterplots of region and area disadvantage with area PHC service characteristic measures – Affordability

Notes:

1. Size of circle is proportional to population of the SA3 plotted; that is, a larger circle indicates a larger population in that SA3.
2. SE, socioeconomic; AIHW, Australian Institute of health and Welfare; FTE, full-time equivalent; URP, usual resident population; OOP, out-of-pocket expenses; GP, general practitioner; %, percentage.
3. Eligible population for health assessments: persons aged 3–5 years, 45–49 years, 75 years and over, Aboriginal and Torres Strait Islander peoples.

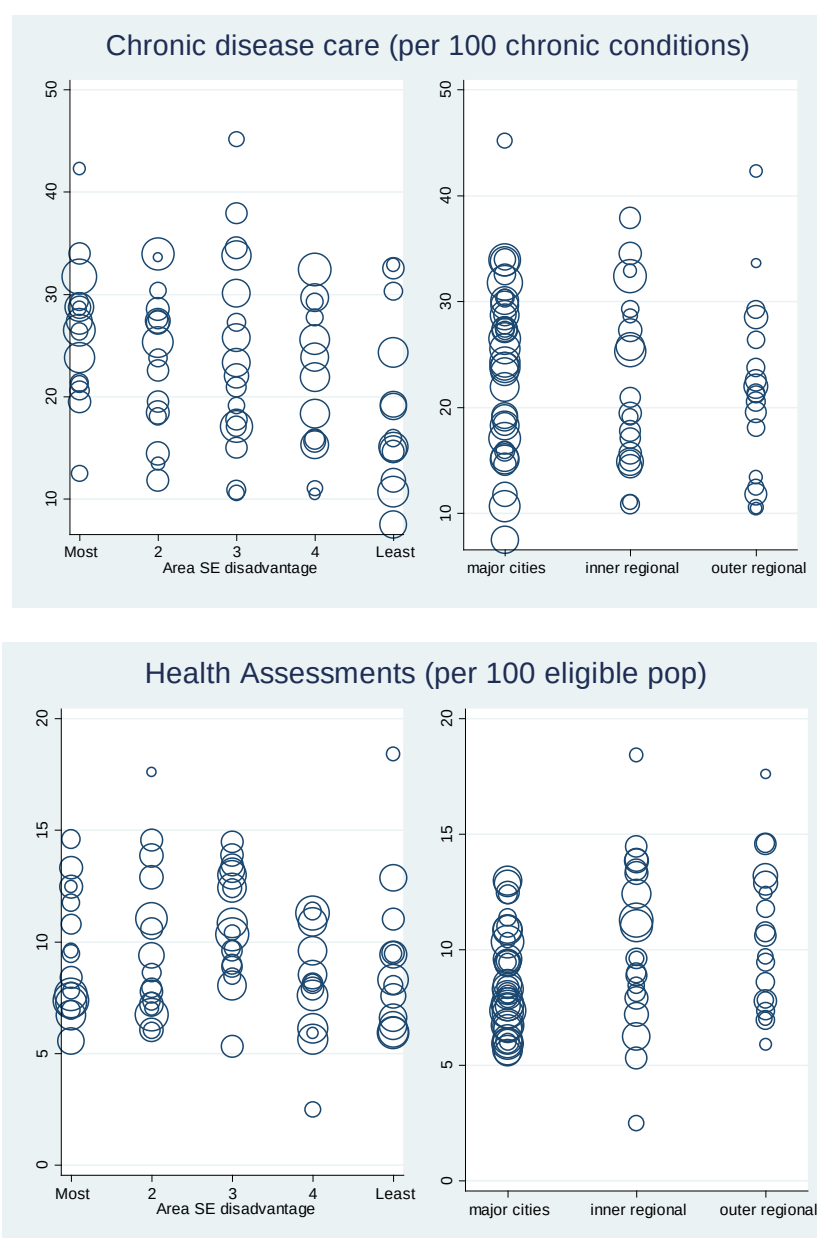


Figure 10(c). Scatterplots of region and area disadvantage with area PHC service characteristic measures – Comprehensiveness, chronic disease care and health assessments

Notes:

1. Size of circle is proportional to population of the SA3 plotted; that is, a larger circle indicates a larger population in that SA3.
2. SE, socioeconomic; AIHW, Australian Institute of health and Welfare; FTE, full-time equivalent; URP, usual resident population; OOP, out-of-pocket expenses; GP, general practitioner; %, percentage.
3. Eligible population for health assessments: persons aged 3–5 years, 45–49 years, 75 years and over, Aboriginal and Torres Strait Islander peoples.

Briefly, in un-stratified bivariate analyses, areas in major cities had the most GPs, were the most affordable and had the most *after-hours care*. On the other hand, outer regional/remote areas had the largest proportion of *HCC holders* and *PC holders*, and the most *health assessments* and *Community HCs*. Disadvantaged areas had the fewest GPs (as measured by AMPCo data only), were the most affordable (across all measures within this subdomain) and had the highest rates on most measures of comprehensive and coordinated care. Areas that were the least disadvantaged

had the highest rates of *cervical screening* participation. Similar significant relationships were observed with categorical variables.

Both *HCC holders* and *PC holders* demonstrated a strong relationship with area SE disadvantage. Adjusted R^2 in bivariate analyses were 0.8 and 0.6. Pearson's correlation coefficients between these variables and IRSD quintile were -0.9 and -0.8, respectively. Given the high correlation with area SE disadvantage it was felt that these measures most likely represented a proxy indicator for area SEP, rather than capturing an aspect of PHC service affordability within an area. As such, these two measures were excluded from further analyses.

Given that previous studies have shown that counts of supply correlate poorly in remote areas [120], further analyses stratified by region were completed to better understand the relationship between these different measures (see Table 9). In major cities, all measures were significantly correlated. *PHIDU FWE* was, however, negatively associated with the three other measures of availability. In outer regional/remote areas, while *PHIDU FWE* was positively associated with the two *AMPCo* measures, these three measures were negatively associated with *AIHW FTE* (the association with *PHIDU FWE* was not significant). Inner regional areas demonstrated the expected positive correlation between availability measures.

Table 9. Correlation between availability measures separately by region

Region	<i>AMPCo count</i>		<i>AMPCo FTE</i>		<i>AIHW FTE</i>	
	r	p	r	p	r	p
Major Cities						
<i>AMPCo FTE</i>	1.00	<.001	–	–	–	–
<i>AIHW FTE</i>	0.49	<.001	0.50	<.001	–	–
<i>PHIDU FWE</i>	-0.69	<.001	-0.66	<.001	-0.49	<.001
Inner regional						
<i>AMPCo FTE</i>	1.00	<.001	–	–	–	–
<i>AIHW FTE</i>	0.62	<.001	0.63	<.001	–	–
<i>PHIDU FWE</i>	0.23	0.221	0.26	0.181	0.38	0.050
Outer regional/remote						
<i>AMPCo FTE</i>	1.00	<.001	–	–	–	–
<i>AIHW FTE</i>	-0.34	0.113	-0.36	0.092	–	–
<i>PHIDU FWE</i>	0.43	0.040	0.45	0.030	-0.14	0.535

Note:

AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; FWE, full-time workload equivalent; r, Pearson's correlation coefficient; p, p-value.

These findings reflect the underlying limitations of each of the availability measures. In cities, it appears that there are areas where there are fewer doctors providing more services (such as outer metropolitan disadvantaged areas), and, on the other hand, areas with more doctors relative to the numbers of services provided (possibly inner city, advantaged areas). This can be seen in Figure 11, in the circled area which corresponds to the greater Sydney area (Sydney is the capital city of NSW). The dark blue indicates areas that have more GPs per capita and are advantaged (more often inner city areas). The pale yellow indicates areas with fewer GPs per capita and are disadvantaged (present in outer metropolitan areas).

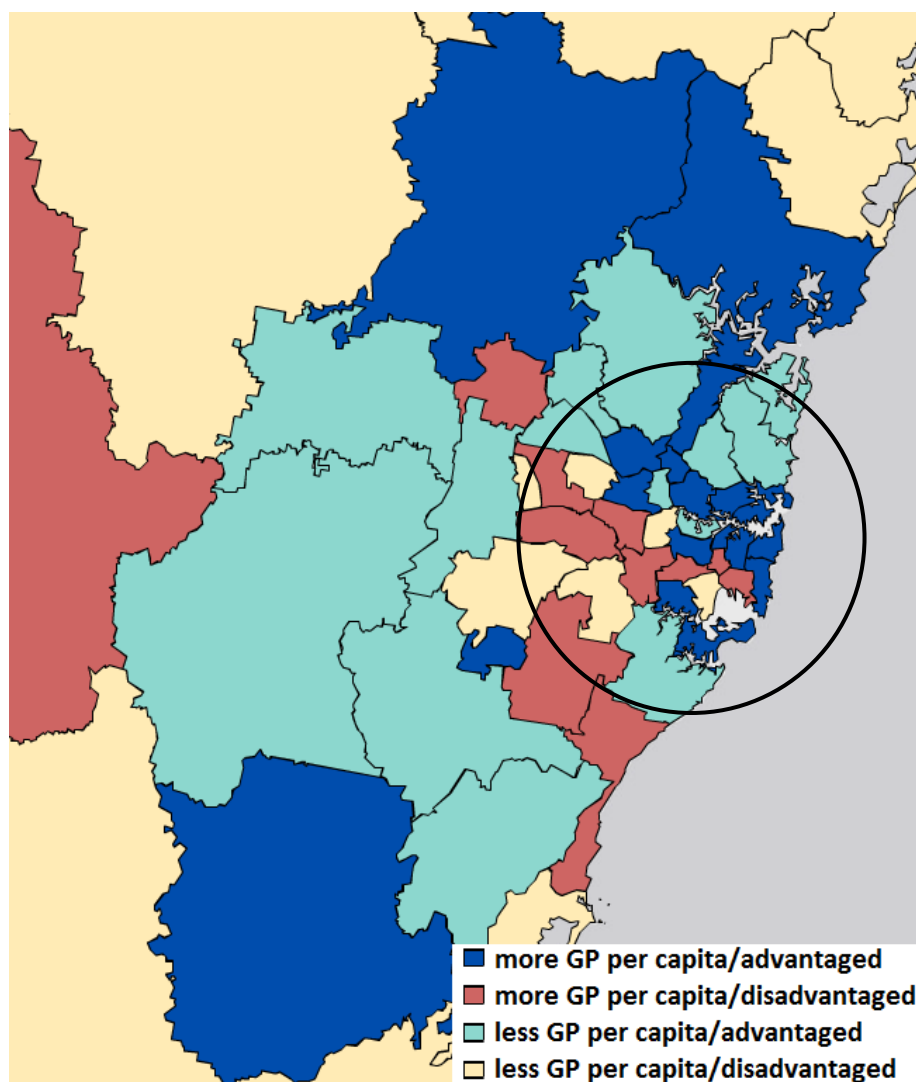


Figure 11. Geographic distribution of GPs per capita in relation to area disadvantage

Notes:

1. GP, general practitioner.
2. Circled area corresponds to greater Sydney area. The dark blue areas in the central part of this circle correspond to inner city areas, while the pale yellow and pink areas are western and outer metropolitan areas of Sydney.

With respect to outer regional/remote areas, it has previously been shown that the AMPCo data tend to overestimate the number of GPs relative to national estimates [120]. The PHIDU measure, while unable to capture work hours provided outside of private billing (for example, in public hospitals, common in outer regional and remote areas), also overestimate actual numbers of GPs if some GPs provide more than one FTE of work hours. It would appear that both the AMPCo and PHIDU measures may overestimate GP availability in more remote areas compared with the AIHW data. As workforce supply rather than services *per se* is of interest for this study, and the AIHW estimates are more consistent with the national estimates produced by DoHA (see Table 1 in Chapter 2; also see Appendix B for comparison with published national figures), *AIHW FTE* was the availability measure selected for further analysis in this study and Study 2.

The following variables were included for subsequent further analyses: *AIHW FTE*, *OOP expenses*, *bulk-billing*, *after-hours care*, *CD care*, *health assessments*, *cervical screening* and *CHC*. When stratified by region, patterns of association were generally similar to the overall pattern. In some instances, however, significance of trends varied according to region, and in a few cases the direction of association reversed. For the full results see Table B3 in Appendix B. Given a lack of power, findings for regional areas need to be interpreted with caution.

Specifically, the relationship of *AIHW FTE*, *OOP expenses* and *bulk-billing* with area disadvantage in major cities was as seen in the overall trend; that is, advantaged areas were less affordable and had more per capita GPs. Figure 12 demonstrates this pattern for *bulk-billing*. Generally, there was no clear or significant trend apparent for these characteristics in inner regional or outer regional/remote areas¹⁷. Given the fewer SA3s in some quintiles of disadvantage in inner regional and outer regional/remote areas, the lack of trends and significance of findings may reflect a lack of power to detect an effect.

¹⁷ *Bulk-billing* also demonstrated a positive association with area disadvantage as per the trend overall and in major cities. However, this was not statistically significant at the 0.05 level.

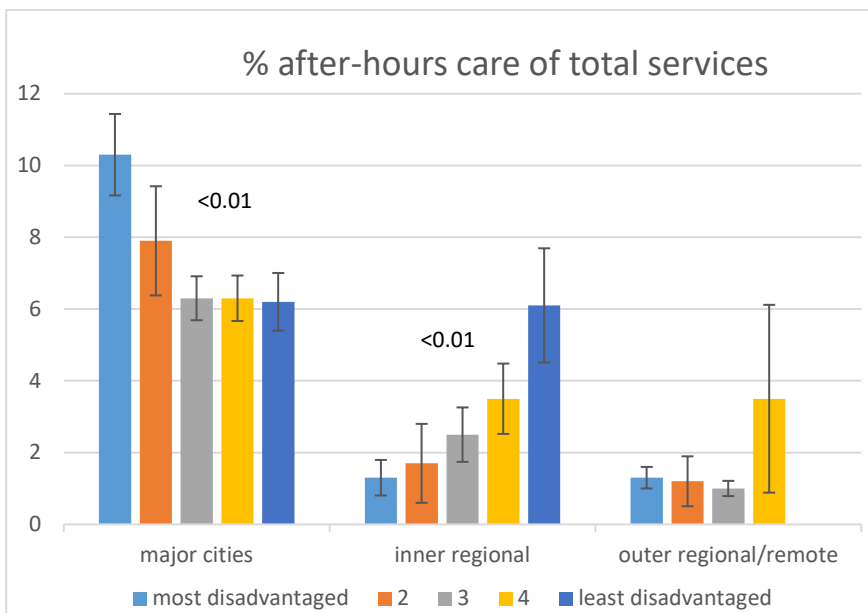
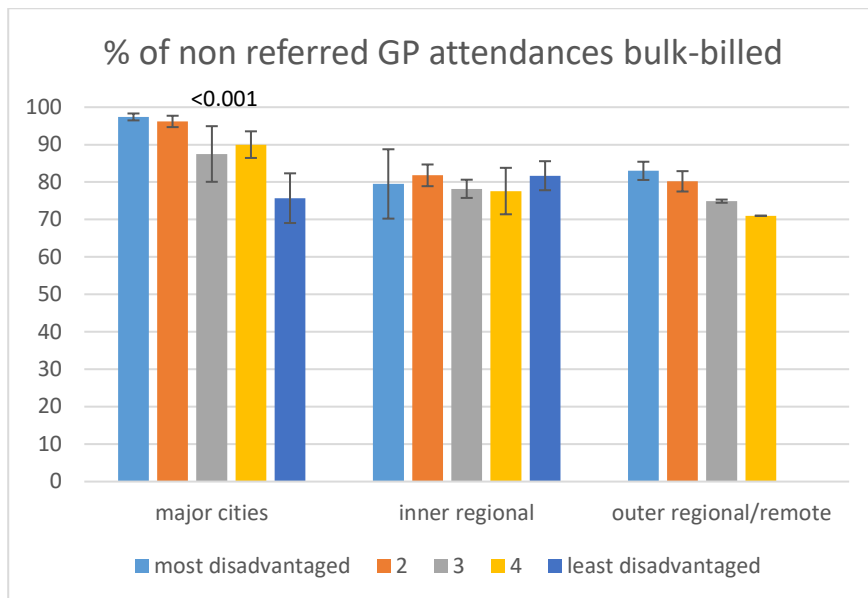


Figure 12. Bulk-billing and after-hours percentages of GP attendances for each quintile of disadvantage by region: Mean and standard error of the mean plotted

Notes:

1. GP, general practitioner; %, percent.
2. Test of trend by bivariate OLS regression for each region. Where significant p-value indicated on graph.

In addition, for *after-hours care*, in major cities more services were provided in socioeconomically disadvantaged areas compared with advantaged areas ($p < .01$), while the reverse was true in inner regional areas (see Figure 12). Across all regions the relationship for *CD care* and *cervical screening* was similar to the overall relationship (that is, disadvantaged areas associated with more *CD care* but less *cervical screening*)¹⁸, while the positive association

¹⁸ Trend for *CD care* and area disadvantage in outer regional/remote areas was not statistically significant to the 0.05 level.

between increasing area disadvantage and *health assessments* was significant only for inner regional areas.

3.3.5 Relationship between Measures from Domains and Subdomains of Strong PHC Systems

The final objective of this study was to examine the relationship between the constructed measures from the domains of access (with the subdomains of availability, affordability and accommodation), comprehensiveness and coordination, to see how these core components of PHC systems relate to each other at the area level in Australia. It was hypothesised that areas with one area PHC service characteristic were more likely to have PHC characteristics from other domains and sub-domains associated with strong PHC systems.

Within the domain of access, unexpectedly there was no correlation between the subdomain of availability and affordability (see Table 10), nor was a relationship evident between availability and accommodation. Affordability (both measures), however, was moderately positively correlated with accommodation, as can be seen in the scatterplot for *OOP expenses* in Figure 13a.

Table 10. Correlation between area PHC service characteristics measures from each domain and subdomain

Domain/ subdomain	PHC characteristic	Availability		Affordability				Accommodation	
		<i>AIHW FTE</i>		<i>OOP expenses</i>		<i>Bulk-billing</i>		<i>After-hours care</i>	
		r	p	r	p	r	p	r	p
Affordability	<i>OOP expenses</i>	0.13	0.206	–	–	–	–	–	–
	<i>Bulk-billing</i>	-0.03	0.789	–	–	–	–	–	–
Accommodation	<i>After-hours care</i>	0.19	0.08	-0.42	<.001	0.51	<.001	–	–
	<i>CD care</i>	0.12	0.274	-0.40	<.001	0.52	<.001	0.17	0.117
Comprehensive- ness/ coordination	<i>Health assessments</i>	-0.02	0.854	-0.05	0.641	0.09	0.425	-0.22	0.041
	<i>Cervical screening</i>	0.07	0.505	0.55	<.001	-0.64	<.001	-0.12	0.268
	<i>Community HC</i>	-0.20	0.039	0.04	0.717	-0.11	0.308	-0.20	0.003

Notes:

PHC, primary health care; AIHW, Australian Institute of Health and Welfare; FTE; full time equivalent; OOP, out-of-pocket; CD, chronic disease; HC, health centre; r, Pearson's correlation coefficients; p, p-value.

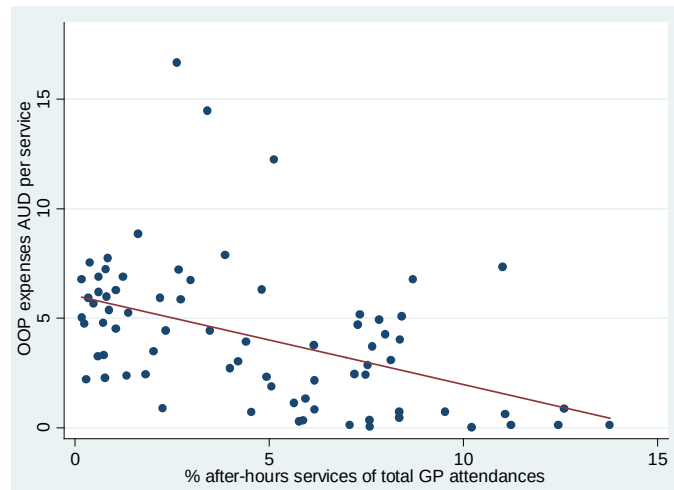


Figure 13(a). Relationship between domain and sub-domain area PHC service characteristics: scatterplot of *OOP expenses* and *after-hours care*

Notes:

1. PHC primary health care; GP, general practice; OOP, out-of-pocket; CD, chronic disease.
2. Eligible population for cervical screening is percentage of women aged 20–69 who have participated in cervical screening. Red line represents line of best fit

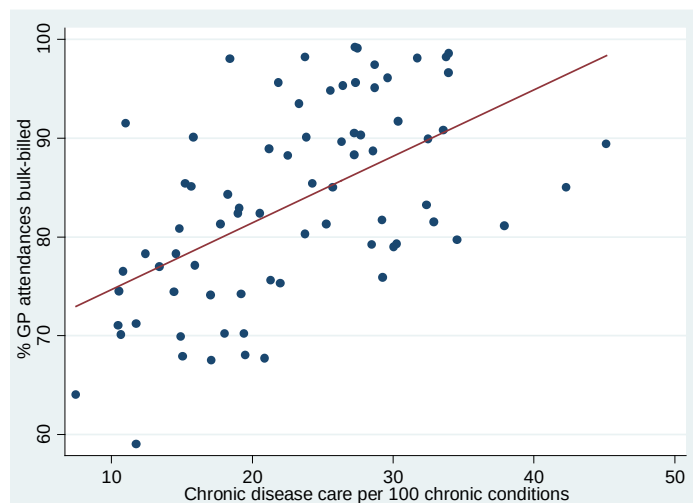


Figure 13(b). Relationship between domain and sub-domain area PHC service characteristics: scatterplot of *bulk-billing* and *CD care*

Notes:

1. PHC primary health care; GP, general practice; OOP, out-of-pocket; CD, chronic disease.
2. Eligible population for cervical screening is percentage of women aged 20–69 who have participated in cervical screening. Red line represents line of best fit

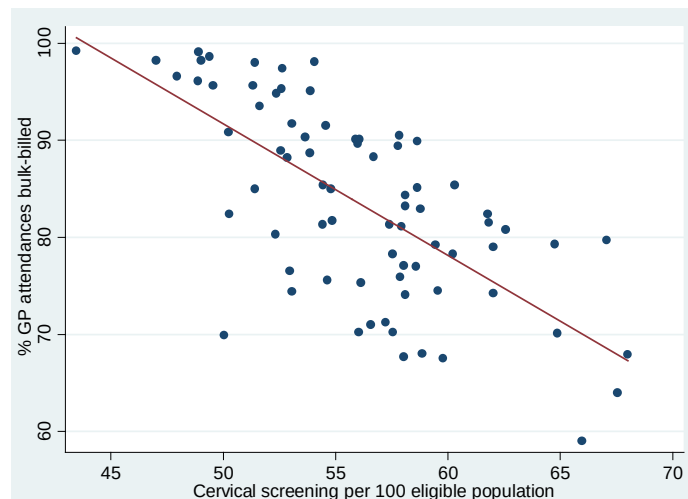


Figure 13(c). Relationship between domain and sub-domain area PHC service characteristics: scatterplot of *bulk-billing* and *cervical screening*

Notes:

1. PHC primary health care; GP, general practice; OOP, out-of-pocket; CD, chronic disease.
2. Eligible population for cervical screening is percentage of women aged 20–69 who have participated in cervical screening. Red line represents line of best fit

For relationships between domains, contrary to what was hypothesised, the subdomain of availability was weakly negatively correlated with comprehensiveness, as measured by *community HC* only. The subdomain of accommodation was also weakly negatively associated with comprehensiveness domain, as measured by *health assessments* and *community HC*. Affordability, on the other hand, had a moderate to strong correlation with the measures of comprehensiveness, *CD care* and *cervical screening*. However, as demonstrated in the scatterplots in Figure 13b and 13c, the direction of relationship was in the opposite direction for the two measures of comprehensiveness. That is, areas that were more affordable had more *CD care*, but less *cervical screening*. The patterns of association between affordability and these measures of comprehensiveness in part reflect the underlying relationship of each measure with area SE disadvantage (as seen in Figure 10). Tests for trends between domain and subdomain categorical variables generally confirmed these findings.

When stratified by region, different relationships were apparent (as shown in Table 11). Within the access domain, again contrary to what was hypothesised, there was a negative correlation between the sub-domain of availability and affordability (both measures) in major cities (shown in Figure 14a): that is, areas with more availability were less affordable. The moderate positive correlation between accommodation and affordability seen in the overall analysis was only significant in major cities.

Table 11. Correlation between area PHC service characteristic measures from each domain and subdomain by region

Major cities									
Domain/ subdomain	PHC characteristic	Availability		Affordability				Accommodation	
		<i>AIHW FTE</i>		<i>OOP expenses</i>		<i>Bulk-billing</i>		<i>After-hours care</i>	
		r	p	r	p	r	p	r	p
Affordability	<i>OOP expenses</i>	0.45	0.004	–	–	–	–	–	–
	<i>Bulk-billing</i>	-0.41	0.008	–	–	–	–	–	–
Accommodation	<i>After-hours care</i>	-0.28	0.085	-0.51	<.001	0.49	<.001	–	–
	<i>CD care</i>	0.01	0.963	-0.66	<.001	0.69	<.001	0.40	0.011
Comprehensive- ness/ coordination	<i>Health assessments</i>	0.07	0.658	-0.15	0.368	0.03	0.832	0.00	0.993
	<i>Cervical screening</i>	0.30	0.057	0.80	<.001	-0.90	<.001	-0.42	0.007
	<i>CHC</i>	-0.05	0.487	0.11	0.487	-0.13	0.42	-0.07	0.675
Inner regional									
Domain/ subdomain	PHC characteristic	Availability		Affordability				Accommodation	
		<i>AIHW FTE</i>		<i>OOP expenses</i>		<i>Bulk-billing</i>		<i>After-hours care</i>	
		r	p	r	p	r	p	r	p
Affordability	<i>OOP expenses</i>	-0.29	0.140	–	–	–	–	–	–
	<i>bulk-billing</i>	0.33	0.100	–	–	–	–	–	–
Accommodation	<i>After-hours care</i>	0.14	0.501	-0.31	0.115	0.34	0.089	–	–
	<i>CD care</i>	0.30	0.122	0.02	0.929	0.20	0.325	-0.22	0.267
Comprehensive- ness/ coordination	<i>Health assessments</i>	0.21	0.284	0.15	0.458	0.03	0.903	-0.20	0.310
	<i>Cervical screening</i>	0.17	0.378	0.11	0.601	-0.07	0.740	0.27	0.197
	<i>CHC</i>	-0.06	0.782	-0.25	0.236	0.26	0.211	0.06	0.793

Outer regional/ remote

Domain/ subdomain	PHC characteristic	Availability		Affordability				Accommodation	
		AIHW FTE		OOP expenses		Bulk-billing		After-hours care	
		r	p	r	p	r	p	r	p
Affordability	OOP expenses	0.34	0.109	–	–	–	–	–	–
	Bulk-billing	-0.28	0.203	–	–	–	–	–	–
Accommodation	After-hours care	-0.35	0.097	-0.20	0.350	0.38	0.082	–	–
	CD care	-0.08	0.734	-0.41	0.057	0.58	0.004	0.24	0.283
Comprehensive- ness/ coordination	Health assessments	0.05	0.818	-0.52	0.013	0.73	<.001	0.11	0.608
	Cervical screening	-0.25	0.252	0.15	0.500	-0.52	0.014	0.33	0.123
	CHC	-0.14	0.536	-0.06	0.515	-0.15	0.515	-0.39	0.077

Notes:

PHC, primary health care; SE, socioeconomic; OLS, ordinary least squares; IRSD, index of relative disadvantage; FTE, full-time equivalent; OOP, out-of-pocket expenses; CD, chronic disease; HA, health assessment; CHC, community health centre; r, Pearson's correlation coefficients; p, p-value.

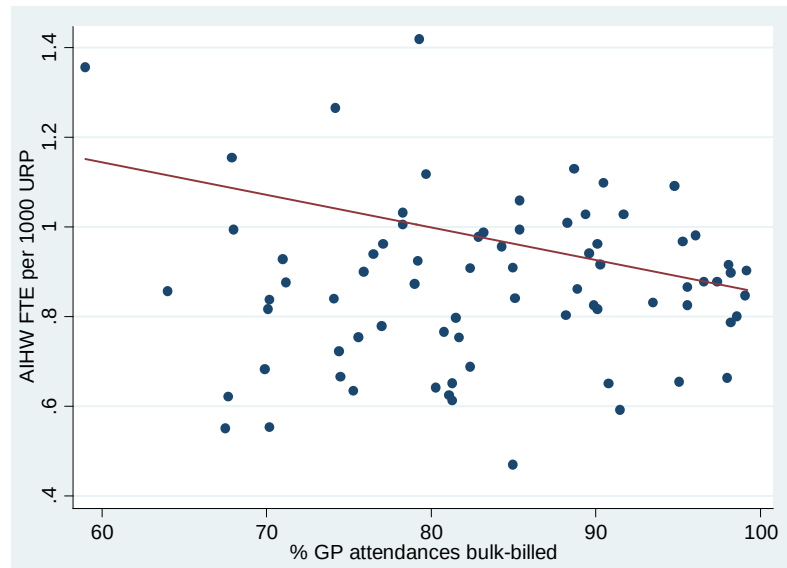


Figure 14(a). Relationship between area PHC service characteristic within major cities: availability and *bulk-billing*

Notes:

1. PHC, primary health care; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; URP, usual resident population; CD, chronic disease.
2. Red line represents line of best fit.

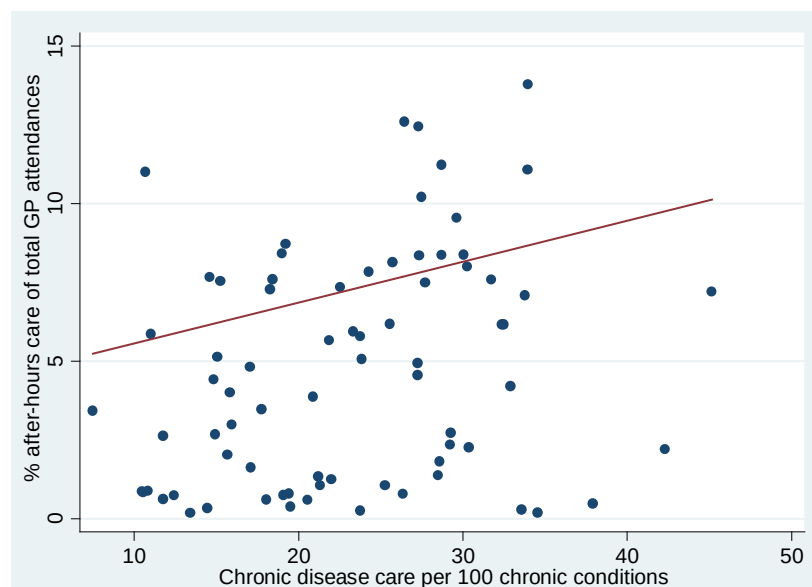


Figure 14(b). Relationship between area PHC service characteristic within major cities: accommodation and *CD care*

Notes:

1. PHC, primary health care; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; URP, usual resident population; CD, chronic disease.
2. Red line represents line of best fit.

With respect to the relationship between domains in stratified analyses (shown in Table 11), the strength and direction of correlation between affordability and comprehensiveness in major cities was similar to the overall pattern (positive association with *CD care*, negative association with *cervical screening*). The findings were similar for *bulk-billing* in outer regional/remote areas. Additionally, in outer regional/remote areas affordability was also positively associated with *health assessments*. Only in major cities was there a significant relationship between accommodation and comprehensiveness, and this differed from the overall association. In this case, accommodation was positively associated with comprehensiveness, as measured by *CD care* (see Figure 14b), but negatively associated with *cervical screening*. This also most likely reflects the underlying relationship of the measures with area SE disadvantage (see Table B3 in Appendix B). There was no correlation between availability and any measure of comprehensiveness across all regions—in particular the negative association with *community HC* did not persist. This suggests that the overall association most likely reflects the relationship each measure has with remoteness (that is, decreasing availability and increasing *community HC* with increasing remoteness).

3.4 Discussion

3.4.1 Summary of Findings

In this study, area-level measures were constructed from data sources, available in Australia, of modifiable organisation and delivery characteristics of PHC services that are representative of strong PHC systems. These measures covered the core domains of PHC systems at the process level, namely access (with the subdomains of availability, affordability and accommodation), comprehensiveness and coordination. A total of thirteen variables were constructed; four relating to availability, four relating to affordability, one relating to accommodation and four capturing comprehensiveness and coordination.

Addressing the first objective of the study, all measures were shown to vary across the study area of NSW, whether measured as continuous or categorical variables. The extent to which measures from within each subdomain or domain were capturing a similar underlying construct was somewhat supported by the weak to moderate correlations between each variable pair. The limited correlation between availability measures partly reflected the limitations of the underlying data used to construct these measures as well as the method of calculation, the consequence of which depends on region. For other relationships between variables within domains and subdomains, the weak correlations suggest that some measures are probably capturing a different underlying construct.

Extending from the first objective of the study, and addressing the third objective, all measures were found to vary according to remoteness and area SE disadvantage. Importantly for some

measures, the relationship with area SE disadvantage depended on region. While, generally, in major cities a similar pattern to un-stratified analyses was found (that is, fewer GPs per capita, more affordability, more *CD care/health assessments* but less *cervical screening* in disadvantaged areas), there were some instances of regional differences. For example, *after-hours care* in inner regional areas demonstrated a reverse relationship to that seen in major cities and overall (that is, increased *after-hours care* in advantaged areas). However, given the decreasing power in regional areas, these findings need to be interpreted with caution.

Finally, with respect to the last objective of the study, the findings suggested that areas with a greater presence of a PHC service characteristic from one domain of either access (or subdomains of access), comprehensiveness or coordination were more likely to have characteristics from other domains. Overall, the access subdomains of affordability and accommodation were moderately positively correlated. Affordability and variables from the comprehensiveness domain were also correlated, the direction of which depended on the comprehensiveness variable examined (discussed further in Section 3.4.4). Stratified analyses revealed additional and, in some cases, unexpected associations. For example, in major cities, increasing availability was associated with decreased affordability.

3.4.2 Strengths and Limitations

3.4.2.1 Data

An important strength of this study is that data were collated from a range of sources that represent those most suited for constructing measures of PHC service characteristics, and are available at a geographic scale relevant to the organisation and delivery of PHC in Australia. Further, this is the first study to collate data in order to construct measures relating to the process level of PHC systems that encompass all core domains at this level; that is, access (and subdomains), comprehensiveness and coordination. All numerator data are full census counts for each variable in each area, increasing the accuracy of representation of these characteristics. Further, denominator data for comprehensiveness and coordination takes into account the eligible population, rather than total population as seen with previously published figures. This provides a better estimate of services available relative to overall need in an area, thereby improving face validity and interpretation of finding when applying these variables in analyses.

However, there are several important data limitations that require consideration for measures of availability. The headcounts and FTE per capita constructed from AMPCo data are an approximation derived from a commercially-held list of doctors. As raised in Chapter 2, assignment to an area is based on address, an unknown quantity of which may be residential addresses as opposed to practice addresses. This may result in misclassification, as possibly suggested by the finding of a higher FTE in advantaged areas based on AMPCo data compared to the *AIHW FTE* measure. The current analysis raises concerns regarding comparability of

availability measures in rural and remote areas. The measures using AMPCo data and *PHIDU FWE* overestimate figures compared with the *AIHW FTE* in more remote areas. The *AIHW FTE* measure correlates well with the AMPCo measures in major cities and inner regional areas, and also corresponds better with nationally published estimates across all regions. However, there are potential inaccuracies in estimates due to data suppression prior to aggregation to the SA3 level. A total of 34 of 199 SLAs had counts suppressed due to confidentiality concerns. These were primarily outer regional, remote or very remote areas. Consequently, once aggregated, these will be an undercount.

The percentage of after-hours care items claimed is only an indicator of one aspect of accommodation, rather than a complete measure. As discussed in Chapter 2, data pertaining to appointment systems, walk-in facilities, telephone and email services are not routinely available. In particular, it would appear that this measure is most relevant to urban and inner regional areas, and may not be able to capture the scope of after-hours care provided in more rural areas (as discussed in Chapter 2).

The measures pertaining to comprehensiveness and coordination—*CD care*, *health assessments*, *cervical screening* and *community HC*—are approximations developed with the best available data at this geographical scale. Ideally, measures would reflect the extent to which most services in an area incorporate aspects of coordination (for example, team-based care, role substitution) and comprehensiveness (for example, specific programs for chronic diseases or maternal/child health, health promotion activities) rather than the output that such resources and activities enable (for example, claiming CD items). Currently such rich sources of data are unavailable. It is possible, with time and the requirements for reporting under the National Health Performance Framework [168]¹⁹, that organisations such as Primary Health Networks may make such data available at a useful geographical scale.

Denominator data for the *CD care* variable were limited, based on what were available at a suitable geographical scale. In the first instance, these estimates were modelled from a survey sample and are not census counts of all reported conditions by area. Further, rather than the number of persons with long-term conditions, only the total number of long term conditions by area was available. It is not possible to determine the extent of inaccuracy in these data, or the direction of this (that is, whether it results in under or over counts in a particular area) or pattern (for example, whether it varies by region).

¹⁹ This has recently been incorporated into the Australian Institute of Health and Welfare. All documents are available directly through their website at <http://www.aihw.gov.au/health-performance/performance-and-accountability-framework/>.

3.4.2.2 Study design

A strength of the study design is that it is the first to describe in detail the geographical variation in area PHC service characteristics across all domains, as well as examining in detail the relationships between variables within domains and between subdomain/domains. Further, this was undertaken at a geographical scale relevant to the organisation and delivery of PHC, and hence suitable for policy and practice intervention. However, there are design limitations of the study that warrant mention.

The size and construction of SA3s can be argued conceptually to represent a fair approximation of an area relevant to the organisation and delivery of PHC services. However, as outlined in Chapter 1, administrative areas such as statistical areas are not ‘fit-for-purpose’. That is, they are not specifically designed on the basis that service characteristics within an area are more alike than their neighbours. Overall, it is expected that this will result in decreased between-area variation and hence real and meaningful area-level relationships may not be detected [19, 60, 63, 65, 169, 170]. In this study, this is of particular concern for more remote parts of Australia, where SA3s are relatively large geographical areas with dispersed communities (see Figure 7, Chapter 1). The recently developed Primary Care Service Areas developed for Australia from utilisation behaviour may serve as more suitable PHC service markets for analysis [171]. Further exploration of differing geographical scales and geographical units of analyses was beyond the scope of the current study.

Area SE disadvantage, availability, *cervical screening* and *CD care* denominator data required aggregation with correspondence tables between the previous and current ABS standard geographies. Given that these do not correspond exactly, there may be measurement error when aggregating to the new geography²⁰. This could potentially result in misclassification (that is, the incorrect quartile may be assigned to that area), but this is likely to be small and will be non-differential and hence when applied for bivariate and multivariate analyses may bias estimates towards the null [65]. The main concern raised in Section 3.4.2.1, is the suppression of AIHW data for low count SLAs—which comprise predominantly outer regional and remote areas. As such, caution is required when interpreting relationships with this measure in more remote regions.

The findings from the current study also raise concerns as to how well the *community HC* variable is measuring the comprehensiveness and coordination of services within an area. The highest rates of *community HC* occurred in remote and disadvantaged areas, and this measure was poorly correlated with other measures within the comprehensiveness domain and negatively correlated

²⁰ This is more likely to be a concern for data aggregated from SLA to SA3 as the CCD/SA3 correspondence was for the most part one to one. See methods section in this chapter.

with availability. This suggests that *community HC* is more likely measuring availability of supporting or supplementary services.

3.4.3 Comparisons with Previous Studies

3.4.3.1 Relationship of PHC service characteristics with remoteness and area socioeconomic disadvantage

The finding that considerable geographic variation existed in area PHC characteristics, and that they varied according to remoteness and area socioeconomic disadvantage, was generally consistent with that found in the literature [120-122, 133, 134, 142, 143, 157, 158]. Specific relationships and discrepancies are discussed in this section.

The finding of fewer GPs per capita in more remote regions as well as more disadvantaged areas was consistent with previous studies [121, 122, 126, 132, 134], although more recently the relationship with remoteness has been shown to be in reverse [122]. In stratified analyses, the finding that in regional and remote areas, GPs per capita was not associated with area disadvantage was also consistent with findings in an earlier study [134]. Also in the earlier study, while there was no significant association between area SEP and GPs per capita in highly accessible areas (such as major cities), highly accessible advantaged areas had the highest rates of GPs per capita [134]. Overall, the findings from the current study confirm that major cities continue to have the most availability, and advantaged areas in major cities even more so.

OOP expenses and *bulk-billing* were associated with remoteness and area disadvantage, in that metropolitan and disadvantaged areas were the most affordable. This is consistent with the finding reported by the NHPA in 2011–2012, where the lowest rates of self-reported deferred care due to costs were in metropolitan disadvantaged areas [133]. The higher rates of deferred care due to costs in remote areas (that is, less affordable compared with other regions) reported by the NHPA was also consistent with the current findings, although their finding that that disadvantaged areas in this region had the highest rates was contrary to the pattern found in stratified analyses in this study. This difference could be due to the way affordability was measured (deferred care due to costs, which may include indirect costs such as loss-of-earnings, compared to bulk-billing) or study design (comparing ‘peer’ groups graphically, as opposed to formal statistical comparisons). Nevertheless, the current study supports previous evidence that disadvantaged metropolitan areas are also the most affordable in terms of care.

In this study, rates of *after-hours care* were highest in major cities. In stratified analyses, rates were highest in disadvantaged areas of major cities, but lowest in disadvantaged areas for inner regional areas. This was similar to previously reported rates of after-hours item claims, although the negative association with area SE disadvantage has not been specifically reported for inner

regional areas [142]²¹. However, the finding of lower rates of after-hours care in regional and remote areas, in the current study and as previously reported, contrasts with findings from a self-reported survey [143]. This survey found that GPs in regional areas (particularly outer regional) are more likely to participate in after-hours care (after taking into account a range of demographic, family, workplace, financial and earning characteristics). Much after-hours care in regional areas is provided within regional hospitals and, as discussed in Chapter 1, is funded by the States, rather than through the MBS. As such, a large proportion of the after-hours services provided in regional and remote areas will not be captured by the MBS data used in this study, which most likely accounts for difference in findings between the two studies.

The study found that the provision of chronic disease care relative to the number of chronic conditions (as a measure of relative need) within an area, whilst increasing with increasing area disadvantage, did not vary across regions. This was consistent with the recent report from the NHPA, which reported the highest rates of care planning in metropolitan disadvantaged areas [142]. The NHPA study, however, also reported that care planning varied between regions, although this was not formally tested, and rates were relative to the entire population and did not take into account the relative need within an area [142]. The finding that rates of *health assessments* increased with remoteness was consistent with age-adjusted findings in earlier studies in 1999–2000 [157]. Similarly, the positive association with increasing area SE disadvantage has been found in a previous study [158]. Overall, the current study confirms previous findings that disadvantaged areas also have more chronic disease care items and health assessments relative to the population in need of these, and confirms previous findings that regional and remote areas also have more health assessments.

There have been no studies examining the geographical variation of community health centres.

The limited variation in cervical screening participation across regions found in the current study was similar to previously reported national figures (57.9% in major cities, 56.7–54.2% for outer regional, remote and very remote areas) [172]. While it has been shown in individual-level studies that disadvantaged women have lower rates of cervical screening [172, 173], the current study is the first to demonstrate that disadvantaged areas also have lower rates of screening.

3.4.3.2 Relationship between measures from the domains and subdomains of strong PHC systems

This study found significant correlations between domains within the process level of PHC systems, as captured by the different measures of access (availability, affordability and accommodation) and comprehensiveness and coordination. This had not been previously

²¹ Previously published findings are from the NHPA reported in the preceding paragraph. As mentioned, there is no comparison group to the current study for inner regional areas.

examined across all domains in Australia. However, the findings in the current study were generally consistent with other work as documented in the review by Kringos and colleagues [17], and the extensive work of Starfield and colleagues [6-8], where a relationship between domains has been observed. In contrast to these previous studies and the current findings, a study from 2013 comparing PHC systems across European countries found no association between each domain (this is discussed in Chapter 2) [135]. A key difference was that the European study included a range of indicators from which a composite score was derived by principal components analyses, rather than the limited and specific measures examined in the current study. The specific associations between domains and subdomains in the context of previous research is considered briefly next.

With respect to the relationship between access subdomains, the negative association seen in this study between availability and affordability is in concordance with a previous Australian study that found that increasing gross price for services within an area was associated with more GPs per capita [127]. However, this contrasts with findings from international studies that have shown that increased availability was associated with reduced costs [6, 7]. An important difference in explaining these disparate findings is the context in which the current analyses have been undertaken and the actual measures used. Previous work was based on US studies or cross-country comparisons, in a context where the baseline level of PCPs was low relative to other medical professions. Further, the relationship with costs comprises overall costs of total health services, rather than affordability. It may be that, in Australia, with an effective gate-keeping mechanism and dominant GP workforce, supply and demand dynamics dictate costs. That is, while GP services generally cost less than specialist services, demand is such that GPs can still co-locate to areas where they can charge more (particularly in metropolitan areas; this notion is supported by the positive association of availability with advantaged areas).

Also with respect to the relationship between access subdomains, the finding that areas that were more affordable also had more after-hours care was consistent with previous findings in Australia that showed that GPs who bulk-bill are more likely to participate in after-hours care [143]. In support of the current findings, international studies have also shown that low or no co-payments (that is, more affordable services) were associated with improved access generally [7, 136].

When considering between-domain associations (that is, between access and comprehensiveness/coordination), the lack of a statistically significant relationship of availability with measures of comprehensiveness in the current study contrasts with the findings of international studies [6, 7]. These studies found that increased PCP supply was associated with improved comprehensive and preventative care. Possible reasons for this include differences in baseline characteristics of the different countries, differences in how preventative care and comprehensiveness was measured or differences in study design (multivariate compared with bivariate analyses, as in the current

study). The relationship between the availability and comprehensiveness/coordination has not previously been examined in Australia.

Further, with respect to relationships between domains, no previous studies in Australia have investigated the relationship between affordability and comprehensiveness, at either the individual or area level. In concordance with the seminal work by Starfield and colleagues [7], which found that low or no co-payment was associated with comprehensiveness and preventative care, the current study demonstrated that areas that were more affordable also had more chronic disease care (that is, comprehensive care). However, contrary to this earlier work, affordability in the current study was associated with less cervical screening (that is, preventative care). Again, this probably reflects the differing baseline characteristics and health systems of the comparison countries, particularly with respect to the underlying relationship of these measures with area disadvantage. No previous Australian studies have specifically examined the association of accommodation with comprehensiveness and coordination. The finding in the current study that that accommodation was associated with more chronic disease care is consistent with previous findings using QUALICOPC data, that showed that in practices where out-of-hours care was provided within primary care only, GPs had a broader service profile [144].

3.4.4 Meaning of Findings

The previous sections discussed the key findings, reviewed the main limitations of the study and considered how these findings compare with previous work. In this section, the main points of the preceding discussion are brought together in order to interpret the findings and consider their implications when applying the constructed measures to investigate variation in receipt of PHC, generally and with respect to equity. The specific measures selected for Study 2, which investigates whether area PHC service characteristics modify socioeconomic variation in receipt of care, are also outlined.

For ease of recollection, the thirteen variables constructed are listed here: for the domain of access, four measures of availability (*AMPCo count/FTE*, *AIHW FTE* and *PHIDU FWE*), four measures of affordability (*OOP expenses*, *bulk-billing*, *HCC* and *PC ownership*), one measure of accommodation (*after-hours care*) and four measures of comprehensiveness/coordination (*CD care*, *health assessments*, *cervical screening*, *CHC*).

With regard to availability, the negative correlation in major cities between *PHIDU FWE* and other estimates most likely reflects that GPs are generally located in areas that require fewer services and where they can probably charge more (for example, in advantaged areas where people are healthier and are able to pay more for care). This notion is supported by the finding that advantaged areas had the highest number of GPs per capita by *AMPCo* and *AIHW FTE*, but the lowest by *PHIDU FWE*, and that areas that had more availability were also less affordable.

As discussed in Section 3.4.2.1, despite potential under counts in more remote regions due to data suppression compared with the other measures, across all regions the *AIHW FTE* measure better captured workforce supply (rather than services provided). Given this and the fact that the *AIHW FTE* was more time concurrent with the study period, this measure was selected as the main availability measure for the second study undertaken for this thesis.

With regard to affordability, metropolitan disadvantaged areas and outer regional/remote areas were the most affordable (as measured by *OOP expenses* and *bulk-billing*), representing an important source of equity in the Australian PHC system. While *OOP expenses* influences affordability, it is not the same notion as affordability (that is, within a person's means to pay). This limitation needs to be taken into account when interpreting the findings using this variable. To that end, *bulk-billing* conceptually is more representative of affordability than *OOP expenses*. However, both these measures provide important information regarding affordability within areas and were retained for the second study.

With regard to accommodation, disadvantaged areas in major cities had more after-hours care (possibly due to a greater need for such services). This may, in part, reflect the presence of Medical Deputising Services in larger centres, where sufficient demand for after-hours care means that bulk-billing of such services can be viable financially [140]. The finding in the current study in major cities of a positive association between affordability and *after-hours care* supports this notion. By contrast, in inner regional areas there were higher rates of *after-hours care* in advantaged areas compared with disadvantaged areas, highlighting a potential source of inequity within the PHC system. A possible explanation for this is that after-hour services, unlike in major cities, are not as readily available and hence only those more inclined to seek care—due to greater health literacy or capacity to afford those services—are likely to access such services. However, the lack of association between measures of affordability and accommodation in inner regional areas suggests there may be an alternative explanation to this finding²². There are clearly limitations to the *after-hours care* measure for outer regional and remote areas. Given the much lower rates in outer regional/remote areas, which is contrary to empirical evidence based on a national health workforce survey [143], this measure does not appear to adequately capture after-hours care outside of MBS services. As such, inferences based on this measure for outer regional/remote areas are unlikely to be valid.

In all regions except outer regional and remote, disadvantaged areas had more comprehensive and coordinated care, suggesting another important source of equity in the PHC system. The positive association of comprehensiveness with affordability and accommodation (and the association of these measures with area SE disadvantage) suggest that these factors may partly explain the

²² In addition, neither *out-of-pocket expenses* nor *bulk-billing* demonstrated an area SEP gradient in inner regional areas.

relationship of comprehensiveness and area disadvantage. That is, areas which are disadvantaged and hence have a greater need for comprehensive services are also more affordable (in major cities at the very least). However, advantaged areas in all regions had higher rates of cervical screening, suggesting an aspect of the PHC system that is inequitable. Possibly, this measure better reflects health behaviour and consequent care received within that area, rather than the area PHC service characteristic *per se*. For example, health behaviours such as propensity to seek care related to health literacy [174, 175], affordability (supported by the positive association with area SEP) and capacity to overcome opportunity costs (such as taking time of work to attend to non-urgent preventative care needs).

Given the nature of the comprehensiveness and coordination measures (that is, services provided measured as a proxy for service organisation and delivery), examining the relationship of these measures with PHC outcomes, such as frequency of GP use, needs to be considered with caution. Indeed, the relationship of *cervical screening* participation and GP use and quality of care is uninterpretable. In addition, hypothesising the direction of association between *CD care* and use of GP services is ambiguous. Further, as discussed in Section 3.4.2, it appears that *community HC* is measuring supportive and supplementary services rather than comprehensiveness and coordination within areas more generally. Given these limitations, only *CD care* and *health assessments* were examined in subsequent analyses investigating PHC use and quality of care. Even so, findings with these measures need to be interpreted with these conceptual caveats in mind.

A final consideration for all associations found between measures from each domain and subdomain is that these may be explained by common factors relating to the population in these areas, such as age and sex.

In summary, while the measures constructed represented the best approximation at a meaningful geographical scale of the PHC system domains of access, comprehensiveness and coordination (given the available data), they all have caveats with respect to their use. Upon weighing up the conceptual considerations and data limitations, the following variables were selected for analyses in Study 2 of the thesis:

1. *AIHW FTE*, noting the potential for under-counting in outer regional/remote areas
2. *OOP expenses* and *bulk-billing*, noting that *OOP expenses* relates to costs rather than affordability *per se*
3. *After-hours care*, noting that this measure is not valid for outer regional/remote areas and should be interpreted with caution for inner regional areas

4. *CD care and health assessments*, noting that while these variables are intended to be a proxy for the extent of comprehensiveness and coordination of services within an area, they actually measure services delivered relative to the eligible population in that area

3.5 Conclusions

This study is the first to comprehensively examine a range of measures capturing modifiable service characteristics across the core domains of strong PHC systems at an area level in Australia. There is marked geographic variation in these measures, as demonstrated by both the range and visual representation.

There are important data availability limitations to be taken into account when considering these measures. Most have strong relationships with rurality and area disadvantage, prompting careful consideration when modelling relationships with PHC relevant outcomes such as GP use and quality of care. While this study has endeavoured to develop measures for the domain of comprehensiveness and coordination at the area level, the limitations conceptually of measures for this domain preclude the use of some of them, and require careful consideration for others when interpreting findings with outcomes relating to receipt of PHC. The measure for accommodation is unable to capture the scope of after-hours care for outer regional and remote areas, and may have some limitations with respect to inner regional areas. It does certainly appear to be most reflective of billing patterns in urban areas. This would suggest that analyses considering this measure should be restricted to urban and possibly inner regional areas only.

The remaining chapters of this thesis seek to apply these measures in order to investigate how area PHC service characteristics modify the relationship between SEP and receipt of PHC. The outcomes of Study 2 may reveal potential avenues for policy and service delivery change that may help to reduce inequalities in health service use, and contribute to health equity.

Chapter 4

Individual- and Area-level Variation in Primary Health Care in Australia: Review of the Literature on Socioeconomic and Geographic Inequalities

Chapter 2 reviewed in detail the literature relevant to organisational and delivery characteristics of PHC services within areas that are modifiable and considered to be indicative of ‘strong’ PHC systems. Chapter 3 developed measures of these from available data for NSW and then described the geographical variation of the constructed measures. The second study, which is presented in Chapters 4–7, applies these measures to determine whether these service characteristics modify the relationship between individual SEP and receipt of PHC services. In doing so, this may reveal opportunities for policy and practice to reduce unwarranted socioeconomic variation in receipt of care, and contribute to health equity. To provide a context for this second study, this chapter provides a review of the evidence to date regarding individual-level socioeconomic variation and area-level variation in receipt of PHC, and the relationship of organisational and delivery service characteristics of areas to equity in receipt of PHC. To assist in interpreting this literature, the chapter begins with an overview of methodological approaches for investigating socioeconomic and area-level variation in health service use. Having identified the gaps in knowledge from the literature review, the chapter concludes with the main research question, aims and hypotheses for the study.

4.1 Methodological Approaches for Investigating Socioeconomic and Geographic Variation in Health Service Use

As mentioned in Chapter 1, there are a number of frequently used methods, informed by social epidemiology and health services theory, for investigating individual socioeconomic variation in health service use and area effects thereon. The three main approaches—individual and ecological studies, studies using multilevel modelling and studies using spatial methods alone or in combination with multilevel modelling—are reviewed briefly here in relation to health service use, with a focus on Australian studies. Relevant international studies are considered where Australian studies are limited.

A large body of work internationally and within Australia is based on individual-level studies [94–96, 155, 176–185], with assignment of area-level characteristics to the individual (community type, or remoteness and area disadvantage, for the most part) [95, 176, 177, 179–183]. Ecological studies in Australia have examined health service outcomes such as use of GP services [127, 133, 134, 142, 186], quality of GP services [157, 158, 187], and ACSC hospitalisations [164, 188, 189]

at a range of different geographical scales, including SLA [127, 134, 186] and, more recently, SA3s [133, 142], local government areas [164], post codes [187] and health administration units such as Divisions of General Practice [157], Medicare Locals [133, 142] and primary care partnership areas in Victoria [188, 189]. While these studies provide important information about relationships at either the individual *or* area level, they are unable to quantify variation in outcomes occurring at each level or the strength of relationships between explanatory variables and outcomes while accounting for within- and between-area variation.

As discussed in Chapter 1, multiple nested levels of contextual influences (such as individuals living in areas with varying services, within states with varying health policies) can shape the distribution of health determinants and health outcomes [1, 20, 60]. Multilevel modelling allows partitioning of variation of outcome data at different levels such that, for example, area and individual effects can be examined independently [60, 190, 191]. Recently, this has been applied increasingly in Australia, predominantly for investigating hospital care [68, 69, 71]. International studies have applied these analytical techniques to study use of GP services [192], quality of GP care as measured by continuity [193], use of specialist services [70, 194, 195] and ACSC hospitalisations [67]. Not only are these studies able to quantify strength of associations at each level, having accounted for within-level clustering, they also allow estimation of how much of the variation in outcomes occurs at each level of interest [60, 63, 66]. Another approach to understanding complex relationships between individual characteristics, area-level features and outcomes is the use of cross-level interaction terms in multilevel models, to account for effect modification of a higher level exposure on the relationship between an exposure and outcome at the lower levels [65, 191]. This is central to what this thesis intends to explore; that is, the modifying effect that PHC service characteristics within the area in which a person resides, has on the relationship between their SEP and the care they receive.

Multilevel models investigate whether belonging to a group (such as an area) affects an outcome, and provide estimates of average relationships at each level [73]. These techniques do not, however, address whether spatial relationships across areas matter for a particular outcome [21, 73]. Studies using spatial analyses and Geographic Information Systems have been applied to better understand spatial relationships in health service use in Australia [109, 123, 171, 196] and internationally [78, 79, 82, 86, 197]. Much of this work has examined spatial accessibility; that is, the availability of providers within a specified area as determined by straight lines, road network or gravity models [79, 82, 109, 123, 196, 198, 199]. Other studies have used travel and usage patterns of patients to develop service catchments areas as more appropriate units of analysis for PHC [67, 85, 171, 192, 200]. Finally, geographically weighted regression has been used to examine relationships between area-level determinants and health service use, such as area-level poverty and physician supply with ACSC hospitalisations [85] or health status, distance, and car ownership with perceived access to GP services [78]. These techniques allow

correction for spatial autocorrelation and adjacency, as well as identifying locations spatially that demonstrate stronger relationships compared with other locations (spatial non-stationarity) [78, 86].

There is emerging work internationally that combines multilevel analyses with spatial techniques to investigate determinants of health [87, 201] and health service use [70], not only in terms of nested hierarchies of contextual influences but also in terms of how relationships vary spatially (or demonstrate a spatially organised pattern). This work has found that the strength of relationships can vary according to spatial location [87], and that strength of associations between area-level variables and outcomes may be stronger when measured over continuous space [70], or when taking into account the proximity of areas with similar characteristics [201]. Further, residual spatial autocorrelation has been shown to remain with multilevel models, which is reduced through measuring area-level variables over continuous space and the application of spatial models, suggesting that this better accounts for spatial variation in outcomes [70]. Finally, multilevel models have also been shown to overestimate significance, compared with combined multilevel and spatial models [70].

4.2 Use of PHC Services and Supporting Secondary Specialist Services

Having provided an overview of methodological approaches in the literature, the chapter now provides a summary of the evidence to date regarding individual-level socioeconomic variation in receipt of PHC, area-level variation in receipt of care, and the relationship of organisational and delivery service characteristics of areas to equitable receipt of care. Specifically, literature relating to the measures of health service use examined in the second study is reviewed. These include four measures relating to receipt of PHC—frequency of use of GP services and three measures of quality of GP care: length of consultation, continuity of care and receipt of care-planning MBS items. These quality of care measures are viewed to be particularly relevant to the service needs of those who are socially disadvantaged with complex care needs [1, 202-204]. Also of relevance is access to essential out-of-hospital supporting secondary care (that is, ambulatory specialist services). Thus, the literature pertaining to use of ambulatory specialist services is also reviewed, with a focus on individual-level socioeconomic variation and area-level variation in specialist use.

4.2.1 Use of GP Services

Use of services, also referred to as realised access, [74, 99] refers to the frequency or volume of services an individual receives. For the purposes of this discussion, a normative judgement stands that increased use is a ‘good thing’, as this represents access to needed services to prevent illness and maintain well-being. The annual rates of per capita number of GP consultations in Australia was estimated to be 5.2, slightly increased from 4.5 at the beginning of the study period (2006)

[48]²³. This is at the upper end of estimates of published international figures for other OECD countries—3.0 in Switzerland (2004) [192], 6.0 in the UK (2009) [205] and 3.7 in New Zealand (2001)[206]. Per capita rates of consultations with any doctor in 2009 was 6.5, which is equivalent to the OECD average [207].

4.2.1.1 Individual socioeconomic variation in use of GP services

In Australia, individual level studies have found that for a given level of need, self-reported use of GP services is either equitable or persons of low SEP used more services compared with their high-SEP counterparts; that is, GP use was pro-low SEP [94, 96]. However, a study using National Health Survey data at the individual level modelled expected use (where it was assumed that, in major cities, demand for services was fully met) and found that those living in disadvantaged communities were underutilising relative to their needs [208].

Most Australian studies investigating socioeconomic variation in GP use have used an ecological study design. Early ecological studies reported that disadvantaged areas (SLAs) had greater per capita use of GP services as measured by Medicare claims, whether age and sex standardised (based on 1996–1997 data) [134, 186] or need-adjusted (2001) [208]. In all of these studies, however, when remote areas were examined separately, a pro-high SEP gradient in per capita use of GP services was apparent. A recent national report on per capita use by Medicare Local suggested that variation in use was not related to area SEP (2009–2011 data) [133, 142]. However, this was based on graphical representation and not formally tested by statistical analysis.

International studies have also found that, irrespective of the measure of SEP at the individual or area level, need-adjusted use of primary health care services is either equitable or pro-low SEP, based on either self-reported use or claims-based data [136, 176-178, 180, 192]. The one exception is in Canada, which found a pro-high education relationship with frequent use of primary care, although when income was the SEP measure the direction of relationship was as seen in other studies [177].

There have been no studies, in Australia or internationally, examining whether individual-level socioeconomic variation in use of GP services is still evident after accounting for variation in use of services according to where a person resides (that is, having accounted for between-area variation).

4.2.1.2 Area-level variation in use of GP services

A national study in Australia using data from 2009–2011 demonstrated marked geographic variation in per capita rates of GP attendances, with a threefold variation across Medicare Locals

²³ Denominator data estimated resident population for financial years is based on ABS catalogue 3101.0 Australian Demographic statistics, table 51 to table 59, released June each year.

[133]. There are no other studies in Australia that have explicitly investigated between-area variation in use. A Swiss study found that nearly 40% of variation of per capita PCP use was at the service area level compared to at the community level, but this study did not specifically quantify variation at the area versus individual level [192].

That area-level variation in use of GP services in Australia is related to remoteness is well documented [133, 134, 186, 208]. A disproportionate number of rural areas, with poorer average health, have lower than average attendance rates, while a large number of metropolitan areas, with better average health, have higher rates [133]. The inverse relationship between area SEP and use in more remote areas, described in Section 4.2.1.1 reflects a more general pattern in Australia of decreasing use with increasing remoteness; this is more evident in disadvantaged areas compared with advantaged areas. While remoteness is not the focus of this project, in Australia this is a significant determinant of health service use and clearly shapes the relationship between SEP (at the area level at least) and use of GP services. As such, this must be taken into consideration when attempting to understand area-level determinants of use of GP services.

4.2.1.3 Relationship between PHC service characteristics and use of GP services

There are no studies explicitly examining the relationship of area-level PHC service characteristics with individual GP use. There are, however, a number of studies (individual and ecological) that provide some insight into the relationship between PHC service characteristics and use of GP services, and how these characteristics may modify socioeconomic variation in use. These are briefly reviewed here.

A study using data from 1996–1997 investigating determinants of GP use at the area level found that across SLAs, increased GP supply was associated with increased per capita GP use; this was even more so in rural areas [134]. A later econometric study with simultaneous demand and supply equations (analysed by SLA), also found that supply increased demand (per capita GP use), but was limited in the context of near vertical supply curves [127]; that is, the point where demand is nearly fully met, so additional supply has little effect on demand. Both of these studies were ecological. It is unknown whether supply has a differential effect on use according to individual or area SEP. International studies have demonstrated a positive association between supply of PCP/GPs and use of services [86, 192].

There is limited evidence in Australia examining affordability and use directly. Increasing age-standardised use (at the area level) does appear to be associated with increased percentage of services bulk-billed within an area [133]. People in Australia do defer care due to costs, affecting those with below average incomes (individual-level study) [136] or in rural disadvantaged communities (ecological study)[133] to a greater extent. Individual-level studies show that, while private health insurance has been shown to be associated with increased use of allied health

services (for those with chronic disease) [209] and contributes to pro-high SEP inequalities in use of allied health and dental services [94, 96], this does not appear to be the case for GP services [96]. Individual-level studies also show that being a holder of a health care card favours a pro-low SEP use of GP services [94, 96]. In summary, the evidence suggests that increased affordability (at both individual and area level) is associated with increased use of GP services, and that this effect varies according to SEP. This has not, however, been tested in a multilevel analytical framework.

There is one previous study specifically examining the relationship of comprehensiveness of services with use of GP services [155]. This study demonstrated that, for individuals who had received extended primary care (EPC) services in that year, the regularity of their use of services, but not the frequency, was increased (having adjusted for age, year, sex and hospitalisation for a chronic disease in the previous year). This could be interpreted as improved care in association with receiving EPC items, in that care is planned and structured (thus resulting in regular visits), as opposed to frequent reactive care. No studies in Australia have specifically examined the effect of comprehensiveness and coordination on socioeconomic variation of GP use.

In summary, there is evidence that, in general, individual need-adjusted use of GP services is at least equitable, if not pro-low SEP. Whether this relationship remains after between-area variation is taken into account is unknown. While use varies between areas, particularly with stark differences between metropolitan and regional areas, whether this remains after accounting for the characteristics of people living in those areas is unknown. There is some evidence that area PHC service characteristics of availability, affordability and comprehensiveness are associated with use and may have a differential effect depending on a person's SEP or area disadvantage. Examining the relationship of these area characteristics with individual use, having accounted for between-area variation, and whether these characteristics modify the relationship between individual SEP and use, has not been specifically investigated.

4.2.2 Length of Consultation

Longer consultations have been shown to be associated with lower prescribing rates, more health promotion, more psychosocial problems identified, more long term problems being dealt with and higher levels of patient enablement and satisfaction [181, 210, 211]. These studies did not, however, account for doctor characteristics, so it is unknown whether these findings simply reflect attributes of the doctor or their care processes. A study investigating the effect of increasing appointment booking times on consultation care processes found that this had a modest effect on increasing the length of consultation and health promotion offered, but no effect on prescription rates, referrals or investigations [212]. The authors suggested that, rather than the length of consultation of itself resulting in better quality of care, it is a marker of provider attributes associated with better quality of care. Based on this, it is reasonable to infer that if a person

receives care from a doctor who, on average, tends to provide longer consultations, they are more likely to have a consultation that includes important aspects considered indicative of good quality of care. In particular, longer consultations are associated with care processes considered specifically important for vulnerable and disadvantaged groups with complex care needs. Rates of long and prolonged consultations in 2002 in Australia were estimated to be 11.7% and 1.1% of all consultations, with average consultations times of 26.1 minutes and 44.6 minutes, respectively [213]. More recent figures have not been published.

4.2.2.1 Individual-level socioeconomic variation in length of consultation

At the individual level, higher SEP has been shown to be associated with longer consultation times [181]. The rate of long and prolonged consultations, and the proportion of total consultations that are long or prolonged, have been reported to be significantly higher for people living in advantaged postcodes, compared with those living in disadvantaged postcodes (0.5 versus 0.72, 7.7% versus 16.87%, respectively) [187]. No studies have examined the relationship between individual SEP and length of consultation after accounting for between-area variation.

4.2.2.2 Area-level variation in length of consultation

There have been no recent studies in Australia describing or quantifying geographic variation in long consultations, nor whether long consultations vary according to remoteness. At the individual level, rural location of GP practice was associated with increased length of consultation, having adjusted for a range of individual and GP characteristics [181].

4.2.2.3 Relationship between PHC service characteristics and length of consultation

No Australian studies have examined the relationship of PHC service characteristics with length of consultation. There is one Australian study that found that individuals who held a concession card (which influences affordability) were more likely to have a longer consultation [181]. However, as discussed in Chapter 3, rates of concession cards, at the area level at least, probably reflect SEP rather than affordability *per se*. Hence the relationship between the affordability of services within an area and length of consultation an individual receives remains unknown.

The main knowledge gaps of relevance to this thesis with respect to length of consultation are:

1. The extent of between-area variation in length of consultation
2. The relationship of availability, affordability, accommodation and comprehensiveness with length of consultation and
3. How these area PHC service characteristics modify the relationship between individual SEP and length of consultation

4.2.3 Continuity of Care

Continuity of care is considered to be a critical component of good primary health care, and essential in achieving quality of care and contributing to improved health outcomes [7, 101, 102, 163]. Continuity of care has been defined variously as relational continuity, management continuity and informational continuity [163, 193]. Informational continuity refers to the use of information to ensure current care is appropriate for each individual (for example, medical record keeping). Management continuity, of particular relevance when more than one provider is involved in care, refers to a consistent and coherent approach to management of a health condition for that individual (for example, shared care plans) [163]. Relational continuity can be seen as consisting of two domains, one describing the length of affiliation with a single provider (longitudinal continuity), the other referring to the quality of the provider–patient relationship (interpersonal continuity) viewed as a consequence of longitudinal continuity²⁴ [193, 214]. The review in this section focuses on relational continuity where care is provided by a regular provider over an extended period of time, as this was the outcome of interest in the second study. This construct was chosen rather than informational or management continuity as it reflects care received by a person, rather than process characteristics of services required to facilitate continuity of care.

Continuity of care has been shown to be associated with improved patient satisfaction, increased compliance, reduced hospitalisations and emergency department visits and improved receipt of preventative services [7, 118, 119, 182, 215, 216]. Given that those who are socially disadvantaged tend to have more complex health and social needs [204], continuity of care is particularly important [217] for these populations. Estimates in Australia suggest that 60–80% of patients attend a single provider or practice, or have a doctor or GP who they regularly see (depending on the specific question asked) [218], although these studies have not considered relationship duration. The most recent estimates, from 2008, found that 57% of patients reported that they always go to the same GP, and an additional 32% usually go to the same GP [182].

4.2.3.1 Individual-level socioeconomic variation in continuity of care

In general, in Australia and other countries with similar universal health care and gate-keeping mechanisms, lower SEP has been shown to be associated with increased continuity of care, as measured by self-reported experiences of continuity of care. An Australian survey in 2008 found that individuals with low income had increased self-reported continuity of care irrespective of other characteristics, including demographics, self-reported health or satisfaction with their GP [182]. A similar finding has been documented in New Zealand [183]. Neither study allowed for

²⁴ Some authors also refer to this as ‘patient affiliation’ (that is, the extent to which a patient affiliates with a single provider) compared with continuity of care, which refers to how well the provider knows the patient and the reliability of accessing the provider from the patient’s perspective see McRae, I., et al. (2011). “Patient affiliation with GPs in Australia—who is and who is not and does it matter?” *Health Policy* **103**(1): 16-23.

between-area variation. However, a recent (2013) Canadian multilevel study examining practice, provider and patient characteristics associated with self-reported continuity of care (patients nested in practices) [193], also found that, having accounted for between-practice variation, low education was associated with increased continuity of care.

4.2.3.2 Area-level variation in continuity of care

Australian studies examining area-level variation in continuity of care are limited to those primarily examining regional differences—people living in major cities are more likely to be affiliated with a single GP, with those living in inner regional areas least likely to be affiliated [182]. A multilevel study (patients nested within GPs within practices) in the UK found that 6.3% of variation in continuity of care is at the practice level [219]. The Canadian multilevel study referred to above also found that rural location of the practice was associated with less self-reported continuity of care [193]²⁵.

4.2.3.3 Relationship between PHC service characteristics and continuity of care

The relationship of continuity of care with area PHC service characteristics in Australia has not been examined. In Canada at the practice level, and of specific relevance to the area indicators investigated in Study 2, patients from practices with more family physicians and after-hours arrangements that included being open on weekend and being on call less than 24hrs per week were less likely to report continuity of care, having accounted for individual characteristics [193]. In the UK, at the practice level increasing practice size (that is, the number of patients in the practice) was associated with reduced continuity of care (seeing their usual doctor at that visit) [219]. Data from QUALICOPC have shown that in countries where GPs had broader service profiles, patients perceived better continuity of care [116]. No studies have examined the influence of area PHC service characteristic on socioeconomic variation in continuity of care.

In summary, studies found those persons of lower SEP were more likely to have continuity of care (having accounted for between-practice variation and adjusted for individual need), while living in regional areas in Australia was associated with reduced continuity of care. International studies identified that some practice-level service characteristics were associated with continuity of care. There have been no studies in Australia examining socioeconomic variation in continuity of care accounting for between-area variation, the relationship of area PHC service characteristics with continuity of care, or the modifying effect these may have on the relationship between individual SEP and continuity of care.

²⁵ The proportion of variation in continuity of care at the practice level was not reported in the Canadian multilevel study.

4.2.4 Chronic Disease and Complex Care Planning

Type of care appropriate to need is also an essential component of quality of care. This includes chronic disease management, preventative care and health promotion, as well as management of acute care needs. The implicit assumption is that good chronic disease care will minimise deterioration in current levels of health [7, 97], and that preventative care will prevent the occurrence of new illness, thereby maintaining well-being [5, 7, 97]. As discussed in Chapter 2, in Australia there are specific MBS items for services relating to chronic disease and complex care planning (forthwith referred to as ‘care planning’)²⁶. These were introduced with the goal of improving the health and quality of life of older Australians, people with chronic disease and those with multidisciplinary care needs [157, 159]. They include items for chronic disease management plans (GPMPs), team care arrangements (TCAs; for multidisciplinary care coordination), cycles of care for diabetes and asthma and health assessments (acute, chronic disease, preventative care and health promotion)–Table 12 in Chapter 5 lists specific item numbers. Given the often complex care needs of those who are vulnerable and socially disadvantaged, the provision of this type of care is particularly pertinent to preventing illness and maintaining health in this group. There has been extensive examination of receipt of chronic disease management items in Australia [95, 155-158, 184, 220]. In 2006, estimates found that these services comprised 3.6% of all GP services in over 65 year olds [156], with 19.6% of those over 65 having received a chronic disease care item in that year [155]. In 2009, approximately 22 GPMPs and 17 TCAs per GP were prepared [220].

4.2.4.1 Individual-level socioeconomic variation in care planning

Higher rates of claims for care planning items have been observed for individuals of lower SEP as measured by income and education [184], with expenditure on GPMPs and TCAs being larger in low income groups (that is, pro-poor, as measured at the individual level by need-adjusted concentration indices: see Appendix A for details on calculation of concentration indices) [95]. Earlier ecological studies also reported higher or similar uptake of care planning in the most disadvantaged areas compared with advantaged areas, reflecting increased provision by GPs living in these areas (that is, there was a higher rate of health assessments and care plans per GP in the disadvantaged quartile) [158]. No studies in Australia have examined need-adjusted use of care planning according to individual SEP while accounting for between-area variation.

4.2.4.2 Area-level variation in care planning

As shown in Chapter 2, there is marked geographic variation in care planning across small areas in Australia [142]. One study, using data from 2008, found no difference in uptake of GPMPs and TCAs between people living cities and regional/remote areas in need-adjusted multivariate

²⁶ This was initially introduced by the Federal Government under the Extended Primary Health Care (EPC) program, the name of which was later changed to the Chronic Disease Management program.

analyses [95]. However, this study did not allow for area-level variation. A study in 1999, shortly after the introduction of the chronic disease and complex care items, also found similar rates of care plans and health assessments per GP between urban and rural areas (having adjusted for age and full-time equivalency of GPs), although crude rates were highest in the most remote areas [157]²⁷.

4.2.4.3 Relationship between PHC service characteristics and care planning

There have been no studies in Australia specifically examining area organisation and delivery of PHC services and the way this relates to chronic disease and complex care planning. Interview studies with stakeholders and key informants in Australia suggest that good practice organisation is necessary for provision of good chronic disease care, which may be reflected by claiming care planning items [221]. However, there are no empirical data on this.

In summary, there is evidence in Australia of individual socioeconomic and area-level variation in receipt of care planning MBS items. No studies taking into account between-area variation have examined this. The relationship between area PHC service characteristics and care planning is unknown. Nor is it known whether these service characteristic modify the relationship between SEP and chronic disease and complex care planning.

4.2.5 Specialist Use

Services provided by specialist doctors have a key role in supporting the PHC system for conditions that are uncommon or complex enough that the primary care provider would not be expected to have sufficient experience or expertise in managing them [7]. Starfield defines this supportive role as consultative, short term in nature and primarily for the purposes of helping primary care physicians with their diagnostic or therapeutic dilemmas [103]. It is this supportive role specifically provided in the ambulatory care setting (that is, out-of-hospital) that is of additional interest in this thesis. Such a role can occur through informal consultation (for example, telephone or corridor advice from a specialist), short-term referral to specialist doctors, or, less frequently in Australia, regular visits by specialists to PHC facilities. While evidence from the US highlights the associated harm and costs of inappropriate use of specialists, particularly for self-referrals [7], lack of appropriate access for uncommon or very complex conditions also has significant potential for poorer outcomes. In Australia, all ambulatory specialist visits must be initiated by referral from a GP. In the Australian Health Experience Survey in 2013, 22–42% of participants reported seeing a specialist in the preceding 12 months [133].

²⁷ This study used the rural, rural and metropolitan classification of Australia (RRMA)—a commonly used classification prior to 2000. This comprised seven categories: capital, other metro, large rural, small rural, other rural remote central and other remote/offshore.

4.2.5.1 Individual socioeconomic variation in specialist use

Pro-high SEP need-adjusted use of specialists has been documented in Australia from the 1990s [91] through to a more recent study in 2004 [96]. This has been observed whether the outcome measure is self-reported use [94, 96] or expenditure (estimated from self-reported use for GP and specialists combined) [91]; SEP is measured by income [91, 94, 96], occupation, education or the socioeconomic status of the area of residence [96]; or specialist use is adjusted for need, as measured by either self-assessed health status, number of chronic conditions [94, 96], symptoms [96] or deterioration in the last month [94]. The pro-high SEP (income and education) bias in use of specialists is consistent with what has been documented internationally, irrespective of the strength of the local primary health care system [136, 177, 195]. There are no studies in Australia examining individual socioeconomic variation in specialist use having accounted for between-area variation. Work in Canada and France using multilevel modelling has also demonstrated a pro-high SEP bias in need-adjusted use of specialist services [70, 194, 195]. This was evident at the individual level (measured by education, income, occupation [194] or when assigning area SEP to the individual [195]), and at the area level [70].

4.2.5.2 Area-level variation in specialist use

In Australia there has been limited examination of area variation in use of specialist services or area-level determinants of use of specialists. The NHPA reported that metropolitan socioeconomically disadvantaged Medicare Locals have slightly higher rates of deferral of specialist care due to costs (10% versus 7–9%) [133]. Actual use of services (self-reported or consultation rates) across areas has not been examined. A multilevel analysis of specialist use in France found substantial area-level variation in specialist use (median odds ratio [MOR] 1.2–1.26; that is, the odds of specialist use when moving from an area of low risk to an area of high risk increases by 20–26%) [194]. Internationally, multilevel analyses have reported that rural communities have a lower use of specialists [194, 195].

In summary, need adjusted use of specialists has been reported to be pro-high SEP in Australian and international studies. While there is evidence internationally that specialist use varies at the area level, and that the pro-high SEP relationship persists after accounting for this, such studies have not been undertaken in Australia.

4.3 Summary

There is evidence internationally, and to a lesser extent within Australia, of socioeconomic variation in use and quality of GP services. The pro-high SEP distribution in use of specialist services is consistent across all jurisdictions. There is evidence of geographic variation in receipt of PHC and specialist care, but limited work quantifying to what extent variation in care occurs at the individual level compared with the area level, none of which has been undertaken in

Australia. A limited number of studies have examined the relationship of service characteristics indicative of a strong PHC system with GP use and quality of care. However, none of these have examined the organisation and delivery of these characteristics specifically at the area level, covering all domains (access with the subdomains of availability, affordability, accommodation; comprehensiveness and; coordination) and how they are associated with these outcomes having accounted for between-area variation. Finally, there have been no studies, internationally or within Australia, investigating whether area PHC service characteristics modify the relationship between SEP and receipt of PHC.

The second study in this thesis assists in addressing these gaps by applying the area measures developed in Chapter 3 to examine socioeconomic variation in five outcomes: four relating to the output of the PHC system (frequency of GP use and three relating to quality of care) and one relating to use of ambulatory specialist services as an essential secondary tier of care. The research question, aims and hypotheses for this study are outlined in Section 4.4.

4.4 Research Question and Study Aims

4.4.1 Research Question

Do area-level PHC service characteristics modify the association between individual SEP and receipt of PHC?

4.4.2 Aims

1. To quantify the within-area and between-area variation in receipt of PHC
2. Having accounted for individual characteristics, to
 - i. Quantify the extent to which area PHC service characteristics explain area-level variation in receipt of care and
 - ii. Quantify the strength of association between area PHC service characteristics and receipt of care
3. Having accounted for area-level variation, to quantify individual-level socioeconomic variation in need-adjusted receipt of care
4. To determine whether the strength of association between SEP and receipt of care varies according to the PHC characteristics of an area

4.4.3 Hypotheses

Between-area variation in receipt of PHC and the association with area PHC characteristics

1. Receipt of care varies between areas and between individuals within areas
2. Having accounted for individual characteristics
 - i. There is area-level variation in receipt of care

- ii. Area-level variation is partly explained by area-level PHC service characteristics
- iii. PHC characteristics indicating a strong PHC system are associated with an increase in receipt of care

Individual-level socioeconomic variation in receipt of PHC and the modifying effect of PHC service characteristics

- 3. Need-adjusted care varies according to individual SEP, after accounting for other individual sociodemographic factors and area-level variation
- 4. Area-level PHC service characteristics indicative of a strong PHC system are associated with a larger increase in receipt of care for persons of low SEP compared with persons of high SEP

4.4.4 Secondary aim

In order to gain a more complete picture of care relevant to the PHC system, in terms of access to supporting secondary-level services provided in an ambulatory setting, individual-level socioeconomic and area-level variation in ambulatory specialist care were also examined. The aims addressed were:

- 1. To quantify the within-area and between-area variation in receipt of specialist care
- 2. Having accounted for area-level variation, to quantify individual-level socioeconomic variation in need-adjusted receipt of specialist care

It is hypothesised specialist varies between areas having accounted for the characteristics of people living in those areas, and that need-adjusted specialist use varies according to individual SEP, after accounting for other individual sociodemographic factors and area-level variation.

Chapter 5 outlines the methods for the second study, including the study population, data sources, variables, and analytical approach. The results are presented in Chapter 6. Chapter 7 provides a discussion of the study, including a summary of the main findings, strength and limitations of the study, comparisons with previous literature and the meaning of the findings.

Chapter 5

Study 2: The Modifying Effect of Area Primary Health Care Service Characteristics on Individual Socioeconomic Variation in Receipt of Primary Health Care—Methods

The previous chapter discussed in detail the evidence to date regarding individual-level socioeconomic variation and area-level variation in receipt of PHC services, and the relationship of organisational and delivery service characteristics of areas to equity in receipt of PHC. This chapter presents the methods for Study 2, which applies the measures constructed in Chapter 3 to investigate whether area PHC service characteristics modify the relationship between individual SEP and receipt of PHC services. As discussed in the preceding chapters, these service characteristics are modifiable and, therefore, are potential avenues for policy and service delivery change to improve equity in receipt of PHC, thereby contributing to health equity. Four outcomes relating to the output of the PHC system—frequency of GP use and three outcomes relating to quality of care—were examined in order to address the following research question:

Do PHC service characteristics of an area modify the association between individual SEP and receipt of primary health care?

Given that access to ambulatory secondary-level care is considered integral to supporting the delivery of care in the PHC system, individual-level socioeconomic and area-level variation in receipt of specialist care was also investigated. Data sources and the study population are described in detail in Sections 5.1 and 5.2. This is followed by a description of the outcome and explanatory variables (individual- and area-level) in Sections 5.3 and 5.4. Literature relevant to multilevel analysis as applied in the study is briefly reviewed with respect to model specification, interpretation and considerations in Section 5.5. The modelling strategy is then outlined and the specific models to address the hypotheses for Study 2 are detailed.

5.1 Data Sources

The study participants comprised respondents to the Sax Institutes' *45 and Up Study*, a prospective cohort study involving 267,112 men and women aged 45 years and over from NSW, Australia. Participants in the study were randomly sampled from the database of Medicare Australia, with over-sampling by a factor of two of individuals aged 80 years and over and people resident in rural Australia. Participants completed the baseline questionnaire, which collected sociodemographic and health information, between 1 January 2006 and 31 December 2008. Approximately 10% of the entire NSW population aged 45 years and over was included in the Study [222]. Overall response rate was ~18%. However, previous research has demonstrated the

sample to be valid and representative when examining epidemiological relationships, with prevalence of survey item responses equivalent to those from the state-run NSW population health survey, which had a response rate of around 60% (weighted and unweighted estimates) [223].

Baseline questionnaire data have been linked to MBS claims data. The MBS claims database includes all claims for subsidised medical and diagnostic services provided by registered medical and other practitioners through the MBS, including all out-of-hospital general practice and specialist attendances, as well as diagnostic and therapeutic procedures (refer to Chapter 1 for details about the MBS). Claims for services provided to veterans through the Department of Veterans Affairs (DVA) are included in MBS data. Specific MBS services are coded using a system of item numbers listed in the MBS book. For each claim for service processed, the MBS data include the date of the service, the item number for the service, patient age, gender and postcode, provider business code, the amount charged by the provider, the Medicare benefit for the service, the method of payment and de-identified information relating to the provider. De-identified information includes a scrambled Medicare provider number. Every provider who accesses Medicare benefits must have a provider number specific to that practice location. Individual providers who practise in more than one location can have multiple Medicare provider numbers.

Linkage of baseline data from *45 and Up Study* participants to MBS was performed through the Sax Institute through deterministic linkage, using an encrypted version of the Medicare number provided directly by the DHS. All analyses were performed through the Secure Unified Research Environment (SURE), a secure remote access computer facility for the analysis of linked data. The *45 and Up Study* participants consented specifically to this linkage, and it is performed under approvals from the ethics committees of Medicare Australia and the Department of Health and Ageing. Data were also linked by probabilistic linkage to the NSW Register of Births, Deaths and Marriages by the Centre for Health Record Linkage (CHeReL), in order to identify those who had died during the study for censoring purposes. Quality assurance data on the CHeReL data linkage show false positive and negative rates of <0.5% and <0.1%, respectively.

Each participant's address was geocoded to 2006 ABS geographies at the CCD and SLA level by the Sax Institute. These geographic identifiers were provided for the study within SURE, and were used for merging individual-level data with area-level variables (described in Section 5.4.2).

5.2 Study Population

The study sample included all *45 and up Study* participants followed up to two years after entry to the study (most had completed entry by 2008). Included in the study were those who had not had a GP attendance in the study period, but excluded from the study was those who:

1. Were unable to be linked to Medicare data (that is, participants who were missing from the original linked MBS data)
2. Did not have a geographical area identifier
3. Were coded to a geographical area outside of NSW
4. Died in the follow-up period; or
5. Had invalid death dates (see Figure 18 in Chapter 6)

Additional participants were excluded for specific outcomes as described below.

Consideration was given to excluding those in residential aged care given that it is quite probable that they would have different service use patterns compared with the main study population. General practitioner attendances relating to care in a residential aged care facility comprised 2.6% of all GP attendances in the study sample, with 3.5% of the total sample having any residential aged care items. For those participants who had any residential aged care items, the median percentage of total services claimed for residential care items was 22% (IQR 45%), with a range for this group of 1–100%. A total of 1040 of the sample (0.4%) identified as living in a nursing home or hostel for the aged. Given the small numbers, and the fact that conceptually it can be argued that nursing home and hostel care forms an essential part of PHC, these participants were not excluded from the analyses.

5.3 Outcomes

5.3.1 Use of GP Services

There have been a range of ways in which use of GP services (as observed numbers of GP visits) has been measured as an outcome. This includes per capita visits for ecological data [127, 134, 186, 192], and categorical or count measures for individual level data based on administrative data (for example, claims data) [224, 225] or self-reported data [91, 94, 96, 176, 177]. Depending on the background rate of consultations in different study populations, varying cut-off points have been used for defining non-frequent/frequent use or low/medium/high use. For example, a Canadian study defined non-frequent use as one to five visits per annum and frequent use as more than six visits [177]. A Dutch study defined the top 10% as frequent users corresponding to a range of 8–16 visits per year, depending on age [225]. An Australian study examining use of PHC services by Indigenous people defined low use as 0–1 visits, medium use as 2–11, and high use as ≥ 12 visits per year [224], while an Australian study of women aged 45–50 years with self-reported use as their outcome measures defined frequent use as more than 7 visits per year [96]. There appears to be no one agreed way of measuring frequency of use, nor a notion of what an ‘appropriate’ quantity of use may be.

For the purposes of this study, the main outcome measure for frequency of use of GP services (*above-average GP use*) was a dichotomous outcome (below average/above average). Services

included all GP (vocationally registered and non-vocationally registered GP related items) attendances, including those provided in residential aged care facilities. Table 12 provides a complete list of all the item numbers included for this outcome. Frequent users were defined as those who had 8 or more visits in the year after entry to the study, based on a sample mean of 7.5 visits and a median of 6 visits. This corresponded to approximately two-thirds of the sample being defined as below average and one-third defined as above average users. This cut-off of ≥ 8 visits is broadly consistent with previous studies.

Table 12: Item numbers for GP services

MBS item groups and name of group	Specific item numbers within item group	Notes on item numbers
A1-GP attendances	3, 23, 36, 44 Remainder A1 attendances=4, 20, 24, 35, 37, 43, 47, 51	Items for services in consulting rooms Items relate to consultations at residential care OR other than residential care/consulting rooms
A2-MPs other than GP	52,53,54,57 Remainder of A2 attendances=58–60, 65, 92, 93, 95, 96	Items for services in consulting rooms Items relate to consultations at residential care OR other than residential care/consulting rooms
A11-GP	597, 599	Urgent after-hours care
A11-MP other than GP	598, 600	Urgent after-hours care
A14-health Assessments	701, 703, 705, 707	
A14-health assessments for Aboriginal and Torres Strait Islander peoples	715	
A15-GP management plans	721, 723, 729, 731, 732	Care plans, care plan reviews and team care arrangements
A15-case conference	735, 739, 743, 747, 750, 758	
A17	900 and 903	Medication reviews
A18-GP, cervical screening	2497, 2501, 2503, 2504, 2506, 2507, 2509	Incentive for overdue pap smears (>4 years since last pap)
A18-GP asthma	2546, 2547, 2552, 2553, 2558, 2559	cycle of care
A18-GP diabetes	2517, 2518, 2521, 2522, 2525, 2526	cycle of care
A19-non-referred cervical screening	2598, 2600, 2603, 2606, 2610, 2613, 2616	As per A19 for non-VR MPs
A19-non-referred, asthma	2664, 2666, 2668, 2673, 2675, 2677	As for A18 for non-VR MPs
A19-non-referred, diabetes	2620, 2622, 2624, 2631, 2633, 2635	As for A18 for non-VR MPs
A20-GP mental health care plans	2700, 2701, 2712, 2713, 2715, 2717, 2721, 2723, 2725, 2727	Preparation and review of mental health care plans
A22-after hours (GP attendances)	5000 , 5003, 5010, 5020 , 5023, 5028, 5040 , 5043, 5049, 5060 , 5063, 5067	Includes consultation room, residential facility and other. At consultation rooms bolded
A23-after hours (non-referred)	5200 , 5203 , 5207 , 5208 , 5220, 5223, 5227, 5228, 5260, 5263, 5265, 5267	As per A22 for non-VR MPs

Notes:

1. GP, general practitioner; MP, medical practitioner; VR vocationally registered.
2. All item numbers were included for frequency of GP use and continuity of care outcome measures. The specific item numbers included for length of consultation were 36, 44, 54, and 57. The specific item numbers for care planning included all those listed under A15 GP management plans.
3. Medical practitioners (MPs) in this case refer to medical doctors who provide non-referred services but are not vocationally registered as a GP (i.e. have not undertaken specialist training in General Practice or other equivalent recognised training program).

5.3.1.1 Sensitivity analyses

A number of alternative cut points were explored as follows:

1. Low use (<3 visits) vs medium use (3–10 visits) versus high use (>10 visits per year)
2. Frequent use defined as greater than the 25th percentile (non-frequent ≤3 visits per year, frequent >3 visit per year)
3. Frequent use defined as greater than the 50th percentile (non-frequent ≤6 visits per year, frequent >6 visits per year)

5.3.2 Quality of Care

5.3.2.1 Length of consultation

In previous studies, length of consultation has been measured either as the number of long consultations per capita (based on MBS claims data) [187] or in minutes or categories of minutes [181, 210, 212, 213]. In Australia, there are specific item numbers which are billed for long (more than 20 minutes but less than 40 minutes: items 36 and 54, GP and other non-referred attendances, respectively) and prolonged (40 minutes or more: item numbers 44 and 57, GP and other non-referred attendances, respectively) consultations. For this study, a binary outcome measure was created—*long consult*—where those who had received a long or prolonged consultation (identified by having received an item 36, 54, 44 or 57 in the first year after entry to the study) were coded as 1. Those who had not were coded as 0 (reference category).

5.3.2.2 Continuity of care

As discussed in section 4.2.3, the outcome of interest for this study was relational continuity of care, as opposed to informational or management continuity, as this represents care received by individuals (that is, an output of PHC), rather than how services are organised to facilitate continuity of care [163]. Specifically, longitudinal continuity was measured as data were unavailable regarding interpersonal continuity. The way in which longitudinal continuity of care is measured has varied greatly in previous studies. Briefly, continuity of care indices based on claims data reflect one of usual care provider, usual practice provider, duration of relationship with a provider or usual source of care [163, 215]. Some of these indices measure duration of relationship between the patient and provider, while others are more concerned with the number or sequence of physicians seen. Density measures are the most commonly used (that is, visits with the same doctor or usual provider of care over a period of time) [215, 226]. This is followed by dispersion measures, which reflect the extent to which different providers were seen. In a systematic review, no continuity of care index took into account the type of care provided [215]. The vast majority of studies were US-based. The authors of the systematic review criticise density measures, suggesting that low scores may reflect appropriate referrals from a usual care provider; this is particularly relevant for those with chronic illness or complex care necessitating multiple health professionals [215]. Other measures based on self-reported data aim to capture aspects of the provider–patient relationship, reflecting relational continuity of care [113, 182, 183, 193].

For this study, continuity of care is defined as the relationship of a patient with a single PHC provider (a GP) over a time period of two years [7]. For each participant, the percentage of consultations with the most frequent provider of total consultations over a two-year period was calculated. A threshold of more than 70% of consultations with a single provider was defined as having continuity of care, to be consistent with what is most frequently reported in the literature [182, 218, 226]. Only those who had had at least four visits were included in the analysis involving

the continuity of care outcome, as recommended in the literature, to minimise instability of estimates if there are few visits during the timeframe of calculation [215, 226]. A binary outcome (*continuity of care*) was created, with those with a continuity of care score of 70% or more coded as 1 (<70% reference category).

The same item numbers included for use were also included in the continuity of care measure (refer to Table 12). After-hours items were retained, as it can be argued that someone may have apparent good continuity of care when in fact most of their care is after hours. Particularly in cities, after-hours care is more likely to be provided by a range of providers, and failing to take this into account could result in skewed estimates.

5.3.2.3 Receipt of care planning

As discussed in Chapters 2 and 4, there are a range of items that can be claimed relating to care planning for chronic and complex care needs, and to enable multidisciplinary coordination of care. Receipt of care planning has been the subject of a number of studies in Australia, and has been measured as percentage of total services [156], rate per provider [220], rate per eligible population [158], expenditure [95] or a binary outcome [155, 184]. For this study, a binary outcome measure was created (*care planning*) and coded as 1 if a participant had received a care plan, team care arrangement item or review items within the study period, or 0 otherwise. The specific item numbers included were 721, 723, 729, 731, and 732 (this includes items claimed for services provided in a residential aged care facility). The analysis for this outcome was restricted to only those that had a least one chronic condition.

Health assessments were also considered as an outcome measure. However, due to the rarity of receiving these in the study sample (eight of over 75 year olds and 26 of 45–49 year olds had received a health assessment during the study period), these were not further investigated.

5.3.3 Specialist Use

As stated at the beginning of this chapter, given that access to ambulatory secondary-level care is integral to the delivery of care in the PHC system, area-level and individual-level socioeconomic variation in specialist care was also examined. The measurement of specialist use (observed, as opposed to self-reported) in previous studies has included dichotomous outcomes with varying thresholds (for example, occasionally, regularly and frequently) [194], rates (number of visits per person in a specified time period) [195] and percentage of all consultations with a specialist [70]. Studies in Australia have primarily examined self-reported use of specialists [91, 96, 133]. In contrast to many international settings, in Australia seeing a specialist is dependent on referral from the GP (who performs a gate keeping and care coordination function). As such, proportions relative to all consultations have less relevance in the Australian setting. In this study, any access to specialist services (as a supporting role to PHC), rather than the frequency and nature of

specialist use, was of interest. Hence, the outcome measure was whether a respondent had visited a specialist in the year following entry to the study (any use), which was coded as 1, or 0 otherwise. The item numbers included are listed in Table 13. Any visits provided within a hospital setting were excluded from analyses.

Table 13. Item numbers included for specialist use

MBS item groups and name of group	Specific item numbers within item group	Notes on item numbers
A3-specialist	99, 104, 105, 106, 107, 108, 109, 113	includes home visits; visits at surgery or hospital 99; 113=telehealth
A4-consultant physician	110, 112, 114, 116, 119, 122, 128, 131, 132, 133	112 & 114 telehealth; 122=home visit
A28-geriatric medicine	141, 143, 145, 147, 149	145=home visit; 149 telehealth
A8-consultant psychiatry	288, 291, 293, 296, 299, 300, 302, 304, 306, 308, 310, 312, 314, 316, 318, 319, 330, 332, 334, 336, 338, 342, 344, 346, 353, 355, 356, 357, 358, 359, 361, 364, 366, 367, 369, 370	288=telehealth; 289 not included, for autism developmental delay, referred from any practitioner; 299=home visit, hospital consults excluded, interviewing other than patient excluded; 353–370 telepsychiatry
A12-occupational physician	384, 385, 386, 387, 388, 389	
A13-public health	410, 411, 412, 413, 414, 415, 416, 417	Case conferences excluded
A24-pain and palliative medicine	2799, 2801, 2806, 2814, 2820, 2824, 2832, 2840, 3003, 3005, 3010, 3014, 3015, 3018, 3023, 3028	Case conferences excluded
A26-neurosurgery	6004, 6007, 6009, 6011, 6013, 6015, 6016	

Note:
A3-specialist also includes all attendances by surgeons (at surgery/consulting rooms or hospital). With respect to surgical specialists, only neurosurgery has specific item numbers for attendances.

5.4 Exposure Variables

5.4.1 Individual Explanatory Variables

All individual-level explanatory variables were derived from the *45 and Up Study* participant responses on the baseline survey. Details for each variable are described in detail in this section.

5.4.1.1 Main explanatory variable: socioeconomic position

As outlined in Chapter 1, the CSDH framework emphasises the importance of the socioeconomic and political context in determining social stratification of the population, resulting in unfair distribution of class, power and prestige within society [227]. This, in turn, results in differential exposure and vulnerability of individuals to health damaging factors, and differential opportunities for health promoting factors. The most important structural stratifiers and their proxy indicators include income, education, occupation, social class, gender, and race/ethnicity, and are broadly referred to as socioeconomic position (SEP). In terms of Andersons' framework of health service use, these factors form part of predisposing factors (social structure) [99], while in Watson's logic model they form part of the broader context in which PHC input and activities occur to produce the outputs of the PHC system [97]. It is variation in receipt of PHC based on a person's SEP that is of specific interest in this study. There is extensive literature on the measurement of SEP [19, 169, 228-231], which is beyond the scope of this study to examine in depth. While it is acknowledged that no single measure can capture the impact of SEP on health service use or health, such indicators enable some insight into this relationship [230].

The main socioeconomic variable used in this study was *education*. Respondents were asked 'What is the highest qualification you have completed?' There were six response options, which were collapsed into a four-category variable for the analysis: no school certificate (included anyone who responded 'no school certificate or other qualification'); school certificate ('school certificate or intermediate certificate', or 'higher school certificate or leaving certificate'); apprenticeship/diploma ('trade or apprenticeship' or 'certificate or diploma'); and university degree ('university degree or higher').

Pre-tax annual household *income* before tax from all sources (<\$20,000, \$20,000–\$29,999, \$30,000–\$39,999, \$40,000–\$49,999, \$50,000–\$69,999, ≥\$70,000, 'I would rather not say' or missing), was included in a supplementary analysis as an alternative measure of SEP. In the survey there were three response options for below \$20,000 (<\$5,000, \$5,000–\$9,999 and \$10,000–\$19,999), which were combined to give the lowest income category. Given that those who responded with 'I would rather not say', invalid or missing responses tended to also demonstrate socioeconomic gradients in health outcomes, this was included as a category in the analyses.

It is acknowledged that, as a single measure, occupation may better capture the construct of socioeconomic position, as it relates not only to a person's educational level, but also has implications for a person's income, power and prestige in society, and better reflects a person's changing SEP over the course of their life [228, 230]. However, this measure was not available in the *45 and Up Study*.

A third measure of SEP was a continuous education measure based on the cumulative proportion of the population in each education category, ordered from the lowest education group to the highest (that is, the fractional rank, based on education, which is forthwith referred to as *continuous education*). As discussed in Chapter 1, the advantage of this SEP measure is that it includes all available data and allows SEP data to be treated as continuous so that a single measure of inequality can be created [93, 94, 96]. Having a continuous measure also facilitates interpretation of interaction terms, and avoids the need to have a number of terms in the model when a categorical variable is used. Appendix A contains further details regarding measurement and quantification of inequality in health care use. The cumulative proportion for each education category was derived from 2006 Census data for NSW population aged 45 years and over. The mid-point value of the cumulative proportion of the population in each education category was then assigned to each participant, based on their corresponding category [93]. The same measure was constructed using the within-sample cumulative proportion of the population for comparison.

5.4.1.2 Need variables

As outlined in Chapter 1, for the purposes of this study, equity of health care access is defined as horizontal equity; that is, equal access for equal need [91, 94, 96, 99]. Hence, when examining socioeconomic variation in receipt of health care, the underlying need for care must be taken into account. Anderson defines 'need' as perceived need and evaluated need [99]. Perceived need refers to need for medical care from the perspective of the individual. Self-reported health is often used as a proxy indicator of perceived need. Evaluated need refers to a clinical judgement about a person's need for medical care.

There are a number of ways evaluated need is measured in the literature. These include a range of co-morbidity and multi-morbidity measures, from simple disease counts through to weighted measures for certain chronic conditions (for example, the Charlson Index), and other indices that take into account not only condition type but also severity of illness [232-235]. A systematic review of measures of multi-morbidity for primary care in the community setting found that simple counts of disease performed almost as well as more complex measures, and that combining measures improved validity [232]. Measures that included an assessment of functional status, disease severity or subjective disease burden, in addition to number and/or type of conditions, appear to be stronger predictors of a range of health outcomes in general [235] and specifically for primary health care settings [232]. For this thesis, *self-reported health* status and *physical*

functioning based on a self-reported scale are used for perceived need, while a measure of disease count is used to assess evaluated need. Each variable was examined for construct validity by examining for expected gradients with SEP and outcome measures, as recommended in the literature [235].

Self-reported health status was measured in five categories, based on participants answering ‘excellent’, ‘very good’, ‘good’, ‘fair’, ‘poor’ to the question ‘In general how would you rate your overall health?’, which was adapted from the 36-item Medical Outcome Score (MOS) Short Form Health Outcomes Survey (SF-36). Missing responses were coded as a separate category.

Chronic conditions was calculated from respondents’ answers to the questions ‘Have you ever been told you have...?’ and ‘In the last month have you been treated for...?’ for the following conditions: cancer, asthma, hayfever, heart disease, heart attack, angina, stroke, diabetes, hypertension, hypercholesterolaemia, arthritis, osteoporosis, anxiety, depression and Parkinson’s disease. The number of conditions for which the participant responded yes was summed²⁸. A three-category variable was created: no chronic conditions, 1–2 chronic conditions and 3 or more chronic conditions. An additional count not including cancer was created in order to identify only those participants who would be eligible for care planning and therefore suitable for inclusion for analyses investigating the *care planning* outcome measure. While it is possible that those with cancer would be eligible and may have received care planning, in the majority of cases it is reasonable to assume that their health needs and health service use would differ significantly from those with other chronic medical conditions, and hence bias results. Only those who had at least one chronic condition were included in the analysis for this outcome.

Physical functioning was assessed using the MOS–Physical Functioning, which is equivalent to items from the physical functional scale of the SF-36 health survey [236]. This scale assesses functional capacity by inquiring about an individual’s ability to perform a range of moderate and vigorous physical tasks as well as everyday activities. Participants were asked ‘Does your health limit you in any of the following activities?’: vigorous activities; moderate activities; lifting or carrying shopping; climbing several flights of stairs; climbing one flight of stairs; walking one kilometre; walking half a kilometre; walking 100 metres; bending, kneeling or stooping; bathing or dressing yourself, with the following response options: ‘yes limited a lot’, ‘limited a little’ and ‘not limited at all’. A total score based on the 10 items was calculated for each respondent (range 10–30). These scores were then scaled to 0 to 100 and categorised as no limitation (100), minor limitation (90–<100), moderate limitation (60–<90), severe limitation (0–<60) and missing. A

²⁸ During data collection of the first wave, there were two versions of the survey. The initial survey asked respondents whether they had ever been told they had asthma or hayfever, while the second version asked the question for each condition specifically. Given the inability to determine whether a person had asthma, which would count as a relevant chronic conditions or hayfever, which would not, all positive responses to the combined question in version one, and separate responses for version two for asthma and hayfever, were included as a chronic condition. As such, the final variable would represent a slight over count of the number of chronic conditions each respondent had.

number of item responses were missing for these questions. Imputation was used for missing responses where possible, based on logic. For example, if a response was missing for moderate activities and they had responded ‘not limited at all’ to vigorous activity, moderate activities was recoded as ‘not limited at all’. All invalid responses were coded as missing if they could not be imputed. In total, 7–11% of responses were missing from each category (a total of 10) after imputation. When calculating the physical functioning score, if there were 9 responses, then the missing category was replaced with the mean of all other responses. If there were fewer than nine responses, the score was coded as missing as it was deemed insufficient for a reliable estimation of physical functioning.

5.4.1.3 Potential confounding factors

Four factors were considered confounders in the relationship between SEP or health care need and health care use (that is, potentially associated with SEP or health care need and causally associated with health care use), and were adjusted for in the analyses. These were age, sex, marital status and country of birth.

Age is a well-established determinant of health service use [99], including GP services in Australia [96, 127]. Increasing age is also known to be associated with poorer self-reported health and health status need variables measured in this analysis [31]. The variable *age* was included as 10-year categories from 45 years through to 85 years or over, with 45–54 years as the reference group. Five-year age groups were also considered; however, this made little difference, as the mean frequency of GP services in the contributing five-year age groups were within one service per year difference to each other, and 0.5 of a service per year of the 10-year age group estimate (with a range of 4.8–13.0 services per year). As such the 10-year age group variable was retained in final analyses.

Sex has also been shown in Australia to be associated with health services use [127], self-reported health and health status [31], and is considered a predisposing factor within a health services research framework [99]. A dichotomous sex variable with male as the reference was included in the analyses.

Country of birth has been shown to be associated with SEP and health service use in previous studies in Australia [237, 238]. Respondents’ country of origin was coded according to the Standard Australian Classification of Countries [239]. A *COB* variable was constructed with the following categories: ‘Australia/NZ’, ‘Europe/Nth America’, ‘Asia’, ‘Africa/Mid East’, and ‘other’, with Australia/NZ as the reference category.

Marital status has also been shown to be associated with SEP and health service use in Australian studies (refs [96]). The variable *marital status* was categorised as either ‘married/de facto’ or ‘not

married/de facto' (that is, single, widowed, divorced/separated), with divorced/separated as the reference category.

5.4.2 Area-level Explanatory Variables

Area-level variables were merged with each participant's record, using the geographical identifier provided by the data custodians. Participants who had no CCD or SLA geocode were excluded from the analyses ($n=109$). Using the same methodology described in Chapter 3, ABS correspondences were used to assign an SA3 code to each respondent based on their CCD or SLA code²⁹. Of those which had a CCD/SLA geocode there was a small proportion who were assigned to either interstate, offshore and migratory areas or did not have a SA3 associated with the donating 2006 geography. These were excluded from analyses ($n=52$). Each participant's record in the study population was then merged with area measures of PHC service characteristics by their SA3 of residence. Data sources for these measures and their construction are described in detail in Chapter 3.

The background, rationale and construction of the area PHC service characteristic variables applied in this study—*AIHW FTE* (availability); *OOP expenses, bulk-billing* (affordability); *after-hours care* (accommodation) and *CD care and health assessments* (comprehensiveness/coordination)—are described in detail in Chapters 2 and 3. To recall, these variables represent those that can be constructed from data available at the small-area level within Australia, which best capture the relevant underlying conceptual construct. As these variables are ordinal, using them categorically loses the importance of the order, while using them continuously assumes a consistent interval structure, which technically is not correct. However, as argued by Long and Freese in 2006 [240], either approach can be applied, keeping these considerations in mind. As such, including these variables as categorical or continuous depended on which approach was best suited to the overall model structure for each part of the analyses. In particular, to minimise the number of terms and facilitate interpretation for multilevel models with interaction terms, area characteristics were included as continuous variables. Those variables that did not have a clear monotonic relationship in bivariate analyses with the outcome of interest were not included as interaction terms. Categorical variables for area PHC service characteristics were constructed using the quartile population distribution breakpoints, with the lowest 25th quartile

²⁹ Given that an individual cannot be 'split' between areas, for those geographies that did not have a one-to-one correspondence, that CCD or SLA code was forcibly assigned to a single SA3, based on which SA3 had greater than 50% of the donating geography's population assigned to it. Three-hundred and thirty-one of 12,254 CCDs were split between SA3s, while 103 of 199 SLAs were split between SA3s. However, in the case of SLAs, most had a clear majority contributing population to one SA3 (i.e. 50% or more). Where there was an equal division of a donor geography, this was randomly assigned to one of the receiving geographies (3 of 12,254 CCDs, 13 of 199 SLAs). In those circumstances where a donating geography was split between three or more SA3 areas of which none contributed 50% or more, these were manually inspected to determine which SA3 received the greatest proportion of the contributing population (1 of 12,254 CCDs, 3 of 199 SLAs). SA3 geographies were first allocated using the CCD to SA3 correspondence file. The SLA to SA3 correspondence was used for those remaining participants that did not have a CCD geocode but did have an SLA geocode (27,467 participants).

as the reference category (as per Chapter 3). Each of the area-level variables included are discussed here briefly in relation to each outcome variable examined.

Frequency of GP use: As discussed in Chapter 4, more availability and affordability have both been associated with increased use of GP services. While there is no empirical evidence, conceptually *after-hours care* as a measure in the access domain can be hypothesised to also be associated with increased use. Although a previous study has shown that *CD care* was associated with increased regularity of use, whether living in an area with more *CD care* would increase or decrease the probability of above-average use is uncertain (similar to *health assessments*). As such, four area PHC service characteristic variables were included in the analyses with above-average GP use. These were *AIHW FTE* (availability), *out-of-pocket expenses* and *bulk-billing* (affordability) and *after-hours care* (accommodation). It was hypothesised that increasing availability, affordability and *after-hours care* would be associated with a higher probability of above-average GP use.

Quality of GP care: As discussed in Chapter 4, the evidence for the relationship between area PHC service characteristics and quality of GP care as defined for this thesis is sparse, with no studies explicitly examining this in Australia. There is some international evidence that increasing GP supply and after-hours arrangements are associated with reduced continuity of care [193]. On the other hand, it has also been shown that GPs with a broader service profile were associated with improved perceived continuity of care [116]. For this study, based on the conceptual underpinnings presented in Chapter 1 and the review of the literature in Chapter 2, it was hypothesised that living in areas with a greater presence of PHC service characteristic, indicative of strong PHC systems, would be associated with a higher probability of receiving quality GP care. The same four variables listed for GP use were examined for all quality of GP care outcomes. Given the uncertainty of hypothesising the direction of association between *CD care* and *health assessments* with long consultations and the overlapping items used in the care planning outcomes, these characteristics were examined for continuity of care only. In this care, it was hypothesised that living in areas where more comprehensive care was provided (as measured by *CD care* and *health assessments*) would be associated with a higher probability of continuity of care.

5.5 Literature Relevant to Multilevel Analytical Approach Applied

While multilevel models have been discussed briefly in Chapters 1 and 4, a more in-depth discussion regarding specific analytical models, interpretation and considerations is covered here. Multilevel analysis (also known as random effects or hierarchical modelling) has been extensively applied in examining contextual and neighbourhood effects particularly in social epidemiology [19, 63, 65, 66, 190, 191, 241]. More recently, there has been increased application of these models in health services research [43, 60, 67, 69, 70]. Australian analyses have focused primarily

on a range of health outcomes (for example, mortality, obesity, cancer survival) [32, 34, 37, 39, 43], with more recent studies investigating hospitalisations and health care costs in NSW [43, 69, 242].

This statistical technique takes into account not only the hierarchical nature of data but also between-group variation. This makes it well suited to health services research, as people are exposed to a range of environments (for example, neighbourhoods, practices, hospitals, work places, schools) within multiple hierarchical levels (people within practices, within neighbourhoods, within districts and so forth) [19, 20, 60, 63, 243], which, in turn, determine their use of services (ultimately contributing to their health outcomes). These models take into account the fact that individuals may share similar characteristics within areas, or, put differently, people with similar characteristics but from different areas may have different levels of health due to their exposure to different contexts [66]. Multilevel analysis allows between-area variation to be quantified (random effects) as well as estimation of the strength of associations between outcomes and individual and area-level characteristics (fixed effects), after accounting for between-area variation. As stated by Merlo and colleagues:

The more the health of people within neighbourhoods are alike (compared to being different to people from other neighbourhoods), the more probable it is that the determinants of individual health are directly related to the contextual environment of the neighbourhood [191] p.1026.

Being able to measure area-level specific variation and understanding relationships in the context of this is critical if policy and practice change is intended to be implemented at this level. Cross-classified (that is, belonging to different contexts in which they may not be hierarchically related, such as neighbourhood of residence and place of work) and multiple membership (that is, belonging to multiple contexts over time, such as a student attending a number of schools over time) models can also be applied with this technique [63, 243], but are beyond the scope of this discussion.

5.5.1 Model Specification and Interpretation

Multilevel analysis is an extension of the ordinary least squares (OLS) regression analysis, under which the mean relationship between the outcome of interest and explanatory variables are estimated. The OLS regression equation takes the following form:

$$y_i = \beta_0 + \beta_1 x_i + e_i$$

Where β_0 is the intercept of the regression line, β_1 is the slope associated with the independent variable x and e_i is the residual (error term) for the i^{th} individual [60]. Random intercept modelling allows for the average outcome to vary across areas (random intercept), where the relationship between x and the outcome is the same across areas. As can be seen in Figure 15, the total variation

of the outcome can be partitioned into the component that occurs between-areas and that which occurs between individuals within areas. The solid grey horizontal line represents the overall average outcome, while the black horizontal lines represent the average outcome for each area.

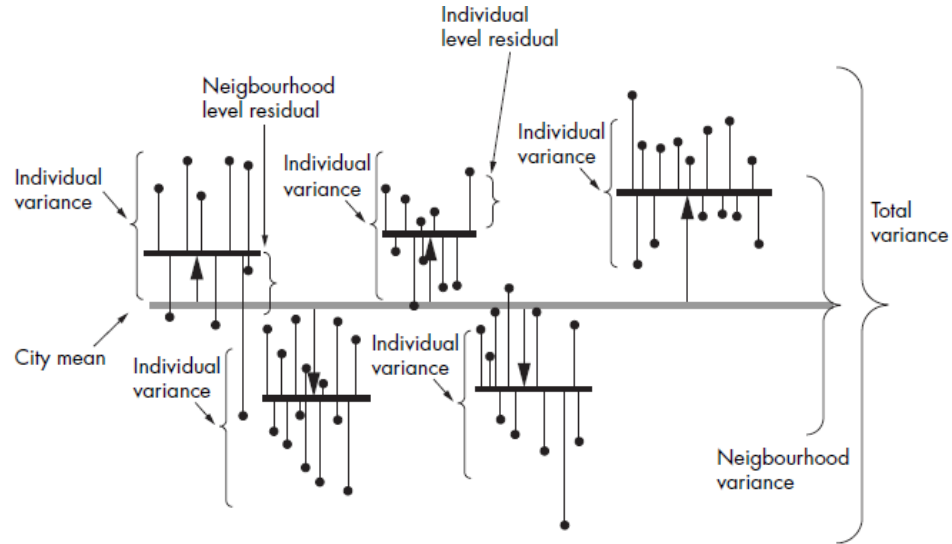


Figure 15. Individual-level and between-area variation

Note: Taken from Merlo et al. (2005) [66].

The mathematical equation for the random intercept as applied in this study is:

$$y_{ij} = \beta_0 + \beta_{ij}x_{ij} + u_j + e_{ij}$$

Where u_j is the residual of the higher level unit and e_{ij} is the residual associated with the lower level (or individual level, in this case). The higher level u_j is an effect of the j^{th} region shared by all individuals within that region [60, 66]. Residuals at both levels are assumed to be independent of one another and to follow a normal distribution with zero mean and constant variance given by $u_j \sim N(0, \sigma_u^2)$ and $e_{ij} \sim N(0, \sigma_e^2)$ [66, 244]. Allowing the overall mean to vary across areas overcomes ecologic fallacy (attributing relationships at the context level to individuals when aggregating all data to the ecological level) and atomistic fallacy (attributing relationships at the context level to individuals when assigning area values to individuals) [20, 60]. This is shown in Figure 16.

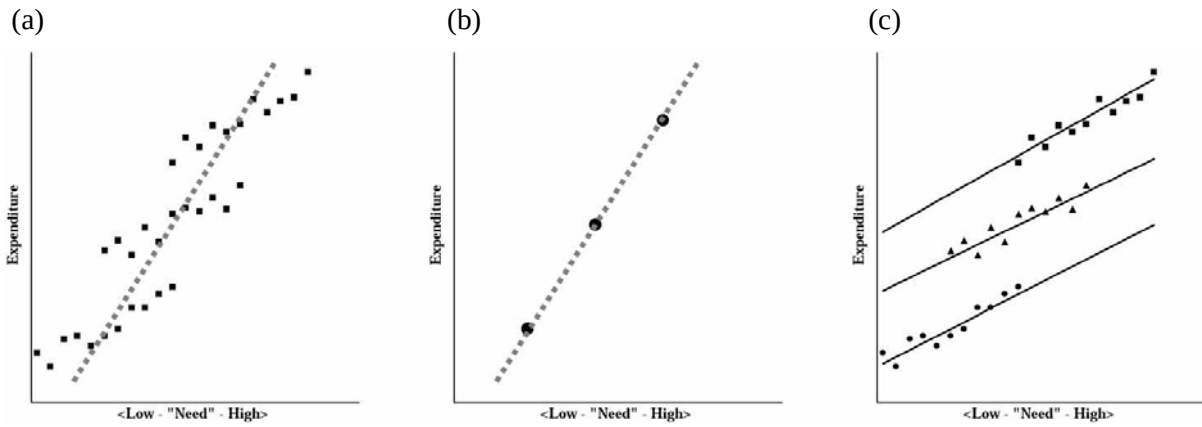


Figure 16. Misrepresentation of relationships when not accounting for multilevel structures

Note:

In this case the example of expenditure and need based on a) individual data, b) aggregated data to the area level and c) multilevel data structure are taken into account; taken from Leyland et al [60]).

Multilevel models are often referred to in terms of their fixed part (the coefficients as per OLS), which gives information about the strength of association between explanatory variables and outcomes (fixed effects), and the random part (random effects and residual error) given by $u_j + e_{ij}$ in the previous equation. The total variance is partitioned into two components; the between-group variance σ_u^2 (or higher-level variance) and the within-group variance σ_e^2 (level-1 variance). The variance partitioning co-efficient (VPC), also referred to as the intra-class coefficient (ICC), given by the formula $\tau = \sigma_u^2 / (\sigma_u^2 + \sigma_e^2)$, enables quantification of how much variation in the outcome is attributable at the higher level [64, 66, 243].

The challenge for binary outcomes and count data when multilevel analysis is applied is that the interpretation of the partitioning of variance is not as straightforward. The general equation for the multilevel logistic regression model is given by:

$$y_{ij} \sim \text{Bernoulli}(\pi_{ij})$$

$$\log\left(\frac{p_{ij}}{1 - p_{ij}}\right) = \mu_j + \beta_0 + \sum_{k=1}^R \beta_k X_{ijk}$$

$$\mu_j \sim N(0, \sigma_u^2)$$

Where p_{ij} is the probability of the outcome and $p_{ij}/1 - p_{ij}$ is the odds of the outcome of interest. u_i is the area-level residual on logistic scale normally distributed with a mean of 0 and variance of σ_u^2 expressed on the logistic scale³⁰ [64, 71, 190].

³⁰ Individual variance is expressed on the probability scale and depends on the predicted probability (pi) of the outcome, given by $V_i = \pi_i(1 - \pi_i)$.

In addition to level 1 or individual variance in this case being dependent on the outcome (and hence x), in multilevel logistic regression the area-level variance is on the logistic scale and, therefore, not directly comparable to individual level variance (which is on the probability scale), as is required for partitioning the variance in the usual case [64, 190].

Alternative methods for calculating the ICC have been proposed for multilevel logistic regression [64, 71, 190]. The most commonly reported is the linear threshold method, or latent variable method, which converts individual level variance to the logistic scale, where it is assumed there is a continuous latent variable underlying the binary response with a logistic variance equal to $\pi^2/3$ (3.29). The ICC in this case is given by:

$$ICC = \sigma_{u0}^2 / (\sigma_{u0}^2 + 3.29)$$

Concerns have been raised in the literature about interpreting the ICC for binary outcomes, given the inherent difficulty in distinguishing individual and area variance in the logistic case [71, 190]. Further, the conversion of binary outcomes to linear latent variables may not always be appropriate. The median odds ratio (MOR) is an alternative measure of variance in logistic regression with an advantage in that, statistically, it does not depend on the prevalence and is expressed in the well understood odds ratio (OR) scale. As such, not only does it allow determination of an interpretable measure of variance, but it also allows comparison with fixed-effects ORs.

The MOR is given by the expression:

$$\begin{aligned} MOR &= \exp(\sqrt{2 \times \sigma_{u0}^2} \times 0.6745) \\ &\approx \exp(0.95\sqrt{\sigma_{u0}^2}) \end{aligned}$$

Conceptually, the MOR is understood as the median of the odds ratios calculated from pairwise comparison of people with identical covariates, but residing in different areas. It quantifies the increased risk (in median) that would occur if moving from one area to another with higher risk [190, 243]. The 95% credible interval can be calculated from the posterior distribution of the area variance term and computing the MOR for the 2.5th and 97.5th centiles, providing a more familiar precision of the estimate measure [190].

5.5.2 Cross-level Effect Modification

A particularly valuable feature of multilevel analysis for this study is the capacity to investigate the relationship between individual and contextual characteristics on outcomes, termed *cross-level interactions* [60, 191, 243]. In multilevel analysis, both fixed (measures of association) and random (measures of variation) cross-level effect modifications can be examined. That is, it is possible to examine the interaction of an individual and area characteristic on an outcome (as

opposed to a direct or indirect or mediating effect of area characteristic on an individual outcome) [65, 191]. Of direct relevance to this thesis, fixed cross-level interaction terms enable the testing of whether the relationship between an individual explanatory variable and outcome is stronger in areas with specific characteristics. For example, the effect of individual SEP on health may be stronger in areas with fewer health services. Or, in other terms, the differences in health between individuals living in areas with more health services compared with those living in areas with fewer health services is more marked for people of low SEP. Random slope models also investigate cross-level effects by allowing the relationship between lower level explanatory variables (individual) and outcome variables to vary across higher levels (across areas, in this case). Random slope models facilitate hypothesis generation, by determining whether more variance in an outcome is explained by an area explanatory variable for certain groups of individuals, while fixed cross-level interactions terms test for specific relationships between variables across levels with an outcome.

As described in the preceding paragraph, modelling cross-level interactions allows testing of real life relationships that would not otherwise be examined through testing direct associations. However, whether studies are sufficiently powered to test these relationships needs to be considered. In multilevel analysis, power relates to not only the overall sample size, but also the number of groups and number of observations per group (group size) [245, 246]. Generally, the group number is more important than total sample size, with large group sizes in part compensating for a small number of groups [245], and few random components advised at the second level when the group number is small [246]. Based on the literature (see pp. 214-215 [246]), there were adequate group numbers in the current study to power stratified analyses with cross-level interactions. However, group numbers were towards the lower end of some recommendations (p.215 [246]). As such, there was a possibility that models with cross-level interactions were underpowered. Further investigation on power was undertaken to facilitate interpretation of results relating to models with cross-level interactions.

5.5.3 Considerations

Blakely and Woodward [65] describe, in depth, key sources of error and weakness in the study design of multilevel analyses that may affect estimates of contextual effects (termed ‘ecological effects’ in their paper). These include lack of variation in the contextual exposure (and outcome); selection bias; confounding at the contextual and individual level (including cross-level confounding); misclassification of variables; misclassification of unit of analysis and assignment of individuals to those units (as discussed above); model misspecification (including level of aggregation) and multicollinearity. It is well established that ecological effects will be small, particularly relative to individual effects [19, 65]. This is primarily due to reduced variation in the ecological variable being studied, as often occurs with a limited study population or time period

(without adequate time lag), and does not necessarily indicate a lack of an important relationship at this level [65].

As raised in section 5.5.2, an important consideration of particular relevance to this study, is whether there are sufficient group numbers to power cross-level interactions to detect a true effect and determine nonbiased estimates. A general rule of thumb has been a group number and group size of 30 (that is, minimum sample of 900), with more groups when interested in cross-level interactions (see p. 215 [246]). In 2014, simulations of models with cross-level interactions suggested that a group number of 20 with a group size as low as 5-10 (see p.214 [246]) was sufficient for nonbiased fixed-effect estimates and their standard errors. For variance terms, a group number of 30 was required although their standard errors may have still been biased [245]. Further, when the ICC was small (<0.1), biased estimates were less problematic [245]. As stated in the preceding section, the group number for stratified analyses were within these recommended ranges, with a substantially larger group size. However, failure to detect a true effect or underestimating effect size remained a possibility. To that end, power calculations were undertaken to facilitate interpretation of findings of cross-level interactions.

5.6 Statistical Analyses for Study 2

Having discussed the literature in depth with respect to methodological issues in multilevel analysis, this discussion now focuses on the specific analyses and model specification applied in Study 2.

5.6.1 Descriptive Analyses

Initial univariate analysis and descriptive statistics allowed exploration of the underlying data at the individual level. Area-level data was described in detail in Chapter 3. Baseline characteristics of the sample are reported for the total sample and stratified by SEP. Bivariate OLS regression analyses were used for initial exploration of the relationships between explanatory variables and outcomes. Findings are presented in Chapter 6 and Appendix C.

5.6.2 Multilevel Analysis

For the main analyses, multilevel logistic regression models were used, with study participants (level 1) nested within their SA3 of residence (level 2). Residuals at each level are assumed to be normally distributed, with zero mean and constant variance, with independence between area and individual residuals. Figure 17 outlines the data structure and levels that variables are operationalised at in order to facilitate explanation of the specified models for the analyses.

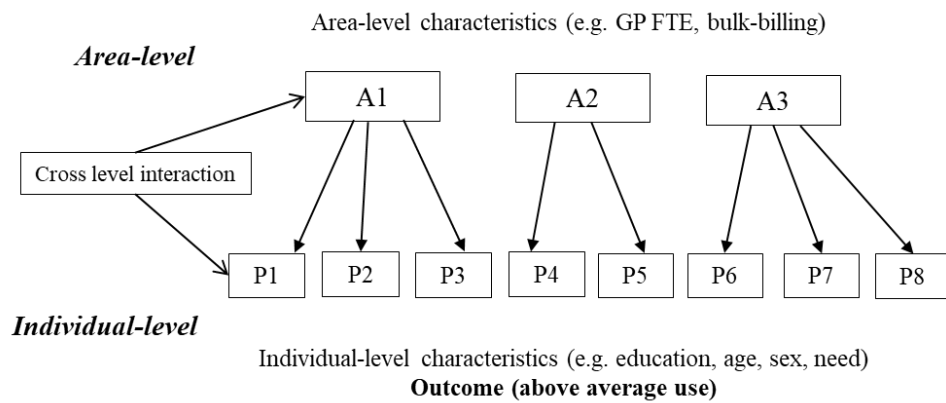


Figure 17. Schematic outline of multilevel structure of data and variables for Study 2

A series of two-level random intercept multilevel models were run for the main and supplementary analyses for each outcome measure described above, using four model specifications.

Null model:

- Random intercept to determine if there was any significant variation in the outcome measure across areas.
- No individual or area-level explanatory variables were included

Model 2:

- Includes individual-level sociodemographic (SEP, age, sex and confounders) and
- Need explanatory variables (self-rated health, chronic conditions and physical functioning),

To determine presence of need-adjusted socioeconomic variation in outcome variables (having accounted for between-area variation).

Model 3:

- Includes variables in Model 2,
- Plus each area-level PHC service characteristic variable of interest, added separately to quantify the extent of variation in the outcome explained by each characteristic and the strength of association between each characteristic and the outcome.

Model 4:

- A cross-level interaction term between individual SEP and each area PHC service characteristic variable was added to Model 3 to determine whether these area characteristics modified the relationship between SEP and the outcome variable.

Area-level variation in each outcome was estimated from the variance term (V_A) by calculating the ICC by the linear threshold model method ($ICC = V_A / (V_A + 3.29)$) and the median odds ratio ($MOR = \exp(0.954\sqrt{V_A})$) [190]. The proportional change in variance ($PCV = (V_A - V_B / V_A) \times 100$)

[191] was used to estimate the proportion of overall variation in outcome explained by addition of explanatory variables to the model.

Second-order penalised quasi-likelihood (PQL) estimation was used as per Rasbash and colleagues [247]. Null single-level and multilevel models were also fitted with Monte Carlo Markov Chain (MCMC) estimation in order to assess model fit statistics. Area-level residuals were also plotted to examine for between-area variation and appropriateness of a two-level model for the data, as well as testing for normality as per model assumptions. Area-level variables were fitted as categorical and continuous measures. To facilitate interpretation, only area categorical variables that demonstrated a monotonic relationship with outcomes (and hence were appropriate for use as linear variables) were included in models for testing interaction terms.

All data were managed and prepared in Stata v14 and multilevel analysis performed using the `runmlwin` add-on. The `runmlwin` command is able to fit the full range of multilevel models available to MLwiN easily from within Stata [244]. This enables use of MLwiN capacity for running models quickly while allowing the use of Stata do files and post estimation procedures, avoiding much of the point and click mechanics of MLwiN. Graphical examination of significant and meaningful interaction terms was undertaken using MLwiN (v.2.35) customised predictions window as this process was completed more readily in MLwiN compared with Stata. All data preparation and analyses were completed within SURE.

5.6.3 Stratification

As demonstrated in Chapter 3, there is significant regional variation in area PHC service characteristics. So too, in use and quality of GP care and specialist use (see Chapter 4). Given this, it is reasonable to expect relationships between area PHC service characteristics and the outcomes examined in this study to vary according to region. On the basis of this, all analyses were stratified according to the region of the SA3 (as per the variable *region* in Chapter 3) in which each participant resided. In brief, analyses were stratified by SA3 areas categorised as ‘major cities’, ‘inner regional’ and ‘outer regional/remote’. This categorisation was chosen as there are very few remote and very remote SA3s in NSW (only 1.85% of the population for remote and very remote area combined), and combining outer regional and remote areas was necessary to sufficiently power multilevel analyses.

Analyses examining *after-hours care* as an area level explanatory variable were restricted to major cities and inner regional areas, as after-hours care is not adequately captured by this measure in outer regional and remote areas (see Chapter 3 for discussion on this).

5.6.4 Supplementary Analyses

The complete stratified model series were also carried out for the two alternative SEP measures, *income* and *continuous education*.

For analyses examining specialist use, only the first two of the model specifications described above were completed for the main SEP measure of interest, *education*. This was in order to determine the extent of individual-level socioeconomic and area level of ambulatory specialist care, given that access to this care is essential in supporting the provision of PHC in Australia.

5.6.5 Sensitivity Analyses

Fully adjusted models for individual covariates (Model 2) were run for the alternative dichotomous outcome measures of use.

5.7 Ethics

Ethics approval for this project was obtained from the NSW Population and Health Services Research Ethics Committee, the University of Western Sydney Ethics Committee and the Australian National University Human Research Ethics Committee.

The results for the second study are presented in Chapter 6.

Chapter 6

The Modifying Effect of Area Primary Health Care Service Characteristics on Socioeconomic Variation in Receipt of the Primary Health Care: Results

Having outlined the research question, aims and hypotheses (in Chapter 4) and methods (in Chapter 5) for Study 2, this chapter presents the findings. Descriptive statistics for the study sample and the relationship of explanatory variables with SEP are presented first, followed by the results of the main analyses presented separately for each of the outcomes examined: frequency of GP use; quality of GP care (measured by receipt of long consults, continuity of care and receipt of care planning); and specialist use (any use). Results for each outcome are presented in the following format:

1. Bivariate relationships with explanatory variables are described
2. Between-area variation in the outcome (all outcomes) and the contribution of PHC service characteristics to explaining this variation (from multilevel models) (GP use and quality of care outcomes only)
3. Individual-level socioeconomic variation in the outcome (all outcomes) and the modifying effect of PHC service characteristics on this variation (cross-level interactions from multilevel models) (GP use and quality of care outcomes only)

Main results with *education* as the SEP variable are presented here, as well as the most relevant findings from supplementary analyses. Appendix E contains information about model diagnostics and detailed results for *income* and *continuous education* and for sensitivity analyses.

6.1 Descriptive statistics

6.1.1 Sample Characteristics

Of the original study sample of 267,112 participants, 2,029 (0.75%) were excluded as per the exclusion criteria (Figure 18), leaving a final sample size of 265,083.

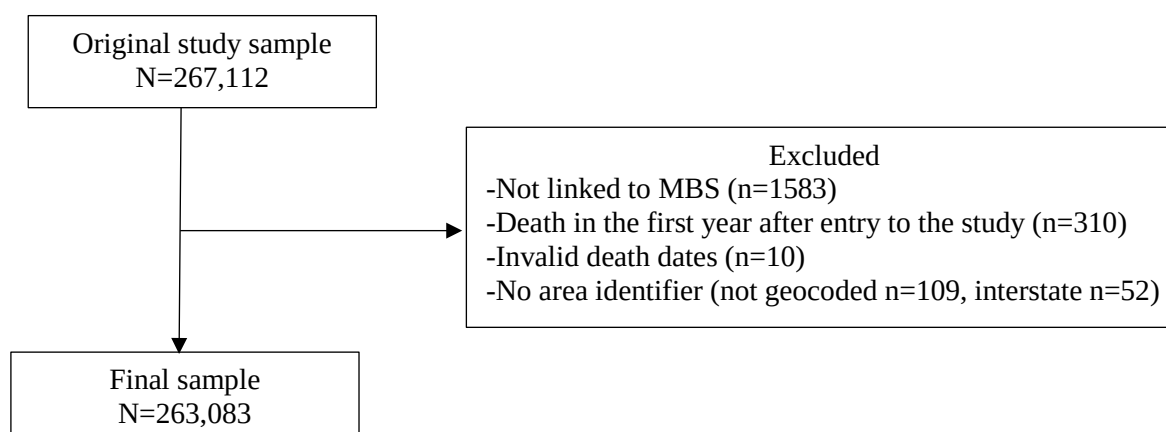


Figure 18. Study sample exclusion flow diagram

The sample was distributed across regions as follows: For major cities, there were 40 SA3s with a mean number of participants of 2373 (minimum 582); for inner regional areas, the respective counts were 28 areas and 3358 participants (minimum 107) and; for outer regional/remote areas, 23 areas and 2948 participants (minimum 39).

6.1.1.1 Participant characteristics

The mean age of the sample was 62.7 years (SD 11.2), 46% were male, the majority were born in Australia or New Zealand (76.8%), most were married or in a de-facto relationship (74.7%). Most of the sample population were in the mid categories for educational attainment (63.6%), with few in the lowest category (11.7% had no school certificate). With respect to need variables, over 80% rated their health as good, very good or excellent, 73% had at least one chronic condition, and just over 50% had no or minor limitation in their physical functioning (see Table 14 for the full results).

6.1.1.2 Individual SEP and explanatory variables

People with lower education were more likely to be female, older, born in Australia or New Zealand, not married or in a de facto relationship, rate their health as poor or fair, have more chronic conditions, and have greater physical limitation than those with higher education (p-value for all associations <.001, Table 14).

People with lower education were also more likely to live in areas with fewer GPs per capita (*AIHW FTE*), lower *OOP expenses* and *after-hours care* and higher *bulk-billing*, *CD care* and

health assessments than those with higher education (p-value for all trends <.001, see Table C1 in Appendix C for full results).

Table 14. Sample characteristics: individual-level variables by educational attainment (%) and for total sample

Variable	Educational attainment					Total for row category (n)	% in each variable category
	No school certificate	School certificate	Apprentice/ diploma	University	Missing		
Educational attainment							
Total (n)	31,126	84,302	84,294	60,933	4,428	265,083	
% of total	11.7	31.8	31.8	23	1.7		100
Sex							
Male	42.1	36.1	55.2	50.0	48.6	122,893	46.4
Female	57.3	63.9	44.8	50.0	51.5	142,190	53.6
Age							
45–54	16.5	24.4	31.6	40.1	14.4	77,397	29.2
55–64	27.4	32.9	31.9	34.8	22.6	85,342	32.2
65–74	28.9	23.7	21.5	15.7	25.4	57,734	21.8
75–84	21.8	15.3	12.7	8.0	28.8	36,516	13.8
85 plus	5.4	3.8	2.3	1.5	8.8	8,082	3.1
missing	0.0	0.0	0.0	0.0	0.0	12	0
Country of birth							
Australia/NZ	75.9	80.8	76.9	72.5	64.8	203,629	76.8
Europe/ N. America	18.6	13.4	17.7	16.8	20.9	43,154	16.3
Asia	2.3	2.6	2.3	6.5	4.0	9,031	3.4
Africa/Mid. East	1.1	1.5	1.3	2.7	1.7	4,397	1.7
Other	0.5	0.8	0.9	0.8	0.9	2,145	0.08
Missing	1.5	1.0	0.8	0.7	7.7	2,727	1
Marital status							
Not married/ not de facto	32.6	26.2	22.3	21.0	33.5	65,288	5.7
Married/de facto	66.8	73.3	77.1	78.5	64.3	198,185	74.7
Missing	0.7	0.5	0.6	0.6	2.2	1,610	0.6

Variable	Educational attainment					Total for row category (n)	% in each variable category
	No school certificate	School certificate	Apprentice/ diploma	University	Missing		
Self-rated health							
Excellent	7.4	12.2	14.1	22.4	10.1	38,575	14.6
Very good	25.6	35.0	36.8	40.8	24.6	94,481	35.6
Good	36.3	34.5	33.8	26.5	32.1	86,451	32.6
Fair	20.5	12.3	10.7	6.9	17.5	30,644	11.6
Poor	4.8	2.2	1.8	1.0	4.0	5,575	2.1
Missing	5.5	3.8	2.9	2.4	11.8	9,357	3.5
Chronic conditions							
none	20.7	25.4	27.3	31.2	25.2	70,991	26.8
1–2	49.9	52.0	52.6	53.0	50.1	198,116	52.1
3 or more	29.4	22.6	20.2	15.8	24.7	55,976	21.1
Physical functioning							
No limitation	18.9	26.5	30.0	39.4	19.2	78,323	29.5
Minor limitation	15.4	23.2	26.9	30.2	14.5	66,072	24.9
Moderate limitation	21.4	22.5	21.6	17.3	16.7	55,097	20.8
Severe limitation	21.8	12.9	10.3	5.5	16.5	30,367	11.5
missing	22.5	14.9	11.4	7.7	33.1	35,224	13.3

Notes:

1. N, number; %, percentage.
2. Columns for each variable category for each educational attainment categories sum to 100%. Values in last two columns give break down by category for each individual variables for the total sample, not stratified by educational attainment. For each variable, total (n) sums to 265,083 and percent sums to 100%.
3. Chi-squared test for trend with education $p < .001$ all variables.

6.2 Frequency of GP Use

6.2.1 Univariate and Bivariate Analysis

Overall, 94% of the sample visited a GP at least once in the first year after entry into the study. The average number of visits in a year was 7.5 (SD 7.2), and 37.5% were classified as having above-average use (that is, ≥ 8 visits per year; see Table 15). Increasing SEP, as measured by *education*, was associated with a decreasing probability of above-average use. As the relationship with *education* was monotonic, this confirmed that educational attainment is suitable for calculating a continuous measure based on the ranked cumulative proportion of the population in each category (*continuous education*, supplementary analysis).

Table 15. GP use categories, by *education* (%), number of respondents in each category and percentage of total sample

GP use	<i>Education</i>					Total for row category (n)	% in each variable category
	No school certificate	School certificate	Apprentice/ diploma	University	Missing		
Below average (%)	46.5	59.0	64.4	74.3	47.8	165,803	62.6
Above average (%)	53.6	41.1	35.6	25.7	52.2	99,280	37.5
Total participants	31,126	84,302	84,294	60,933	4,428	265,083	100

Notes:

1. GP, general practitioner; n, number; %, percentage.
2. Columns for each educational attainment categories sum to 100%. Values in last two columns give total number and percentage of participants in each category of GP use.

Bivariate regression analyses demonstrated expected relationships (based on existing literature) between individual explanatory variables and above-average use. Specifically, increasing age, female gender, not being married or in a de facto relationship, country of birth other than Australia or New Zealand, poor health, chronic disease and poor physical functioning were all associated with above-average GP use (all $p < .001$). For full results see Table C2 in Appendix C.

There was a significant trend towards a decreased probability of above-average use in areas that were more remote. When stratified by region (major cities, inner regional, outer regional/remote), bivariate analyses of categorical and continuous area PHC characteristics with GP use showed a similar pattern across regions, although there were some distinct regional differences for some measures. For example, increasing GP availability was associated with decreased probability of above-average use in cities, but the reverse was seen in inner regional and outer regional/remote areas (see Appendix C for full results). For nearly all area PHC service characteristics across all regions, the relationship with above-average use was approximately monotonic. For ease of interpretation, PHC service characteristics were included as categorical variables for multilevel models examining associations of characteristics with above-average use (Model 3). However, in models examining cross-level interactions between *education* and area characteristics (Model 4), they were included as continuous variables, to minimise the number of terms and facilitate interpretation. Only *OOP expenses* for inner regional areas did not have a clear monotonically increasing or decreasing relationship with above-average use; hence, it was not included as a cross-level interaction term.

6.2.2 Multilevel Analyses

6.2.2.1 Multilevel analyses, part 1: between-area variation in GP use and the association with PHC service characteristics

6.2.2.1.1 Between-area variation in GP use

There was marked variation in use of GP services across areas in the null model, apparent in all regions ((MOR: major cities 1.45, inner regional 1.30, outer regional/remote 1.29; see Table 16). These MORs are a means of expressing the amount of between-area variation and indicate that, when a person moves from an area of lower to higher probability of above-average use, their odds of above-average use will increase by 29–45%, depending on the region. Expressed another way, when comparing all people with identical covariates but residing in different areas (within the same region), the median increase in the odds of above-average GP use for persons living in an area of higher odds compared to an area of lower odds is 29–45%.

Table 16. Between-area variation in odds of above-average GP use.

	Null model	Model 2
Cities		
ICC	0.044	0.028
PCV (%)	na	36
MOR	1.45	1.34
Inner regional		
ICC	0.023	0.026
PCV (%)	na	-13
MOR	1.30	1.32
Outer regional/remote		
ICC	0.022	0.029
PCV (%)	na	-32
MOR	1.29	1.35

Notes:

1. ICC, intra-class coefficient; PCV, proportional change in variance (reported change from null model); MOR, median odds ratio.
2. Null model, random intercept only, no covariates; Model 2 adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation.
3. Wald test that between-area variance for the null model is non zero (i.e. $\delta_u^2=0$) $p<.001$. See Appendix G for full details of model diagnostics.

In cities, just over a third of the between-area variation in the probability of above-average use was explained by individual characteristics, as indicated by the reduction in the ICC in Model 2 (see Table 16). That is, there was a 36% reduction in the proportion of variance explained at the area level by the addition of individual characteristics to the model (expressed as the proportional change in variance [PCV]). In the case of regional and remote areas, however, between-area variation increased after adjustment for individual characteristics. That is, the differences in GP use between areas was greater after accounting for the characteristics of those who lived in those areas.

The between-area variation remaining in Model 2 after adjustment for individual characteristics is shown in Figure 19. The unexplained between-area variation was similar across regions after adjustment for individual characteristics, as demonstrated by the similar MORs and ICCs in Table 16 as shown by the distribution of the residuals plotted in Figure 19. Findings were the same in supplementary analyses with *income* and *continuous education* as the SEP measure (see Appendix C for full results).



Figure 19. Difference between mean for each SA3 and the mean across all areas in log odds of above-average use (95% CI) for each SA3, by region

Notes:

1. GP, general practitioner; CI, confidence interval; SA3, statistical area 3.
2. Estimates from Model 2, i.e. adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation.
3. Mean log odds of above-average use across areas for that region set a 0 and given by the horizontal red line
4. Each dot represents the mean for each SA3 of the difference in log odds of above-average use for each person in that SA3 from the mean log odds of above-average use for all areas (i.e. the mean of the residuals by SA3). Bars are the 95% confidence intervals around the mean for each SA3. SA3 values that lie above and below the red with CIs that do not cross the red line, are significantly different from the mean log odds of above-average use for all SA3s in that region. A person living in an area above the line has a higher probability of above-average GP use than the overall sample mean, irrespective of their individual characteristics.

6.2.2.1.2 Area-level PHC service characteristics

The addition of area PHC service characteristics separately to the model (specifically, *AIHW FTE* per capita, *OOP expense*, *bulk-billing* and *after-hours care* in Models 3a–f) explained some of the between-area variation in above-average GP use, with some measures explaining more variation than others (as shown in Table 17). The proportion of variance explained also depended on the region examined. Significant associations between PHC characteristics and GP use (fixed part of the model) were consistent with proportion of variance explained (random part). As discussed in Chapter 5, given the lack of a clear conceptual relationship between *CD care* and *health assessments* and GP use, these variables were not investigated for this outcome.

In major cities, as expected, a person who lived in areas that were more affordable and had better accommodation was more likely to have above-average use of GP services (Table 17, Figure 20). That is, increasing *bulk-billing* and *after-hours care* and decreasing *OOP expenses* were associated with an increased probability of above-average use (PCV: *OOP expenses*, 71%; *bulk-billing* 86%; *after-hours care*, 29%; in major cities). This pattern was evident for measures of affordability across all regions. Contrary to expectation, in major cities more availability within an area was associated with decreased use (PCV 21%), with no relationship with use in regional areas (Table 17, Figure 20). Findings were comparable in supplementary analyses (for full results see Appendix C). It should be noted that lack of power for regional areas may have limited the ability to detect some associations.

Table 17. Models 3a–3d: association of each PHC characteristic with above-average GP use, adjusted for individual covariates

	<i>AIHW FTE (3a)</i> OR (95%CI)	<i>OOP expenses (3b)</i> OR (95%CI)	<i>Bulk-billing (3c)</i> OR (95%CI)	<i>After-hours care (3d)</i> OR (95%CI)
Cities				
1st quartile (ref)	1	1	1	1
2nd quartile	0.68 (0.48–0.97)	0.78 (0.68–0.89)	1.23 (1.07–1.40)	1.23 (0.71–2.12)
3rd quartile	0.78 (0.55–1.11)	0.65 (0.55–0.77)	1.52 (1.35–1.70)	1.73 (1.01–2.96)
4th quartile	0.59 (0.42–0.84)	0.51 (0.44–0.58)	2.11 (1.89–2.35)	1.76 (1.03–3.02)
p-value for term	0.009	<.001	<.001	<.001
ICC	0.022	0.008	0.004	0.020
PCV (%)	21	71	86	29
MOR	1.29	1.17	1.11	1.28
Inner regional				
1st quartile (ref)	1	1	1	1
2nd quartile	1.07 (0.78–1.46)	1.00 (0.71–1.40)	1.68 (1.44–1.95)	1.13 (0.90–1.42)
3rd quartile	0.96 (0.70–1.30)	0.88 (0.63–1.23)	1.76 (1.50–2.06)	1.49 (1.00–2.22)
4th quartile	1.30 (0.98–1.73)	0.56 (0.39–0.80)	–	1.42 (1.05–1.93)
p-value for term	0.279	<.001	<.001	0.058
ICC	0.023	0.012	0.008	0.021
PCV (%)	12	54	69	19
MOR	1.3	1.21	1.16	1.29
Outer regional				
1st quartile (ref)	1	–	1	
2nd quartile	0.95 (0.67–1.35)	1	1.24 (0.98–1.57)	
3rd quartile	1.19 (0.80–1.75)	0.74 (0.56–0.97)	1.66 (1.34–2.07)	
4th quartile	0.91 (0.62–1.35)	0.64 (0.49–0.83)	–	
p-value for term	0.735	0.004	<.001	

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>Bulk-billing (3c)</i>	<i>After-hours care (3d)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
ICC	0.028	0.020	0.014	
PCV (%)	3	31	52	
MOR	1.34	1.28	1.23	

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket; ICC, intra-class coefficient; PCV, Proportional change in variance.
2. PCV reported change from model adjusted for sociodemographic and need variables (Model 2).
3. MOR median odds ratio. Wald test of significance for addition of area variable. Significant values bolded.
4. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

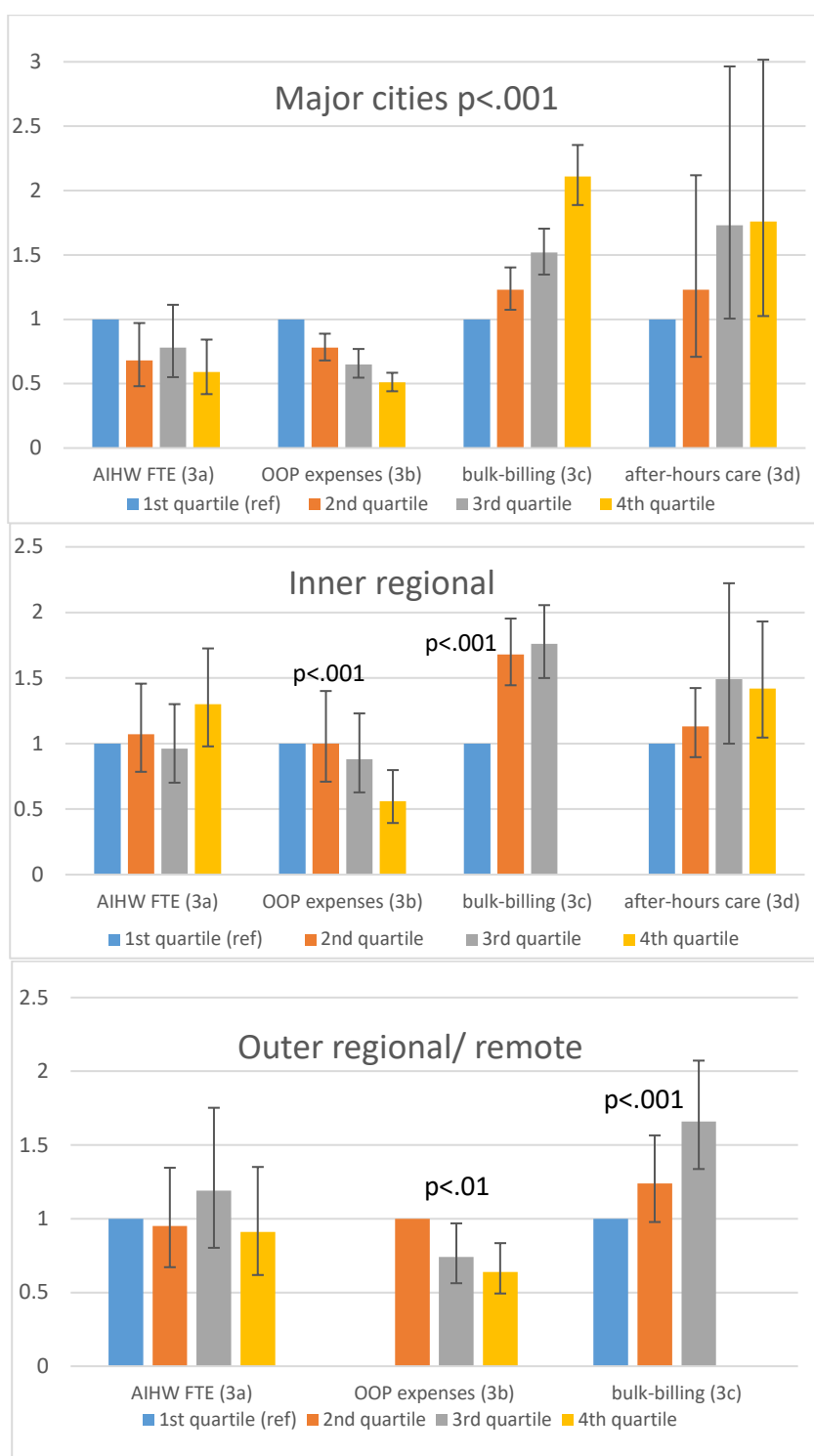


Figure 20. Models 3a–3d: association of PHC characteristics with above-average GP use, ORs and 95% CIs, by region

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket.
2. Odds ratio and 95% confidence intervals shown, Wald joint test of significance shown. In major cities all terms significant. Models adjusted for individual sociodemographic and need variables.

6.2.2.1.3 Summary of between-area variation in GP use

The probability of above-average use varies between areas, with the extent of between-area variation similar across regions after accounting for the characteristics of people living in those areas. Area-level PHC service characteristics explain part of the between-area variation in GP use. Findings quantifying strength of associations support the hypothesis that the increasing presence of area PHC service characteristics indicative of strong PHC systems, namely more bulk-billing and after-hours care and lower out-of-pocket costs, was associated with increased GP use. In contrast, availability was not associated with increased use, which was contrary to expectation. The interpretation and implications of these results is discussed in Chapter 7.

6.2.2.2 Multilevel analyses, part 2: Individual-level socioeconomic variation in GP use and the modifying effect of PHC service characteristics

Having established that, for the most part, area PHC service characteristics are associated with an increased probability of above-average use (having accounted for individual characteristics), the analysis now turns to determine if these characteristics modify socioeconomic variation in GP use. Specifically the analyses will investigate if the association between SEP and use changes depending on service characteristics in that area. If the change in association between SEP and use with the increasing presence of an area characteristic is in a direction that confers a larger increase in the probability of above-average use for a person of low SEP (compared to high), then that area characteristic can be viewed as pro-low SEP.

Individual-level socioeconomic variation, adjusted for individual-level need and between-area variation in use, is first quantified. The findings from the cross-level interaction models (Models 4a-4d) are reported in the next section. Main results with *education* as the SEP of interest are presented first. Following this, additional relevant findings from supplementary analyses are presented.

6.2.2.2.1 Individual-level socioeconomic variation in GP use

In all three regions, increasing education level was associated with decreasing probability of above-average GP use, having taken in account between-area variation and after adjusting for need and other explanatory variables (Table 18). That is, for a given level of need and irrespective of where a person lives, those who have lower education are more likely to have above-average use. This pattern was found regardless of the SEP measure used (see Appendix C for results for *continuous education* and *income*). The other explanatory variables demonstrated patterns as per bivariate analyses (see Appendix C for full model series).

Table 18. Model 2: fixed effects for above-average GP use by region

	Major cities	Inner regional	Outer regional/remote
	OR (95% CI)	OR (95% CI)	OR (95% CI)
No school certificate (ref.)	1	1	1
School certificate	0.76 (0.72–0.80)	0.82 (0.78–0.86)	0.83 (0.78–0.87)
Apprentice/ diploma	0.70 (0.67–0.74)	0.76 (0.72–0.80)	0.75 (0.71–0.80)
University	0.52 (0.49–0.55)	0.61 (0.58–0.65)	0.58 (0.54–0.62)

Notes:

1. GP, general practitioner; OR, odds ratio; CI, confidence interval; 5, percentage; ref., reference.
2. Adjusted for sociodemographic (educational attainment, age, sex, country of birth, marital status) and need (self-rated health status, number of chronic disease, physical functioning) variables.
3. Wald joint test of significance for education $p < .001$ for all regions

6.2.2.2.2 Cross-level interactions: modifying effect of area PHC characteristics on socioeconomic variation in GP use: main analyses

In order to determine whether area PHC characteristics modify the relationship between SEP and GP use, cross-level interaction terms between education categories and area PHC service characteristics as continuous variables were added to Model 2 (Models 4a–4d, Table 19). Only those area characteristic variables that had a monotonic relationship with above-average GP use in bivariate analyses were included in the interaction models. Odds ratios for these terms are interpreted as the effect of an increasing level of the PHC characteristic on the odds of above-average GP use for that education category, compared with the lowest education category (no school certificate).

Estimates for interaction terms for each PHC characteristic with education can be interpreted as follows. Where the odd ratios are <1 , this indicates that the increasing presence of that PHC service characteristic is pro-low SEP (the difference between groups with the increasing presence of a service characteristic is such that a person of low SEP has relatively more use than persons of higher SEP). Where the odds ratios are >1 , this indicates that the PHC service characteristics is pro-high SEP (the difference between groups with the increasing presence of a service characteristic is such that a person of high SEP has relatively more use than persons of lower SEP). Only significant interactions are discussed here.

Table 19. Model 4: cross-level effect modification, GP use. OR (95% CIs) for area PHC service characteristics (continuous) and as interaction with education

PHC characteristic and interaction terms	Cities	Inner regional	Outer regional/ remote
	OR (95%CI)	OR (95%CI)	OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	0.583 (0.344–0.988)	1.314 (0.676–2.555)	0.62 (0.316–1.215)
No school certificateX <i>AIHW FTE</i>	1	1	1
School certificateX <i>AIHW FTE</i>	0.852 (0.609–1.193)	1.264 (0.959–1.668)	1.172 (0.842–1.631)
Apprentice/diplomaX <i>AIHW FTE</i>	0.842 (0.602–1.179)	1.351 (1.024–1.782)	1.235 (0.872–1.750)
UniversityX <i>AIHW FTE</i>	0.670 (0.481–0.934)	1.303 (0.953–1.782)	1.396 (0.903–2.159)
p-value for interaction	0.027	0.197	0.472
<i>OOP expenses (Model 4b)</i>	0.948 (0.929–0.967)	–	0.895 (0.845–0.948)
No school certificateX <i>OOP expenses</i>	1	–	1
School certificateX <i>OOP expenses</i>	0.988 (0.972–1.004)	–	1.017 (0.987–1.047)
Apprentice/diplomaX <i>OOP expenses</i>	0.996 (0.980–1.012)	–	0.999 (0.970–1.030)
UniversityX <i>OOP expenses</i>	0.992 (0.976–1.008)	–	1.017 (0.981–1.055)
p-value for interaction	0.223	–	0.421
<i>Bulk-billing (Model 4c)</i>	1.022 (1.016–1.028)	1.029 (1.019–1.039)	1.031 (1.017–1.044)
No school certificateX <i>bulk-billing</i>	1	1	1
School certificateX <i>bulk-billing</i>	1.006 (1.001–1.011)	1.000 (0.994–1.007)	0.996 (0.989–1.003)
Apprentice/diplomaX <i>bulk-billing</i>	1.001 (0.996–1.007)	0.996 (0.990–1.003)	1.001 (0.993–1.008)
UniversityX <i>bulk-billing</i>	1.003 (0.998–1.009)	0.991 (0.984–0.998)	0.996 (0.987–1.004)
p-value for interaction	0.027	0.007	0.364
<i>After-hours care (Model 4d)</i>	1.025 (0.99–1.060)	1.061 (1.021–1.102)	–
No school certificateX <i>after-hours care</i>	1	1	–
School certificateX <i>after-hours care</i>	1.029 (1.008–1.050)	0.989 (0.969–1.009)	–
Apprentice/diplomaX <i>after-hours care</i>	1.033 (1.011–1.055)	0.983 (0.963–1.003)	–
UniversityX <i>after-hours care</i>	1.038 (1.015–1.060)	0.990 (0.969–1.012)	–
p-value for interaction	0.008	0.382	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket.
2. Models 4a–d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. OR for area characteristic as a continuous variable given, followed by OR for interaction term for each education level.
3. P-value, Wald test of joint significance for addition of cross-level interaction term. Significant terms bolded.
4. In models with income, the interaction term for out-of-pocket expenses in major cities is statistically significant and is in the same direction as seen in this table.
5. Interaction term for *OOP expenses* in inner regional areas not tested, as relationship with above-average use was not monotonic.

Cross-level interactions revealed the complexity of the relationship between these PHC service characteristics and socioeconomic variation in GP use (see Table 19). Odds ratios are given for an area characteristic as a continuous term, followed by odds ratios for the interaction term between that area characteristic and each education level. Significant interactions are demonstrated in Figures 21–23. While a number of the PHC characteristics did modify the relationship between education and GP use, the effect was not always in the direction anticipated, and it was different across regions. Table 20 summarises the findings for associations between area characteristics as a categorical variable and GP use (Part 1 of results for multilevel analyses, as reported in Table 17), and whether these can be viewed as pro-low or high SEP based on cross-level interactions (Part 2 of results for multilevel analyses, as reported in Table 19). Table 31 summarises the cross-level interaction findings by region for main and supplementary analyses for all outcomes (that is, GP use and quality of care).

In major cities, increased *bulk-billing* and *after-hours care* were associated with increased use across all education levels. However, the increase in use from areas of low to high *bulk-billing/after-hours care* was larger for persons of higher educational attainment (see Figure 21); that is, the association of these characteristics with use was pro-high SEP.

As described in Section 6.2.2.1.2, in major cities increasing availability (GP FTE per capita) was associated with decreased use across all education levels. However, as shown in Figure 22a, the absolute reduction in use with increased availability was larger for persons of high education. As such, in major cities increasing availability may be viewed as pro-low SEP, but only insofar that the associated reduction in use was less for a person of low-education compared to high.

In regional areas, increasing *bulk-billing* was also associated with increased GP use. In contrast with cities, however, the increase in use was larger for persons of low education (see Figure 23). Hence, in regional areas, more *bulk-billing* within areas was pro-low education. Interaction terms for other characteristics in regional areas were not significant.

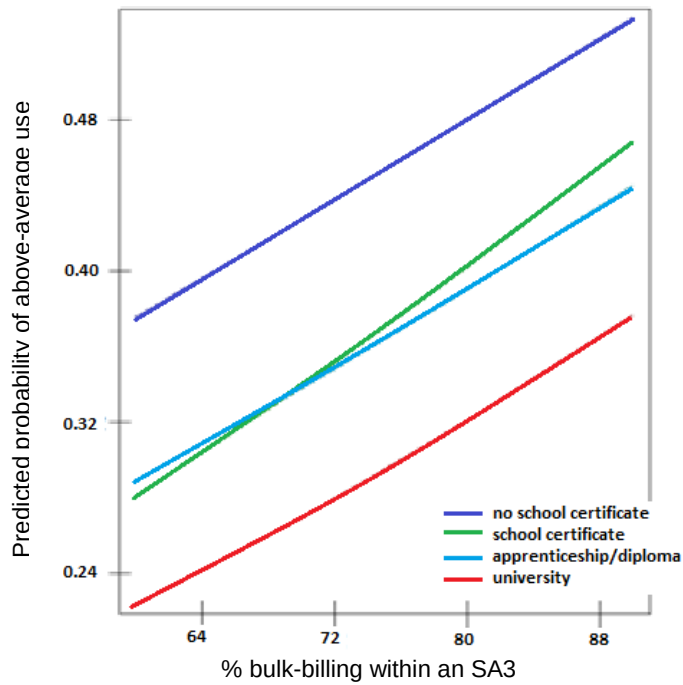


Figure 21(a). Cross-level effect modification, major cities: predicted probabilities of above-average for each education category by bulk-billing

Notes:

1. Percentage of bulk-billing values for prediction ranged from 60–90% of all services.
2. After-hours percent values for prediction ranged by 3–12% of all services.
3. Interaction terms all significant to the $p < .05$ level.

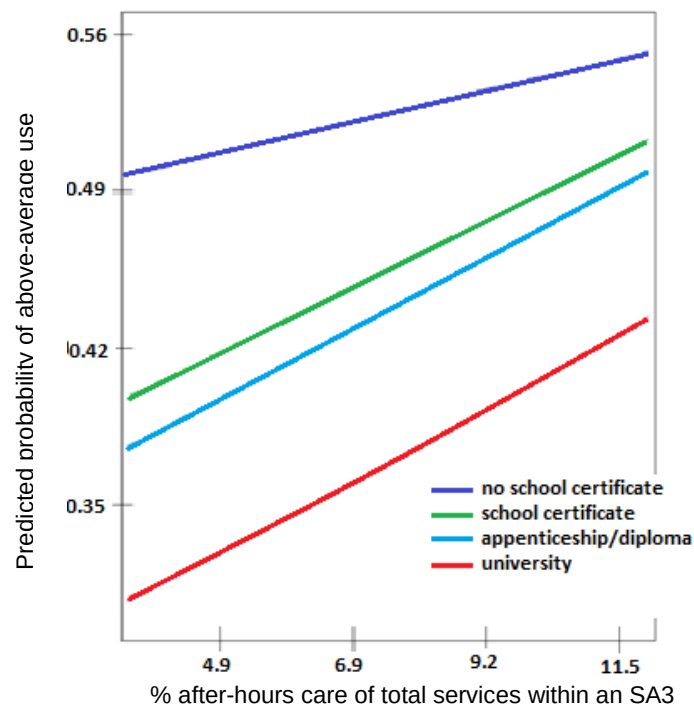


Figure 21(b). Cross-level effect modification, major cities: predicted probabilities of above-average for each education category by after-hours

Notes:

1. Percentage of bulk-billing values for prediction ranged from 60–90% of all services.
2. After-hours percent values for prediction ranged by 3–12% of all services.
3. Interaction terms all significant to the $p < .05$ level.

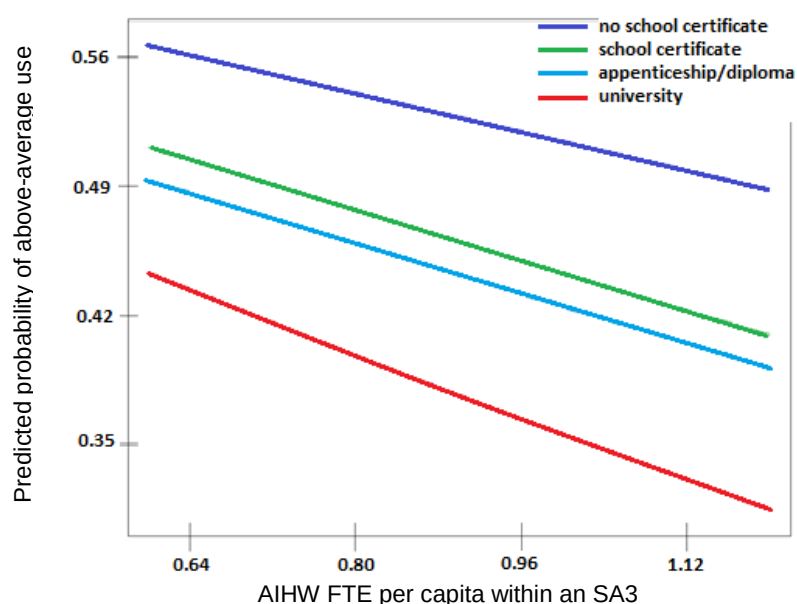


Figure 22(a). Cross-level effect modification, availability: predicted probability of above-average use for AIHW FTE by educational category for major cities

Notes:

1. AIHW FTE values used for prediction 0.6, 0.8, 1 and 1.2 FTE per 1000 population.
2. Continuous education of 0.1 corresponds to the proportion of the population in the lowest education category, and a continuous education of 0.85 is cumulative proportion of the population in the highest education category.

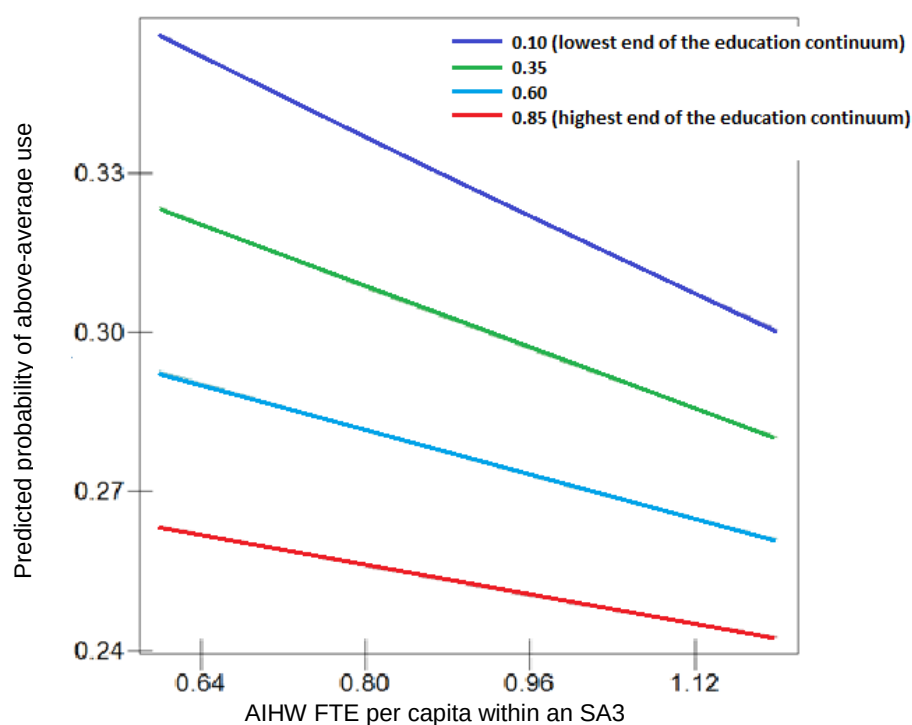


Figure 22(b). Cross-level effect modification, availability: predicted probability of above-average use for AIHW FTE for continuous education, outer regional/remote

Notes:

1. AIHW FTE values used for prediction 0.6, 0.8, 1 and 1.2 FTE per 1000 population.
2. Continuous education of 0.1 corresponds to the proportion of the population in the lowest education category, and a continuous education of 0.85 is cumulative proportion of the population in the highest education category.

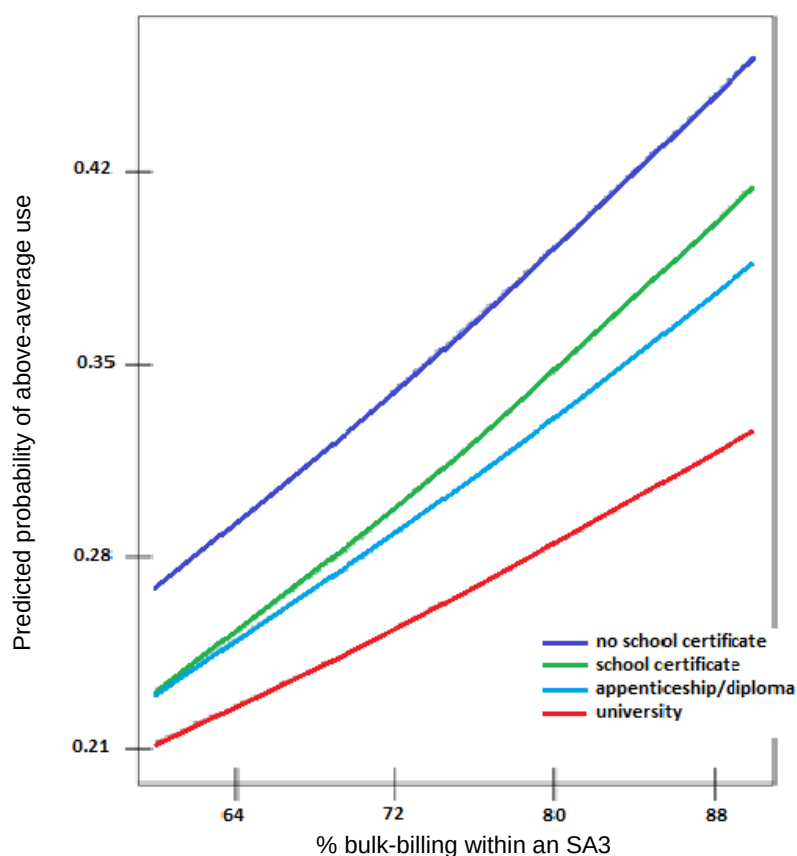


Figure 23. Cross level-effect modification, inner regional: predicted probabilities of above-average use for each educational category for bulk-billing

Notes:

1. Percentage of bulk-billing values for prediction ranged from 60–90% of all services.
2. Interactions significant to the $p < .05$ level.

6.2.2.2.3 Cross-level interactions: supplementary analyses

In supplementary analyses, where income and continuous education were used instead of categorical SEP, findings in major cities were unchanged from the main analyses for *AIHW FTE*, *bulk-billing* and *after-hours care*. In analyses with income, the interaction term for *OOP expenses* was significant in major cities, with the direction of association consistent with that found for other characteristics in the main analysis. That is, the increase in above-average GP use from areas of high to low *OOP expenses* was greater for high-income persons (see Table C10 in Appendix C). Hence, more affordable areas (as measured by decreasing *OOP expenses*) were associated with a larger increase in use for a person of high SEP compared to low SEP.

For outer regional/remote areas, unlike in the main analyses, the interaction terms for availability in the supplementary analyses were significant and the pattern of association differed to that found for availability in major cities. Figure 22b plots the predicted probabilities of above-average use with increasing availability by *continuous education* for inner regional areas. It can be seen that, for the theoretical lowest end of the education continuum, more availability was associated with

larger decrease in use, compared with the theoretical highest end of the education continuum. That is, the association was pro-high SEP. For full results, see Table C11 in Appendix C.

While the interaction term for *after-hours care* in inner regional areas was significant in supplementary analyses with income, the direction of association was uninterpretable.

6.2.2.2.4 Summary for cross-level interactions

In summary, while living in areas with more *bulk-billing* and lower *OOP expenses* (affordability measures) and more *after-hours care* (accommodation) was associated with increased use for all SEP groups, only *bulk-billing* in regional areas was associated with a larger increase in use for those of low SEP (that is, pro-low SEP). That is, a person of low SEP who lives in an area with more bulk-billing was even more likely to have increased use, compared with their high-SEP counterpart. The relationship between availability and GP use was contrary to what was anticipated, with findings suggesting that increasing availability was not associated with a specific benefit for low-SEP persons (in terms of increased use) in either major cities or regional areas. The possible reasons for these findings are discussed in Chapter 7.

Table 20. Summary of significant findings for PHC characteristics and probability of above-average GP use for main analyses with education: direction of association and pro-low or pro-high SEP effect

PHC characteristic	Association with above-average use	Cross-level effect: low or high education
<i>AIHW FTE</i>	↓ (major cities only)	Low (major cities)
<i>OOP expenses</i>	↓	-
<i>Bulk-billing</i>	↑	High (major cities) Low (inner regional)
<i>After-hours care</i>	↑ (major cities only)	High (major cities)

Notes:

1. PHC, primary health care; GP, general practitioner; AIHW, Australian Institute of Health and Welfare; FTE, full time equivalent (per capita); OOP, out-of-pocket; IR, inner regional; cont., continuous.
2. For association with above-average use, direction of arrows indicates direction on odds of above-average use. Effect is the same for all regions unless otherwise stated.
3. For cross-level effect: for bulk-billing and after-hours care, the SEP group for which there is larger increase in the probability of above-average use (i.e. a favourable effect) is reported. For AIHW FTE, the SEP group for which there is a smaller decrease in the probability of above-average use (i.e. a favourable effect) is reported.
4. Only interaction terms that are statistically significant are included.

6.2.3 Sensitivity Analyses

The frequency and percentage distribution of the alternative cut points for above-average GP use, described under outcomes in Section 5.3.1 of Chapter 5, are given in Table C13 in Appendix C. Empty and fully-adjusted models without stratification demonstrated similar findings across these

alternate outcome measures. In addition, a multinomial outcome measure was included in the model, with analyses revealing no differences in relationships to binary outcomes^{ee}.

6.3 Quality of GP Care

6.3.1 Univariate and Bivariate Analyses

Three binary outcomes were examined as measures of quality of GP care: *long consult*, *continuity of care* (more than 70% of consultations with a single provider) and *care planning*. On inspection of plotted data, there were three participants where the number of long consultations in the following year were outliers, and as such these were excluded from analysis. For continuity of care, 346 persons were excluded due to death occurring in the first two years after study entry (as this measure was calculated over two years), and 31,249 were excluded as they had fewer than four visits over the two-year period (the final sample number was 233,488). A total of 81,222 participants did not have a chronic disease and were excluded from the analyses examining *care planning* (final sample number was 183,861).

Overall, 40.9% of participants received a long consultation, 53.7% had more than 70% of their consultations with a single provider and 14.3% of those with a chronic disease had received care planning (see Table 21). As with GP use, a person of low-education was more likely have a long consultation, continuity of care and care planning ($p < .001$ for all outcomes). Again, relationships between quality of care outcomes and *education* were monotonic, confirming that it was suitable to also use a continuous SEP measure based on the ranked cumulative proportion of the population in each category (*continuous education*, supplementary analysis).

^{ee} Models comparing medium use as the reference to low use yielded coefficients of similar magnitude, but in the reverse direction.

Table 21. Quality of care outcomes by educational attainment (%) and for total sample

Quality of care	Education					Total for row category (n)	% in each variable category
	No school certificate	School certificate	Apprentice/ diploma	University	Missing		
<i>Long consult</i>							
No (ref.)	56.5	58.7	60.1	59.8	56.2	156,652	59.1
Yes	43.5	41.3	39.9	40.2	43.8	108,428	40.9
<i>Continuity of care</i>							
<70% (ref.)	41.1	44.8	46.5	50.4	41.6	105,433	46.1
≥70%	58.7	55.0	53.4	49.6	58.1	128,055	53.7
Missing	0.2	0.1	0.1	0.1	0.3	346	0.1
<i>Care planning</i>							
No (ref.)	53.5	54.8	55.3	56.3	51.6	146,046	55.1
Yes	22.4	15.9	13.5	8.5	20.1	37,815	14.3
Missing	24.1	29.4	31.2	35.1	28.3	81,222	30.6
<i>Total participants</i>	<i>31,126</i>	<i>84,302</i>	<i>84,294</i>	<i>60,933</i>	<i>4,428</i>	<i>265,083</i>	<i>100</i>

Notes:

1. GP, general practitioner; n, number; %, percentage; ref., reference.
2. Columns for each variable category for each education categories sum to 100%. Values in last two columns give total number and percentage of participants in each category of quality of GP care.
3. Missing for care planning includes those excluded as ineligible (i.e. do not have a chronic disease or long-term condition).

Bivariate regression analyses demonstrated expected relationships (similar to those with GP use) between individual explanatory variables and quality of care outcomes (see Table C2 in Appendix C).

The probability of a long consultation and continuity of care decreased with increasing remoteness ($p < .001$), with a similar but non-significant pattern seen for *care planning*. When stratified by region, it was found in bivariate analyses that increasing PHC characteristics indicative of strong PHC systems were generally associated with an increased probability of continuity of care, care planning and long consultations. Exceptions to this were the negative association of characteristics with continuity of care in regional areas and long consultations in major cities. Patterns of association between availability (GPs per capita, *AIHW FTE*) and outcomes differed from other characteristics. In major cities and inner regional areas, increasing availability per capita was associated with an increased probability of long consultations, but decreased continuity of care³² and care planning (major cities only). The reverse pattern of association was seen in outer regional/remote areas (that is, decreased probability of long consultations and increased probability of continuity of care). For full results, see Appendix C.

As described for above-average GP use, for ease of interpretation PHC service characteristics were included as categorical variables in multilevel models examining associations of characteristics with quality of GP care outcomes (Model 3). However, in multilevel models examining cross-level interactions between *education* and area characteristics (Model 4), they were included as continuous variables, to minimise the number of terms and facilitate interpretation. With the quality of care outcomes there were more instances in which the relationship with categorical PHC characteristic variables was not clearly increasing or decreasing monotonically³³. These were not included as cross-level interactions terms in Model 4.

6.3.2 Multilevel analyses

6.3.2.1 Multilevel analyses, part 1: Between-area variation in quality of GP care and association with PHC service characteristics

6.3.2.1.1 Between-area variation in quality of GP care

Analyses demonstrated between-area variation in all quality of care outcome measures, within all regions (Table 22, null model, MORs between 1.16 and 1.48). Median odds ratios ranged across regions, from 18% in major cities to 37% in outer regional/remote areas for long consults, 16 to 40%, respectively, for continuity of care, and 48% to 44%, respectively, for care planning.

³² A monotonically decreasing relationship was not clearly evident when *AIHW FTE* included as a categorical variable.

³³ These were: for long consults, *OOP expenses* in inner regional and *bulk-billing* in major cities; for continuity of care, *AIHW FTE* in major cities and *after-hours care* and *health assessments* in all regions; for care planning, *AIHW FTE* in regional/remote areas, *OOP expenses* and *after-hours care* in inner regional areas.

For all three quality of care measures, individual characteristics accounted for very little of the between-area variance (as evidenced by a decrease in MOR or change in PCV of <10% after addition of these variables; see Table 22). Rather, for long consultations, adjustment for individual characteristics increased the MOR (resulting in a negative PCV), for all regions, suggesting that differences between areas in the probability of a long consultations are greater after accounting for the characteristics of those who lived in these areas. Supplementary analyses were similar to main findings.

Table 22. Between-area variation in odds of quality of GP care outcomes

	Long consults		Continuity of care		Care planning	
	Null model	Model 2	Null model	Model 2	Null model	Model 2
Cities						
ICC	0.009	0.013	0.007	0.007	0.049	0.039
PCV (%)	na	-44	na	1.5	na	22
MOR	1.18	1.21	1.16	1.16	1.48	1.41
Inner regional						
ICC	0.027	0.031	0.017	0.019	0.049	0.048
PCV (%)	na	-16	na	-8	na	4
MOR	1.33	1.36	1.26	1.27	1.48	1.47
Outer regional						
ICC	0.033	0.041	0.037	0.037	0.043	0.044
PCV (%)	na	-24	na	-0.4	na	-2.1
MOR	1.37	1.43	1.40	1.40	1.44	1.45

Notes:

1. ICC: intra-class coefficient; PCV: proportional change in variance (reported change from null model), MOR median odds ratio; na, not applicable.
2. Null model, random intercept only, no covariates; Model 2 adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation.
3. Wald test that between-area variance for the null model is non zero (i.e. $\delta_u^2=0$) $p<.001$ for all outcomes. See Appendix G for full details of model diagnostics.

6.3.2.1.2 Area-level PHC service characteristics

Area PHC service characteristics (namely, *AIHW FTE* per capita, *OOP expense*, *bulk-billing* and *after-hours care*) explained part of the between-area variation in all of the quality of care outcomes (see Tables 23–25), as demonstrated by a decrease in MOR (or change in PCV) between Model 2 (without adjustment for PHC characteristics) and Model 3 (with adjustment). In addition, PHC service characteristics relating to comprehensiveness and coordination (*CD care* and *health assessments*) also explained part of the between-area variation in continuity of care. To reiterate, given the conceptual limitations of these measures, they were not examined in relation to other quality of GP care outcomes.

While there were fewer statistically significant terms with quality of GP care outcomes, compared with GP use, overall, as expected, increasing presence of PHC characteristics was associated with an increased probability of quality of GP care outcomes (Tables 23–25). Specifically, the probability of a long consultation increased with availability in major cities (PCV 27%), and with affordability and accommodation in regional areas (PCV for *OOP expenses*: 23% for inner regional, 47% for outer regional; for *bulk-billing*, 22 and 46%, respectively; for *after-hours care*, 24% for inner regional). The probability of continuity of care increased with affordability (PCV 34% for *OOP expenses* and 41% for *bulk-billing*) and *CD care* (PCV 31%) in major cities, but decreased with *bulk-billing* (PCV 19%) in inner regional areas. The probability of care planning generally increased with affordability in all regions (PCV: *OOP expenses*, 28–48%; *bulk-billing*, 30–54% across regions), and increased with accommodation in major cities only (PCV 26%).

Findings were unchanged in supplementary analyses with *income* and *continuous education* as alternative SEP measures (see Appendix C for full results).

Table 23. Models 3a–3f: association of each PHC characteristic with long consults, adjusted for individual covariates

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>Bulk-billing (3c)</i>	<i>After-hours care (3d)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities				
1st quartile (ref)	1	1	1	1
2nd quartile	1.07 (0.85–1.36)	1.04 (0.89–1.22)	1.03 (0.83–1.27)	0.95 (0.62–1.46)
3rd quartile	0.99 (0.78–1.26)	1.20 (0.98–1.46)	1.00 (0.83–1.21)	0.90 (0.59–1.37)
4th quartile	1.27 (1.00–1.60)	1.16 (0.99–1.37)	0.87 (0.73–1.03)	0.84 (0.55–1.28)
p-value for term	0.007	0.165	0.140	0.449
ICC	0.010	0.011	0.011	0.012
PCV (%)	27	14	14	9
MOR	1.19	1.20	1.20	1.21
Inner regional				
1st quartile (ref)	1	1	1	1
2nd quartile	1.25 (0.89–1.75)	1.46 (0.92–2.31)	1.47 (1.12–1.91)	1.37 (1.07–1.76)
3rd quartile	0.98 (0.7–1.37)	1.08 (0.69–1.70)	1.38 (1.05–1.82)	1.39 (0.90–2.13)
4th quartile	1.32 (0.97–1.80)	0.98 (0.61–1.57)	–	1.48 (1.07–2.06)
p-value for term	0.218	0.029	0.011	0.024
ICC	0.027	0.024	0.024	0.024
PCV (%)	13	23	22	24
MOR	1.33	1.31	1.31	1.31
Outer regional				
1st quartile (ref)	1	–	1	–
2nd quartile	0.93 (0.63–1.38)	ref	1.17 (0.88–1.57)	–
3rd quartile	0.94 (0.61–1.47)	0.64 (0.48–0.85)	1.57 (1.20–2.05)	–
4th quartile	0.67 (0.43–1.04)	0.56 (0.42–0.73)	–	–
p-value for term	0.362	<.001	0.004	–
ICC	0.036	0.022	0.022	–
PCV (%)	12	47	46	–
MOR	1.4	1.29	1.30	–

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (Model 2); MOR, median odds ratio; ref, reference.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

Table 24. Models 3a–3f: association of each area PHC characteristic with continuity of care, adjusted for individual covariates

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>Bulk-billing (3c)</i>	<i>After-hours care (3d)</i>	<i>CD care (3e)</i>	<i>Health assessments (3f)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities						
1st quartile (ref)	1	1	1	1	1	1
2nd quartile	0.98 (0.80–1.21)	0.92 (0.83–1.02)	1.00 (0.87–1.15)	1.47 (1.07–2.03)	1.19 (1.04–1.36)	1.09 (0.96–1.24)
3rd quartile	1.02 (0.83–1.26)	0.84 (0.73–0.97)	1.20 (1.06–1.35)	1.44 (1.05–1.98)	1.27 (1.12–1.43)	1.01 (0.89–1.15)
4th quartile	0.95 (0.77–1.16)	0.79 (0.71–0.89)	1.26 (1.12–1.41)	1.41 (1.02–1.93)	1.17 (1.04–1.33)	0.97 (0.82–1.14)
p-value for term	0.694	<.001	<.001	0.127	<.001	0.427
ICC	0.007	0.005	0.004	0.006	0.005	0.007
PCV (%)	4	34	41	13	31	8
MOR	1.16	1.13	1.12	1.15	1.13	1.15
Inner regional						
1st quartile (ref.)	1	1	1	1	1	1
2nd quartile	0.97 (0.75–1.25)	0.91 (0.61–1.36)	0.76 (0.61–0.94)	1.00 (0.80–1.24)	0.91 (0.72–1.16)	0.82 (0.63–1.05)
3rd quartile	0.87 (0.67–1.12)	1.02 (0.69–1.50)	0.86 (0.69–1.07)	0.94 (0.64–1.36)	0.81 (0.61–1.06)	1.15 (0.88–1.51)
4th quartile	0.77 (0.61–0.98)	1.08 (0.72–1.63)	–	1.09 (0.82–1.46)	0.84 (0.66–1.07)	0.87 (0.70–1.07)
p-value for term	0.169	0.616	0.036	0.899	0.357	0.069
ICC	0.016	0.017	0.015	0.018	0.017	0.015
PCV (%)	15	6	19	3	10	21
MOR	1.24	1.26	1.24	1.27	1.25	1.24
Outer regional						
1st quartile (ref.)	1	–	1	–	1	1
2nd quartile	0.97 (0.66–1.44)	ref	0.87 (0.60–1.27)	–	0.97 (0.67–1.41)	1.63 (0.98–2.72)
3rd quartile	0.79 (0.51–1.24)	1.01 (0.70–1.45)	1.03 (0.73–1.46)	–	0.93 (0.57–1.54)	1.36 (0.88–2.10)
4th quartile	1.06 (0.68–1.65)	0.84 (0.59–1.20)	–	–	1.00 (0.63–1.59)	1.29 (0.86–1.93)
p-value for term	0.739	0.532	0.659	–	0.993	0.293
ICC	0.035	0.035	0.036	–	0.037	0.031
PCV (%)	4	5	3	–	0	16
MOR	1.4	1.39	1.4	–	1.41	1.37

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (Model 2); MOR, median odds ratio; ref., reference.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

Table 25. Models 3a–3f: association of each are PHC characteristic with care planning, adjusted for individual covariates

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>Bulk-billing (3c)</i>	<i>After-hours care (3d)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities				
1st quartile (ref.)	1	1	1	1
2nd quartile	0.74 (0.47–1.16)	0.86 (0.70–1.06)	1.52 (1.16–2.01)	2.32 (1.16–4.66)
3rd quartile	0.77 (0.49–1.21)	0.85 (0.65–1.12)	1.90 (1.50–2.42)	3.00 (1.50–5.96)
4th quartile	0.67 (0.43–1.06)	0.51 (0.41–0.64)	2.12 (1.69–2.66)	3.06 (1.54–6.09)
p-value for term	0.375	<.001	<.001	0.003
ICC	0.036	0.020	0.018	0.029
PCV (%)	7	48	54	26
MOR	1.40	1.28	1.26	1.35
Inner regional				
	1	1	1	1
2nd quartile	1.08 (0.70–1.66)	0.84 (0.46–1.55)	1.74 (1.27–2.38)	0.84 (0.59–1.18)
3rd quartile	0.97 (0.63–1.49)	0.88 (0.48–1.60)	1.50 (1.08–2.07)	1.26 (0.70–2.27)
4th quartile	1.45 (0.98–2.15)	0.59 (0.31–1.10)	–	0.91 (0.57–1.43)
p-value for term	0.274	0.132	0.002	0.526
ICC	0.042	0.040	0.033	0.044
PCV (%)	12	17	31	8
MOR	1.44	1.42	1.37	1.45
Outer regional				
	1	–	1	–
2nd quartile	0.95 (0.63–1.45)	1	1.27 (0.90–1.81)	–
3rd quartile	0.86 (0.54–1.38)	0.74 (0.52–1.05)	1.66 (1.20–2.30)	–
4th quartile	0.67 (0.42–1.07)	0.62 (0.44–0.87)	–	–
p-value for term	0.402	0.022	0.009	–
ICC	0.039	0.032	0.031	–
PCV (%)	12	28	30	–
MOR	1.42	1.37	1.36	–

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent per capita; OOP, out-of-pocket; ICC, intra-class coefficient; PCV, proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (Model 2); MOR, median odds ratio; ref., reference.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

6.3.2.1.3 Summary of between-area variation in quality of GP care

Similarly to GP use, the findings suggest that quality of GP care varies between areas, even after accounting for the characteristics of individuals living in those areas. Area PHC service characteristics explain part of the between-area variation in quality of GP care, although not for all characteristics in all regions. More availability was only associated with a higher probability of long consultations, and only in major cities. Areas that were more affordable were associated with a higher probability of long consultations in regional areas, and with continuity of care in major cities and care planning across all regions. However, for inner regional areas more bulk-billing was associated with a lower probability of continuity of care. Areas with more after-hours care (accommodation) were associated with a higher probability of care planning in major cities and long consultations in inner regional areas. Finally, only in major cities was more *CD care* (comprehensiveness) associated with an increased probability of continuity of care.

6.3.2.2 Multilevel analyses, part 2: individual-level socioeconomic variation in quality of GP care and the modifying effect of PHC service characteristics

Having established that generally area PHC service characteristics indicative of a strong PHC system were associated with increased quality of GP care, the modifying effect of these characteristics on the relationship between SEP and quality of GP care was examined. The analyses investigated whether the association between SEP and use was stronger or weaker depending on the presence of service characteristics in that area. If the change in association between SEP and the quality of GP care outcome with the increasing presence of an area characteristic is in a direction that confers a larger increase in the probability of that outcome for a person of low SEP (compared with high), then that area characteristic can be viewed as pro-low SEP.

Findings are presented as per GP use. That is, individual-level socioeconomic variation, adjusted for individual-level need and between-area variation in quality of GP care, is quantified first. The findings from the cross-level interaction models (Models 4a–d) are then presented in the Section 6.3.2.2.2. The main results with *education* as the SEP of interest are presented first. Additional relevant findings from supplementary analyses for cross-level interactions for quality of GP care are presented separately.

6.3.2.2.1 Individual-level socioeconomic variation in quality of GP care

In all three regions, increasing education level was associated with a decreased probability of continuity of care and care planning, having taken into account between-area variation, and after adjusting for individual need and other explanatory variables (see Table 26). That is, for a given level of need, and irrespective of where a person lives, those who have lower education are more likely to have better quality of GP care. Again, the pro-low education association with these

quality of care outcomes most likely reflects under-adjustment for need. In contrast, those who were of high education were more likely to have a long consultation ($p<.05$); that is, this aspect of quality of care differentially favoured high education individuals. These patterns were found irrespective of the SEP measure, except in the case of *income* and long consults (that is, increasing income associated with decreased probability of long consultations, all SEP terms significant to the $p<.001$ level; see Appendix C for full results for main and supplementary analyses). The other explanatory variables demonstrated patterns as per bivariate analyses and as seen for frequency of GP use (see Appendix C for full results).

Table 26. Model 2: fixed effects for quality of care outcomes by region

	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Long consults			
No school certificate	1	1	1
School certificate	1.00 (0.95–1.05)	0.99 (0.95–1.04)	0.97 (0.93–1.02)
Apprentice/ diploma	1.05 (1.00–1.10)	1.05 (1.00–1.10)	1.02 (0.97–1.08)
University	1.05 (0.99–1.10)	1.11 (1.05–1.16)	1.09 (1.02–1.15)
Continuity of care			
No school certificate	1	1	1
School certificate	0.98 (0.93–1.03)	0.98 (0.93–1.03)	1.02 (0.97–1.08)
Apprentice/ diploma	0.94 (0.90–1.00)	0.94 (0.90–1.00)	0.92 (0.87–0.97)
University	0.88 (0.83–0.93)	0.88 (0.83–0.93)	0.87 (0.82–0.92)
Care planning			
No school certificate	1	1	1
School certificate	0.86 (0.81–0.92)	0.85 (0.80–0.91)	0.89 (0.83–0.95)
Apprentice/ diploma	0.80 (0.75–0.85)	0.78 (0.73–0.83)	0.78 (0.72–0.83)
University	0.66 (0.61–0.71)	0.61 (0.57–0.66)	0.62 (0.57–0.68)

Notes:

1. GP, general practitioner; OR, odds ratio; CI, confidence interval.
2. Adjusted for sociodemographic (educational attainment, age, sex, country of birth, marital status) and need (self-rated health status, number of chronic disease, physical functioning) variables.
3. Wald joint test of significance for education $p<.001$ for all outcomes and regions, except long consults in major cities ($p<.05$).

6.3.2.2.2 Cross-level interactions: modifying effect of area PHC characteristics on socioeconomic variation in quality of GP care, main analyses

As described for GP use, to determine whether PHC service characteristics modified the association between SEP and quality of GP care, cross-level interaction terms between education and area PHC service characteristics were added to Model 2 (Models 4a–f; Tables 27–29). Only area characteristic variables that had a monotonic relationship with quality of GP care outcomes in bivariate analyses were included interaction models.

Table 27. Model 4: cross-level effect modification, continuity of care. OR (95% CIs) for area PHC service characteristics (continuous) and as interaction with education

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	–	0.583 (0.335–1.014)	0.802 (0.394–1.633)
No school certificateX <i>AIHW FTE</i>	–	1	1
School certificateX <i>AIHW FTE</i>	–	1.009 (0.775–1.313)	0.749 (0.544–1.030)
Apprentice/diplomaX <i>AIHW FTE</i>	–	0.858 (0.660–1.117)	0.864 (0.620–1.204)
UniversityX <i>AIHW FTE</i>	–	1.068 (0.799–1.427)	0.626 (0.425–0.923)
p-value for interaction	–	0.214	0.080
<i>OOP expenses (Model 4b)</i>	0.994 (0.976–1.012)	1.023 (0.985–1.063)	0.952 (0.880–1.030)
No school certificateX <i>OOP expenses</i>	1	1	1
School certificateX <i>OOP expenses</i>	0.981 (0.965–0.997)	0.982 (0.961–1.003)	1.021 (0.992–1.050)
Apprentice/diplomaX <i>OOP expenses</i>	0.980 (0.964–0.996)	0.996 (0.975–1.017)	1.035 (1.005–1.065)
UniversityX <i>OOP expenses</i>	0.988 (0.972–1.004)	0.984 (0.962–1.006)	1.027 (0.993–1.062)
p-value for interaction	0.028	0.156	0.134
<i>Bulk-billing (Model 4c)</i>	1.003 (0.997–1.009)	0.992 (0.980–1.004)	1.004 (0.984–1.025)
No school certificateX <i>bulk-billing</i>	1	1	1
School certificateX <i>bulk-billing</i>	1.006 (1.001–1.012)	1.005 (0.999–1.012)	0.998 (0.991–1.005)
Apprentice/diplomaX <i>bulk-billing</i>	1.008 (1.003–1.013)	1.002 (0.996–1.008)	0.995 (0.988–1.001)
UniversityX <i>bulk-billing</i>	1.006 (1.000–1.011)	1.004 (0.998–1.011)	0.995 (0.987–1.003)
p-value for interaction	0.030	0.241	0.357
<i>After-hours care (Model 4d)</i>	0.996 (0.972–1.021)	–	–
No school certificateX <i>after-hours care</i>	1	–	–
School certificateX <i>after-hours care</i>	1.012 (0.992–1.033)	–	–
Apprentice/diplomaX <i>after-hours care</i>	1.012 (0.992–1.033)	–	–
UniversityX <i>after-hours care</i>	0.996 (0.975–1.016)	–	–
p-value for interaction	0.054	–	–

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>CD care (Model 4e)</i>	1.001 (0.993–1.009)	0.992 (0.982–1.003)	1.005 (0.99–1.02)
No school certificateXCD care	1	1	1
School certificateXCD care	1.006 (0.999–1.013)	0.999 (0.994–1.005)	0.998 (0.993–1.002)
Apprentice/diplomaXCD care	1.010 (1.003–1.017)	1.000 (0.995–1.006)	0.996 (0.992–1.001)
UniversityXCD care	1.007 (1.000–1.014)	1.001 (0.995–1.007)	0.997 (0.992–1.003)
p-value for interaction	0.041	0.890	0.542

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; OOP, out-of-pocket.
2. P-value, Wald test of joint significance for addition of cross-level interaction term. Significant terms bolded.
3. Models 4a–d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given, followed by odds ratio for interaction term for each education level,
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. *After-hours care* not tested in outer regional/ remote areas due to unreliability of this estimate in this region.

Table 28. Model 4: cross-level effect modification, long consult. OR (95% CIs) for area PHC service characteristics (continuous) and as interaction with education

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	1.593 (1.059–2.397)	2.397 (1.19–4.827)	0.445 (0.216–0.917)
No school certificateX <i>AIHW FTE</i>	1	1	1
School certificateX <i>AIHW FTE</i>	0.962 (0.709–1.305)	0.834 (0.645–1.079)	1.094 (0.802–1.492)
Apprentice/diplomaX <i>AIHW FTE</i>	0.890 (0.656–1.207)	0.844 (0.653–1.090)	1.144 (0.828–1.579)
UniversityX <i>AIHW FTE</i>	0.891 (0.662–1.199)	0.836 (0.633–1.105)	1.326 (0.912–1.929)
p-value for interaction	0.749	0.536	0.504
<i>OOP expenses (Model 4b)</i>	1.029 (1.009–1.050)	–	0.872 (0.824–0.922)
No school certificateX <i>OOP expenses</i>	1	–	1
School certificateX <i>OOP expenses</i>	0.988 (0.973–1.002)	–	0.992 (0.966–1.020)
Apprentice/diplomaX <i>OOP expenses</i>	0.991 (0.976–1.006)	–	0.998 (0.971–1.026)
UniversityX <i>OOP expenses</i>	0.987 (0.973–1.002)	–	1.025 (0.993–1.058)
p-value for interaction	0.336	–	0.112
<i>Bulk-billing (Model 4c)</i>	–	1.01 (0.996–1.024)	1.032 (1.019–1.046)
No school certificateX <i>bulk-billing</i>	–	1	1
School certificateX <i>bulk-billing</i>	–	1.006 (1.000–1.012)	1.002 (0.995–1.008)
Apprentice/diplomaX <i>bulk-billing</i>	–	1.003 (0.997–1.009)	1.002 (0.995–1.008)
UniversityX <i>bulk-billing</i>	–	1.003 (0.997–1.010)	0.995 (0.987–1.003)
p-value for interaction	–	0.279	0.151
<i>After-hours care (Model 4d)</i>	0.971 (0.945–0.997)	1.070 (1.027–1.114)	–
No school certificateX <i>after-hours care</i>	1	1	–
School certificateX <i>after-hours care</i>	1.005 (0.987–1.024)	0.988 (0.970–1.006)	–
Apprentice/diplomaX <i>after-hours care</i>	1.011 (0.992–1.030)	0.985 (0.967–1.003)	–
UniversityX <i>after-hours care</i>	1.005 (0.986–1.024)	0.970 (0.951–0.989)	–
p-value for interaction	0.661	0.012	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; OOP, out-of-pocket.
2. P-value, Wald test of joint significance for addition of cross-level interaction term. Significant terms bolded.
3. Models 4a–d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given, followed by odds ratio for interaction term for each education level.
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. *After-hours care* not tested in outer regional/ remote areas due to unreliability of this estimate in this region.

Table 29. Model 4: cross-level effect modification, care planning. OR (95% CIs) for area PHC service characteristics (continuous) and as interaction with education

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	0.592 (0.306–1.146)	–	–
No school certificateX <i>AIHW FTE</i>	1	–	–
School certificateX <i>AIHW FTE</i>	0.949 (0.630–1.428)	–	–
Apprentice/diplomaX <i>AIHW FTE</i>	1.080 (0.713–1.637)	–	–
UniversityX <i>AIHW FTE</i>	0.923 (0.609–1.398)	–	–
p-value for interaction	0.777	–	–
<i>OOP expenses (Model 4b)</i>	0.940 (0.916–0.966)	–	0.895 (0.831–0.964)
No school certificateX <i>OOP expenses</i>	1	–	1
School certificateX <i>OOP expenses</i>	1.001 (0.981–1.022)	–	1.008 (0.972–1.046)
Apprentice/diplomaX <i>OOP expenses</i>	0.995 (0.974–1.015)	–	0.981 (0.944–1.018)
UniversityX <i>OOP expenses</i>	0.999 (0.978–1.020)	–	1.012 (0.964–1.062)
p-value for interaction	0.824	–	0.310
<i>Bulk-billing (Model 4c)</i>	1.023 (1.014–1.032)	1.02 (1.003–1.038)	1.03 (1.011–1.049)
No school certificateX <i>bulk-billing</i>	1	1	1
School certificateX <i>bulk-billing</i>	1.001 (0.994–1.008)	1.006 (0.997–1.014)	1.000 (0.992–1.009)
Apprentice/diplomaX <i>bulk-billing</i>	1.003 (0.997–1.010)	0.999 (0.991–1.008)	1.007 (0.998–1.017)
UniversityX <i>bulk-billing</i>	1.002 (0.995–1.010)	0.996 (0.986–1.006)	0.999 (0.987–1.010)
p-value for interaction	0.66	0.10	0.18
<i>After-hours care (Model 4d)</i>	1.045 (1.002–1.091)	–	–
No school certificateX <i>after-hours care</i>	1	–	–
School certificateX <i>after-hours care</i>	0.998 (0.974–1.022)	–	–
Apprentice/diplomaX <i>after-hours care</i>	0.992 (0.967–1.017)	–	–
UniversityX <i>after-hours care</i>	1.007 (0.980–1.035)	–	–
p-value for interaction	0.605	–	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; OOP, out-of-pocket.
2. P-value, Wald test of joint significance for addition of cross-level interaction term. Significant term bolded.
3. Models 4a–d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given, followed by odds ratio for interaction term for each education level.
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. *After-hours care* not tested in outer regional/ remote areas due to unreliability of this estimate in this region.

Generally, findings were similar to those seen for GP use, although there were fewer terms that reached statistical significance (as seen in Tables 27–29). That is, while PHC service characteristics were associated with increased quality of GP care across all education levels, these were only associated with a larger increase for low-education individuals in regional areas; that is, pro-low SEP. Table 30 gives a summary of the findings from main analyses for associations between area characteristics as a categorical variable and quality of GP care outcomes (part 1 of results for multilevel analyses, as in Tables 23–25), and if these can be viewed as pro-low or high SEP based on cross-level interactions (part 2 of results for multilevel analyses, as in tables 27–29). Table 31 gives a summary of the cross-level interaction findings by region for main and supplementary analyses for all outcomes (GP use and quality of care). Only significant interactions are discussed in the following text.

In major cities, cross-level interaction terms were significant for continuity of care only (see Table 27). A similar pattern of effect modification as that for GP use was found. That is, the increase in continuity of care associated these characteristics was larger for higher-education groups (that is, pro-high SEP). In addition, more *after-hours care* was associated with reduced continuity of care for the lowest education group, but with increased continuity of care for mid-education categories (see Table 27 and Figure 24a). Hence in major cities, while the increasing presence of these characteristics was associated with increased continuity of care, the gains for lower education groups are minimal.

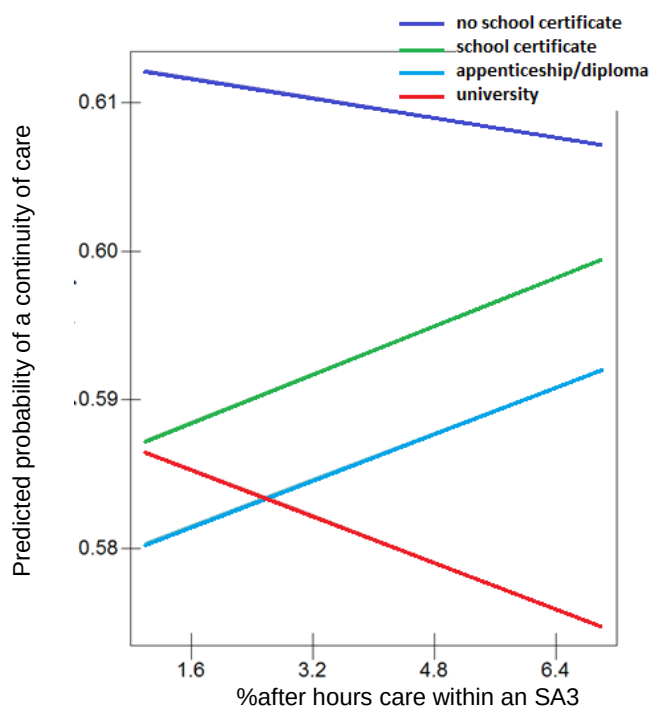


Figure 24(a). Cross-level effect modification, main analyses: predicted probability of continuity of care in major cities, by *education* and *after-hours care*

Notes:

1. SA3, Statistical Areas Level 3; %, percentage.
2. After-hours values used for prediction 1–7% of total services claimed.
3. Interaction terms significant to the $p < .05$ level, Wald joint test of significance

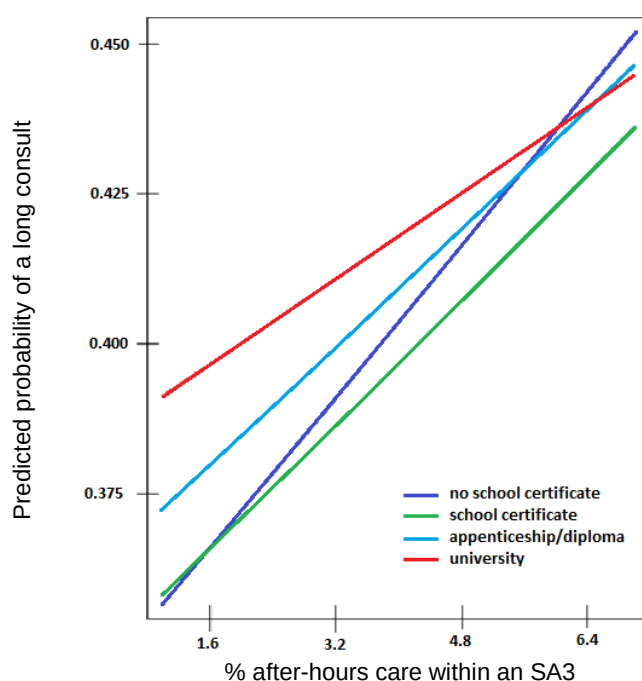


Figure 24(b). Cross-level effect modification, main analyses: predicted probability of long consults in inner regional areas, by *education* and *after-hours care*

Notes:

1. SA3, Statistical Areas Level 3; %, percentage.
2. After-hours values used for prediction 1–7% of total services claimed.
3. Interaction terms significant to the $p < .05$ level, Wald joint test of significance.

With regard to regional/remote areas, in the main analyses interaction terms were significant only for *after-hours care* and long consultations in inner regional areas (see Table 28 and Figure 24b). This characteristic can be viewed as pro-low SEP, as more *after-hours care* was associated with a greater increase in long consultations for a person of low-education. In fact, when recalling the pro-high education association with long consultations, as shown in Figure 24b, in areas with the most *after-hours care* this association reverses and become pro-low education.

There were no significant interaction terms for availability for any outcome, nor for any characteristic with care planning.

6.3.2.2.3 Cross-level interactions: supplementary analyses

In supplementary analyses, additional interaction terms were significant predominantly for long consultations and care planning. For full results see Tables C34–39 in Appendix C.

In major cities, findings for care planning and *income* were consistent with that seen for continuity of care in main analyses: the increase in care planning associated with more *bulk-billing*, *after-hours care* and less *OOP expenses* was larger for higher-income groups (that is, it was pro-high SEP). In addition, the decrease in long consultations associated with less *OOP expenses* was greater for *low-income* individuals. Hence, in major cities, living in an area that was more affordable and had more *after-hours care* was not associated with a specific benefit for persons of low income (in terms of increased care planning and long consultations). On the other hand, more availability in major cities was associated with a larger increase in long consultations for a person of low-income; that is, pro-low SEP, as shown in Figure 25a. Findings for availability in major cities with respect to income and care planning were as seen for main analyses with GP use; this is demonstrated in Figure 25b for ease of recollection of this relationship.

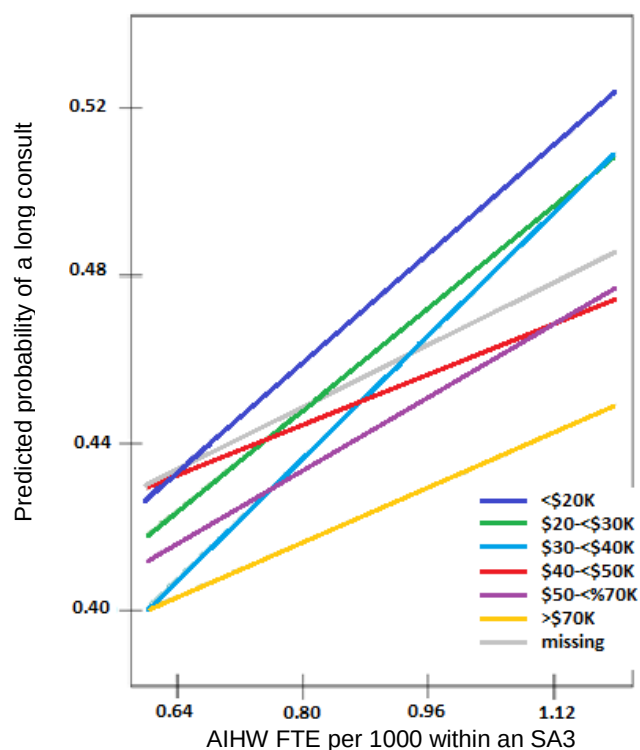


Figure 25(a). Cross-level effect modification, supplementary analyses, major cities: predicted probability of a long consult, by income and availability

Notes:

1. AIHW FTE values used for prediction 0.6, 0.8, 1 and 1.2 FTE per 1000 population.
2. Interaction terms significant to the $p < .05$ level, Wald joint test of significance.

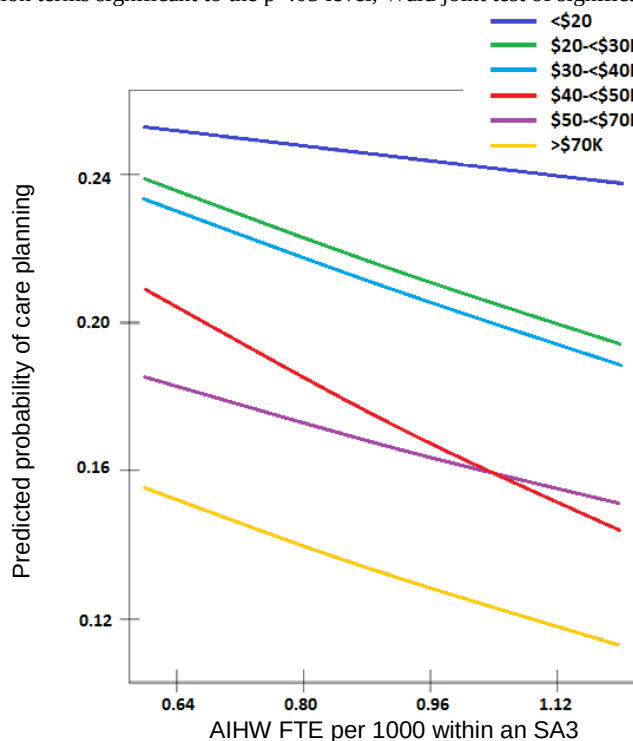


Figure 25(b). Cross-level effect modification, supplementary analyses, major cities: predicted probability of care planning, by income and availability

Notes:

1. AIHW FTE values used for prediction 0.6, 0.8, 1 and 1.2 FTE per 1000 population.
2. Interaction terms significant to the $p < .05$ level, Wald joint test of significance.

In regional and remote areas, also consistent with the main analyses, the findings from supplementary analyses were that the pro-low SEP association with long consultations was stronger in areas that were more affordable and had more *after-hours care*; that is, measures were pro-low SEP. An example of this relationship is given in Figure 26a. Specifically, in outer regional/remote areas, more *bulk-billing* and lower *OOP expenses* were associated with a larger increase in long consultations for low-income individuals, compared with their higher-income counterparts (see Figure 26a). The cross-level interaction in inner regional areas between continuous education and *after-hours care* for long consultations was the same as that seen with education (that is; an increase in long consults that was pro-low SEP).

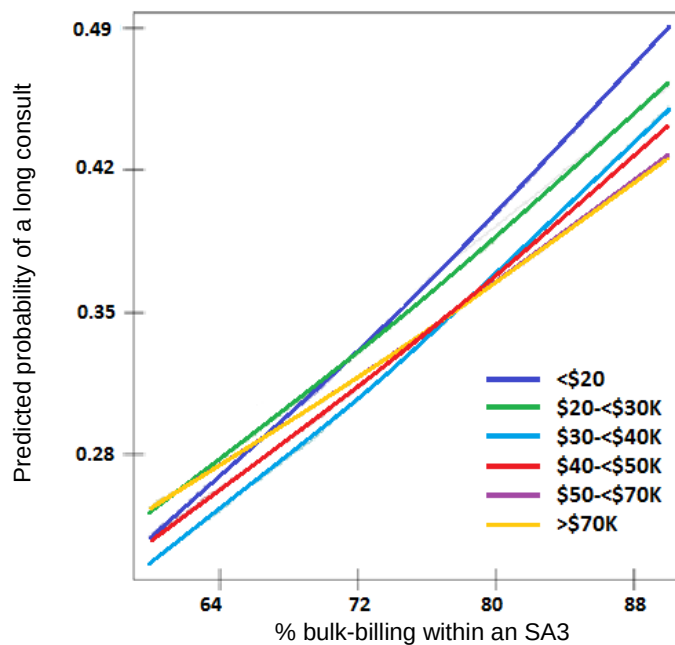


Figure 26(a). Cross-level effect modification, supplementary analyses, outer regional/remote: predicted probability of a long consult, by income and bulk-billing

Notes:

1. Percentage of bulk-billing values for prediction ranged from 60–90% of all services.
2. AIHW FTE values used for prediction 0.6, 0.8, 1 and 1.2 FTE per 1000 population.
3. Interaction terms significant to the $p < .05$ level, Wald joint test of significance
4. Continuous education of 0.1 corresponds to the proportion of the population in the lowest SEP category, and a continuous education of 0.85 is the cumulative proportion of the population in the highest SEP category.
5. Predictions for \$50-<\$70k and >\$70k categories near identical, and hence overlapping in Figure 26(a).

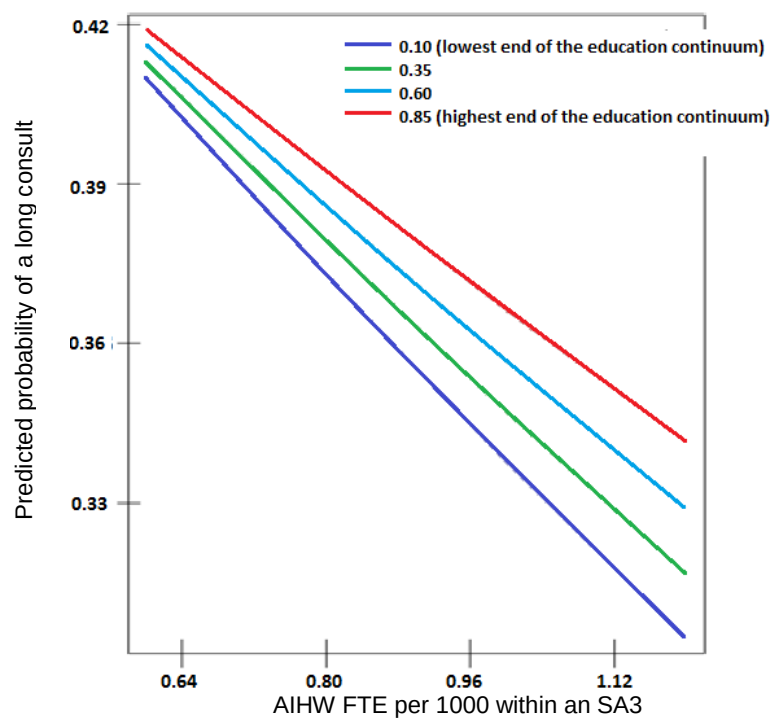


Figure 26(b). Cross-level effect modification, supplementary analyses, outer regional/ remote: predicted probability of a long consult, by continuous education and availability

Notes:

1. Percentage of bulk-billing values for prediction ranged from 60–90% of all services.
2. AIHW FTE values used for prediction 0.6, 0.8, 1 and 1.2 FTE per 1000 population.
3. Interaction terms significant to the $p < .05$ level, Wald joint test of significance
4. Continuous education of 0.1 corresponds to the proportion of the population in the lowest SEP category, and a continuous education of 0.85 is the cumulative proportion of the population in the highest SEP category.
5. Predictions for \$50- < \$70k and > \$70k categories near identical, and hence overlapping in Figure 26(a).

With respect to availability in outer regional/ remote areas, more availability was associated with a larger decrease in long consultations for low-continuous education individuals (Figure 26b), but with a larger decrease in continuity of care for high-income individuals. Either way, the associated gains for those of low SEP with more availability for these outcomes is minimal in outer regional/ remote areas (as was found for availability and GP use across all regions).

6.3.2.2.4 Summary for cross-level interactions.

As seen with GP use in major cities, living in an area with more *bulk-billing*, *after-hours care* and fewer *OOP expenses* were not associated with a specific benefit, in terms of quality of care, for those of low SEP, irrespective of the overall association between area characteristics and quality of GP care outcomes. That is, the increased presence of these characteristics was associated with either a larger increase in continuity of care and care planning for those who are high SEP, or a larger decrease in long consultations for low-SEP groups. Increasing availability however, was associated with a larger increase in long consultations for low-SEP individuals. By contrast, in regional areas, more *bulk-billing* and *after-hours care* and fewer *OOP expenses* was associated with a larger increase for a person of low SEP, although this was found only for long consultations, while availability was not associated with a specific benefit for a person of low

SEP (other than that the decrease in continuity of care was less compared with higher-SEP groups).

Table 30. Summary of significant findings for PHC characteristics and the probability of quality of GP care outcomes for main analyses with education: direction of association and pro-low or pro-high SEP effect

Outcome PHC Characteristic		Association with outcome	Cross-level effect: low or high education
Long consult	<i>AIHW FTE</i>	↑ (major cities)	–
	<i>OOP expenses</i>	↓ (outer regional/ remote)	–
	<i>Bulk-billing</i>	↑(regional/ remote)	–
	<i>After-hours care</i>	↑(inner regional)	Low (inner regional)
Continuity of care	<i>AIHW FTE</i>	No association	–
	<i>OOP expenses</i>	↓ (major cities)	High (major cities)
	<i>Bulk-billing</i>	↑(major cities)	High (major cities)
	<i>After-hours care</i>	↓ (inner regional)	High (major cities)
	<i>CD care</i>	No association	High (major cities)
	<i>Health assessments</i>	↑(major cities)	High (major cities)
Care planning	<i>AIHW FTE</i>	No association	–
	<i>OOP expenses</i>	↓ (major cities/outer regional/remote)	–
	<i>Bulk-billing</i>	↑	–
	<i>After-hours care</i>	↑(major cities)	–

Notes:

1. PHC, primary health care; GP, general practitioner; AIHW, Australian Institute of Health and Welfare OOP, out-of-pocket; IR, inner regional; cont., continuous.
2. For association with quality of GP care outcomes, direction of areas indicates direction of odds of quality of GP care outcome. Effect is the same for all regions unless otherwise stated.
3. For cross-level effect: the SEP group for which there is larger increase in the probability of quality of GP care (i.e. a favourable effect) is reported.
4. Only interaction terms that are statistically significant are included.

Table 31. Summary of findings for cross-level interactions for area PHC characteristics by region and outcome. Pro-high or pro-low SEP effect of characteristic reported.

Major cities

		<i>GP FTE per capita</i>	<i>Lower OOP expenses</i>	<i>Bulk-billing</i>	<i>After-hours care</i>	<i>CD care</i>
Above-average use	Main	Low (smaller decrease)	no assoc.	High	High	—
	Supplementary	Low (income, smaller decrease)	High (income)	High (income)	High (both)	—
Long consult	Main	no assoc.	no assoc.	—	no assoc.	—
	Supplementary	Low	High (smaller decrease)	—	no assoc.	—
Continuity of care	Main	—	High	High	High	High
	Supplementary	—	no assoc.	no assoc.	no assoc.	High (cont. education)
Care planning	Main	no assoc.	no assoc.	no assoc.	no assoc.	—
	Supplementary	Low (income, smaller decrease)	High (income)	High (income)	High (income)	—

Inner regional

		<i>GP FTE per capita</i>	<i>Lower OOP expenses</i>	<i>Bulk-billing</i>	<i>After-hours care</i>	<i>CD care</i>
Above-average use	Main	no assoc.	—	Low	no assoc.	—
	Supplementary	no assoc.	—	Low (cont. education)	Direction of association unclear	—
Long consult	Main	no assoc.	—	no assoc.	Low	—
	Supplementary	no assoc.	—	no assoc.	Low (cont. education)	—
Continuity of care	Main	no assoc.	no assoc.	no assoc.	—	no assoc.
	Supplementary	no assoc.	no assoc.	no assoc.	—	no assoc.
Care planning	Main	—	—	no assoc.	—	—
	Supplementary	—	—	no assoc.	—	—

Outer regional/ remote

		<i>GP FTE per capita</i>	<i>Lower OOP expenses</i>	<i>Bulk-billing</i>	<i>After-hours care</i>	<i>CD care</i>
Above-average use	Main	no assoc.	no assoc.	no assoc.	—	—
	Supplementary	High (cont. education, smaller decrease)	no assoc.	no assoc.	—	—
Long consult	Main	no assoc.	no assoc.	no assoc.	—	—
	Supplementary	High (cont. education, smaller decrease)	Low (income)	Low (income)	—	—
Continuity of care	Main	no assoc.	no assoc.	no assoc.	—	no assoc.
	Supplementary	Low (income, smaller decrease)	no assoc.	no assoc.	—	Direction of association unclear
Care planning	Main	—	no assoc.	no assoc.	—	—
	Supplementary	—	no assoc.	no assoc.	—	—

Notes:

1. GP, general practitioner; FTE, full-time equivalent; OOP, out-of-pocket; CD, chronic disease; assoc., association;
2. The SEP group whose use and quality of care increases to larger extent with the increasing presence of an area service characteristic is reported.
3. In main analyses, education was the SEP measure. In supplementary analyses, income and continuous education were tested as alternative SEP measures.
4. Only significant interactions are given in the table (Wald joint test of significance, $p < .05$).
5. GP FTE per capita in major cities had a negative association with outcomes. In this instance the SEP group that had smaller reduction in the probability of an outcome is reported (i.e. that group's use and quality of care less affected in areas with more GPs per capita).
6. Where there was not a monotonic relationship between an area characteristic and outcome, this was not tested in cross-level interaction models (represented by a hyphen in the table).

6.4 Specialist Use

6.4.1 Univariate and Bivariate Analyses

A binary outcome for specialist use was examined as a point of contrast to receipt GP use and quality of care. On inspection of plotted counts of participant specialist consultations in the year after entry, there was one participant for whom the number of visits was deemed an outlier and this case was excluded from analysis. Of the sample, 54.7% had received at least one specialist consultation in the year after entry to the study (Table 32). A person of low-education was more likely to see a specialist in the year after entry to the study, compared with those of higher education ($p < .001$). Associations with other individual sociodemographic and need variables were in the same direction as the preceding outcome measures examined ($p < .001$ for all variables; see Table C2 in Appendix C for full results). Those who lived in more remote areas were significantly less likely to have had a specialist visit (as shown in Table C40 in Appendix C).

Table 32. Specialist use by educational attainment (%) and for total sample

Specialist use	<i>Education</i>					Total for row category (n)	% in each variable category
	No school certificate	School certificate	Apprentice/ diploma	University	Missing		
No (%)	40.5	44.3	46.5	47.9	40.5	120,063	45.3
Yes (%)	59.5	55.7	53.6	52.1	59.5	145,019	54.7
Total participants	31,126	84,302	84,294	60,933	4,428	265,083	100

Notes:

1. n, number; %, percentage.
2. Columns for each variable category for each education categories sum to 100%. Values in last two columns give total number and percentage of participants in each category of specialist use.

6.4.2 Multilevel Analyses

6.4.2.1 Between-area and socioeconomic variation

There was between-area variation in specialist use across all regions (MOR 1.16–1.17; see Table 33). That is the effect of an individual moving from an area of lower to higher probability of specialist use was an increase in their odds of seeing a specialist by 16–17%. Adjustment for individual characteristics increased the MOR slightly (resulting in a negative PCV) for all regions, suggesting that the differences between areas in specialist use was greater after accounting for the characteristics of those who lived in these areas.

Table 33. Between-area variation in the odds of specialist use

	Null model	Model 2
Major cities		
ICC	0.007	0.007
PCV (%)	na	-8
MOR	1.15	1.16
Inner regional		
ICC	0.008	0.009
PCV (%)	na	-19
MOR	1.17	1.18
Outer regional		
ICC	0.008	0.008
PCV (%)	na	-8
MOR	1.16	1.17

Notes:

1. ICC: intra-class coefficient; PCV: proportional change in variance. Reported change from null model; MOR, median odds ratio; na, not applicable.
2. Null model, random intercept only, no covariates; Model 2 adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation.
3. Wald test that between-area variance for the null model is non zero (i.e. $\delta_u^2=0$) $p<.001$ for major cities and inner regional, $<.01$ for outer regional/remote. See Appendix G for full details of model diagnostics.

In major cities and inner regional areas, increasing educational level was associated with an increased probability of seeing a specialist, having taken into account between-area variation and adjusting for need and other explanatory variables (Table 34). There was no significant association between education and specialist use in outer regional and remote areas. Other individual explanatory variables demonstrated similar gradients to bivariate analyses and previous outcomes examined. See Appendix C for full model results.

Table 34. Model 2: fixed effects for specialist use by region

Model 2, specialist use	Cities	Inner regional	Outer regional/ remote
	OR (95%CI)	OR (95%CI)	OR (95%CI)
No school certificate	1	1	1
School certificate	1.05 (0.99–1.10)	1.07 (1.02–1.12)	1.00 (0.95–1.05)
Apprentice/diploma	1.10 (1.05–1.16)	1.08 (1.03–1.14)	1.00 (0.95–1.05)
University	1.17 (1.11–1.24)	1.17 (1.11–1.23)	1.05 (0.99–1.11)
p-value for SEP term	<.001	<.001	ns

Notes:

1. OR, odds ratio; CI, confidence interval; SEP, socioeconomic position; ns, not statistically significant.
2. Adjusted for sociodemographic (educational attainment, age, sex, country of birth, marital status) and need (self-rated health status, number of chronic disease, physical functioning) variables.
3. Wald joint test of significance for education.

To summarise, the probability of seeing a specialist varies between areas, even after accounting for the characteristics of individuals living in those areas. In major cities and inner regional areas, for a given level of need, a person of high SEP was more likely to see a specialist than their low-SEP counterparts, regardless of where they lived.

6.5 Model Diagnostics

For main analyses for each outcome by region, the Wald test that the between-area variation was non zero was significant (that is, the null hypothesis that $\delta_u^2=0$ was rejected; $p<.001$). Fitting null models with MCMC estimation procedure demonstrated a reduction in the Deviance Information Criteria (DIC) from a single level to a two-level random intercept model, confirming that the latter model was a better fit to the data.

For all outcomes, coefficients produced for multilevel models (null and adjusted for individual covariates) with MCMC estimation were almost identical to PQL estimation. Q-Q plots demonstrated normality of the area-level residuals, confirming that model assumptions that the residuals were normally distributed were met. For full model diagnosis see Appendix E.

Chapter 7 discusses the results of the second study in detail, summarising the findings, reviewing the strengths and limitations of the study, and providing a discussion comparing the current results with earlier studies and the meaning of the findings.

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Chapter 7

The Modifying Effect of Area Primary Health Care Service Characteristics on Socioeconomic Variation in Primary Health Care: Discussion

7.1 Summary of Principal Findings

Both GP use and quality of GP care varied between areas, in all regions, even after accounting for the characteristics of individuals living in those areas. Area PHC service characteristics explained part of the between-area variation in all outcomes, and generally across all measures from each domain (access, accommodation and comprehensiveness). For the most part, the increasing presence of area PHC service characteristics indicative of strong PHC systems was associated with increased GP use and quality of care.

For a given level of need, a person of low SEP had more use and better quality of GP care, regardless of where they lived. The one exception to this general pattern was that a person of higher educational level was more likely than someone of lower education to have received a long consultation in the reference year.

Area PHC service characteristics modified some of these pro-low SEP associations, but were not consistently associated with a greater increase in use and quality of care for persons of low SEP, with findings different in major cities, compared with regional and remote areas. In major cities, generally areas that were more affordable (that is, had increased bulk-billing or decreased OOP expenses) and had more after-hours and chronic disease care were associated with a larger increase in use and quality of care for persons of high SEP, compared with persons of low SEP; that is, they were pro-high SEP. On the other hand, increasing availability was associated with an increase in long consultations, and this was pro-low SEP. In contrast, in regional and remote areas, measures of affordability and, to a lesser extent, after-hours care were associated with larger increases in use and a larger increase in long consultations for those who were low SEP compared with high SEP; that is, these PHC characteristics were pro-low SEP.

The probability of seeing a specialist also varied between areas, in all regions, even after accounting for the characteristics of individuals living in those areas. Unlike GP care, for a given level of need, a person of high SEP was more likely to see a specialist compared with their low-SEP counterparts, regardless of where they lived.

7.2 Strengths and Limitations of the Study

7.2.1 Study Population

This study used data from the *45 and Up Study*, a population-based cohort study, and currently the largest of its kind in the Southern hemisphere [248]. The large sample size, with an average of 2913 participants per SA3, meant there was sufficient power to carry out multilevel modelling including a large number of explanatory variables at both levels. In addition, the oversampling in rural areas enabled stratified analyses to examine differences in relationships across regions, which was critical. Participants in the *45 and Up Study* have consented to have their survey data linked to a wide range of administrative data, making this an extremely rich dataset for investigating health service use and health outcomes.

An important limitation of the study population was that it was restricted to NSW and to those who are 45 years of age and over, limiting the generalisability of findings to the rest of Australia and other age groups. This population may differ from other jurisdictions where the population is more dispersed and has a higher percentage of Aboriginal and Torres Strait Islander people (for example, far North QLD, NT, and WA). It is well established that there is lower use of ambulatory services in rural and remote areas [42, 134, 186, 208] and Indigenous Australians generally use more health services compared with non-Indigenous Australians (with crude adjustment for need) [224]. Whether this would change the relationship with SEP or alter the cross-level effects of PHC service characteristics is not clear.

A further consideration is that, although the final sample incorporated 10% of the NSW population aged 45 and over, the overall response rate for participation was 18%. As such it is potentially subject to selection bias. However, a study comparing the cohort responders with data from the target population sourced from the NSW Population Health Survey (which is representative of the general population in NSW) found similar prevalences for a number of highly and moderately comparable survey items including age, sex (weighted estimates), country of birth and educational attainment [223]. More importantly, while absolute estimates of health services use may be biased, compared with the general population, representativeness is not necessary for relative estimates based on internal comparisons, and patterns of association estimated within the cohort remain valid and broadly generalisable [223, 249].

While, for stratified analyses, the number of areas and participants per area were well within the range reported from simulations that are required for unbiased estimates [245, 246] and as reported in multilevel studies of health services [102, 114, 191], there remains the potential for analyses to be underpowered. For all regions, the number of participants per area was large (at least more than 2000 participants per area). However, at least for outer regional/remote areas, the number of groups per region was at the lower end of recommended (that is, at least 20 groups

when interested in cross-level interactions) [246]. Power calculations using MLPowSim [250] for fully adjusted models with a cross-level interaction term and 2000 observations per group, provided a power estimate for major cities of 0.72 for 40 groups, and for outer regional/remote areas 0.5, 0.63 and 0.73 for 20, 30 and 40 groups respectively. This suggests that analyses had moderate to high power [246]. The limited number of significant cross-level interaction terms found in this study, particularly in regional and remote areas, may have been due to a lack of power to detect a true cross-level interaction, rather than confirming that individual SEP and area service characteristics do not interact to alter receipt of care (that is, the null hypothesis). In addition, true effect size may have been underestimated where interaction terms were significant, although to what extent the current study has been affected by this is unknown. Given the potential population size that could be affected (30,000–130,000 people per SA3), a small increase in the effect size of an area characteristic being pro-low SEP for receipt of care would likely be of clinical and policy relevance (for example, a 1% increase in bulk-billing within an area associated with additional 1% increase in use of services for low-SEP persons compared to high-SEP).

7.2.2 Data

A major strength of this study is the use of unit record survey linked to MBS data. The ability to link datasets, as was done for this study, has for the first time allowed the investigation of individual-level socioeconomic variation in observed receipt of PHC and specialist services accounting for between-area variation. Linking to MBS data allowed measurement of objectively recorded utilisation. While studies have found general agreement between self-reported use of health services and claims- or record-based use, over- or under-reporting has been found, depending on respondent characteristics (for example, age, sex, co-morbidities and country of birth) [251-253]. Hence, objective measurement of use overcomes this potential source of bias. At the same time, linking administrative data to measures of baseline characteristics provides a richness of information about participants not routinely available with administration data alone.

Another strength of the study is the use of global area-level variables derived from data entirely separate from the individual-level dataset. Not only does this provide construct validity (measurement of a true area-level process that is not reducible to the individual) [20, 254], it also maximises the capacity to quantify an area-level effect should one exist [65]. While a number of the area-level variables were derived from data from *all* individuals residing within that area, the final measures are attributes of an area that are the *same* for all individuals in that area. For example, while the number of chronic disease items was measured at the individual-level, the number of these relative to the number of long-term conditions within an area can only be calculated at the area level.

There are three considerations pertinent to this study when using MBS health service use data. These are the inability to capture GP visits provided in public health services; the limited capacity

to measure specific qualities and types of care provided (that is, the quality of care measures available are proxy measures) and the lack of health service use data for other aspects of PHC (for example, allied health, psychological and dental services).

First, while MBS data will capture nearly all GP services, they do exclude some relevant services; for example, services that are provided through publicly-funded community health centres, which are known to be more likely attended by low SEP individuals [4, 47]. Further, some GP services may have been provided in emergency departments in rural and remote areas, which at the time of the study mostly did not attract MBS benefits. In addition, a substantial proportion of specialist services are provided in publicly-funded outpatient clinics, which for the most part are not billed under Medicare, so do not appear in the MBS data. In both scenarios, it is probable that lower-SEP individuals are more likely to use these hospital-based services [96]. Overall this may bias estimates for SEP gradients in receipt of care to be pro-high SEP. Hospital-based services comprise a small proportion of the total services, however, and including such services in total counts has been found to have little effect on estimates of SEP variation in receipt of GP and specialist ambulatory care [96, 173].

Second, the measures of quality of care represent proxies for qualities and types of care associated with improved health and well-being. The MBS data have very limited scope for measuring the nature and range of services provided in terms of specific management for acute illnesses, chronic disease, prevention and health promotion, as is the case internationally (as seen, for example, in Quality Outcomes Framework [QOF] data in the UK [12, 255, 256] and Medicare data in the US [151]). The assumption underpinning the notion that longer consultations are indicative of quality of care is that more complex and comprehensive care can only be provided in a longer time period. This is supported by the literature [210]. Care planning represents one of the few specific care processes that can be measured more directly from MBS data. However, this does not account for the chronic disease management that would occur in routine clinical practice. Density-based measures of continuity of care, as used in this study, have been criticised as they do not account for appropriate referral to other providers for certain conditions [215]. While this would certainly be pertinent for all medical visits, the measure in this case is restricted to GPs, and referral within this group is generally not routine practice. Nevertheless, this study did find evidence of individual socioeconomic and area-level variation in these outcomes, and, in particular, there was important cross-level effect modification by area service characteristics on the socioeconomic distribution of these outcomes that are meaningful for policy.

Third, the health service data used in this study had limited ability to capture other aspects of PHC such as community and practice nursing, allied health, mental health and dental care. While some of these services may attract a Medicare benefit (through care planning items, mental health care plans, and practice incentive payment programs), the vast majority of these services are provided

privately [257] and thus are more likely to be used by persons of high SEP [96], or through state-funded community health services, which are more likely used by those of low SEP [47]. As such, this study provides an incomplete picture of receipt of PHC in Australia.

Education was chosen as the main measure of SEP. It was chosen as it is relatively stable (after age 45 at least), has little missing data, and provides an indication of the relative prestige, capacity to generate income and power a person may have. However, as discussed in Chapter 5, this measure does not capture all dimensions of SEP. Supplementary analyses with income (which capture the interaction between education and occupation over the life course [229, 230]) generally produced similar findings for socioeconomic gradients in outcomes, and for both measures of SEP the direction of associations for cross-level interactions were the same. The exception was education compared with income for long consultations, discussed further in Section 7.4.2. Further, the findings (in terms of socioeconomic variation) were broadly consistent with previous work [91, 94, 96].

As this study sought to investigate health care equity; that is, equal health care use for equal need, adjustment for ‘need’ was required. As discussed in Chapter 1, need is conceptually complex, and actual need for health care services can only be measured indirectly. Three sources of data were used in this study as proxy measures: self-reported health status, number of chronic conditions and self-reported physical functioning, providing some indication as to disease severity. As is common to all survey-based studies, these data are potentially subject to self-report bias. Specifically, there is some evidence that self-reported health status may vary according to race/ethnicity and SEP, resulting in underestimation of health inequalities [258]. In addition, these variables are broad measures of health care need, and, while they were strongly associated with GP use, they are unlikely to adequately capture true levels of need within the study population, with subsequent under-adjustment in models. Given that persons of low SEP are more likely to have chronic conditions and experience severe illness, the pro-low SEP receipt of GP care probably reflects this under-adjustment.

7.2.3 Study Design

A major strength of this study is the multilevel analytical design. As described in detail in Chapter 5, this enabled modelling of the nested hierarchy of data and quantification of the extent of between-area variation, providing more accurate estimates of area effects on outcomes, compared with single-level models. This is the first study in Australia to use this approach when examining socioeconomic variation in receipt of PHC. However, as with all multilevel models, there are a number of potential sources of error in the study design. Three relevant potential sources of error are discussed here, all of which, if anything, may have resulted in an underestimation of area-level effects: misclassification of individuals to area units, appropriate scale of area units and timing of ecological variables in relation to individual variables.

A potential source of information bias is the incorrect assignment of individuals to higher-level units (area in this case), generally expected to reduce the ability to detect an area effect [65]. In this study, there are two potential sources of misclassification. The first is when individuals were originally assigned to CCDs and SLAs (through geocoding of addresses), although the overall accuracy of match for each address was reported by the data custodians to be high. The second source was during assignment to SA3s from CCDs and SLAs. Given that concordances were not exactly one to one, there was a small percentage for which the contributing area was assigned to the new area based on population proportions. This will, inevitably, have resulted in some occasions of incorrect assignment to an SA3. Given the few instances in which this occurred, which are likely to be non-differential with respect to SEP, the impact on the results is likely to be negligible.

A related issue is misspecification of the geographical unit (or higher-level group more generally for multilevel models) [20, 63, 65]. The geographical units (SA3s) used for area-level variables were based on what data were available at the smallest appropriate scale. These units cover large geographical areas of physically-dispersed communities in outer regional and remote areas. While it can be argued that, conceptually, SA3s are a reasonable approximation of a scale at which the organisation and delivery of PHC services might influence individual use (as opposed to a smaller or larger scale), these areas are not specifically designed with this in mind. This could result in underestimations of associations of area-level variables with outcomes [65], potentially obscuring real area-level effects. It is difficult to know to what extent the study has been affected by this. It is, however, likely to be minimal, as suggested by a recent ecological study using the same dataset for investigating use of GP services, which found little difference in relationships when examined at different geographical scales (one purpose-built areas and the other, administrative areas) [259].

Another consideration for multilevel models is the timing between when area-level and individual-level outcome variables are measured [65]. In this study, time periods for area-level data were contemporaneous with individual-level data. However, according to statistics published by the DHS MBS statistics [48], figures for bulk-billing rates, out-of-pocket costs, and EPC claims per capita have been relatively stable over the period 2007–2008 to 2011–2012 (rates are unavailable for after-hours MBS items). As such, the impact on results is likely to be negligible.

A technical consideration is that parameters were determined for main and supplementary analyses by PQL estimation procedure. While this estimation procedure may produce biased estimates, particularly in underestimating random effects variances, [247, 260] this is the estimation procedure commonly used in health service literature for logistic regression [43, 69, 247]. Estimates for un-stratified analyses by MCMC procedure were unchanged. Additionally, multicollinearity is a particular problem for area-level variables, making estimation of independent effects for more than one area-level exposure simultaneously often not possible [65].

While it is generally thought that one higher group variable per 10 groups is a reasonable to avoid this, given the nature of the area-level variables used in the study it was elected to test each variable separately. For example, given the strong association between availability and costs [127], it would be difficult to determine to what extent the relationship of each variable with use is explained by an association with each other (or, put another way, the strength of association between availability and use net of costs).

A final consideration is that although the current study uses data from a large population-based cohort study, like all observational studies, causation cannot be inferred.

7.2.4 Summary of Strengths and Limitations

The strengths of this study are that it is based on a large cohort study linked to health service use data (MBS data), and it uses a multilevel design that accounts for the nested hierarchical nature of the data and allows determination of area and cross-level effects. It is the first of its kind in Australia to examine socioeconomic variation in receipt of PHC and specialist services in this way. Further, the area-level variables can be considered ‘true’ area constructs as they are not reducible to the individual level and reflect an exposure that is common to all individuals residing within the same area. The main sample and data limitations relate to the generalisability to younger age groups and other jurisdictions; reduced power to detect true cross-level interactions for regional/remote areas and potentially underestimated effect sizes of cross-level interactions due to a low number of groups; the limited capacity to measure specific aspects of quality of care outcomes; and the inability to capture all relevant services provided in state funded services (particularly in rural areas) and other PHC services such as allied health and dental care. There were three important potential limitations with respect to the design of the study: misclassification error in assigning individuals to areas; the scale used for area-level variables was based on available administrative geographies; and contemporaneous period of measurement for area-level exposure variables and outcomes. All three sources of error could have resulted, if anything, in an underestimation of an area effect. However, the overall impact on results of the study is likely to be negligible.

7.3 Comparisons with Other Studies

There are no other studies specifically investigating a cross-level effect modification of area PHC service characteristic on socioeconomic variation in receipt of PHC, in Australia or internationally. The following discussion considers the current findings in the context of previous studies in Australia with respect to between-area variation in GP and ambulatory specialist care; the association of area-level PHC service characteristics and receipt of GP care; and socioeconomic variation in need-adjusted receipt GP and ambulatory specialist care. Where Australian studies are lacking, relevant international studies are discussed.

7.3.1 Between-area Variation in Receipt of GP and Ambulatory Specialist Care

The finding that there was between-area variation in GP use is consistent with previous ecological studies in Australia examining variation across SLAs [134, 186, 208] and Medicare Locals [133]. Individual and ecological studies in Australia also have suggested that there is variation between areas in continuity of care (varied according to rurality) [182] and care planning (Medicare Local and SA3 level) [142].

There are no Australian studies that have partitioned the variance in GP use and quality of care at the area and individual level, and no Australian studies reporting area variation in specialist use (ecological, individual or multilevel). Generally, the proportion of variance explained at the area level in this study was within the range of Australian studies examining area-level (SLA) variation in health outcomes such as mortality [34], hospitalisations [69] and acute myocardial infarction [42] (that is, MOR from 1.2–1.45 and ICC from 1–5% across all outcomes). Findings for between-area variance in GP care were also within the range reported at the practice level for continuity of GP care in countries with a similar health system to Australia, such as the UK [219]. Estimates of between-area variation in specialty care reported in France were also similar to those found in this study. It should be noted, however, that while health care in France is underpinned by universal health insurance, access to specialty care does not require referral from a GP as occurs in Australia [194]; as such, findings are not directly comparable.

7.3.2 Association of Area-level PHC Service Characteristics with Receipt of GP Care

There are no studies, in Australia or internationally, quantifying the extent to which area service characteristics explain between-area variation in receipt of PHC. A limited number of ecological and individual-level studies, and two multilevel studies specifically examined the relationship of service characteristics with receipt of care, with the multilevel studies investigating this relationship at either the individual-, physician/practice-, or country-level. Nevertheless, to better understand the current study within the context of the literature to date, these findings are compared according to each outcome investigated.

7.3.2.1 Area characteristics and GP use

The finding that increased availability of GPs within areas was associated with decreased use in major cities, with no clear association in regional/remote areas, was contrary to expectations, based on previous ecological studies. An Australian study using data from 1996–1997 demonstrated that increasing availability was associated with increased use; this was more so in rural areas [134]. A subsequent ecological study using data from 1998–1999 found a positive association of GP availability and the decision to consult a GP, but not frequency of use, for those who had visited a GP [261]. A study with simultaneous supply and demand equations using data pooled from 1996–2003 found that this effect was attenuated at upper limits of availability [127].

Measures of supply for all studies were calculated in a similar manner (that is, per capita rates based on headcounts or FTE from hours worked per GP with counts capped at 1). The reason for the discrepancy in findings may be related to differing time periods and/or study design (ecological versus multilevel in the current study). Possible explanations for these discrepant findings are discussed in more detail in Section 7.4.1.

The finding of a positive association of bulk-billing and a negative association of out-of-pocket expenses with GP use is consistent with previous ecological studies in Australia. Recent (2011–2013) ecological studies at the SA3 and Medicare Local level reported that age-standardised use was higher in areas with higher bulk-billing rates [133]. An ecological study (Divisions of General Practice) from 1998–1999 also reported that, after adjusting for area SES and GP availability, use increased with bulk-billing in highly accessible areas (such as cities) [261].

There are no studies examining the relationship between area accommodation and use.

7.3.2.2 Area characteristics and quality of GP care

The finding that a person is less likely to receive a long consultation if they live in an area that is less affordable (in major cities), is conceptually congruent with one previous Australian study. That study showed that those who do not have a concession card (and, hence, are less likely to be bulk-billed) had longer consultations [181]. The relationship of affordability in inner regional areas with long consultations contrasts with this finding, and the reasons for this are discussed in detail in the Section 7.4 of this chapter. There are no studies examining the relationship of availability or accommodation with length of consultation. Further, there are no Australian studies examining area service characteristics and continuity of care or receipt of care planning.

There are two international studies that have investigated the association of service characteristics with continuity of care [116, 193]. Firstly, a Canadian multilevel study showed that availability (as measured by the number of family physicians in the practice) and after-hours arrangements (open on weekends but also being on call less than 24 hours per week) were associated with less continuity of care. By contrast, the current study found no relationship between availability and accommodation with continuity of care. There are a number of study design factors that may explain the different findings; for example, characteristics measured at the practice level compared with the area level, or continuity of care based on self-reporting rather than scores derived from visits. More importantly, however, while there are some similarities between Australia's and Canada's health systems (both underpinned by universal health insurance with a strong PHC sector), there are a number of possible differences that may contribute to the discrepant findings. Secondly, consistent with the current findings, a cross-country multilevel European study using QUALICOPC data found that when GPs had a broader service profile (that is, had greater comprehensiveness) that patients perceived better continuity of care [116].

7.3.3 Individual-level Socioeconomic Variation in Receipt of GP and Ambulatory Specialist Care

There are no Australian studies examining socioeconomic variation in the outcomes investigated in this thesis, having accounted for between-area variation. There are, however, individual and ecological studies in Australia examining the relationship between SEP and receipt of PHC and specialist services, and some international work examining this after accounting for between-area variation. These are considered briefly here.

7.3.3.1 Socioeconomic variation in GP use

The pro-low SEP use of GP services was consistent with a previous individual-level study examining self-reported use of GP services by household income in 2001 (pro-poor) [94], and as found in middle aged women in a study using health service use data linked to the Australian Longitudinal Study of Women's Health (ALSWH) survey data from 1996–1997 (pro-low education) [262]. This was also consistent with findings reported in ecological studies of per capita GP use from the same time period (1998–2000) [208, 261]. Two studies from the late 1990s and 2000 found opposing results—that is a pro-high SEP relationship with GP use. One used data from the 1997 Australian Survey of Mental Health and Well-being [263] and the other used data from a community survey of young adults linked to health service use data in the Canberra region in 1999–2000 [264]. The conflicting findings may relate to differences in study design (self-reported versus health service use data, varying adjustment for need, time periods examined) or real differences relating to gender, age, location of services and mental well-being. On balance, these earlier studies suggest that disadvantaged individuals have greater need-adjusted use of services. Further, while these studies were need-adjusted, this does not mean they were fully adjusted. As such, the pro-low SEP association with use most likely reflects need, at least in part.

The most recent individual-level study using data from more recent waves of the ALSWH (2004) found that, after adjusting for need, those who were disadvantaged reported similar levels use of GP services to their advantaged counterparts (that is, GP use was equitable) [96]. While there are a number of differences in study design that may explain the disparate findings, probably the most important difference is that the study using ALSWH data did not account for between-area variation, potentially obscuring important relationships that exist at the individual level [60, 65]. In line with these findings, recent descriptive ecological studies at the SA3 and Medicare Local level have reported a lack of variation in use according to area disadvantage. However, no formal statistical analyses were undertaken, and SEP was measured at the area-level, not the individual-level [133, 142]. The current findings are also consistent with international studies of countries with universal public health [136, 177, 178, 180, 265], although these have not accounted for between-area variation.

While the pro-low SEP pattern found here (and elsewhere) most likely reflects under-adjustment for need, overall the pattern remains that GP use in Australia is either pro-low SEP or least equitable, and this has remained relatively stable over the first decade of this century.

7.3.3.2 Socioeconomic variation in quality of GP care

There are far fewer studies examining socioeconomic variation in quality of GP care, in Australia or internationally. The current findings of a pro-high education relationship with long consultations is consistent with previous Australian studies reporting that high-SEP individuals (as measured by area SES of residence) had longer consultations [181] and that higher rates of long consultations occurred in advantaged postcodes [187]. The pro-low SEP relationship with continuity of care has been previously demonstrated in an Australian individual-level study, which found that those of low income were more likely to be affiliated with a single GP (self-reported) [182]. Similarly, for care planning, Australian studies have shown that increased uptake in persons with low income or educational levels [184], and that expenditure on MBS items for care planning was pro-poor [95]. Presumably, the pro-low SEP association with continuity of care and care planning, in part, reflects unmeasured need.

Similar patterns have also been demonstrated for continuity of care in countries with a gate-keeping mechanism and universal health insurance. For example, a pro-low SEP association was found in a New Zealand individual level study [183], and in a Canadian multilevel study that accounted for between-practice variation [193].

7.3.3.3 Socioeconomic variation in specialist use

That those who are of high SEP use more specialist services for a given level of need, compared with their low-SEP counterparts, has been documented previously in Australia [91, 94, 96]. While recognising that there are important differences in health systems between countries (particularly with respect to gate-keeping mechanisms for specialty care), the findings from two international studies, that the pro-high SEP association with specialist use remained even after accounting for between-area variation [194, 195] is consistent with the current study.

7.4 Meaning of Findings

7.4.1 Area Variation and Association of PHC Characteristics and Receipt of Care

The finding that there is marked between-area variation in all outcomes examined, even after accounting for the characteristics of people living in those areas, suggests that there are processes within a person's local context that influence health care use. For example, and as investigated in this study, the organisation and delivery of services within areas. These processes reflect opportunities for policy intervention within the PHC system that may contribute to improving receipt of care for those who need it most. While the amount of variation explained at the area

level, compared with the individual level, seems relatively small, it is well within the range of expected effect theoretically [19, 65] and empirically (as discussed in Section 7.3).

A number of process characteristics of PHC service organisation and delivery within areas contributed to the between-area variation in receipt of GP care. In many cases, the increasing presence of characteristics viewed as indicative of a strong PHC system was associated with increased use and quality of care. There were a few important exceptions, which are discussed in detail here.

The finding that increasing GP availability was associated with decreased use in major cities was unexpected. An explanation is that, in cities, GPs are locating to areas where fewer services per capita are required, but where they are able to be more selective with the services they provide (supported by the positive association with long consultations in major cities for Model 3 of this study) and probably charge more (as suggested by the finding in Chapter 3 of more availability in advantaged and less affordable areas). For example, this may include areas that are more affluent or at least have a higher proportion of highly-educated people, where individuals have less need of services (because they are on average healthier) but receive a longer consultation when they do go (either because they ‘collect’ their problems for single visit and need more time to address these, or have a preference for a longer consultation when they go infrequently).

In major cities, people living in areas with lower out-of-pocket expenses are less likely to receive a long consultation. It may be that this association reflects the way services are delivered, in order to provide them at minimal cost to individuals and be financially viable in a fee-for-service environment [266]. That is, in areas with lower costs (and hence more bulk-billing), more frequent and shorter consultations are provided as this generates more income than less frequent, longer consultations (that is, the benefit per minute decreases with longer consultations when bulk-billed). Alternatively, this finding may simply reflect that in areas with more out-of-pocket expenses there are also more long consultations overall (which cost more). The association is likely reflecting a combination of both of these dynamics; however, the current study was unable to determine this.

In addition, the negative association in regional areas between bulk-billing and continuity of care was contrary to what was hypothesised. Possibly, in those regional areas where there is more bulk-billing, it may also mean people have less choice about who provides their care, which may impact on continuity of care. However, why this was not the case in major cities is not readily apparent. Perhaps, where there is an adequate supply of GPs in major cities in areas where bulk-billing rates are high, people are still able to see the same doctor and hence maintain continuity of care.

7.4.2 Individual-level Socioeconomic Variation in Receipt of GP Care

It is clear that, not only are socioeconomically-disadvantaged individuals using more GP services (after at least partial adjustment for need), their quality of care (in terms of continuity and complex care planning, but not in terms of longer consultations) is greater relative to their advantaged counterparts. This remains even after taking into account between-area differences in GP use and quality of care. While the pro-low SEP use of GP services is unsurprising, given previous findings and the nature of gate-keeping and minimal cost sharing arrangements in Australia (bulk-billing and safety net provisions), it is reassuring that this also translates into pro-low SEP quality of care. Continuity of care and care planning is essential, as those who are of lower SEP are more likely to have multiple and complex health and psychosocial care needs [1, 202-204], and these care processes enable these care needs to be met.

While observed previously in Australia [187], the ongoing pro-high education relationship with long consultations across all regions demonstrates that there are aspects of GP care that remain 'unfair'. A possible explanation is that people with lower educational levels are also more likely to be bulk-billed and, for bulk-billed services, the benefit per minute falls with longer consultations. If this was the case, a similar relationship would be expected with income. However, this study found a pro-poor relationship with long consultations, suggesting that an alternative process explains this association. Long consultations are viewed to reflect episodes of care that cover a range of health needs (acute, chronic, preventative) and, given the greater health need of those who are low SEP, it was hypothesised that this group should have more long consultations for a given level of need. That the finding of inequity is limited to analyses with education as the measure of SEP may reflect underlying differentials in health literacy. Those who are better educated may be better able to identify their health needs and navigate the health system to ensure those health needs are met [174, 175, 267]. As such, highly-educated individuals may be more likely to anticipate and expect a range of health issues to be addressed in a single episode, and request a consultation length to that effect. On the other hand, previous research has shown that length of consultation may be more reflective of practitioner characteristics, rather than the appointment length itself [212]. It may be that more educated individuals actively seek out practitioners with characteristics associated with longer consultations.

7.4.3 Cross-level Effect Modification of PHC Characteristics on Socioeconomic Variation in Receipt of GP Care

While many of the PHC characteristics examined in this study modified the association between SEP and receipt of GP care, this was not always in the direction anticipated. Generally, in terms of contributing to equity within the PHC system, in major cities increasing strong PHC service characteristics has marginal gains for low-SEP individuals, while in regional areas increasing these characteristics can be viewed as pro-low SEP. That is, these characteristics were associated

with increased use and better quality of GP care, particularly for those who are disadvantaged and hence need it most. For ease of interpretation, each area PHC service characteristic is briefly considered here.

In major cities, while people living in areas with more FTE GPs per capita receive fewer services, it would appear that low-SEP individuals are less affected by this. It is unknown whether a person of low SEP who lives in an area with more GPs (compared to living in an area with fewer GPs) truly requires fewer services, or is underutilising relative to their needs (because there are fewer services available overall in areas with more GPs). The reduced number of services received by disadvantaged persons in areas with more GPs (compared to areas with less GPs) was somewhat mitigated by the fact that they were more likely to receive a long consultation, even more so than their advantaged counterparts. Whether this translates to overall better care (more time to address needs in one visit rather than addressing multiple issues over multiple visits), was unable to be tested, although qualitative work in this areas could provide some further insight (this is discussed in further in Chapter 8).

In outer regional/remote areas in supplementary analyses, people living in areas with more GPs per capita not only had fewer services but were more likely to have shorter consultations. This was even more so for those who were disadvantaged than for their advantaged counterparts. Possibly, as in major cities, GPs are locating to areas where there is less demand overall for services. However, because there is a relative undersupply of GPs in regional and remote areas, the cost for services in these areas is such that those who are disadvantaged are affected more. Similarly, in areas with more GPs, perhaps because inadequate supply remains (and hence GPs can charge more), long consultations are less affordable for all groups, and this is particularly so for low-SEP individuals. This is partly supported by the findings from the current study in cross-level interaction models with affordability measures.

With respect to affordability, for major cities, the findings suggest that either increasing bulk-billing or decreasing out-of-pocket costs within areas will make minimal difference in receipt of PHC for persons of low SEP. This finding suggests that, in cities at least, current measures to contain out-of-pocket costs such as bulk-billing are in fact working effectively and have possibly reached saturation for those who are disadvantaged (that is, the vast majority of low-SEP persons are bulk-billed in cities across all areas). The effect of increasing these measures of affordability from this base appears to be to increase use and quality of care for higher SEP groups, so that they ‘catch up’ to lower SEP groups. Whether this represents overuse by these groups or an ‘unmet’ need is unknown. Conversely, in regional areas, it would appear that there may be unmet need across all groups that is addressed by increasing bulk-billing and decreasing out-of-pocket costs; even more so for those who are disadvantaged. The findings suggest that there are significant gains to be had for low-SEP groups in maximising these measures of affordability. Further, given

the modifying effect of availability on use and long consultations according to SEP, addressing undersupply in regional areas without concomitant attention to costs is unlikely to facilitate better care, specifically for those who are disadvantaged and need health care most.

The interpretation of the modifying effect of affordability on socioeconomic variation in receipt of long consultations in major cities is not immediately apparent. The findings suggest that in areas with lower out-of-pocket costs, those who are disadvantaged are even less likely to have a long consultation, compared with their advantaged counterparts. This may reflect the interplay between overall bulk-billing and provider charging practices. Whatever the reason, in major cities it remains that if equity is of prime concern, increasing affordability through decreasing bulk-billing is unlikely to facilitate the receipt of longer consultation in those who are disadvantaged. Nevertheless, reducing these affordability initiatives could potentially undermine the current status quo in terms of equity of GP use and quality of care.

With regard to the modifying effect of accommodation and comprehensive care in major cities, the findings most likely reflect a similar dynamic to measures of affordability. It would seem that in areas where services are organised to provide high levels of after-hours care (for example) also provide better continuity of care and care planning, but it is primarily advantaged persons that gain from this (that is, they ‘catch up’ to their disadvantaged counterparts). So, too, for chronic disease care and continuity of care. In regional areas, similarly to affordability, the findings suggest that, in areas with more after-hours care, a person of low SEP is even more likely to receive a longer consultation than their high SEP counterparts. The direct mechanism by which this may occur cannot be answered by these analyses and, given the limitations of the *after-hours care* measure in regional areas and the *CD care* measure generally, the findings need to be interpreted cautiously. These findings do, however, highlight an opportunity for improving care for those who have the most to benefit from this.

7.4.4 Area and Individual Socioeconomic Variation in Specialist Use

Inequalities in use of specialist services persist, with socioeconomically disadvantaged individuals using less of these services for a given level of need, for most regions. Given that there have been no policy changes to address this inequity this is not surprising. There are no bulk-billing incentives for seeing a specialist, out-of-pocket costs for specialist care have doubled over the first decade of the millennium [48]³⁴ and government funded private health insurance rebates have remained in place. There may be other reasons which explain this inequity aside from inequitable access. This includes differences in propensity to seek care either due to differences in health literacy, attitudes and beliefs [268]; or that in response to negative behaviour from providers, those who are disadvantaged are less likely to seek care [269]. However, if this were

³⁴ Between 40-45 AUD (2006–2007 and 2009–2010) per consultation for those not bulk billed, 31% of services bulk-billed

the case a similar pattern would be expected with GP care. Further, previous studies have found no differences between SEP groups in propensity to seek care based on clinical scenarios or questionnaires [270, 271] nor differences between SEP groups in rates of completion of specialist referrals [272].

Alternatively, given referral from a GP in Australia is required for accessing specialist care, inequitable specialist use may reflect provider preferences and bias. There is some evidence in Australian that GPs may be less likely to offer lifestyle advice to persons of low SEP, as they do not expect this to be acted on [273]. International evidence also suggests that providers are more likely to negatively discriminate against those of low SEP in terms of provision of care [269, 274] and higher SEP individuals are more likely to be offered referral (in the private sector at least) [275]. Whether the social stratification of specialist use is partly due to propensity to seek care or provider bias, care still does not reflect need and hence can be viewed as inequitable.

Like GP care, specialist use varies between areas, for all regions, even after accounting for the characteristics of people living in those areas. This again suggests that there are processes within a person's local context, such as the organisation and delivery services of an area, which may facilitate or impede access to specialty care and can be changed by policy or practice. International multilevel studies in countries with [195] and without [70, 194] a gate-keeping mechanism have shown that the availability of GPs or specialists within an area was associated with specialist use. However, whether this varied according to a person's SEP was not examined. Ensuring that the health system is organised such that those who need specialist care most can access this care, is critical for supporting the PHC sector in achieving the goals of not only improving overall levels of health but also the distribution of health within the population.

7.5 Conclusions

For the most part, GP use and quality of care is pro-low SEP across all regions after accounting for between-area variation. However, some aspects of quality of care remain pro-high SEP. Having first determined that receipt of PHC does vary across areas, this study has sought to identify aspects of service organisation and delivery that may contribute to mitigating any potential sources of inequity in health care use in Australia's PHC system. In major cities, it appears that area service characteristics considered indicative of a strong PHC system are currently working effectively for low-SEP individuals, and the gains associated with increasing these characteristics is that this results in high-SEP groups 'catching up'. In regional areas, however, increasing strong PHC service characteristics (namely, bulk-billing, lower out-of-pocket costs, more after-hours and chronic disease care) was associated with a larger increase in receipt of GP care for persons of low SEP—that is, these characteristics were pro-low SEP. The modifying effect of availability on socioeconomic variation in receipt of PHC is an important exception to these findings. Increasing availability in major cities may contribute to pro-low

receipt of long consultations, and possibly to greater use and long consultations in regional areas, but not without concomitant effort to improve affordability. Adequate access to specialist advice and care is essential for an effective PHC system—yet this remains inequitable for most regions. However, that specialist care varies between-areas suggests that there are opportunities for service organisation and delivery change that may redress this. Implications for future research and policy are discussed in the next and final chapter.

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Chapter 8

Discussion: Contributions to the Field of Area-effects and Health Equity, and the Implications for Policy and Future Research

‘Health inequity is a complex technical problem, with no easy or simple solution. However, we must not allow this technical complexity and lack of clear guidance on action to consign health inequity to the “elephant in the room”’

Furler and Palmer, 2011 p.298[13]

8.1 What the Thesis has Contributed

The premise on which the thesis is based is that equitable receipt of PHC may serve to mitigate the unfair distribution of exposure and vulnerability to ill health and the consequences of illness according to an individual’s SEP. Further, it was argued that PHC service organisation and delivery within a person’s local area contributes to equitable receipt of care. This research has shown that modifiable service characteristics of areas across the core domains of strong PHC systems—access (availability, affordability and accommodation), comprehensiveness and coordination—shape socioeconomic variation in receipt of GP care. It has identified specific opportunities for improving receipt of care for those who need it most by strengthening these service characteristics within the area where a person resides. In turn, this has the potential to contribute to health equity.

This thesis has, for the first time in Australia, constructed measures of PHC service organisation and delivery within areas that represent avenues for policy and service delivery change. This research further builds evidence that the organisation and delivery of services varies geographically at the small-area level, whether it be in major cities, regional or remote areas. As found internationally, while service characteristics from each domain and subdomains of strong PHC systems co-vary systemically across areas, the direction of association depends on the region investigated. That is, the greater presence of one characteristic does not necessarily imply that there will be a greater presence of other characteristics associated with strong PHC systems. Importantly, there are conceptual and technical limitations with available measures that preclude the use of some of them, and require careful consideration for others when interpreting findings with outcomes relating to receipt of PHC. Nevertheless, this research has clarified the strengths and limitations with respect to measuring modifiable aspects in PHC service organisation and delivery at a geographical scale that is meaningful for policy intervention.

Receipt of GP care varied across areas beyond what can be attributed to the characteristics of the people living in those areas. This suggests that there are aspects within a person’s local context

that systemically shape the care of all who live in that area. Primary health care service organisation and delivery contribute to this variation. Generally, a person living in an area with a greater presence of service characteristics central to strong PHC systems was more likely to receive more care than average, and better quality of that care.

The finding that, for the same level of need, those who are low SEP had a greater use of GP services than their high-SEP counterparts is not new [94, 136, 208], and in part, reflects under-adjustment for the greater need for care by low SEP groups. However, this research adds to this existing knowledge by showing that, for the most part, for the same level of need, quality of care was also pro-low SEP. The one exception to this—that is receipt of long consults was pro-high SEP (that is, inequitable)—has also been found previously. However, the current findings qualify that possibly this is only the case with respect to some dimensions of SEP; in this instance, education.

Importantly, for the first time, this research has extended understanding of socioeconomic variation in receipt of care, by demonstrating that the way services were organised and delivered within a person's local area altered the distribution of the quantity and quality of care received according to SEP. This was clearly the case across all regions. However, in major cities, specific initiatives to promote equity appear to be working well across all areas. That is, while living in an area with greater affordability, accommodation and comprehensive care was associated with increased GP use and quality of care, the main effect was to increase care for higher-SEP groups such that they 'catch up' to their lower-SEP counterparts. By contrast, in regional areas, the findings suggest that there is much to be gained from an equity perspective, particularly through greater affordability and accommodation of services in increasing use and receipt of long consultations for low-SEP individuals.

An effective PHC system also relies on equitable access to supporting secondary-level care. This research has confirmed that access to ambulatory specialist care continues to be inequitable, and clarified that this is so, regardless of where a person lives. Furthermore, this research is the first to have shown that use of specialist services varies between areas, above what can be attributed to the characteristics of the people living in those areas. This suggests that there are aspects within a person's local context that could be altered to promote equitable specialist use.

8.2 Relationship of Findings to the Theory on Area Effects

This thesis has sought not only to demonstrate that where a person lives matters for the care that they receive, but has further extended this understanding, by investigating the mechanisms through which this might occur. The findings suggest that individuals are exposed to a shared contextual influence based on where they live that determines their care, independently of who they are. As phrased by Leyland and Groenewegen (2003) [60], 'the opportunities and constraints'

within an area, as represented by organisational features of services such as GP availability or after-hours care, determine the amount and quality of care a person receives, with likely consequent impacts on their health. Identifying such opportunities and constraints within areas has the potential for important health gains, as policies implemented at this level may effect change across a larger number of people than if targeted at the individual level.

There is much debate in social epidemiology with respect to disentangling contextual (area-level) and compositional (individual-level) effects in health and health care [19, 20]. Multilevel analysis provides the statistical means by which to investigate and explicitly model this complexity, including cross-level effect modification. This research adds to international evidence investigating cross-level interactions in health outcomes, and provides new evidence that there are cross-level interactions that matter for receipt of health care. In doing so, this research provides greater clarity on how policy interventions may contribute to health care equity and thereby help address socioeconomic inequalities in health.

The ability to adequately model area effects on individual health and health behaviour depends on how the area (or context) is defined and how area-level constructs are measured [20, 243]. This is not without its challenges. The area-level measures constructed for this research reflect a shared context, in terms of the way services are organised and delivered, that is not reducible to the individual level. However, as was the case in this thesis with measures of the comprehensiveness and coordination of services, and accommodation in remote areas, accurate and valid measurement of an area-level construct is limited by what data are available. Unless measures are conceptually and technically robust, interpretation of relationships with health outcomes (including receipt of health care) is, at best, hindered and, in the worst case, may result in erroneous or uninterpretable findings.

8.3 Relationship of Findings to PHC Systems and Health Care Equity

The health system itself is generally accepted to be an intermediary determinant of health [1]. While it is a product of upstream cultural, social, economic and political contexts, it can alter the unfair distribution of illness according to SEP through equitable receipt of care. Drawing on four key conceptual frameworks, this research has shown that PHC service characteristics operating at the meso level (that is, within a person's local area), for a given level of need, shape the distribution in receipt of care across social gradients.

Consistent with evidence from cross-country comparisons [7, 116, 118, 119], this research found that living in areas with a greater presence of service characteristics associated with strong PHC systems increases not only the likelihood of an individual accessing more services, but also of receiving better quality of care. This is evident across all domains and sub-domains of strong PHC systems; namely, access (affordability and accommodation), comprehensiveness and

coordination. This research has shown that the specific initiatives in Australia to address these domains—that is, greater bulk-billing, lower out-of-pocket costs and more after-hours care within an area—benefits individuals living in those areas in terms of the GP care they receive, and, for the most part, across all regions.

From an equity perspective, the PHC system is clearly working well, in that those who are low SEP use more services and have better quality of care relative to their needs. That those who are more educated are more likely to have a long consultation, however, does highlight the potential for inequity for those aspects of health care that may require a greater capacity to navigate the health system or articulate the need for care—a personal resource captured better by education than by other measures of SEP such as income.

Determining which modifiable aspects of the PHC system are associated with equitable receipt of care was central to the thesis. Arguably, in major cities, current levels of bulk-billing, out-of-pocket costs, after-hours care and chronic disease care planning and team care arrangements are near optimal in all areas for the most disadvantaged individuals, in terms of their receipt of GP care. Hence, in major cities in Australia, only marginal gain would be achieved (in terms of being pro-low SEP) by increasing these initiatives. This research is unable to shed light on whether the increased receipt of care found for higher SEP individuals as a consequence of a greater presence of these measures represents unmet need or over/misuse of services. The latter, should this be the case, could be viewed as a source of inequity in the health system. Nevertheless, the findings suggest that, in major cities, current measures addressing affordability, accommodation and comprehensiveness of services within areas are working well for those who need it most.

In regional areas, on the other hand, the findings highlight opportunities for current initiatives for improving receipt of GP care for those who are of low SEP, in terms of use and long consultations at least. In contrast to major cities, in regional and remote areas it would appear that affordability and after-hours care has not reached saturation in terms of maximal benefit for care received by low-SEP individuals. In this setting, it would appear that more bulk-billing, less out-of-pocket costs and more after-hours care would increase use and quality of care, particularly for those who need it most.

Contrary to international [86, 192] and previous Australian studies [127, 134, 261], this research suggests that increasing the supply of GPs per capita within areas will not necessarily increase receipt of care nor be pro-low SEP. While this partly reflects the flat of the demand-supply curve (that is, once a certain level of supply has been reached, additional supply will make minimal difference to demand), it would seem that GPs are locating to areas where fewer services are required, and that they can be more selective in the services provided (and probably charge more). That there are more GPs per capita in areas that are advantaged and less affordable supports this premise. Currently in Australia, while there are some restrictions for overseas trained doctors in

the long-term and for doctors-in-training for a short period of their training, for the vast majority there is no restriction on where they can practise nor on how much they can charge. A number of financial incentives exist that are intended to address shortages of workforce and improve retention in regional and remote areas [276, 277]. Until the last few years, the means of identifying an eligible area had been based on the five categories from a broad geographical classification of Australia, considered by some to be a crude means of allocation that has contributed to further maldistribution of the workforce [130, 131, 278]. The current findings lend weight to that argument in that, in outer regional and remote areas, those living in areas with more GPs had lower use and quality of care, particularly those who were of low SEP. Hence, under current workforce and remuneration arrangements, more GPs are locating to areas where there is less need for care, but in local market conditions, this is still financially viable. While, in major cities (where presumably there is an adequate supply of GPs) disadvantaged individuals are less impacted by this (and actually benefit for some aspects of care), in regional areas (where there is insufficient workforce) they are worse off than their advantaged counterparts. This is not to suggest that increasing availability is detrimental to equitable receipt of care. Rather, reducing availability is likely to make things worse. However, in the absence of any specific initiative to control location of practice or fees charged, it is unlikely that increasing overall availability will contribute to improving care for those who are disadvantaged and need it most.

Similarly to GP care, whether an individual accesses specialist care or not depends on where they live, irrespective of who they are. As raised in Section 8.1, there may be aspects of a person's local context—including how services are organised and delivered—that could be altered to influence the specialist care they receive. Importantly, this research has confirmed that, for the same level of health need, those who are advantaged are more likely to receive specialist care than their disadvantaged counterparts. Addressing this inequity certainly has potential gains for health equity, and the findings suggest that a possible avenue for improvement is through how services are delivered locally.

It must be acknowledged that the impact of equitable receipt of care on the distribution of health within a population is likely to be substantially less than addressing upstream determinants (such as social and economic policies). Whilst most studies have shown that characteristics considered indicative of a strong PHC system are associated with improved levels of health within a population [7, 8, 106, 111], there is a trade off with reduced patient satisfaction [7, 17] and, as suggested more recently, greater costs [111]. Clear evidence that strong PHC systems reduce health inequity is limited [9, 17, 18]. Nevertheless, there remains an ethical and human rights imperative to redress health inequities where possible [1, 23]. Further, societies make significant investments in their health systems with the associated costs anticipated to continue to escalate [10, 101, 111]. Given this, ensuring that health systems are organised and funded in a manner that

is most likely to contribute to health equity is all the more pressing. The findings from this research offer some direction to that effect.

8.4 Implications

8.4.1 Policy

In order to justify the resources underpinning health care programs, there is an imperative to demonstrate that the policies guiding them are likely to achieve the intended objectives. Clearly outlining the causal pathway by which health policies may influence health care and hence outcomes, and explicitly modelling this, is necessary to understand the impact of such policies. By accounting for nested levels of influence in receipt of care and the way the various levels relate to each other, it can be seen that policies that determine how services are delivered and organised within a person's local area can shape receipt of care, including how care varies according to SEP. In this way, policies can be tested for their effectiveness, particularly in terms of equity.

Given that socioeconomic inequalities in health continue to be documented in Australia, there are significant potential gains to be had in reducing this through equitable receipt of care. Health inequity is technically and conceptually a complex problem, and addressing this requires sustained political will [13]. Health care reform in Australia over the last decade [10, 50] has emphasised the central role of the PHC system, in not only improving overall levels of health efficiently but specifically addressing socioeconomic inequalities through equitable access to care. The research in this thesis provides supportive evidence for this notion, by demonstrating the role of the PHC system in increasing receipt of care for those of low SEP, and highlights opportunities for further gains. The NPHCS framework gave the beginnings of a blueprint to achieving equitable access to care [10], with the National Performance and Accountability framework establishing the mechanisms for monitoring equity in the health system [168]. Yet early fears that health reform in Australia would culminate in an 'opportunity lost' for health equity [13] appear to have come to pass, reflecting the inherent tension between efficiency and equity [16, 52]. As argued by Furler and Palmer 'health inequity is a moral and ethical problem that is a concern for professionals, policy makers and theorists' ([13] p.298), which requires explicitly valuing equity over efficiency (notwithstanding that some would argue that equity does result in efficiency in terms of a society's overall well-being [12, 23, 279]). Nevertheless, despite a current lack of political prioritisation for health care equity, proposed initiatives with an efficiency-based focus (for example, the recent freeze on increasing Medicare reimbursement for GP visits) need to be considered in terms of their impact on equity. In doing so, at the very least, this trade-off can be quantified and possibly mitigated.

Beyond documenting equity of PHC in the Australian health system, this thesis sought to investigate specific service organisation and delivery mechanisms that contribute to equitable

receipt of care and are amenable to policy change. As outlined in Section 8.3, in major cities, current initiatives (such as, bulk-billing, provision of after-hours care, and so forth) are working well for those who need care most. That is not to suggest that all need for services and quality of care has been fully met for those who are disadvantaged. Rather, it would seem that these specific measures in the current service delivery environment (that is, fee-for-service funding) have reached a threshold in terms of the extent to which they facilitate GP use and quality of care for this group. However, removing any of these measures would likely undermine equity in the current system.

Further, while GP use, continuity of care, and care planning were facilitated by affordability and accommodation initiatives, there is a trade-off. In major cities, people living in areas that are more affordable are less likely to have a long consultation—and those who are disadvantaged are even less likely. This may reflect the response of organisations attempting to maintain economic viability when providing services at minimal cost on a fee-for-service basis. Possibly, in major cities, the lack of further equity gains from bulk-billing, lower out-of-pocket expenses and more after-hours care is not so much a limitation of the initiatives themselves, but rather a reflection of the funding environment in which they operate.

In that case, what alternative funding arrangements are there that could possibly contribute further to pro-low SEP receipt of care? At the time of writing, Australia was embarking on a trial of the ‘Health Care Homes’ [55, 280], based on the initial patient-centred medical home (PCMH) that was developed in the US [281, 282]. This model is based on providing a package of care coordinated through a range of providers for those with chronic disease and complex care needs [53, 55]—a model of care that has been delivered for many decades in Australia by Aboriginal Community-Controlled Health services and a number of community health centres via salaried arrangements. In a departure from usual care and funding provisions in Australia, under the Health Care Home arrangement, individuals will enrol with a specific practice and providers will receive bundled payments (needs-based). In the US, UK and New Zealand, medical home enrolment with capitation has been shown to improve continuity of care, health outcomes and reduce costs [281-283]. Potentially, this model of care provision and funding may, in time, mitigate the compromise that occurs under fee-for-service funding arrangements. This comes at a cost with respect to choice of care provider, however, and has remuneration implications for practitioners involved. Further, under the Health Care Home, there is no requirement not to charge a co-payment and individuals can still receive usual MBS services for care other than their chronic disease care. As such, unless this model is adequately funded, providers will seek other measures (that is, increase co-payments or shift care to higher turnover fee-for-service consults) to manage the shortfall, possibly undermining any gains for equitable service provision.

In contrast to major cities, there is still more to be gained in regional areas by enhancing current initiatives for affordability and after-hours care for some aspects of GP care. Investing in increasing bulk-billing is likely to facilitate changes in service delivery that promote the provision of more services and longer consultations, with greater gains for disadvantaged individuals who are more likely to have multiple and complex care needs. Although a similar association was found with after-hours care (that is, pro-low SEP for GP care), a direct link seems less likely. What the underlying driver is for both more after-hours care within an area and the increased GP care for a person of low SEP living in that area remains unknown. Nevertheless, this thesis highlights the multiple disadvantages for those who are low SEP and who also live in regional areas for meeting their health care needs. Importantly, this is not only the case for the more remote areas but for inner regional areas as well. From a policy perspective, building on current equity measures within the PHC system will go some way to redressing this imbalance. However, it is not unreasonable to anticipate that a similar ceiling effect may occur at a certain threshold, as seen in major cities. Again, overcoming this may require reconsideration of the overall funding of how services are delivered (that is, fee-for-service, capitation or mixed), rather than the policy lever itself (such as initiatives intended to increase bulk-billing and after-hours care).

Formulating possible policy directions with respect to GP availability and equitable receipt of PHC are not without significant challenge. While some restrictions and incentives have been introduced to address medical workforce maldistribution [276, 277], primarily for urban versus rural place of practice, these have not been applied across the entire workforce. As raised in section 8.3, restrictions have existed for overseas trained and doctors-in-training only, yet there are incentives for all who practise in regional and remote areas. Nearly a decade of advocacy has resulted in recent changes where incentives are now allocated for practice in regional and remote areas that are characterised by the greatest recruitment and retention need [131, 277]. The impact of this on equity of care is yet to be seen. Increasing availability of GPs in regional and remote areas certainly will improve urban–rural inequity, and will in all probability tip the balance in favour of those who are low SEP. However, under current policies this is still unlikely to result in more doctors where they are needed most. The most immediate policy options could be the introduction of greater restrictions on where GPs can practise and how much they can charge; or increasingly targeted eligibility for incentives. However, the former is likely to be met with insurmountable resistance. At the very least, for regional and remote areas, further initiatives to ensure services are more affordable for low-SEP individuals may help to redress the imbalance, in terms of volume and duration of visits.

It can be argued that there is a social responsibility to the community for which the medical profession should be held to account [284, 285]. That is, in exchange for the social investment (given that higher education is primarily funded through tax, and that much postgraduate training is partly state- and partly federally-funded) and prestige afforded the profession, there is an

obligation to provide care where it is needed most. However, not only does this sit at odds with how the profession has traditionally operated, it also conflicts with strongly-held values of personal choice and autonomy. There are current efforts within Australia and internationally to develop and instil values of social accountability within medical education such that this translates into practice [285, 286]. While the benefits of such a strategy are some years away, they are more likely to result in long-term sustainable change than the ‘carrot-and-stick’ measures currently employed.

Finally, while there are many aspects of the PHC system that are working well for GP use and quality of care, inequity in specialist care remains pervasive. The effectiveness of a strong PHC system relies on ready access to reliable and expert secondary specialist care. Yet, currently in Australia, despite universal insurance, there are significant inequalities in access to specialist care, undermining the equity that exists in the PHC system. The fact that there is variation in receipt of specialist care between areas across all regions suggests that there may be modifiable characteristics of the system that could contribute to equity. In Australia, private health insurance has been shown to contribute to inequitable specialist use [96, 173]. Internationally, specialist and GP availability within areas is associated with whether an individual sees a specialist or not [70, 194]. Possibly the measures that have been shown to promote equity in the PHC system could be extended to specialist care—in particular, bulk-billing incentives. Although not examined in this thesis, one consideration is that the inequity in community-based specialist services is balanced by a pro-low SEP preference in the public hospital system. However, the majority view is that waiting times for less urgent and more discretionary health needs in the public system exceed that in the private sector [287], although actual times are not published. This inevitably increases the impact of illness, through compromised well-being, quality of life and capacity to engage with one’s community (including work), with a differential impact on those who are disadvantaged. If anything, from a policy perspective this brings to the fore the need to better understand inequalities in specialist care, and the mechanisms in the health system contributing to this. Too often, policy changes focus on the PHC sector with little or no attention to specialist care.

8.4.2 Unanswered Questions and Future Research

Accurate measurement of area PHC service characteristics with current available data has been challenging. There have been limitations with a number of measures across the subdomains of access (availability, affordability, and accommodation), and adequately capturing the extent of comprehensiveness and coordination of services within an area has been particularly difficult. To best measure this latter construct would require details such as the range and mix of problems managed within services (such as a scope of practice score, as developed in the US [151]), specific programs provided within practice (for example, child and maternal health, chronic disease clinic, social and emotional well-being programs), skill mix (nurses, Aboriginal health worker, dieticians) and availability of specialist outreach services within practices. Data of this richness

are currently unavailable. However, with the mandate on Primary Health Networks to undertake needs assessment and identify service gaps, and to report on this, there is the potential at least for such data to be collected. The development of the QUALICOPC questionnaires and subsequent study findings, offer a robust starting point for standards of data collection and statistical analysis that would also allow for international comparisons [101, 102, 113]. The challenge remains in collating and sharing these disparate sources of data in a way that is not prohibitively costly, does not place privacy at risk, and is available at a conceptually relevant geographical scale. There are emerging efforts to meet this challenge; for example MedicineInsight [288] nationally, GRAPHIC [289] and AIHW in the ACT [290], SURE in NSW [291] and Melbourne East Monash General Practice Database (MAGNET) [292] and Generic Health Network Information Technology for the Enterprise (GRHANITE) [293] in Victoria, to name a few.

This thesis has extended our understanding of equitable receipt of PHC, as it has investigated not only use but type and quality of care received. While some of these measures are considered essential outcomes in their own right (such as continuity of care), the others are proxy measures (that is, a longer consult implies all care needs are addressed, while receiving a care plan implies complex chronic disease care and coordination with other care providers). In the UK (QOF [255]) and the US (Medicare), data relating to specific care processes and management are collected routinely. Examples of specific measures derived from these data include anticoagulation therapy for patients with AF; immunisation rates for certain eligible populations; appropriate monitoring investigations and specialist review for patients with heart failure; blood pressure and cholesterol targets met for patients with diabetes and so on. In the UK, these data are used specifically for quality improvement and performance monitoring [255, 294-296], as well as for monitoring health and health care inequalities [256, 297]. In the US, these data have also been applied for health system evaluation [67, 298]. While the disadvantage of the UK QOF measures is that they are disease-specific, they do reflect individual outcomes that are best practice, with demonstrated long-term benefit for disease progression, complications and mortality. There is developing capacity in Australia for collecting detailed patient clinical information, akin to QOF and Medicare data in the US, which can also be linked to the patient's location of residence (and, hence, relevant health service area), while maintaining data security and privacy concerns. Based on these data, localised analyses of the PHC system and outcomes have been undertaken [299-301]. The use of condition-specific data could supplement the broader findings of this thesis, by offering policy options for health care equity relevant to specific population groups.

Socioeconomic inequalities in access to specialist care sit in stark contrast to GP care, yet from a policy and research perspective they remain the 'elephant in the room' of health care equity. The fact that receipt of specialist care varies between areas suggests that organisation and service delivery characteristics may contribute to this variation. Given that the health gains are greater, as those who are disadvantaged suffer greater morbidity and mortality, identifying aspects of the

health system that encourage or impede access to specialist care for lower-SEP groups would seem to be an essential line of enquiry.

In Australia, as with many health systems internationally, GP care forms the backbone of the PHC system as well as the larger health system. However, the PHC system is not limited to GPs. Pharmacy, nursing, physiotherapy, psychology and dental care, to name but a few, are an essential part of PHC required to maintain the health and well-being of the community. Furthermore, given the limited coverage for many of these services under Australia's universal health care system, Medicare, there is significant risk for inequitable distribution in receipt of these services. In many respects, these forms of care can be viewed as discretionary, in that they are not immediately life-saving, nor are the benefits for morbidity or mortality readily apparent in the short term. This fact, and that private health insurance (less affordable to those who are of lower SEP) covers only some of the costs associated with allied health and dental care (that is, ancillary services), likely exacerbates inequity in these services—which has been documented at least at the individual level [96]. However, the implications of this for injury recovery, disability, returning to work, and psychological and social well-being, in terms of compounding the unfair differential impact of illness according to SEP, is profound. While we have some understanding of health system determinants of inequity in these aspects of PHC, there is much more to be done.

This thesis acknowledged at the outset the difficulty in determining the contribution of health system policies implemented at the area level on health outcomes such as disease prevalence, hospitalisations and mortality. As argued early on, many of the determinants of these health outcomes are beyond what the PHC system can reasonably be held to account for. Hence, proving that health care equity does translate to reducing health inequalities remains challenging. Cross-country comparisons [6, 111] and health equity impact assessments within countries pre- and post- reform can provide some empirical evidence on this. Possibly, as the role of PHNs mature and initiatives such as Health Care Homes are implemented, there is potential to undertake comparative analyses across PHNs and pre-and post-implementation of the Health Care Homes project (or even case-control community level analyses of implementation and non-implementation sites). However, this would be predicated on systemically collecting standardised data regarding service characteristics, to determine whether there are specific initiatives at the local-area level that not only shape socioeconomic variation in receipt of care, but also contribute to health equity.

On a technical note, this research has considered contextual influences in terms of individual membership of an area of residence. It has not explicitly modelled spatial processes that may underpin the relationship between individual receipt of care and the characteristics of the services of the area in which they live. Borders between administrative areas, while delimiting areas of resource allocation, do not mean that people living in one area are not influenced by service

characteristics of neighbouring areas. Previous work has shown that spatial relationships as well as group membership do matter for health care [70]. Future work could similarly include modelling of these spatial processes through continuous area-level measures (that take into account neighbourhood characteristics weighted by distance) or through specific spatial analysis combined with multilevel modelling.

Finally, the nature of quantitative analysis is that it is limited to examining the health system at a broader level, rather than a detailed investigation of local dynamics in a specified location (or locations). While this approach clearly allows important generalisations relevant for policy, it does not provide the nuance and depth of understanding that can be obtained through qualitative work. This research has revealed some unexpected relationships, particularly with respect to availability of GPs and equitable receipt of care. This research allows some insight into why this may be the case; however, it cannot directly explain it. Using area-level and spatial analysis, work in the US investigating health service use has presented case studies and map-based visual representations of key findings to policy makers, service providers and community members [302-304]. Qualitative methodologies have then been applied to generate a deeper understanding of specific processes that may confirm or challenge interpretation of broader findings. For example, there may be factors other than affordability that explain the relationship of availability and socioeconomic variation in receipt of care, that only come to light through focus groups and informant interviews. Qualitative work could also address further development of domains and sub-domains of PHC service organisation and delivery within areas relevant to the Australian context. Findings from this could inform data collection by PHNs, as discussed above, that could then be applied in the same manner as in this thesis. This would enrich our understanding of how the PHC system influences health care equity and, thereby, possibly contribute to reducing socioeconomic inequalities in health.

8.5 Conclusions

For a given level of need, those who are disadvantaged benefit more from the PHC system in terms of how frequently they access care and the quality of the care they receive, compared with their advantaged counterparts. The organisation and delivery of services within a person's local context that reflect the core principles of strong PHC systems—affordability, accommodation, comprehensiveness and coordination—do shape the distribution of care received according to individual SEP. In major cities, initiatives that promote affordability, accommodation and comprehensiveness of services within areas are working well from an equity perspective. Any additional gains for pro-low SEP receipt of care may require alternative approaches to how care is provided and funded, rather than simply increasing current equity measures. On the other hand, in regional and remote areas, there are clear opportunities for reducing health inequalities by improving receipt of care for those who are disadvantaged by current policy initiatives. The

relationship of availability with the social distribution of care is complex. Simply increasing the numbers of GPs is unlikely to promote significantly greater equity in the PHC system without addressing where they will provide care and the affordability of that care. Further research is needed to better describe and measure the organisation and delivery of PHC service at the small-area level, so that novel policy and program interventions can be identified and/or monitored. In addition, yet to be fully understood is whether those service characteristics that promote pro-low SEP receipt of care do, in fact, contribute to reducing health inequalities. Current PHC reform in Australia, the emerging efforts in use of aggregated practice-level data and ongoing strengthening of data linkage offer important opportunities for this future work.

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Appendices

Appendix A: Measurement of Inequality in Health Outcomes

Studies of socioeconomic inequalities in health and health care are concerned with observable differences in health-related outcomes between individuals from different social and economic groups. As noted in Chapter 1 of this thesis, this is distinct from studies that are concerned with quantifying differences in health across population groups, which may or may not be viewed as unfair or unjust. This thesis is concerned with the former. As noted in the recent revision of the seminal review by Harper and Lynch (2016) [305], over the last decade there has been an explosion of studies and literature concerned with the measurement and monitoring of socioeconomic inequalities in health-related outcomes. While the distribution or gradient of health-related outcomes among social and economic groups frequently is measured (as has primarily been done for this thesis), increasingly summary measures that quantify the extent of that distribution are being determined. Those measures most commonly applied in epidemiology and relevant to the data analyses in this thesis are reviewed here with references to definition, calculation and considerations for use. There is no one correct measure to use, and the choice will depend on the research question asked, the data available and the implicit assumptions and values that underpin that choice [305].

Unless otherwise indicated, this section is based on reviews by Harper and Lynch (2016) [305], Keppel and colleagues (2005) [93] and Korda (2008) [173].

Inequality Measures

The SEP measures used in this thesis, education and income, are ordinal measures in that they are categorical measures of SEP that can be ranked. A number of methods have been developed that capture the SEP gradient in health-related outcomes (should one exist), either in terms of absolute differences in quantifiable outcomes between socioeconomic groups, or relative differences (that is; the ratio of health outcomes between SEP groups). There are two main approaches to this: pairwise comparisons of rates, comparing each SEP group with a reference group, and single summary measures of inequality that take into account both the size and ranking of the SEP groups in the estimate.

Pairwise Comparisons: Risk Differences and Risk Ratios

The risk difference (RD), which is the difference in rates between the comparison groups, gives an absolute measure of inequality, while the risk ratio (RR) is the ratio of the rates of the comparison groups, and gives a measure of relative inequality. The RD compares rates on the arithmetic scale and is the difference between rates of the comparison groups:

$$RD = R_i - R_r$$

Where R_i is the rate in the group of interest and R_r is the rate in the reference group.

The RR compares rates on the multiplicative scale and is the ratio of the rates between the two groups:

$$RR = \frac{R_i}{R_r}$$

Usually either the lowest or highest ranked group is used as the reference group. When there are more than two SEP groups, a series of $(k - 1)$ pairwise comparisons for k groups, using one group as the reference point, or k pairwise comparison using an external reference point, can be calculated. While these measure have the advantage that they are relatively easy to calculate and interpret, when there are multiple SEP groups, this can result in a large number of comparisons and make presentation and interpretation of findings challenging.

Single Summary Measures: Concentration Index, the Relative Index of Inequality and the Slope Index of Inequality

A number of methods have been developed for ordinal SEP measures that provide a summary measure of the extent of inequality in health and health care. That is, they summarise inequality across all SEP groups, rather than making pairwise comparisons. This includes the measures of relative inequality, such as the concentration curve and associated concentration index, and the relative index of inequality (RII) and absolute inequality as measured by the slope index of inequality (SII). The concentration index, RII and SI can be used when there is a hierarchical classification of SEP groups and there is a systemic relationship between SEP and the health outcome.

The SEP measure used for calculating these inequality measures is derived from the cumulative proportion of the population in each SEP groups, ranked from the lowest to the highest SEP. For a given population, the range that each SEP group occupies in the cumulative distribution is first calculated. The rank variable for each SEP group is the midpoint of this range. This is demonstrated in Figure A1, where cumulative proportion of population range for ‘poor’ is 0–0.5 with a midpoint value of 0.025, the range for ‘near poor’ is 0.05–0.2 with a midpoint of 0.8, and so on. Health related outcomes can then be plotted against the midpoint SEP category variable, where SEP can now be treated as a continuous variable.

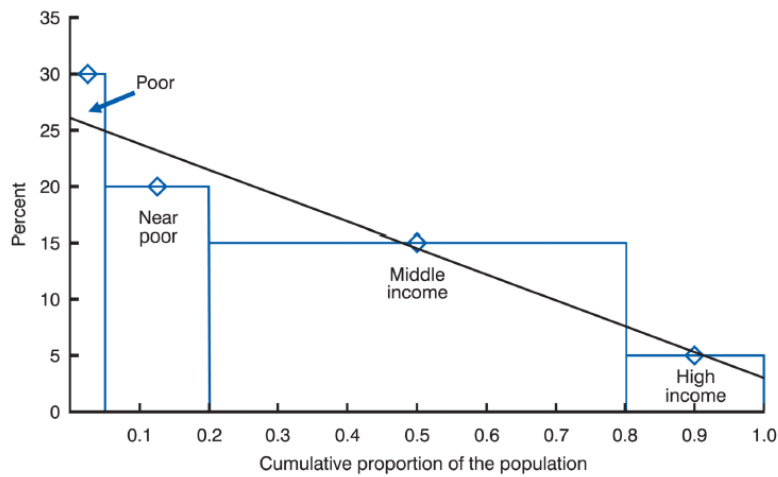


Figure A1. Percentage of population in fair or poor health by SEP, where SEP is the midpoint of the cumulative proportion of the population, ranked from low to high income

Note:

Taken from Keppel et al. [93] p. 22. All material appearing in this report is in the public domain and may be reproduced or copied without permission.

The concentration index is a measure of economic inequality adapted to measure health inequality, akin to the Gini index (which plots cumulative health by cumulative population ranked by health) but differing in that it measures the relationship between SEP ranking and health. The concentration index is derived from the concentration curve, which plots the cumulative proportion of health and health care according to the cumulative proportion of the population ranked by SEP. Twice the area above or below the diagonal gives the concentration index. A positive value indicates a pro-high SEP inequality, a negative value indicates a pro-low SEP inequality, and zero indicates no inequality. Multiplying the concentration index by 75 gives the proportion of the outcome that would need to be linearly redistributed from high-SEP groups to the lower groups (if pro-high SEP inequality is found) in order to arrive at a value of zero for concentration index.

The SII and RII are estimated from regression equations when the midpoint SEP category variable is used. The SII is the absolute difference in predicted rates at the hypothetical top and bottom of the socioeconomic continuum. For linear regression given by:

$$y = \beta_0 + \beta_1 x$$

Where y is the health outcome and x is the SEP midpoint value, the SII is given by the difference between the estimated outcome for a hypothetical person at the bottom of the SEP hierarchy ($x=0$) and a hypothetical person at the top of the SEP hierarchy ($x=1$), equivalent to:

$$SII = (\beta_0 + \beta_1) - \beta_0 = \beta_1$$

The RII, when defined as the ratio of the predicted rate at the hypothetical lowest end of the SEP continuum ($x=0$) to the predictive rate for the hypothetical highest end of the SEP continuum ($x=1$), is given by:

$$RII = \frac{\beta_0}{\beta_0 + \beta_1}$$

And for log-link expressions:

$$\begin{aligned} RII &= \frac{\exp(\beta_0)}{\exp(\beta_0 + \beta_1)} \\ &= \exp(-\beta_1) \end{aligned}$$

An RII value <1 indicate a pro-high SEP inequality (that is, those at the hypothetically lowest end of the SEP continuum have higher events rates than those at the higher end), and a value >1 indicates a pro-low SEP inequality (event rates are lower at the lower end of the SEP continuum).

When estimates are adjusted for need, then a measure of inequity (or need adjusted inequality) is determined [94]. The advantage of these measures, in addition to providing a readily interpretable summary measure, which is presented easily, is that they include the whole population at risk. As such, these measures are able to incorporate changes in the distribution of SEP groups over time (and place) that affect the population health burden of health inequalities. They also allow comparison of results across different dimensions of SEP. A further advantage of rank-based inequality measures is that they specifically reflect socioeconomic gradients in health. However, the determination of these indices is more complex, with greater restrictions on the data compared with the RR and RD. Further, given that these measures are sensitive to gradients in health, they may not detect inequality when present in some circumstances. For example, it may be that it is the middle groups which have the worst outcomes and this would not be reflected in either the concentration index or the RII.

Other Measures of Inequality

There are additional methods that have been developed to measure inequalities in health-related outcome across social groups. Other summary measures include those that measure the mean difference in groups rates (either absolute or relative), those that quantify and compare the between SEP group variance and within SEP group variance (for example, entropy based measures, Kolm index and Atkinson index), or population impact measures (for example, population attributable risk) that give an estimate to the improvement of health that would occur if other SEP groups had the same health as the healthiest SEP group. A further expanding areas is decomposing social groups inequality by risk factors, such that the extent of the inequality

explained by the social distribution of risk factors for that outcome may be determined. For more in depth details see Lynch and Harper (2016) [305].

Choosing Inequality Measures

Pairwise Comparison versus Summary Measures

Generally there are more than two groups to SEP measure and, as such, a decision is required as to whether the focus is on the individual groups or the SEP as the broader measure. Pairwise comparison, as discussed above in this chapter, enables consideration of differences in outcomes for each group from the reference, while summary measure quantifies the extent of differences (or inequality) across the SEP domain. For this thesis, ORs are reported for each SEP groups, although the main point of interest was the trend across the SEP domain. Keppel and colleagues [93] recommend that ‘pairwise measures are used to monitor progress towards the elimination of inequalities (sic.) for individual groups, and summary measures are used to monitor progress toward the elimination of inequalities (sic.) for each domain of three or more groups’.

Choice of Reference Group

Generally when there is a natural ordering to SEP groups, either the highest or lowest SEP group is chosen as the reference point. Harper and Lynch [305] argue that, while there is no ‘correct’ reference group, it is more important to make the rationale for that choice clear. Alternatives include the population average (although this may change over time and is subject to influence by outliers), the group with the largest proportion of the population or the healthiest social group (yet this may skew comparisons if this group represents a small proportion of the overall population). More often than not, the highest SEP group is used as the reference group in determining the SII and RII. While these measures of inequalities were not specifically calculated for this thesis, the lowest SEP group was chosen as the reference group, such that an OR >1 implied that higher SEP groups had the advantage in terms of receipt of care.

Absolute and Relative Measures

Inequality can be expressed in terms of relative or absolute difference, providing different perspectives, both of which are important for public health. While relative differences are more commonly used in epidemiology, they can be misleading if underlying prevalence is not taken into account. For example, the relative difference between SEP groups may be small, but if there is a high background prevalence of a condition then the absolute differences may be large. This is particularly important when comparing over time or at different settings (such as between-country comparisons). On the other hand, it may be that, over time, absolute inequalities are decreasing (as the background prevalence of mortality, for example; see Korda [35]), while relative inequalities are increasing. The advantage of relative inequalities is that these enable comparison of results across a large range of health outcomes with different levels of baseline

risk. Again, the choice of relative versus absolute will depend on the research and policy question, and both give important information. Frequently both are indicated, particularly when comparing inequalities over time, geographic areas and across different outcomes, as conclusions often depend on the underlying rates of outcomes.

Appendix B: Supplementary Tables for Chapter 3

Table B1. Full list of those eligible for a health care or pension card

Health Care Card	Pensioner Concession Card
Those aged 0 to 64 years who do not hold a Pensioner Concession Card and receive one of the following Centrelink payments: Carer Allowance; Carer Payment (child) (short term or episodic); Exceptional Circumstances Relief Payment; Family Tax Benefit A (maximum rate only); Mobility Allowance (if not receiving a Disability Support Pension); Newstart Allowance; Parenting Payment (partnered); Partner Allowance; Special benefit; Widow Allowance; and Youth Allowance (job seekers only). People may also be eligible for a HCC if they are a foster carer; ex-holder of a Carer Allowance (child) Health Care Card; or are a low income earner	Those aged 15 years and over who receive one of the following centrelink payments: Age Pension; Bereavement Allowance; Carer Payment (adult); Carer Payment (child); Disability Support Pension; Newstart Allowance and Youth Allowance (job seeker) if single and caring for a dependent child; and Parenting Payment (single). People aged over 60 years may receive a Pensioner concession card if they have been receiving income support payments for more than nine months and receive: Newstart Allowance; Parenting Payment (partnered); Partner Allowance; Sickness Allowance; Special Benefit; and Widow Allowance. People may also be eligible for a Pensioner Concession Card if they have a partial capacity to work and are receiving any of the following payments: Newstart Allowance; Parenting Payment (partnered); and Youth Allowance (job seeker).

Table B2. National estimates of GP workforce by remoteness and by region, as published by the Department of Health

Location	FTE	FWE	FSE	population	FTE per 1000	FWE per 1000	FSE per 1000
Overall	16482	19729	18158	22328847	0.74	0.88	0.81
Major cities	11675	14248	13170	15337721	0.76	0.93	0.86
Inner regional	3197	3667	3265	4401672	0.73	0.83	0.74
Outer regional	1333	1525	1447	2086609	0.64	0.73	0.69
Remote	196	208	183	326643	0.60	0.64	0.56
Very remote	91	81	92	176202	0.52	0.46	0.52
Outer regional/ remote combined	1620	1814	1722	2589454	0.63	0.70	0.67

Notes:

1. FTE, full time equivalent; FWE, full time workload equivalent; FSE, full service equivalent
2. Estimated resident population as of June 30 2010, use for per capita estimates, sourced from ABS [306].
3. FTE and FWE, sourced originally from the General Practice work force Statistics, Department of Health online, but no longer available publicly. See Mazumdar and colleagues for counts at the time these were publicly available [120].
4. Counts for FSE available through Department of Health [307]

Table B3. Association of area PHC service characteristics with area disadvantage, by region, mean (SD)

Major cities								
Area SE disadvantage	AIHW FTE	OOP expenses	Bulk-billing	After-hours care	CD care	HA	Cervical screening	Community HC
1 (most disadvantaged)	0.9(0.1)	0.3(0.3)	97.4 (1.6)	10.3(3.0)	28.7(3.4)	7.9(2.2)	50.7(3.8)	6.1(2.7)
2	0.9(0.1)	0.5(0.4)	96.2(2.8)	7.9(3.4)	27.5(5.7)	7.2(1.4)	50.2(2.0)	8.1(1.6)
3	0.9(0.1)	2.5(2.3)	87.5(9.1)	6.3(1.5)	29.4(9.6)	10.8(1.8)	55.7(5.4)	3.6(2.9)
4	1.0(0.2)	2.8(2.3)	90.0(4.9)	6.3(1.9)	23.1(5.6)	8.5(1.9)	53.5(3.0)	5.9(2.6)
5. (least disadvantaged)	1.0(0.2)	7.4(4.9)	75.7(11.3)	6.2(2.9)	17.6(8.0)	8.2(2.2)	62.5(4.9)	6.6(5.5)
Total	0.9(0.2)	3.5(4.2)	87.0(11.5)	7.2(2.9)	23.8 (8.2)	8.5(2.2)	55.9(6.4)	6.1(3.8)
Test for trend	0.037	<.001	<.001	0.003	<.001	0.715	<.001	0.987
Inner regional								
IRSD quintile	AIHW FTE	OOP expenses	Bulk-billing	After-hours care	CD care	HA	Cervical screening	Community HC
1 (most disadvantaged)	1.0(0.2)	4.8(3.4)	79.5(13.1)	1.3(0.7)	24.0(6.5)	11.5(2.6)	55.1(2.6)	7.2(0.3)
2	0.8(0.2)	4.1(1.5)	81.8(5.8)	1.7(2.2)	24.4(7.0)	11.4(3.1)	55.9(2.8)	9.6(9.7)
3	0.8(0.2)	5.3(2.2)	78.2(7.7)	2.5(2.4)	22.0(8.5)	10.3(3.1)	57.4(4.5)	7.6(6.3)
4	0.8(0.2)	5.3(4.8)	77.6(15.2)	3.5(2.4)	19.4(10.8)	7.2(3.2)	56.8(1.8)	8.7(3.4)
5. (least disadvantaged)	0.8(0.1)	3.0(2.8)	81.7(9.5)	6.1(3.9)	12.2(11.6)	6.7(6.6)	61.3(4.7)	7.1(1.4)
Total	0.8(0.2)	4.6(2.9)	79.4(9.3)	3.3(3.0)	19.8(9.8)	9.2(4.3)	57.8(4.1)	8.1(5.6)
Test for trend	0.413	0.425	0.944	0.006	0.029	0.026	0.035	0.868
Outer regional remote								
IRSD quintile	AIHW FTE	OOP expenses	Bulk-billing	After-hours care	CD care	HA	Cervical screening	Community HC
1 (most disadvantaged)	0.8(0.2)	4.1(2.0)	83.0(7.3)	1.3(0.9)	24.5(8.5)	11.8(4.7)	53.1(3.2)	12.2(8.0)
2	0.7(0.2)	5.0(1.9)	80.2(8.6)	1.2(2.2)	23.4(12.4)	11.5(3.8)	55.7(3.9)	11.6(6.0)
3	0.6(0.0)	6.4(0.6)	74.9(0.6)	1.0(0.3)	16.3(8.1)	11.4(2.5)	57.8(2.4)	7.0(1.7)
4	0.5(0.7)	5.2(3.5)	71(-)	3.5(3.7)	10.5(-)	4.9(1.4)	66.2(13.7)	10.7(-)
5. (least disadvantaged)	—	—	—	—	—	—	—	—

IRSD quintile	<i>AIHW FTE</i>	<i>OOP expenses</i>	<i>Bulk-billing</i>	<i>After-hours care</i>	<i>CD care</i>	<i>HA</i>	<i>Cervical screening</i>	<i>Community HC</i>
Total	0.7(0.2)	4.8(2.0)	80.4(7.9)	1.4(1.8)	22.6(10.4)	11.0(4.2)	55.8(5.7)	11.4(6.5)
Test for trend	0.09	0.214	0.07	0.291	0.173	0.094	0.002	0.481

Notes:

1. SD, standard deviation; PHC, primary health care; SE, socioeconomic; FTE, full time equivalent; OOP, out-of-pocket expenses; CD, chronic disease; HA, health assessment; CHC, community health centre.
2. Test for trend bivariate analyses OLS regression

Appendix C: Supplementary Tables for Chapter 6

Descriptive Statistics

Table C1. SEP by quartiles of area PHC service characteristics (percentage of SEP category in each quartile).

	No school certificate	School certificate	Apprentice/ diploma	University	Missing	Total (n) (100%)
<i>GP availability</i>						
1st quartile	35.6	31.2	30.5	23.3	31.0	122,893
2nd quartile	25.5	25.7	26.4	25.8	26.8	142,190
3rd quartile	20.4	20.5	20.2	19.8	20.4	53,608
4th quartile	18.5	22.6	23.0	31.1	21.8	64,087
<i>OOP expenses</i>						
1st quartile	14.5	11.0	10.3	9.3	13.6	28,722
2nd quartile	26.1	26.2	26.3	23.9	25.7	68,073
3rd quartile	35.3	35.2	36.2	31.2	33.6	91,680
4th quartile	24.1	27.5	27.2	35.6	27.2	76,499
Missing	0.0	0.0	0.1	0.1	0.0	109
<i>Bulk-billing</i>						
1st quartile	27.6	30.3	30.6	36.9	30.0	83,736
2nd quartile	30.9	31.4	32.2	29.0	29.9	82,200
3rd quartile	25.2	25.5	25.6	24.5	24.8	66,915
4th quartile	16.2	12.7	11.6	9.4	15.3	31,817
Missing	0.1	0.1	0.2	0.2	0.0	415
<i>After-hours care</i>						
1st quartile	46.8	43.6	42.1	33.0	41.4	108,758
2nd quartile	19.9	22.1	23.4	30.6	23.1	64,204
3rd quartile	17.1	17.9	17.4	18.7	17.8	47,190
4th quartile	16.1	16.4	17.1	17.7	17.7	44,822
Missing	0.0	0.0	0.1	0.1	0.0	109

	No school certificate	School certificate	Apprentice/ diploma	University	Missing	Total (n) (100%)
<i>CD care</i>						
1st quartile	18.2	22.9	24.5	33.3	21.7	66,798
2nd quartile	30.7	29.6	28.3	25.5	29.5	75,228
3rd quartile	23.4	21.2	20.4	17.1	22.5	53,685
4th quartile	27.6	26.3	26.8	24.1	26.3	69,224
Missing	0.0	0.1	0.1	0.1	0.0	148
<i>Health assessments</i>						
1st quartile	18.0	19.3	19.8	22.8	19.2	53,355
2nd quartile	17.6	18.6	18.2	21.1	19.2	50,257
3rd quartile	22.9	23.5	23.3	25.1	22.9	62,910
4th quartile	41.5	38.5	38.7	30.8	38.7	98,452
Missing	0.0	0.0	0.1	0.1	0.0	109

Notes:

1. N, number; % percentage
2. Columns for each variable category for each educational attainment categories sum to 100%. Values in last column gives break down by category for each individual variable not stratified by educational attainment. For each variable, total (n) sums to 265,083
3. 1st quartile corresponds to 25% of the population in the lowest category, 4th quartile 25% of the population in the highest category
4. Chi-squared test of trend $p < 0.001$ for all variable pairs

Bivariate Analysis

Table C2. Bivariate regression analyses for individual characteristics and all outcomes. Odds ratio and 95% confidence intervals given

Outcome	Use OR (95%CI)	Long consultations OR (95%CI)	Continuity of care OR (95%CI)	Care planning OR (95%CI)	Specialist use OR (95%CI)
Male					
Female	1.14 (1.12–1.15)	1.35 (1.33–1.37)	0.76 (0.75–0.77)	0.76 (0.75–0.77)	1.03 (1.02–1.05)
43–54	1	1	1	1	1
55–64	1.64(1.60–1.67)	1.17 (1.15–1.20)	1.39 (1.36–1.42)	1.39 (1.36–1.42)	1.62 (1.58–1.65)
65–74	3.47(3.39–3.56)	1.44 (1.41–1.47)	1.91 (1.87–1.96)	1.91 (1.87–1.96)	2.99 (2.93–3.06)
75–84	6.56(6.38–6.74)	1.73 (1.68–1.77)	2.65 (2.57–2.72)	2.65 (2.57–2.72)	4.42 (4.30–4.54)
85 plus	3.65(6.34–7.00)	1.53 (1.46–1.60)	2.71 (2.58–2.86)	2.71 (2.58–2.86)	2.84 (2.71–2.98)
Australia/New Zealand	1	1	1	1	1
Europe/N. America	1.26 (1.24–1.29)	1.09 (1.07–1.11)	1.13 (1.11–1.16)	1.13 (1.11–1.16)	1.07 (1.05–1.09)
Asia	1.51 (1.45–1.57)	1.07 (1.02–1.11)	0.98 (0.94–1.03)	0.98 (0.94–1.03)	0.84 (0.81–0.88)
Africa/Mid East	1.55 (1.46–1.65)	1.27 (1.20–1.35)	1.02 (0.96–1.09)	1.02 (0.96–1.09)	1.26 (1.18–1.34)
Other	1.69 (1.55–1.84)	1.43 (1.32–1.56)	0.85 (0.77–0.92)	0.85 (0.77–0.92)	1.03 (0.95–1.12)
Not married/de facto	1	1	1	1	1
Married/de facto	0.63 (0.62–0.64)	0.79 (0.78–0.8)	0.94 (0.93–0.96)	0.94 (0.93–0.96)	0.92 (0.91–0.94)
Excellent	1	1	1	1	1
Very good	1.80 (1.74–1.85)	1.14 (1.12–1.17)	1.24 (1.20–1.27)	1.24 (1.20–1.27)	1.35 (1.32–1.38)
Good	3.37 (3.28–3.47)	1.41 (1.37–1.44)	1.47 (1.43–1.51)	1.47 (1.43–1.51)	1.86 (1.81–1.90)
Fair	6.61 (6.39–6.84)	1.91 (1.85–1.97)	1.72 (1.67–1.78)	1.72 (1.67–1.78)	2.79 (2.70–2.88)
Poor	11.12 (10.44–11.86)	2.52 (2.38–2.67)	1.86 (1.75–1.98)	1.86 (1.75–1.98)	3.45 (3.24–3.67)
Missing self-rated health	4.60 (4.39–4.83)	1.63 (1.56–1.71)	1.44 (1.37–1.51)	1.44 (1.37–1.51)	1.88 (1.80–1.97)
No conditions	1	1	1	1	1
1–2 conditions	2.29 (2.24–2.34)	1.38 (1.35–1.40)	1.30 (1.25–1.33)	1.30 (1.28–1.33)	1.81 (1.77–1.84)
3 or more conditions	6.46 (6.30–6.62)	2.16 (2.11–2.21)	1.72 (1.68–1.76)	1.72 (1.68–1.76)	3.74 (3.66–3.83)
No limitation	1	1	1	1	1
Minor limitation	1.56 (1.52–1.60)	1.19 (1.16–1.21)	1.21 (1.18–1.23)	1.21 (1.18–1.23)	1.41 (1.38–1.44)
Moderate limitation	3.36 (3.28–3.44)	1.58 (1.55–1.62)	1.47 (1.43–1.50)	1.47 (1.43–1.50)	2.30 (2.25–2.35)
Severe limitation	7.01 (6.81–7.21)	2.14 (2.08–2.20)	1.85 (1.79–1.90)	1.85 (1.79–1.90)	3.28 (3.19–3.37)

Outcome	Use OR (95%CI)	Long consultations OR (95%CI)	Continuity of care OR (95%CI)	Care planning OR (95%CI)	Specialist use OR (95%CI)
Missing (functional limitation)	3.78 (3.68–3.89)	1.61 (1.57–1.65)	1.41 (1.37–1.45)	1.41 (1.37–1.45)	2.05 (1.99–2.10)

Notes:

1. OR, odds ratio; CI, confidence interval.
2. Analyses all single level logistic regression. All associations with outcomes significant, $p < .001$.

Additional Tables for Above Average GP Use

Table C3. Percentage of respondent in each use category by region. Total number of respondents and the mean (SD) of frequency of services given for each region

Region	Below-average (%)	Above-average (%)	Total (n)	Mean (SD)
Major cities	57.5	42.5	98,149	8.3(7.8)
Inner regional	63.9	36.1	96,880	7.3(6.9)
Outer regional/ remote	67.7	32.3	70,054	6.7(6.7)
Total	62.6	37.5	265,083	7.5(7.2)

Notes:

1. N, population; SD, standard deviation
2. Chi-squared test of trend $p < 0.001$

Table C4. Frequency and percentage of respondents in above-average GP use categories, by area PHC service characteristic quartile, stratified by region: mean number of services and standard deviation also given

GP availability	Below average	Above average	Mean(sd)	Out-of-pocket expenses	Below average	Above average	Mean(sd)	Bulk billing	Below average	Above average	Mean(sd)
Major cities											
1st quartile	47.8	52.2	9.7(8.4)	1st quartile	47.34	52.66	9.9(8.6)	1st quartile	67.09	32.91	6.9(6.7)
2nd quartile	58.8	41.2	8.0(7.3)	2nd quartile	55.26	44.74	8.6(7.8)	2nd quartile	62.84	37.16	7.5(7.1)
3rd quartile	51.8	48.2	9.2(8.3)	3rd quartile	60.59	39.41	7.8(7.2)	3rd quartile	57.4	42.6	8.3(7.8)
4th quartile	62.7	37.3	7.6(7.5)	4th quartile	66.88	33.12	6.9(6.9)	4th quartile	47.05	52.95	10.0(8.6)
p-value		<.001				<.001				<.001	
Inner regional											
1st quartile	65.17	34.83	7.1(6.6)	1st quartile	62.19	37.81	7.4(6.3)	1st quartile	71.94	28.06	6.2(6.1)
2nd quartile	64.78	35.22	7.1(6.5)	2nd quartile	61.56	38.44	7.7(7.2)	2nd quartile	60.04	39.96	7.9(7.2)
3rd quartile	66.31	33.69	7.0(7.1)	3rd quartile	61.46	38.54	7.7(7.0)	3rd quartile	60.62	39.38	7.8(7.1)
4th quartile	59.45	40.55	8.0(7.5)	4th quartile	73.36	26.64	5.9(5.8)	4th quartile	na	na	na
				missing	65.14	34.86		missing	68.62	31.38	
p-value		<.001				<.001				<.001	
Outer regional											
1st quartile	68.93	31.07	6.6(6.6)	1st quartile	na	na	na	1st quartile	72.91	27.09	6.0(6.1)
2nd quartile	66.01	33.99	7.0(6.9)	2nd quartile	62.04	37.96	7.6 (7.3)	2nd quartile	67.08	32.92	6.8(6.7)
3rd quartile	64.58	35.42	7.1(6.7)	3rd quartile	67.15	32.85	6.8(6.7)	3rd quartile	61.35	38.65	7.7(7.3)
4th quartile	70.48	29.52	6.4(6.4)	4th quartile	72.11	27.89	6.1(6.2)	4th quartile	na	na	na
								missing	69.23	30.77	
p-value		<.001				<.001				<.001	

After-hours care	Below average	Above average	Mean(sd)
Major cities			
1st quartile	68.14	31.86	7.0(6.7)
2nd quartile	64.7	35.3	7.2(7.1)
3rd quartile	54.47	45.53	8.8(7.9)
4th quartile	54.69	45.31	7.4(6.8)
		0.000	
Inner regional			
1st quartile	64.99	35.01	7.2(6.8)
2nd quartile	64.35	35.65	7.3(6.8)
3rd quartile	58.3	41.7	8.1(7.3)
4th quartile	62.66	37.34	7.4(6.8)
missing	65.14	34.86	
		<.001	

Notes:

1. GP, general practitioner; PHC, primary health care; sd, standard deviation; na, not applicable
2. 1st quartile corresponds to 25% of the population in the lowest category, 4th quartile 25% of the population in the highest category
3. Chi-squared test of trend for area PHC characteristics categories and *above-average* use.

Table C5. Between-area variation in odds of above-average GP use: supplementary income and continuous education

	Null model	Income, Model 2	Continuous education, Model 2
Cities			
ICC	0.044	0.028	0.029
PCV (%)	na	36	34
MOR	1.45	1.34	1.35
Inner regional			
ICC	0.023	0.026	0.026
PCV (%)	na	-13	-13
MOR	1.3	1.32	1.33
Outer regional			
ICC	0.022	0.029	0.029
PCV (%)	na	-32	-32
MOR	1.29	1.35	1.35

Notes:

1. ICC: intra-class coefficient; PCV: Proportional change in variance. Reported change from null model, MOR median odds ratio; na, not applicable.
2. Null model, random intercept only, no covariates; Model 2 adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease, and physical functional limitation.
3. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.
4. Wald test that between-area variance for the null model is non zero (i.e. $\delta_u^2=0$) $p<.001$. See appendix G for full details of model diagnostics.

Table C6. Full model results for above-average GP use, education

Model 2, Education	Cities	Inner regional	Outer regional/ remote
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cons	0.16 (0.14–0.19)	0.09 (0.08–0.11)	0.07 (0.06–0.09)
No school certificate			
School certificate	0.76 (0.72–0.80)	0.82 (0.78–0.86)	0.83 (0.78–0.87)
Apprentice/ diploma	0.70 (0.67–0.74)	0.76 (0.72–0.80)	0.75 (0.71–0.80)
University	0.52 (0.49–0.55)	0.61 (0.58–0.65)	0.58 (0.54–0.62)
Male (ref)			
Female	1.22 (1.18–1.26)	1.24 (1.21–1.28)	1.24 (1.19–1.29)
43–54 (ref)			
55–64	1.32 (1.27–1.37)	1.49 (1.43–1.55)	1.48 (1.41–1.56)
65–74	2.46 (2.36–2.58)	2.87 (2.75–3.01)	2.67 (2.53–2.82)
75–84	3.57 (3.39–3.76)	4.34 (4.11–4.58)	4.10 (3.84–4.38)
85 plus	2.66 (2.45–2.88)	3.52 (3.20–3.88)	3.28 (2.88–3.74)
Australia/NZ			
Europe/N. America	1.17 (1.13–1.21)	1.03 (0.99–1.08)	1.09 (1.03–1.15)
Asia	1.70 (1.61–1.80)	1.09 (0.95–1.27)	1.33 (1.07–1.65)
Africa/Mid East	1.80 (1.66–1.96)	1.15 (0.98–1.36)	1.09 (0.84–1.42)
Other	1.74 (1.55–1.95)	1.29 (1.03–1.62)	1.20 (0.82–1.77)
Not married/not de facto			
Married/de facto	0.94 (0.91–0.98)	0.91 (0.88–0.95)	0.93 (0.89–0.97)
Excellent			
Very good	1.31 (1.24–1.37)	1.30 (1.23–1.37)	1.32 (1.23–1.41)
Good	1.73 (1.65–1.83)	1.74 (1.65–1.84)	1.72 (1.60–1.85)
Fair	2.16 (2.02–2.31)	2.43 (2.27–2.61)	2.58 (2.37–2.82)
Poor	2.92 (2.58–3.30)	3.23 (2.84–3.67)	3.37 (2.92–3.88)
Missing (self-rated health)	2.20 (2.01–2.41)	2.41 (2.19–2.66)	2.38 (2.12–2.68)
No conditions			
1–2 conditions	1.84 (1.78–1.91)	1.84 (1.77–1.92)	1.97 (1.87–2.07)
3 or more conditions	3.27 (3.11–3.43)	3.26 (3.10–3.42)	3.66 (3.45–3.89)
No limitation			
Minor limitation	1.12 (1.07–1.17)	1.10 (1.05–1.15)	1.10 (1.04–1.16)
Moderate limitation	1.54 (1.47–1.61)	1.53 (1.46–1.61)	1.52 (1.43–1.61)
Severe limitation	1.88 (1.77–2.00)	2.03 (1.91–2.16)	2.10 (1.95–2.26)
Missing (functional limitation)	1.65 (1.56–1.74)	1.58 (1.49–1.67)	1.54 (1.44–1.64)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; NZ, New Zealand; N., North; ref, reference.
2. Wald joint test of significance for SEP term $p < .001$ for all regions

Table C7. Full model results for GP use, income

Model 2, Income	Cities	Inner regional	Outer regional/ remote
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cons	0.18 (0.16–0.20)	0.10 (0.09–0.12)	0.08 (0.07–0.09)
<\$20k	1	1	1
\$20–<\$30k	0.83 (0.78–0.88)	0.87 (0.83–0.92)	0.87 (0.82–0.93)
\$30–<\$40k	0.78 (0.73–0.83)	0.74 (0.69–0.78)	0.75 (0.70–0.80)
\$40–<\$50k	0.71 (0.67–0.76)	0.70 (0.66–0.75)	0.66 (0.61–0.71)
\$50–<\$70k	0.62 (0.58–0.66)	0.60 (0.57–0.64)	0.59 (0.55–0.64)
>\$70k	0.47 (0.44–0.49)	0.55 (0.52–0.58)	0.54 (0.50–0.58)
Missing	0.80 (0.76–0.84)	0.88 (0.84–0.92)	0.90 (0.86–0.95)
Male	1	1	1
Female	1.19 (1.15–1.23)	1.21 (1.18–1.25)	1.19 (1.15–1.24)
43–54	1	1	1
55–64	1.25 (1.21–1.30)	1.41 (1.35–1.47)	1.41 (1.34–1.49)
65–74	2.11 (2.01–2.21)	2.50 (2.39–2.62)	2.39 (2.26–2.53)
75–84	2.99 (2.83–3.15)	3.72 (3.52–3.94)	3.63 (3.40–3.88)
85 plus	2.34 (2.16–2.54)	3.17 (2.88–3.49)	3.04 (2.67–3.45)
Australia/NZ	1	1	1
Europe/N. America	1.16 (1.11–1.20)	1.02 (0.98–1.06)	1.04 (0.99–1.11)
Asia	1.45 (1.37–1.53)	1.00 (0.86–1.15)	1.20 (0.97–1.49)
Africa/Mid East	1.63 (1.50–1.77)	1.11 (0.94–1.31)	0.99 (0.76–1.29)
Other	1.59 (1.42–1.78)	1.21 (0.96–1.52)	1.13 (0.76–1.66)
Not married/ not de facto	1	1	1
Married/de facto	1.02 (0.99–1.06)	0.99 (0.96–1.03)	1.00 (0.96–1.05)
Excellent	1	1	1
Very good	1.30 (1.24–1.37)	1.29 (1.22–1.36)	1.33 (1.24–1.42)
Good	1.72 (1.63–1.81)	1.73 (1.63–1.82)	1.73 (1.61–1.85)
Fair	2.10 (1.97–2.25)	2.39 (2.23–2.56)	2.56 (2.35–2.79)
Poor	2.75 (2.43–3.10)	3.08 (2.71–3.49)	3.26 (2.83–3.75)
Missing self-rated health	2.10 (1.92–2.30)	2.32 (2.11–2.56)	2.30 (2.05–2.58)
No conditions	1	1	1
1–2 conditions	1.85 (1.79–1.92)	1.84 (1.77–1.92)	1.96 (1.86–2.06)
3 or more conditions	3.23 (3.08–3.38)	3.24 (3.08–3.40)	3.61 (3.40–3.83)
No limitation	1	1	1
Minor limitation	1.11 (1.06–1.15)	1.09 (1.04–1.13)	1.07 (1.02–1.14)
Moderate limitation	1.49 (1.42–1.56)	1.49 (1.42–1.56)	1.46 (1.38–1.55)
Severe limitation	1.79 (1.68–1.90)	1.92 (1.81–2.04)	1.96 (1.82–2.11)
Missing (functional limitation)	1.61 (1.53–1.70)	1.53 (1.45–1.62)	1.50 (1.40–1.60)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; NZ, New Zealand; N., North; ref, reference.
2. Wald joint test of significance for SEP term $p < .001$ for all regions.

Table C8. Full model results for GP use, continuous education

Model 2, Continuous education	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.16 (0.14–0.18)	0.09 (0.08–0.11)	0.08 (0.06–0.09)
Continuous education	0.53 (0.50–0.56)	0.62 (0.58–0.65)	0.59 (0.55–0.63)
Male	1	1	1
Female	1.20 (1.17–1.24)	1.23 (1.19–1.27)	1.22 (1.18–1.27)
43–54	1	1	1
55–64	1.32 (1.27–1.37)	1.49 (1.42–1.55)	1.48 (1.41–1.56)
65–74	2.47 (2.36–2.59)	2.87 (2.75–3.00)	2.67 (2.53–2.82)
75–84	3.58 (3.40–3.77)	4.33 (4.11–4.57)	4.09 (3.83–4.37)
85 plus	2.66 (2.45–2.88)	3.51 (3.18–3.86)	3.27 (2.86–3.72)
Australia/NZ	1	1	1
Europe/N.America	1.18 (1.13–1.22)	1.04 (1.00–1.08)	1.09 (1.03–1.16)
Asia	1.67 (1.58–1.77)	1.08 (0.93–1.25)	1.31 (1.06–1.63)
Africa/Mid East	1.78 (1.64–1.94)	1.14 (0.97–1.35)	1.08 (0.83–1.41)
Other	1.75 (1.56–1.96)	1.29 (1.02–1.62)	1.20 (0.82–1.77)
Not married/not de facto	1	1	1
Married/de facto	0.94 (0.91–0.97)	0.91 (0.88–0.95)	0.93 (0.89–0.97)
Excellent	1	1	1
Very good	1.31 (1.25–1.38)	1.30 (1.23–1.37)	1.32 (1.23–1.41)
Good	1.74 (1.65–1.84)	1.75 (1.66–1.85)	1.73 (1.61–1.85)
Fair	2.17 (2.03–2.32)	2.45 (2.28–2.62)	2.60 (2.39–2.83)
Poor	2.93 (2.60–3.32)	3.25 (2.86–3.69)	3.39 (2.94–3.91)
Missing self-rated health	2.21 (2.02–2.42)	2.43 (2.20–2.67)	2.39 (2.13–2.69)
No conditions	1	1	1
1–2 conditions	1.84 (1.78–1.91)	1.84 (1.77–1.92)	1.97 (1.87–2.07)
3 or more conditions	3.26 (3.11–3.42)	3.26 (3.10–3.42)	3.67 (3.45–3.89)
No limitation	1	1	1
Minor limitation	1.12 (1.07–1.17)	1.10 (1.05–1.15)	1.10 (1.04–1.16)
Moderate limitation	1.54 (1.47–1.61)	1.53 (1.46–1.61)	1.52 (1.44–1.61)
Severe limitation	1.89 (1.78–2.02)	2.04 (1.91–2.17)	2.11 (1.96–2.27)
Missing (functional limitation)	1.66 (1.57–1.75)	1.58 (1.5–1.67)	1.55 (1.45–1.65)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; NZ, New Zealand; N., North; ref, reference.
2. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.
3. Wald joint test of significance for SEP term $p < .001$ for all regions.

Table C9. Models 3a-3d: association of each PHC characteristic with above-average GP use, income

	<i>AIHW FTE (3a)</i> OR (95%CI)	<i>OOP expenses (3b)</i> OR (95%CI)	<i>bulk-billing (3c)</i> OR (95%CI)	<i>after-hours care (3d)</i> OR (95%CI)
Cities				
1st quartile (reference)	1	1	1	1
2nd quartile	0.68 (0.48–0.97)	0.78 (0.68–0.90)	1.21 (1.05–1.40)	1.22 (0.70–2.11)
3rd quartile	0.78 (0.55–1.11)	0.65 (0.55–0.78)	1.52 (1.34–1.72)	1.72 (1.00–2.96)
4th quartile	0.59 (0.42–0.84)	0.51 (0.44–0.59)	2.09 (1.87–2.35)	1.75 (1.02–3.01)
p-value for term	0.009	<.001	<.001	<.001
ICC	0.022	0.008	0.004	0.020
PCV (%)	21	71	86	29
MOR	1.30	1.17	1.12	1.28
Inner regional				
1st quartile (reference)	1	1	1	1
2nd quartile	1.05 (0.77–1.44)	1.00 (0.71–1.41)	1.66 (1.42–1.94)	1.14 (0.91–1.43)
3rd quartile	0.95 (0.70–1.30)	0.88 (0.62–1.23)	1.74 (1.48–2.05)	1.51 (1.02–2.24)
4th quartile	1.28 (0.96–1.70)	0.57 (0.40–0.81)	–	1.45 (1.08–1.96)
p-value for term	0.339	<.001	<.001	0.036
ICC	0.023	0.012	0.008	0.02
PCV (%)	12	54	69	23
MOR	1.3	1.21	1.17	1.28
Outer regional				
1st quartile (reference)	1	–	1	–
2nd quartile	0.95 (0.67–1.34)	1	1.25 (0.99–1.58)	–
3rd quartile	1.16 (0.78–1.71)	0.74 (0.56–0.97)	1.67 (1.34–2.07)	–
4th quartile	0.91 (0.61–1.34)	0.65 (0.50–0.84)	–	–
p-value for term	0.778	0.004	<.001	–
ICC	0.028	0.02	0.014	–
PCV (%)	3	31	52	–
MOR	1.34	1.28	1.23	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket; ICC, intra-class coefficient; PCV, Proportional change in variance. PCV reported change from model adjusted for sociodemographic and need variables (Model 2).
2. MOR median odds ratio. Wald test of significance for addition of area variable. Significant values bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

Table C10. Models 3a-3d: association of each PHC characteristic with above-average GP use, continuous education

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>bulk-billing (3c)</i>	<i>after-hours care (3d)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities				
1st quartile (reference)	1	1	1	1
2nd quartile	0.68 (0.47–0.97)	0.77 (0.68–0.89)	1.23 (1.08–1.41)	1.23 (0.70–2.15)
3rd quartile	0.78 (0.54–1.11)	0.64 (0.54–0.77)	1.53 (1.36–1.73)	1.75 (1.01–3.04)
4th quartile	0.58 (0.41–0.83)	0.50 (0.43–0.58)	2.14 (1.92–2.40)	1.79 (1.03–3.10)
p-value for term	0.008	<.001	<.001	<.001
ICC	0.023	0.008	0.004	0.021
PCV (%)	21	72	86	28
MOR	1.30	1.17	1.12	1.29
Inner regional				
1st quartile (reference)	1	1	1	1
2nd quartile	1.07 (0.78–1.45)	1.00 (0.71–1.40)	1.68 (1.45–1.96)	1.13 (0.9–1.42)
3rd quartile	0.95 (0.70–1.30)	0.88 (0.63–1.23)	1.76 (1.50–2.06)	1.49 (.001–2.23)
4th quartile	1.30 (0.98–1.73)	0.56 (0.39–0.80)	–	1.42 (1.04–1.93)
p-value for term	0.278	<.001	<.001	0.060
ICC	0.023	0.012	0.008	0.021
PCV (%)	12	54	69	19
MOR	1.3	1.21	1.16	1.29
Outer regional				
1st quartile (reference)	1	–	1	–
2nd quartile	0.95 (0.67–1.35)	1	1.24 (0.98–1.57)	–
3rd quartile	1.19 (0.80–1.75)	0.74 (0.56–0.97)	1.67 (1.34–2.08)	–
4th quartile	0.91 (0.62–1.35)	0.64 (0.49–0.83)	–	–
p-value for term	0.736	0.004	<.001	–
ICC	0.028	0.02	0.014	–
PCV (%)	3	31	52	–
MOR	1.34	1.28	1.23	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket; ICC, intra-class coefficient; PCV, Proportional change in variance. PCV reported change from model adjusted for sociodemographic and need variables (Model 2). MOR median odds ratio.
2. Wald test of significance for addition of area variable. Significant values bolded. There were no areas in regional areas that were in the 4th quartile for bulk-billing. In addition, there were no areas in outer regional areas that were in the 1st quartile for OOP expenses.
3. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.

Table C11. Model 4: cross-level effect modification, GP use. OR (95% CIs) for area PHC service characteristics (continuous) and as interaction with income

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	0.737 (0.455–1.193)	1.509 (0.79–2.885)	0.641 (0.332–1.237)
<\$20kXAIHW FTE	1	1	1
\$20–<\$30kXAIHW FTE	0.589 (0.406–0.854)	1.101 (0.816–1.486)	1.390 (0.939–2.059)
\$30–<\$40kXAIHW FTE	0.612 (0.421–0.891)	1.210 (0.869–1.685)	0.735 (0.469–1.151)
\$40–<\$50kXAIHW FTE	0.636 (0.437–0.926)	0.912 (0.636–1.308)	0.932 (0.572–1.516)
\$50–<\$70kXAIHW FTE	0.702 (0.510–0.967)	0.865 (0.622–1.205)	1.132 (0.710–1.805)
>\$70kXAIHW FTE	0.519 (0.402–0.670)	1.065 (0.802–1.414)	1.324 (0.871–2.012)
missingXAIHW FTE	0.545 (0.416–0.714)	1.206 (0.939–1.550)	1.160 (0.838–1.605)
p-value for interaction	0.000	0.391	0.186
<i>OOP expenses (Model 4b)</i>	0.952 (0.936–0.968)	–	0.902 (0.854–0.954)
<\$20kXOOP expenses	1	–	1
\$20–<\$30kXOOP expenses	0.993 (0.977–1.009)	–	1.004 (0.972–1.038)
\$30–<\$40kXOOP expenses	0.993 (0.977–1.010)	–	0.984 (0.948–1.022)
\$40–<\$50kXOOP expenses	0.987 (0.971–1.003)	–	0.979 (0.940–1.020)
\$50–<\$70kXOOP expenses	1.000 (0.986–1.014)	–	1.046 (1.005–1.088)
>\$70kXOOP expenses	0.985 (0.974–0.997)	–	1.013 (0.978–1.049)
missingXOOP expenses	0.980 (0.969–0.992)	–	0.994 (0.967–1.022)
p-value for interaction	0.007	–	0.140
<i>bulk billing (Model 4c)</i>	1.021 (1.016–1.026)	1.026 (1.016–1.035)	1.03 (1.017–1.043)
<\$20kXbulk-billing	1	1	1
\$20–<\$30kXbulk-billing	1.002 (0.997–1.008)	1.004 (0.997–1.012)	0.997 (0.989–1.005)
\$30–<\$40kXbulk-billing	1.002 (0.996–1.008)	0.997 (0.989–1.005)	1.003 (0.994–1.012)
\$40–<\$50kXbulk-billing	1.004 (0.998–1.010)	1.002 (0.993–1.01)	1.003 (0.993–1.013)
\$50–<\$70kXbulk-billing	1.001 (0.996–1.006)	1.001 (0.993–1.008)	0.991 (0.981–1.000)
>\$70kXbulk-billing	1.005 (1.001–1.010)	0.994 (0.988–1.000)	0.997 (0.988–1.005)
missingXbulk-billing	1.007 (1.002–1.011)	1.002 (0.996–1.008)	1.001 (0.994–1.008)
p-value for interaction	0.037	0.122	0.283

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>after-hours care (Model 4d)</i>	1.038 (1.006–1.072)	1.05 (1.012–1.088)	–
<\$20kX <i>after-hours care</i>	1	1	–
\$20–<\$30kX <i>after-hours care</i>	0.993 (0.970–1.016)	1.010 (0.988–1.032)	–
\$30–<\$40kX <i>after-hours care</i>	1.021 (0.997–1.045)	0.986 (0.963–1.010)	–
\$40–<\$50kX <i>after-hours care</i>	1.029 (1.005–1.054)	1.017 (0.992–1.043)	–
\$50–<\$70kX <i>after-hours care</i>	1.000 (0.979–1.022)	1.029 (1.006–1.052)	–
>\$70kX <i>after-hours care</i>	1.029 (1.010–1.047)	0.990 (0.972–1.009)	–
missingX <i>after-hours care</i>	1.023 (1.005–1.041)	0.997 (0.979–1.015)	–
p-value for interaction	0.001	0.011	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket.
2. Models 4a–d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. OR for area characteristic as a continuous variable given, followed by OR for interaction term for each education level.
3. P-value, Wald test of joint significance for addition of cross-level interaction term. Significant terms bolded.
4. Interaction term for *OOP expenses* in inner regional areas not tested, as relationship with above-average use was not monotonic.

Table C12. Model 4: cross-level effect modification, GP use. OR (95% CIs) for area PHC service characteristics (continuous) and as interaction with continuous education

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	0.915 (0.825–1.015)	1.058 (0.963–1.163)	0.965 (0.852–1.092)
Cont. educationX <i>AIHW FTE</i>	0.954 (0.900–1.011)	1.014 (0.970–1.060)	1.079 (1.015–1.147)
p-value for interaction	0.114	0.549	0.015
<i>OOP expenses (Model 4b)</i>	0.801 (0.760–0.845)		0.813 (0.709–0.934)
Cont. educationX <i>OOP expenses</i>	0.988 (0.944–1.034)		0.969 (0.892–1.051)
p-value for interaction	0.598		0.447
<i>bulk-billing (Model 4c)</i>	1.294 (1.236–1.354)	1.394 (1.257–1.546)	1.272 (1.133–1.427)
Cont. educationX <i>bulk-billing</i>	0.999 (0.954–1.046)	0.921 (0.854–0.993)	1.034 (0.955–1.118)
p-value for interaction	0.962	0.031	0.412
<i>after-hours care (Model 4d)</i>	1.147 (1.028–1.280)	1.156 (1.043–1.282)	
Cont. educationX <i>after-hours care</i>	1.079 (1.012–1.152)	0.971 (0.916–1.030)	
p-value for interaction	0.021	0.326	

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket; cont. continuous.
2. Models 4a–d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. OR for area characteristic as a continuous variable given, followed by OR for interaction term for each education level.
3. P-value, Wald test of joint significance for addition of cross-level interaction term. Significant terms bolded.
4. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.
5. Interaction term for *OOP expenses* in inner regional areas not tested as relationship with above-average use was not monotonic.

Table C13. Frequency and percentages of alternate cut-off points for dichotomous GP use outcome measure

	Mean		25th Centile		50th Centile		low use	medium use	high use
Cut-off point	<8 visits	>8 visits	≤ 3 visits	> 3 visits	≤6 visits	> 6 visits	< 3 visits	3-10 visits	>10 visits
Frequency	165,803	99,280	83,070	182,013	148,871	116,212	58,138	145,162	61,789
Percent	62.6	37.5	31.3	68.7	56.2	43.8	21.9	54.8	23.3

Table C14. Alternate cut-off points for GP use: Model 2, OR(95% CIs)

	Below vs above average	≤3visits/>3visits (25th centile)	≤6visits/>6visits (50th centile)	Medium use (3–10 visits) vs high use (>10 visits)	Medium use (3–10 visits) vs low use (<3 visits)
Cons	0.11 (0.10–0.13)	0.51 (0.46–0.55)	0.16 (0.15–0.18)	0.1 (0.09–0.11)	1.38 (1.28–1.49)
No school certificate	1	1	1	1	1
School certificate	0.80 (0.78–0.83)	0.81 (0.78–0.84)	0.79 (0.77–0.82)	0.84 (0.81–0.86)	1.17 (1.12–1.21)
Apprentice/ diploma	0.74 (0.72–0.76)	0.75 (0.73–0.78)	0.73 (0.71–0.75)	0.75 (0.73–0.78)	1.22 (1.17–1.27)
University	0.57 (0.55–0.59)	0.62 (0.60–0.64)	0.57 (0.55–0.59)	0.60 (0.58–0.62)	1.42 (1.36–1.48)
Male	1	1	1	1	1
Female	1.23 (1.21–1.25)	1.42 (1.4–1.45)	1.27 (1.25–1.30)	1.03 (1.01–1.06)	0.69 (0.67–0.70)
43–54 (reference)	1	1	1	1	1
55–64	1.41 (1.38–1.45)	1.51 (1.47–1.54)	1.42 (1.39–1.45)	1.24 (1.20–1.28)	0.67 (0.66–0.69)
65–74	2.64 (2.57–2.71)	2.90 (2.82–2.98)	2.66 (2.59–2.73)	2.08 (2.01–2.15)	0.38 (0.37–0.39)
75–84	3.93 (3.81–4.06)	3.68 (3.54–3.82)	3.93 (3.80–4.05)	3.36 (3.23–3.48)	0.43 (0.41–0.45)
85 plus	3.02 (2.85–3.19)	1.93 (1.81–2.06)	2.81 (2.66–2.98)	3.48 (3.27–3.70)	1.06 (0.98–1.15)
Australia/NZ	1	1	1	1	1
Europe/N. America	1.10 (1.08–1.13)	1.06 (1.03–1.09)	1.08 (1.05–1.11)	1.06 (1.03–1.10)	0.96 (0.94–0.99)
Asia	1.58 (1.50–1.66)	1.45 (1.38–1.54)	1.57 (1.50–1.65)	1.50 (1.41–1.59)	0.79 (0.74–0.84)
Africa/Mid East	1.59 (1.48–1.70)	1.33 (1.23–1.43)	1.58 (1.47–1.69)	1.59 (1.47–1.72)	0.87 (0.80–0.95)
Other	1.59 (1.44–1.76)	1.51 (1.35–1.69)	1.61 (1.46–1.78)	1.51 (1.36–1.69)	0.74 (0.65–0.84)
Not married/not de facto	1	1	1	1	1
Married/def acto	0.93 (0.91–0.95)	1.02 (1.00–1.04)	0.94 (0.92–0.96)	0.84 (0.82–0.86)	0.89 (0.87–0.91)
Excellent (	1	1	1	1	1
Very good	1.30 (1.26–1.35)	1.25 (1.22–1.28)	1.28 (1.24–1.32)	1.27 (1.22–1.33)	0.82 (0.80–0.84)
Good	1.73 (1.68–1.79)	1.55 (1.51–1.60)	1.70 (1.65–1.75)	1.70 (1.62–1.77)	0.72 (0.70–0.74)
Fair	2.37 (2.27–2.47)	1.86 (1.78–1.95)	2.27 (2.18–2.37)	2.50 (2.37–2.63)	0.71 (0.67–0.75)
Poor	3.15 (2.92–3.40)	2.07 (1.89–2.28)	2.94 (2.72–3.17)	3.78 (3.49–4.09)	0.86 (0.77–0.97)
Missing (self-rated health)	2.33 (2.20–2.46)	1.97 (1.85–2.10)	2.23 (2.11–2.36)	2.21 (2.07–2.36)	0.62 (0.58–0.67)
No conditions	1	1	1	1	1
1–2 conditions	1.86 (1.82–1.91)	2.00 (1.96–2.04)	1.88 (1.84–1.92)	1.52 (1.47–1.57)	0.51 (0.50–0.53)
3 or more conditions	3.35 (3.25–3.45)	3.72 (3.60–3.84)	3.40 (3.31–3.5)	2.56 (2.47–2.65)	0.33 (0.32–0.34)

	Below vs above average	≤3visits/>3visits (25th centile)	≤6visits/>6visits (50th centile)	Medium use (3–10 visits) vs high use (>10 visits)	Medium use (3–10 visits) vs low use (<3 visits)
No limitation	1	1	1	1	1
Minor limitation	1.10 (1.08–1.13)	1.11 (1.08–1.13)	1.10 (1.08–1.13)	1.07 (1.03–1.11)	0.89 (0.86–0.91)
Moderate limitation	1.53 (1.48–1.57)	1.46 (1.42–1.51)	1.52 (1.48–1.56)	1.49 (1.44–1.55)	0.72 (0.70–0.75)
Severe limitation	2.00 (1.93–2.08)	1.73 (1.65–1.80)	1.93 (1.86–2.01)	2.06 (1.98–2.15)	0.79 (0.75–0.83)
Missing (functional limitation)	1.59 (1.54–1.65)	1.4 (1.35–1.45)	1.55 (1.50–1.60)	1.63 (1.57–1.70)	0.81 (0.78–0.84)
ICC	0.046	0.037	0.045	0.040	0.020
MOR	1.46	1.40	1.46	1.42	1.28

Notes:

1. GP, general practitioner; OR, odds ratio; CI, confidence interval; ICC, intra-class coefficient; MOR, median odds ratio; NZ, New Zealand; N. North.
2. Fully adjusted model for individual sociodemographic and need variables, sample not stratified by region.

Additional Tables for Quality of GP Care

Table C15. Percentage of participants in each outcome category, by region

Region	<i>Long consult</i>			<i>Continuity of care</i>			<i>Care planning</i>			Total
	no	Yes	Missing	<70%	≥70%	Missing	No	Yes	Missing	
Major cities	55.0	45.0	0	37.3	52.4	10.4	54.5	14.1	31.5	98,149
Inner regional	60.8	39.2	0	41.6	46.5	11.9	55.1	14.8	30.2	96,880
Outer regional/ remote	62.4	37.6	0	40.7	45.2	14.1	56	13.8	30.1	70,054
Total	59.1	40.9	0	39.8	48.3	11.9	55.1	14.3	30.6	265,083
p-value	<.001			<.001			ns			

Notes:

1. N, population; sd, standard deviation; ns, not significant
2. Total, row totals
3. P-value, Chi-squared test of trend

Table C16. Frequency and percentage of respondents in long consult categories, by area PHC service characteristic quartile, stratified by region

<i>long consult</i>	<i>GP availability</i>		<i>OOP expenses</i>		<i>bulk-billing</i>		<i>after-hours care</i>	
	no	yes	no	yes	no	yes	no	yes
Major cities								
1st quartile	59.9	40.1	56.4	43.6	54.9	45.1	63.0	41.0
2nd quartile	56.1	44.0	55.4	44.6	54.8	45.2	54.6	45.4
3rd quartile	57.0	43.1	53.4	46.6	53.0	47.0	53.6	46.4
4th quartile	51.5	48.5	54.4	45.6	56.8	43.2	56.7	43.3
Inner regional								
1st quartile	63.0	37.0	63.7	36.4	65.9	34.1	64.2	35.8
2nd quartile	61.8	38.2	56.9	43.2	57.5	41.6	58.3	41.7
3rd quartile	62.9	37.1	60.9	39.1	58.5	41.5	53.6	46.4
4th quartile	54.5	45.5	65.2	34.8	–	–	58.4	41.6
missing	–	–	55.1	45.0	63.6	36.4	55.1	45.0
Outer regional/ remote								
1st quartile	61.7	38.3	–	–	67.0	33.0	–	–
2nd quartile	60.1	40.0	55.9	44.1	62.7	37.3	–	–
3rd quartile	61.5	38.5	62.2	37.8	56.0	44.0	–	–
4th quartile	69.6	30.4	67.1	32.9	–	–	–	–
missing	–	–	–	–	35.9	64.1	–	–

Notes:

1. GP, general practitioner; PHC, primary health care; OOP, out-of-pocket expenses; CD, chronic disease; sd, standard deviation.
2. 1st quartile corresponds to 25% of the population in the lowest category, 4th quartile 25% of the population in the highest category
3. Chi-squared test of trend for area PHC characteristics categories and *long consult*, all significant at the p<.001 level.
4. There were no areas in regional areas that were in the 4th quartile for bulk-billing. In addition, there were no areas in outer regional areas that were in the 1st quartile for OOP expenses.

Table C17. Frequency and percentage of respondents in continuity of care categories, by area PHC service characteristic quartile, stratified by region

<i>Continuity of care</i>	<i>GP availability</i>		<i>OOP expenses</i>		<i>Bulk-billing</i>		<i>After-hours care</i>		<i>CD care</i>		<i>Health assessments</i>	
	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Major cities												
1st quartile	41.7	58.2	39.6	60.3	43.3	56.5	48.6	51.3	44.4	55.4	43.2	56.7
2nd quartile	41.3	58.5	40.6	59.2	44.1	55.8	40.7	59.2	40.4	59.5	40.0	59.9
3rd quartile	40.0	60.0	42.5	57.3	40.6	59.3	41.4	58.5	39.4	60.5	41.0	58.8
4th quartile	43.3	56.6	43.6	56.2	39.5	60.4	41.9	57.9	41.7	58.2	42.0	57.9
Inner regional												
1st quartile	44.9	55.0	48.5	51.3	43.8	56.1	46.9	52.9	45.1	54.8	45.9	53.9
2nd quartile	46.1	53.7	49.3	50.5	49.2	50.7	47.4	52.4	46.7	53.2	49.4	50.4
3rd quartile	47.6	52.3	46.8	53.1	47.6	52.2	49.0	50.8	47.9	52.0	41.5	58.4
4th quartile	52.1	47.7	45.4	54.4	–	–	45.6	54.2	48.8	51.0	48.2	51.6
missing	–	–	41.7	58.3	45.9	53.8	41.7	58.3	41.7	58.3	41.7	58.3
Outer regional/ remote												
1st quartile	48.1	51.7	–	–	44.8	55.0	–	–	44.8	55.0	49.7	50.2
2nd quartile	47.2	52.7	46.4	53.5	50.8	49.1	–	–	47.6	52.3	41.8	58.1
3rd quartile	49.0	50.8	49.4	50.5	47.3	52.6	–	–	48.0	51.8	45.8	54.1
4th quartile	43.4	56.5	46.3	53.6	–	–	–	–	48.5	51.4	49.3	50.6
missing	–	–	–	–	42.4	57.6	–	–	42.4	57.6	–	–

Notes:

1. GP, general practitioner; PHC, primary health care; OOP, out-of-pocket expenses; CD, chronic disease; sd, standard deviation.
2. 1st quartile corresponds to 25% of the population in the lowest category, 4th quartile 25% of the population in the highest category
3. Chi-squared test of trend for area PHC characteristics categories and *continuity of care*, all significant at the p<.001 level.
4. There were no areas in regional areas that were in the 4th quartile for bulk-billing. In addition, there were no areas in outer regional areas that were in the 1st quartile for OOP expenses.

Table C18. Frequency and percentage of respondents in care planning categories, by area PHC service characteristic quartile, stratified by region

<i>Care planning</i>	<i>GP availability</i>		<i>OOP expenses</i>		<i>Bulk-billing</i>		<i>After-hours care</i>	
	No	Yes	No	Yes	No	Yes	No	Yes
Major cities								
1st quartile	72.8	27.3	73.3	26.7	86.7	13.3	91.7	8.3
2nd quartile	80.2	19.8	79.1	20.9	81.1	18.9	83.8	16.2
3rd quartile	76.4	23.6	78.7	21.3	78.7	21.3	78.4	21.6
4th quartile	82.7	17.4	86.3	13.7	73.7	26.3	77.1	23.0
Inner regional								
1st quartile	79.5	20.5	79.5	20.5	84.7	15.3	77.3	22.7
2nd quartile	80.1	19.9	79.5	20.5	74.8	25.2	82.2	17.8
3rd quartile	81.7	18.3	76.3	23.7	78.8	21.2	74.2	25.9
4th quartile	74.7	25.3	84.8	15.2	–	–	81.1	19.0
missing	–	–	86.8	13.2	82.3	17.7	86.8	13.2
Outer regional								
1st quartile	80.3	19.7	–	–	84.5	15.5	–	–
2nd quartile	77.8	22.2	73.9	26.1	79.8	20.2	–	–
3rd quartile	79.8	20.2	80.8	19.2	75.0	25.0	–	–
4th quartile	84.7	15.3	84.1	15.9	–	–	–	–
missing	–	–	–	–	100.0	0.0	–	–

Notes:

1. GP, general practitioner; PHC, primary health care; OOP, out-of-pocket expenses; CD, chronic disease; sd, standard deviation.
2. 1st quartile corresponds to 25% of the population in the lowest category, 4th quartile 25% of the population in the highest category
3. Chi-squared test of trend for area PHC characteristics categories and *care planning*, all significant at the $p < .001$ level.
4. There were no areas in regional areas that were in the 4th quartile for bulk-billing. In addition, there were no areas in outer regional areas that were in the 1st quartile for OOP expenses.

Table C19. Between-area variation in odds of quality of GP care outcomes: supplementary analyses, income and continuous education

	Long consult			Continuity of care			Care planning		
	Null model	Income	Cont. education	Null model	income	Cont. education	Null model	income	Cont. education
Cities									
ICC	0.009	0.014	0.013	0.007	0.007	0.007	0.049	0.036	0.039
PCV (%)	na	-61	-39	na	1.5	0.9	na	28	20
MOR	1.18	1.23	1.22	1.16	1.16	1.16	1.48	1.39	1.42
Inner regional									
ICC	0.027	0.033	0.031	0.017	0.019	0.019	0.049	0.046	0.048
PCV (%)	na	-22	-16	na	-10	-8	na	6	3
MOR	1.33	1.38	1.36	1.26	1.27	1.27	1.48	1.46	1.47
Outer regional									
ICC	0.033	0.040	0.040	0.037	0.037	0.037	0.043	0.043	0.044
PCV (%)	na	-22	-24	na	-2	-2	na	0.2	-2
MOR	1.37	1.42	1.43	1.40	1.40	1.40	1.44	1.44	1.45

Notes:

1. ICC: intra-class coefficient; PCV: Proportional change in variance. Reported change from null model, MOR median odds ratio; na, not applicable; cont. continuous.
2. Null model, random intercept only; Model 2 adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease, and physical functional limitation.
3. Wald test that between-area variance for the null model is non zero (i.e. $\delta_u^2=0$) $p<.001$ for all outcomes. See Appendix G for full details of model diagnostics.
4. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.

Table C20. Full model results for Long consult, education

Long consult, education	Cities	Inner regional	Outer regional/ remote
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cons	0.39 (0.35–0.42)	0.28 (0.24–0.32)	0.29 (0.24–0.34)
No school certificate	1	1	1
School certificate	1.00 (0.95–1.05)	0.99 (0.95–1.04)	0.97 (0.93–1.02)
Apprentice/ diploma	1.05 (1.00–1.10)	1.05 (1.00–1.10)	1.02 (0.97–1.08)
University	1.05 (0.99–1.10)	1.11 (1.05–1.16)	1.09 (1.02–1.15)
Male (ref)	1	1	1
Female	1.49 (1.45–1.54)	1.41 (1.37–1.45)	1.27 (1.23–1.32)
43–54 (ref)	1	1	1
55–64	1.08 (1.04–1.11)	1.15 (1.11–1.19)	1.13 (1.08–1.18)
65–74	1.25 (1.20–1.31)	1.34 (1.28–1.39)	1.34 (1.28–1.41)
75–84	1.22 (1.16–1.28)	1.43 (1.36–1.5)	1.53 (1.44–1.62)
85 plus	0.87 (0.80–0.93)	1.15 (1.05–1.26)	1.17 (1.04–1.33)
Australia/NZ	1	1	1
Europe/N. America	1.05 (1.01–1.08)	1.02 (0.98–1.05)	1.05 (1.00–1.11)
Asia	0.94 (0.89–0.99)	1.01 (0.89–1.15)	0.94 (0.78–1.14)
Africa/Mid East	1.23 (1.14–1.32)	1.05 (0.91–1.22)	0.94 (0.75–1.19)
Other	1.35 (1.22–1.50)	1.26 (1.03–1.54)	1.13 (0.81–1.58)
Not married/not de facto	1	1	1
Married/de facto	0.96 (0.93–0.99)	0.93 (0.9–0.96)	0.95 (0.92–0.99)
Excellent	1	1	1
Very good	1.06 (1.02–1.11)	1.06 (1.01–1.11)	1.04 (0.98–1.10)
Good	1.15 (1.10–1.20)	1.17 (1.12–1.23)	1.16 (1.10–1.23)
Fair	1.27 (1.20–1.35)	1.43 (1.34–1.52)	1.44 (1.34–1.55)
Poor	1.48 (1.34–1.64)	1.77 (1.58–1.98)	1.68 (1.48–1.91)
Missing (self-rated health)	1.25 (1.15–1.36)	1.45 (1.32–1.58)	1.40 (1.26–1.55)
No conditions	1	1	1
1-2 conditions	1.26 (1.22–1.30)	1.27 (1.23–1.31)	1.29 (1.24–1.34)
3 or more conditions	1.65 (1.58–1.72)	1.64 (1.57–1.72)	1.72 (1.64–1.82)
No limitation	1	1	1
Minor limitation	1.06 (1.02–1.10)	1.12 (1.08–1.17)	1.07 (1.02–1.12)
Moderate limitation	1.21 (1.16–1.26)	1.27 (1.22–1.33)	1.27 (1.20–1.33)
Severe limitation	1.30 (1.23–1.37)	1.46 (1.38–1.55)	1.56 (1.46–1.67)
Missing (functional limitation)	1.24 (1.18–1.30)	1.28 (1.21–1.34)	1.28 (1.21–1.36)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N. North.
2. Wald joint test of significance for education $p < .001$ for all regions, excepting long consults in major cities ($p < .05$)

Table C21. Full model results for Long consult, income

Long consult Income	Cities	Inner regional	Outer regional/ remote
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cons	0.47 (0.43–0.52)	0.34 (0.29–0.39)	0.33 (0.28–0.39)
<\$20k	1	1	1
\$20–<\$30k	0.95 (0.9–1.01)	0.97 (0.92–1.02)	0.95 (0.90–1.00)
\$30–<\$40k	0.93 (0.87–0.98)	0.92 (0.87–0.97)	0.87 (0.82–0.93)
\$40–<\$50k	0.90 (0.85–0.96)	0.88 (0.83–0.94)	0.88 (0.82–0.94)
\$50–<\$70k	0.88 (0.83–0.93)	0.83 (0.79–0.88)	0.86 (0.81–0.92)
>\$70k	0.80 (0.76–0.84)	0.81 (0.78–0.86)	0.86 (0.81–0.91)
Missing	0.93 (0.89–0.97)	0.91 (0.88–0.95)	0.97 (0.93–1.02)
Male	1	1	1
Female	1.45 (1.41–1.49)	1.37 (1.34–1.41)	1.24 (1.2–1.29)
43–54	1	1	1
55–64	1.05 (1.01–1.08)	1.11 (1.07–1.15)	1.1 (1.05–1.15)
65–74	1.16 (1.11–1.21)	1.24 (1.18–1.29)	1.27 (1.21–1.33)
75–84	1.12 (1.07–1.18)	1.31 (1.25–1.38)	1.43 (1.35–1.52)
85 plus	0.81 (0.75–0.87)	1.07 (0.98–1.17)	1.10 (0.98–1.25)
Australia/NZ	1	1	1
Europe/N.America	1.04 (1.01–1.08)	1.02 (0.98–1.05)	1.06 (1.01–1.11)
Asia	0.91 (0.87–0.96)	1.02 (0.9–1.16)	0.96 (0.79–1.16)
Africa/Mid East	1.20 (1.12–1.29)	1.08 (0.93–1.25)	0.98 (0.78–1.23)
Other	1.33 (1.20–1.48)	1.28 (1.05–1.57)	1.15 (0.82–1.60)
Not married/not de facto	1	1	1
Married/de facto	0.99 (0.96–1.02)	0.96 (0.93–1)	0.98 (0.94–1.01)
Excellent	1	1	1
Very good	1.05 (1.00–1.09)	1.04 (1.00–1.09)	1.03 (0.97–1.08)
Good	1.12 (1.07–1.17)	1.14 (1.09–1.20)	1.13 (1.07–1.20)
Fair	1.23 (1.16–1.30)	1.37 (1.29–1.46)	1.39 (1.29–1.49)
Poor	1.39 (1.26–1.54)	1.70 (1.52–1.90)	1.62 (1.43–1.84)
Missing self-rated health	1.21 (1.11–1.31)	1.40 (1.28–1.52)	1.33 (1.20–1.48)
No conditions	1	1	1
1–2 conditions	1.26 (1.22–1.31)	1.27 (1.23–1.32)	1.30 (1.25–1.35)
3 or more conditions	1.65 (1.58–1.72)	1.64 (1.57–1.72)	1.72 (1.64–1.82)
No limitation	1	1	1
Minor limitation	1.06 (1.02–1.10)	1.12 (1.08–1.17)	1.08 (1.03–1.13)
Moderate limitation	1.19 (1.15–1.24)	1.25 (1.20–1.31)	1.26 (1.20–1.33)
Severe limitation	1.27 (1.20–1.35)	1.41 (1.33–1.49)	1.52 (1.42–1.62)
Missing (functional limitation)	1.22 (1.16–1.28)	1.25 (1.19–1.32)	1.25 (1.18–1.33)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N. North
2. Wald joint test of significance for income $p < .001$ for all regions

Table C22. Full model results for Long consult, continuous education

Long consult, Continuous education	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.38 (0.35–0.42)	0.27 (0.23–0.31)	0.28 (0.23–0.33)
Continuous education	1.07 (1.02–1.13)	1.15 (1.09–1.21)	1.12 (1.05–1.19)
Male	1	1	1
Female	1.49 (1.45–1.53)	1.41 (1.37–1.45)	1.27 (1.23–1.31)
43–54	1	1	1
55–64	1.08 (1.04–1.11)	1.15 (1.11–1.19)	1.13 (1.08–1.18)
65–74	1.25 (1.20–1.31)	1.34 (1.28–1.39)	1.34 (1.28–1.41)
75–84	1.22 (1.17–1.28)	1.43 (1.36–1.50)	1.53 (1.44–1.62)
85 plus	0.87 (0.80–0.93)	1.15 (1.05–1.26)	1.18 (1.04–1.33)
Australia/NZ	1	1	1
Europe/N. America	1.05 (1.01–1.08)	1.02 (0.98–1.06)	1.05 (1.00–1.11)
Asia	0.94 (0.89–0.99)	1.01 (0.89–1.15)	0.94 (0.78–1.15)
Africa/Mid East	1.23 (1.14–1.32)	1.05 (0.91–1.22)	0.95 (0.75–1.19)
Other	1.35 (1.22–1.50)	1.26 (1.02–1.54)	1.14 (0.81–1.59)
Not married/not de facto	1	1	1
Married/de facto	0.96 (0.93–0.99)	0.93 (0.9–0.96)	0.95 (0.92–0.99)
Excellent	1	1	1
Very good	1.06 (1.02–1.11)	1.06 (1.01–1.1)	1.04 (0.98–1.09)
Good	1.15 (1.10–1.20)	1.17 (1.12–1.23)	1.16 (1.09–1.23)
Fair	1.27 (1.20–1.35)	1.43 (1.34–1.52)	1.44 (1.34–1.55)
Poor	1.49 (1.34–1.65)	1.77 (1.58–1.98)	1.69 (1.49–1.92)
Missing self-rated health	1.25 (1.15–1.36)	1.45 (1.32–1.58)	1.4 (1.26–1.55)
No conditions	1	1	1
1–2 conditions	1.26 (1.22–1.30)	1.27 (1.23–1.32)	1.29 (1.24–1.34)
3 or more conditions	1.65 (1.58–1.72)	1.64 (1.57–1.72)	1.73 (1.64–1.82)
No limitation	1	1	1
Minor limitation	1.06 (1.02–1.10)	1.12 (1.08–1.17)	1.07 (1.02–1.12)
Moderate limitation	1.21 (1.16–1.26)	1.27 (1.22–1.33)	1.27 (1.20–1.33)
Severe limitation	1.30 (1.23–1.37)	1.46 (1.38–1.55)	1.56 (1.46–1.67)
Missing (functional limitation)	1.24 (1.18–1.30)	1.28 (1.22–1.35)	1.29 (1.21–1.36)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N. North
2. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.
3. Wald joint test of significance for continuous education $p < .001$ for all regions, except major cities $p < .01$.

Table C23. Full model results for Continuity of care, education

Continuity of care, education	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.74 (0.68–0.81)	0.74 (0.68–0.81)	0.76 (0.64–0.91)
No school certificate	1	1	1
School certificate	0.98 (0.93–1.03)	0.98 (0.93–1.03)	1.02 (0.97–1.08)
Apprentice/ diploma	0.94 (0.90–1.00)	0.94 (0.90–1.00)	0.92 (0.87–0.97)
University	0.88 (0.83–0.93)	0.88 (0.83–0.93)	0.87 (0.82–0.92)
Male (ref)	1	1	1
Female	0.81 (0.78–0.83)	0.81 (0.78–0.83)	0.79 (0.76–0.82)
43–54 (ref)	1	1	1
55–64	1.43 (1.38–1.48)	1.43 (1.38–1.48)	1.21 (1.15–1.26)
65–74	2.07 (1.98–2.16)	2.07 (1.98–2.16)	1.46 (1.39–1.53)
75–84	3.03 (2.87–3.19)	3.03 (2.87–3.19)	1.63 (1.54–1.74)
85 plus	3.01 (2.75–3.28)	3.01 (2.75–3.28)	1.74 (1.52–1.98)
Australia/NZ	1	1	1
Europe/N. America	1.00 (0.96–1.04)	1.00 (0.96–1.04)	1.04 (0.99–1.10)
Asia	0.92 (0.87–0.97)	0.92 (0.87–0.97)	1.17 (0.95–1.44)
Africa/Mid East	0.91 (0.84–0.99)	0.91 (0.84–0.99)	1.02 (0.80–1.31)
Other	0.73 (0.65–0.81)	0.73 (0.65–0.81)	1.1 (0.77–1.56)
Not married/not de facto	1	1	1
Married/de facto	1.14 (1.1–1.17)	1.14 (1.1–1.17)	1.03 (0.98–1.07)
Excellent	1	1	1
Very good	1.08 (1.04–1.13)	1.08 (1.04–1.13)	1.13 (1.07–1.2)
Good	1.13 (1.07–1.18)	1.13 (1.07–1.18)	1.19 (1.12–1.26)
Fair	1.16 (1.09–1.24)	1.16 (1.09–1.24)	1.24 (1.15–1.34)
Poor	1.13 (1.01–1.27)	1.13 (1.01–1.27)	1.30 (1.14–1.48)
Missing (self-rated health)	1.07 (0.98–1.17)	1.07 (0.98–1.17)	1.20 (1.08–1.34)
No conditions	1	1	1
1-2 conditions	1.19 (1.15–1.24)	1.19 (1.15–1.24)	1.1 (1.05–1.15)
3 or more conditions	1.33 (1.27–1.39)	1.33 (1.27–1.39)	1.21 (1.15–1.28)
No limitation	1	1	1
Minor limitation	1.06 (1.02–1.1)	1.06 (1.02–1.1)	0.99 (0.95–1.04)
Moderate limitation	1.12 (1.07–1.17)	1.12 (1.07–1.17)	1.03 (0.98–1.08)
Severe limitation	1.23 (1.15–1.30)	1.23 (1.15–1.30)	1.14 (1.07–1.22)
Missing (functional limitation)	1.05 (0.99–1.10)	1.05 (0.99–1.10)	0.99 (0.93–1.05)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N. North
2. Wald joint test of significance for education $p < .001$ for all regions

Table C24. Full model results for continuity of care, income

Continuity of care, income	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.74 (0.68–0.8)	0.75 (0.67–0.84)	0.78 (0.66–0.92)
<\$20k	1	1	1
\$20–<\$30k	1.00 (0.94–1.06)	0.91 (0.86–0.96)	0.96 (0.91–1.02)
\$30–<\$40k	0.97 (0.90–1.03)	0.90 (0.85–0.96)	0.94 (0.88–1.00)
\$40–<\$50k	0.90 (0.84–0.96)	0.82 (0.77–0.87)	0.88 (0.82–0.95)
\$50–<\$70k	0.91 (0.86–0.97)	0.82 (0.78–0.87)	0.90 (0.84–0.96)
>\$70k	0.90 (0.85–0.94)	0.79 (0.75–0.83)	0.86 (0.81–0.91)
Missing	1.03 (0.98–1.08)	0.95 (0.91–1.00)	0.99 (0.94–1.04)
Male	1	1	1
Female	0.81 (0.78–0.83)	0.77 (0.75–0.79)	0.80 (0.77–0.82)
43–54	1	1	1
55–64	1.42 (1.37–1.47)	1.25 (1.20–1.30)	1.20 (1.15–1.25)
65–74	2.02 (1.93–2.11)	1.60 (1.53–1.67)	1.43 (1.36–1.50)
75–84	2.94 (2.79–3.10)	1.96 (1.86–2.07)	1.60 (1.50–1.70)
85 plus	2.91 (2.67–3.18)	1.86 (1.69–2.04)	1.76 (1.54–2.00)
Australia/NZ	1	1	1
Europe/N.America	0.99 (0.96–1.03)	1.02 (0.98–1.06)	1.02 (0.97–1.08)
Asia	0.89 (0.84–0.94)	0.92 (0.80–1.05)	1.13 (0.92–1.38)
Africa/Mid East	0.89 (0.82–0.96)	1.02 (0.87–1.19)	1.01 (0.79–1.28)
Other	0.72 (0.64–0.80)	1.01 (0.82–1.25)	1.07 (0.75–1.51)
Not married/not de facto	1	1	1
Married/de facto	1.15 (1.11–1.19)	1.07 (1.04–1.11)	1.05 (1.00–1.09)
Excellent	1	1	1
Very good	1.09 (1.04–1.14)	1.10 (1.05–1.15)	1.13 (1.07–1.2)
Good	1.13 (1.08–1.19)	1.17 (1.11–1.22)	1.19 (1.12–1.26)
Fair	1.16 (1.09–1.24)	1.21 (1.14–1.29)	1.24 (1.15–1.34)
Poor	1.13 (1.01–1.27)	1.23 (1.09–1.38)	1.28 (1.12–1.46)
Missing self-rated health	1.04 (0.96–1.14)	1.15 (1.05–1.26)	1.18 (1.06–1.32)
No conditions	1	1	1
1–2 conditions	1.20 (1.16–1.24)	1.19 (1.15–1.24)	1.10 (1.05–1.15)
3 or more conditions	1.33 (1.27–1.39)	1.32 (1.26–1.38)	1.20 (1.14–1.27)
No limitation	1	1	1
Minor limitation	1.06 (1.01–1.10)	1.01 (0.97–1.05)	0.99 (0.95–1.04)
Moderate limitation	1.11 (1.06–1.16)	1.10 (1.05–1.15)	1.03 (0.98–1.08)
Severe limitation	1.22 (1.15–1.30)	1.21 (1.14–1.29)	1.13 (1.06–1.21)
Missing (functional limitation)	1.03 (0.98–1.09)	1.02 (0.97–1.07)	0.99 (0.93–1.05)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N. North.
2. Wald joint test of significance for income $p < .001$ for all regions

Table C25. Full model results for continuity of care, continuous education

Continuity of care, continuous education	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.76 (0.70–0.82)	0.76 (0.68–0.85)	0.81 (0.68–0.96)
Continuous education	0.86 (0.82–0.91)	0.76 (0.72–0.81)	0.81 (0.76–0.87)
Male	1	1	1
Female	0.80 (0.78–0.83)	0.77 (0.75–0.80)	0.79 (0.77–0.82)
43–54	1	1	1
55–64	1.43 (1.38–1.48)	1.27 (1.22–1.32)	1.21 (1.15–1.26)
65–74	2.07 (1.99–2.17)	1.67 (1.60–1.74)	1.46 (1.39–1.53)
75–84	3.03 (2.88–3.19)	2.07 (1.96–2.18)	1.63 (1.54–1.74)
85 plus	3.01 (2.75–3.28)	1.91 (1.73–2.10)	1.74 (1.52–1.99)
Australia/NZ	1	1	1
Europe/N. America	1.00 (0.96–1.04)	1.03 (0.99–1.07)	1.04 (0.98–1.09)
Asia	0.91 (0.87–0.96)	0.95 (0.83–1.09)	1.17 (0.95–1.43)
Africa/Mid East	0.91 (0.84–0.98)	1.07 (0.91–1.25)	1.02 (0.80–1.30)
Other	0.73 (0.66–0.81)	1.04 (0.84–1.28)	1.09 (0.77–1.55)
Not married/not de facto	1	1	1
Married/de facto	1.14 (1.1–1.18)	1.04 (1–1.07)	1.03 (0.99–1.07)
Excellent	1	1	1
Very good	1.08 (1.04–1.13)	1.09 (1.05–1.15)	1.13 (1.07–1.20)
Good	1.13 (1.08–1.19)	1.16 (1.11–1.22)	1.19 (1.12–1.26)
Fair	1.16 (1.09–1.24)	1.21 (1.13–1.29)	1.24 (1.15–1.34)
Poor	1.13 (1.01–1.27)	1.22 (1.08–1.37)	1.29 (1.13–1.48)
Missing self-rated health	1.07 (0.98–1.17)	1.18 (1.08–1.30)	1.20 (1.08–1.34)
No conditions	1	1	1
1–2 conditions	1.19 (1.15–1.23)	1.20 (1.15–1.24)	1.10 (1.05–1.15)
3 or more conditions	1.33 (1.27–1.39)	1.33 (1.27–1.39)	1.21 (1.14–1.28)
No limitation	1	1	1
Minor limitation	1.06 (1.02–1.10)	1.02 (0.98–1.06)	0.99 (0.95–1.04)
Moderate limitation	1.12 (1.07–1.17)	1.11 (1.07–1.16)	1.03 (0.98–1.09)
Severe limitation	1.23 (1.15–1.30)	1.24 (1.17–1.32)	1.14 (1.06–1.22)
Missing (functional limitation)	1.05 (0.99–1.11)	1.04 (0.98–1.09)	0.99 (0.93–1.05)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N, North.
2. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.
3. Wald joint test of significance for continuous education $p < .001$ for all regions

Table C26. Full model results for care planning, education

Care planning, education	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.08 (0.07–0.1)	0.07 (0.06–0.09)	0.08 (0.06–0.09)
No school certificate	1	1	1
School certificate	0.86 (0.81–0.92)	0.85 (0.80–0.91)	0.89 (0.83–0.95)
Apprentice/ diploma	0.80 (0.75–0.85)	0.78 (0.73–0.83)	0.78 (0.72–0.83)
University	0.66 (0.61–0.71)	0.61 (0.57–0.66)	0.62 (0.57–0.68)
Male (ref)	1	1	1
Female	1.01 (0.97–1.06)	0.96 (0.92–1.00)	0.91 (0.87–0.96)
43–54 (ref)	1	1	1
55–64	1.29 (1.22–1.38)	1.55 (1.45–1.66)	1.44 (1.34–1.55)
65–74	2.15 (2.02–2.30)	2.48 (2.32–2.65)	2.02 (1.87–2.18)
75–84	2.35 (2.19–2.52)	2.78 (2.59–2.99)	2.18 (2.00–2.38)
85 plus	1.68 (1.51–1.86)	2.11 (1.88–2.37)	1.75 (1.49–2.06)
Australia/NZ	1	1	1
Europe/N. America	1.12 (1.07–1.18)	1.13 (1.08–1.20)	1.18 (1.10–1.27)
Asia	1.36 (1.26–1.48)	0.97 (0.79–1.20)	1.46 (1.08–1.96)
Africa/Mid East	1.69 (1.51–1.88)	1.05 (0.83–1.33)	0.98 (0.68–1.42)
Other	1.47 (1.27–1.71)	0.95 (0.68–1.34)	1.24 (0.76–2.03)
Not married/not de facto	1	1	1
Married/de facto	0.90 (0.86–0.94)	0.85 (0.81–0.89)	0.87 (0.83–0.92)
Excellent	1	1	1
Very good	1.29 (1.17–1.41)	1.31 (1.19–1.43)	1.43 (1.28–1.61)
Good	1.58 (1.44–1.73)	1.71 (1.55–1.87)	1.79 (1.59–2.00)
Fair	1.91 (1.72–2.12)	2.00 (1.80–2.22)	2.31 (2.04–2.63)
Poor	2.13 (1.86–2.44)	2.52 (2.18–2.91)	2.38 (2.00–2.82)
Missing (self-rated health)	1.76 (1.52–2.04)	1.77 (1.51–2.06)	2.02 (1.68–2.43)
1–2 conditions	1	1	1
3 or more conditions	1.58 (1.52–1.65)	1.75 (1.68–1.83)	1.82 (1.73–1.92)
No limitation	1	1	1
Minor limitation	1.17 (1.09–1.26)	1.12 (1.05–1.20)	1.03 (0.95–1.12)
Moderate limitation	1.46 (1.36–1.56)	1.38 (1.29–1.48)	1.30 (1.19–1.41)
Severe limitation	1.71 (1.58–1.86)	1.70 (1.57–1.84)	1.53 (1.39–1.68)
Missing (functional limitation)	1.49 (1.37–1.61)	1.38 (1.27–1.50)	1.22 (1.11–1.34)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N. North.
2. Wald joint test of significance for education $p < .001$ for all regions

Table C27. Full model results for care planning, income

Care planning, income	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.11 (0.09–0.13)	0.08 (0.07–0.1)	0.08 (0.07–0.1)
<\$20k	1	1	1
\$20–<\$30k	0.84 (0.78–0.90)	0.88 (0.83–0.94)	0.87 (0.81–0.94)
\$30–<\$40k	0.81 (0.74–0.88)	0.74 (0.68–0.80)	0.75 (0.68–0.82)
\$40–<\$50k	0.63 (0.57–0.69)	0.66 (0.60–0.72)	0.68 (0.61–0.75)
\$50–<\$70k	0.61 (0.56–0.66)	0.62 (0.57–0.68)	0.66 (0.60–0.73)
>\$70k	0.45 (0.42–0.49)	0.48 (0.45–0.53)	0.52 (0.47–0.58)
Missing	0.81 (0.77–0.86)	0.87 (0.82–0.92)	0.92 (0.86–0.98)
Male	1	1	1
Female	1.00 (0.95–1.04)	0.95 (0.91–0.99)	0.89 (0.85–0.94)
43–54	1	1	1
55–64	1.21 (1.13–1.29)	1.45 (1.36–1.55)	1.37 (1.27–1.48)
65–74	1.77 (1.66–1.90)	2.11 (1.97–2.26)	1.81 (1.67–1.96)
75–84	1.90 (1.77–2.04)	2.37 (2.19–2.55)	1.97 (1.80–2.15)
85 plus	1.41 (1.27–1.56)	1.84 (1.64–2.07)	1.60 (1.36–1.88)
Australia/NZ	1	1	1
Europe/N.America	1.11 (1.05–1.17)	1.12 (1.06–1.18)	1.14 (1.06–1.23)
Asia	1.19 (1.10–1.30)	0.89 (0.72–1.10)	1.28 (0.95–1.72)
Africa/Mid East	1.54 (1.39–1.72)	0.96 (0.75–1.21)	0.91 (0.63–1.31)
Other	1.34 (1.16–1.56)	0.86 (0.61–1.2)	1.16 (0.71–1.90)
Not married/not de facto	1	1	1
Married/de facto	0.97 (0.93–1.02)	0.93 (0.89–0.97)	0.94 (0.89–0.99)
Excellent	1	1	1
Very good	1.28 (1.17–1.40)	1.29 (1.18–1.42)	1.40 (1.25–1.57)
Good	1.56 (1.42–1.71)	1.68 (1.53–1.84)	1.74 (1.55–1.95)
Fair	1.83 (1.65–2.02)	1.96 (1.76–2.17)	2.22 (1.96–2.52)
Poor	2.05 (1.79–2.35)	2.4 (2.08–2.77)	2.26 (1.91–2.68)
Missing self-rated health	1.74 (1.51–2.00)	1.74 (1.5–2.02)	2.03 (1.70–2.42)
1–2 conditions	1	1	1
3 or more conditions	1.56 (1.50–1.63)	1.74 (1.67–1.82)	1.79 (1.7–1.89)
No limitation	1	1	1
Minor limitation	1.15 (1.08–1.24)	1.10 (1.03–1.18)	1.02 (0.94–1.11)
Moderate limitation	1.39 (1.30–1.49)	1.33 (1.24–1.42)	1.25 (1.15–1.36)
Severe limitation	1.60 (1.47–1.73)	1.60 (1.48–1.73)	1.46 (1.33–1.60)
Missing (functional limitation)	1.43 (1.32–1.54)	1.35 (1.24–1.46)	1.19 (1.08–1.30)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N. North.
2. Wald joint test of significance for income $p < .001$ for all regions

Table C28. Full model results for care planning, continuous education

Care planning, continuous education	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
Cons	0.08 (0.07–0.10)	0.07 (0.06–0.09)	0.08 (0.06–0.10)
Continuous education	0.65 (0.60–0.70)	0.61 (0.57–0.66)	0.61 (0.56–0.67)
Male	1	1	1
Female	1.00 (0.96–1.05)	0.95 (0.91–0.99)	0.91 (0.86–0.95)
43–54	1	1	1
55–64	1.29 (1.21–1.38)	1.55 (1.45–1.66)	1.44 (1.34–1.55)
65–74	2.16 (2.02–2.30)	2.48 (2.32–2.65)	2.03 (1.88–2.19)
75–84	2.36 (2.20–2.53)	2.78 (2.59–2.99)	2.18 (2.00–2.38)
85 plus	1.68 (1.51–1.86)	2.11 (1.88–2.37)	1.75 (1.49–2.06)
Australia/NZ	1	1	1
Europe/N. America	1.13 (1.07–1.19)	1.14 (1.08–1.20)	1.18 (1.10–1.27)
Asia	1.35 (1.24–1.46)	0.96 (0.78–1.18)	1.44 (1.07–1.94)
Africa/Mid East	1.67 (1.50–1.86)	1.04 (0.82–1.32)	0.97 (0.67–1.41)
Other	1.47 (1.27–1.71)	0.95 (0.68–1.33)	1.24 (0.76–2.02)
Not married/not de facto	1	1	1
Married/de facto	0.90 (0.86–0.94)	0.85 (0.81–0.89)	0.88 (0.83–0.93)
Excellent	1	1	1
Very good	1.29 (1.18–1.41)	1.31 (1.20–1.44)	1.44 (1.28–1.61)
Good	1.59 (1.45–1.74)	1.72 (1.56–1.88)	1.79 (1.60–2.01)
Fair	1.92 (1.73–2.12)	2.01 (1.81–2.23)	2.32 (2.04–2.64)
Poor	2.14 (1.87–2.45)	2.53 (2.19–2.93)	2.38 (2.01–2.83)
Missing self-rated health	1.77 (1.53–2.05)	1.78 (1.53–2.08)	2.03 (1.69–2.44)
1–2 conditions	1	1	1
3 or more conditions	1.58 (1.51–1.65)	1.75 (1.68–1.83)	1.82 (1.73–1.92)
No limitation	1	1	1
Minor limitation	1.17 (1.09–1.26)	1.12 (1.04–1.20)	1.03 (0.95–1.12)
Moderate limitation	1.46 (1.36–1.56)	1.38 (1.29–1.48)	1.30 (1.20–1.41)
Severe limitation	1.72 (1.59–1.86)	1.70 (1.57–1.85)	1.54 (1.40–1.69)
Missing (functional limitation)	1.49 (1.38–1.62)	1.38 (1.28–1.50)	1.22 (1.11–1.34)

Notes:

1. GP, General Practitioner; OR, odds ratio; CI, confidence interval; ref, reference; NZ, New Zealand; N, North.
2. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.
3. Wald joint test of significance for continuous education $p < .001$ for all regions

Table C29. Models 3a–3d: association of each PHC characteristic with long consults, income

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>Bulk-billing (3c)</i>	<i>After-hours care (3d)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities				
1st quartile (ref)	1	1	1	1
2nd quartile	1.09 (0.85–1.40)	1.07 (0.91–1.26)	1.02 (0.82–1.27)	0.94 (0.60–1.47)
3rd quartile	1.01 (0.79–1.30)	1.23 (1.00–1.52)	0.98 (0.81–1.19)	0.87 (0.56–1.35)
4th quartile	1.32 (1.03–1.69)	1.22 (1.03–1.44)	0.83 (0.69–.001)	0.81 (0.52–1.26)
p-value for term	0.004	0.071	0.057	0.344
ICC	0.011	0.012	0.012	0.013
PCV (%)	26	15	16	8
MOR	1.20	1.21	1.21	1.22
Inner regional				
1st quartile (ref)	1	1	1	1
2nd quartile	1.26 (0.89–1.78)	1.48 (0.92–2.37)	1.46 (1.11–1.92)	1.39 (1.08–1.78)
3rd quartile	0.98 (0.69–1.40)	1.08 (0.68–1.72)	1.37 (1.03–1.83)	1.38 (0.89–2.14)
4th quartile	1.31 (0.95–1.80)	0.98 (0.60–1.61)	–	1.52 (1.09–2.12)
p-value for term	0.268	0.031	0.018	0.020
ICC	0.029	0.025	0.026	0.025
PCV (%)	12	23	20	25
MOR	1.35	1.32	1.33	1.32
Outer regional				
1st quartile (ref)	1	–	1	–
2nd quartile	0.93 (0.63–1.38)	ref	1.17 (0.87–1.56)	–
3rd quartile	0.95 (0.61–1.48)	0.65 (0.49–0.86)	1.55 (1.18–2.03)	–
4th quartile	0.67 (0.43–1.04)	0.57 (0.43–0.74)	–	–
p-value for term	0.359	<.001	0.006	–
ICC	0.035	0.022	0.022	–
PCV (%)	12	45	45	–
MOR	1.39	1.29	1.30	–

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of health and welfare; FTE, full time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (model 2); MOR, median odds ratio; ref, reference.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

Table C30. Models 3a–3d: association of each PHC characteristic with long consults, continuous education

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>bulk-billing (3c)</i>	<i>after-hours care (3d)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities				
1st quartile (ref)	1	1	1	1
2nd quartile	1.07 (0.85–1.36)	1.04 (0.89–1.22)	1.03 (0.83–1.27)	0.95 (0.63–1.46)
3rd quartile	0.99 (0.78–1.26)	1.19 (0.98–1.46)	1.00 (0.83–1.21)	0.90 (0.60–1.37)
4th quartile	1.26 (1.00–1.60)	1.16 (0.99–1.37)	0.87 (0.73–1.04)	0.84 (0.56–1.28)
p-value for term	0.007	0.172	0.146	0.458
ICC	0.009	0.011	0.011	0.012
PCV (%)	24	12	12	6
MOR	1.18	1.2	1.2	1.21
Inner regional				
1st quartile (ref)	1	1	1	1
2nd quartile	1.25 (0.89–1.75)	1.46 (0.92–2.31)	1.46 (1.12–1.91)	1.37 (1.07–1.75)
3rd quartile	0.98 (0.70–1.37)	1.08 (0.69–1.70)	1.38 (1.05–1.81)	1.39 (0.90–2.12)
4th quartile	1.32 (0.97–1.80)	0.98 (0.61–1.57)	–	1.48 (1.07–2.06)
p-value for term	0.218	0.028	0.011	0.024
ICC	0.027	0.024	0.024	0.024
PCV (%)	14	23	22	24
MOR	1.33	1.31	1.31	1.31
Outer regional				
1st quartile (ref)	1	–	1	–
2nd quartile	0.93 (0.63–1.38)	1	1.17 (0.88–1.57)	–
3rd quartile	0.94 (0.61–1.47)	0.64 (0.48–0.85)	1.57 (1.20–2.05)	–
4th quartile	0.67 (0.43–1.04)	0.56 (0.43–0.73)	–	–
p-value for term	0.358	<.001	0.004	–
ICC	0.036	0.021	0.022	–
PCV (%)	12	47	46	–
MOR	1.39	1.29	1.3	–

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (model 2); MOR, median odds ratio.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.
4. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.

Table C31. Models 3a-3d: association of each PHC characteristic with continuity of care, income

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>Bulk-billing (3c)</i>	<i>After-hours care (3d)</i>	<i>CD care (3e)</i>	<i>Health assessments (3f)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities						
1st quartile (ref)	1	1	1	1	1	1
2nd quartile	0.98 (0.80–1.21)	0.92 (0.83–1.02)	1.00 (0.87–1.15)	1.47 (1.07–2.03)	1.19 (1.05–1.36)	1.09 (0.96–1.24)
3rd quartile	1.02 (0.83–1.26)	0.84 (0.73–0.96)	1.20 (1.06–1.35)	1.44 (1.05–1.98)	1.27 (1.12–1.43)	1.02 (0.89–1.15)
4th quartile	0.94 (0.77–1.16)	0.79 (0.71–0.89)	1.26 (1.13–1.42)	1.41 (1.03–1.94)	1.17 (1.04–1.33)	0.97 (0.82–1.14)
p-value for term	0.669	<.001	<.001	0.120	<.001	0.417
ICC	0.007	0.005	0.004	0.006	0.005	0.007
PCV (%)	5	35	42	14	32	9
MOR	1.16	1.13	1.12	1.15	1.13	1.15
Inner regional						
1st quartile (ref)	1	1	1	1	1	1
2nd quartile	0.96 (0.74–1.24)	0.91 (0.61–1.35)	0.75 (0.61–0.93)	1.00 (0.80–1.24)	0.91 (0.71–1.15)	0.81 (0.63–1.05)
3rd quartile	0.87 (0.67–1.12)	1.01 (0.68–1.50)	0.85 (0.68–1.06)	0.94 (0.65–1.38)	0.80 (0.61–1.06)	1.15 (0.87–1.51)
4th quartile	0.77 (0.60–0.97)	1.08 (0.72–1.63)	–	1.10 (0.82–1.47)	0.84 (0.66–1.07)	0.86 (0.69–1.06)
p-value for term	0.154	0.572	0.030	0.895	0.325	0.066
ICC	0.016	0.018	0.015	0.019	0.017	0.015
PCV (%)	16	6	19	1	11	21
MOR	1.25	1.26	1.24	1.27	1.25	1.24
Outer regional						
1st quartile (ref)	1	–	1	–	1	1
2nd quartile	0.97 (0.66–1.45)	1	0.88 (0.60–1.28)	–	0.97 (0.67–1.41)	1.66 (0.99–2.77)
3rd quartile	0.79 (0.51–1.23)	1.01 (0.7–1.45)	1.03 (0.73–1.47)	–	0.93 (0.56–1.53)	1.37 (0.88–2.12)
4th quartile	1.06 (0.68–1.66)	0.84 (0.59–1.2)	–	–	1.00 (0.63–1.59)	1.30 (0.87–1.95)
p-value for term	0.729	0.526	0.675	–	0.991	0.268
ICC	0.036	0.036	0.037	–	0.038	0.032
PCV (%)	4	4	2	–	–1	16
MOR	1.4	1.39	1.4	–	1.41	1.4

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (model 2); MOR, median odds ratio.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

Table C32. Models 3a-3d: association of each PHC characteristic with continuity of care, continuous education

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>Bulk-billing (3c)</i>	<i>After-hours care (3d)</i>	<i>CD care (3e)</i>	<i>Health assessments (3f)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities						
1st quartile (ref)	1	1	1	1	1	1
2nd quartile	0.98 (0.80–1.21)	0.92 (0.83–1.02)	1.00 (0.87–1.15)	1.47 (1.07–2.03)	1.19 (1.04–1.36)	1.09 (0.96–1.24)
3rd quartile	1.02 (0.83–1.26)	0.84 (0.73–0.97)	1.20 (1.06–1.35)	1.44 (1.05–1.98)	1.27 (1.12–1.43)	1.01 (0.89–1.15)
4th quartile	0.95 (0.77–1.16)	0.79 (0.71–0.89)	1.26 (1.12–1.41)	1.41 (1.02–1.93)	1.17 (1.04–1.33)	0.97 (0.82–1.14)
p-value for term	0.676	<.001	<.001	0.129	<.001	0.431
ICC	0.007	0.005	0.004	0.006	0.005	0.007
PCV (%)	5	34	42	13	31	8
MOR	1.16	1.13	1.12	1.15	1.13	1.15
Inner regional						
1st quartile (ref)	1	1	1	1	1	1
2nd quartile	0.97 (0.75–1.25)	0.91 (0.61–1.36)	0.76 (0.61–0.94)	1.00 (0.8–1.24)	0.91 (0.72–1.16)	0.82 (0.63–1.05)
3rd quartile	0.87 (0.67–1.12)	1.02 (0.69–1.50)	0.86 (0.69–1.07)	0.94 (0.64–1.36)	0.81 (0.61–1.06)	1.15 (0.88–1.51)
4th quartile	0.77 (0.61–0.98)	1.08 (0.72–1.63)	–	1.09 (0.82–1.46)	0.84 (0.67–1.07)	0.87 (0.70–1.07)
p-value for term	0.169	0.615	0.036	0.899	0.357	0.069
ICC	0.016	0.017	0.015	0.018	0.017	0.015
PCV (%)	15	6	18	3	10	21
MOR	1.24	1.26	1.24	1.27	1.25	1.24
Outer regional						
1st quartile (ref)	1	–	1	–	1	1
2nd quartile	0.98 (0.66–1.45)	1	0.87 (0.60–1.27)	–	0.97 (0.67–1.41)	1.63 (0.98–2.72)
3rd quartile	0.79 (0.51–1.23)	1.01 (0.7–1.44)	1.03 (0.73–1.46)	–	0.94 (0.57–1.54)	1.36 (0.88–2.10)
4th quartile	1.06 (0.68–1.65)	0.84 (0.59–1.2)	–	–	1.00 (0.63–1.58)	1.29 (0.86–1.93)
p-value for term	0.737	0.533	0.659	–	0.993	0.290
ICC	0.036	0.036	0.037	–	0.038	0.032
PCV (%)	4	4	2	–	–1	16
MOR	1.4	1.4	1.4	–	1.41	1.37

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (model 2); MOR, median odds ratio
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.
4. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.

Table C33. Models 3a-3d: association of each PHC characteristic with care planning, income

	<i>AIHW FTE (3a) OR (95%CI)</i>	<i>OOP expenses (3b) OR (95%CI)</i>	<i>bulk-billing (3c) OR (95%CI)</i>	<i>after-hours care (3d) OR (95%CI)</i>
Cities				
1st quartile (ref)	1	1	1	1
2nd quartile	0.75 (0.48–1.16)	0.87 (0.71–1.07)	1.49 (1.13–1.96)	2.31 (1.18–4.52)
3rd quartile	0.78 (0.50–1.21)	0.88 (0.68–1.16)	1.84 (1.45–2.34)	2.93 (1.51–5.68)
4th quartile	0.70 (0.45–1.08)	0.54 (0.43–0.67)	2.01 (1.60–2.51)	2.99 (1.54–5.80)
p-value for term	0.446	<.001	<.001	0.003
ICC	0.033	0.020	0.018	0.026
PCV (%)	7	45	51	26
MOR	1.38	1.28	1.26	1.33
Inner regional				
1st quartile (ref)	1	1	1	1
2nd quartile	1.07 (0.70–1.63)	0.84 (0.46–1.54)	1.71 (1.25–2.34)	0.84 (0.60–1.18)
3rd quartile	0.97 (0.63–1.48)	0.88 (0.48–1.59)	1.47 (1.06–2.03)	1.28 (0.71–2.28)
4th quartile	1.43 (0.97–2.11)	0.59 (0.32–1.11)	–	0.93 (0.60–1.46)
p-value for term	0.308	0.154	0.003	0.522
ICC	0.041	0.039	0.033	0.043
PCV (%)	11	16	30	8
MOR	1.43	1.42	1.37	1.44
Outer regional				
1st quartile (ref)	1	–	1	–
2nd quartile	0.94 (0.62–1.43)	1	1.29 (0.91–1.82)	–
3rd quartile	0.84 (0.53–1.34)	0.75 (0.53–1.06)	1.65 (1.20–2.28)	–
4th quartile	0.68 (0.43–1.08)	0.63 (0.45–0.88)	–	–
p-value for term	0.414	0.027	0.009	–
ICC	0.038	0.032	0.030	–
PCV (%)	12	27	30	–
MOR	1.41	1.37	1.36	–

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (model 2); MOR, median odds ratio.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.

Table C34. Models 3a-3d: association of each PHC characteristic with care planning, continuous education

	<i>AIHW FTE (3a)</i>	<i>OOP expenses (3b)</i>	<i>bulk-billing (3c)</i>	<i>after-hours care (3d)</i>
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cities				
1st quartile (ref)	1	1	1	1
2nd quartile	0.74 (0.47–1.16)	0.86 (0.69–1.06)	1.53 (1.16–2.01)	2.33 (1.15–4.69)
3rd quartile	0.76 (0.48–1.20)	0.85 (0.65–1.11)	1.91 (1.50–2.44)	3.02 (1.51–6.03)
4th quartile	0.67 (0.42–1.05)	0.51 (0.40–0.63)	2.14 (1.71–2.69)	3.09 (1.55–6.17)
p-value for term	0.356	<.001	<.001	0.002
ICC	0.036	0.020	0.018	0.029
PCV (%)	8	49	55	26
MOR	1.4	1.28	1.26	1.35
Inner regional				
1st quartile (ref)	1	1	1	1
2nd quartile	1.08 (0.70–1.65)	0.84 (0.46–1.55)	1.75 (1.28–2.39)	0.84 (0.59–1.18)
3rd quartile	0.97 (0.63–1.48)	0.88 (0.48–1.60)	1.50 (1.08–2.08)	1.26 (0.70–2.28)
4th quartile	1.46 (0.98–2.16)	0.58 (0.31–1.10)	–	0.90 (0.57–1.43)
p-value for term	0.272	0.128	0.002	0.527
ICC	0.042	0.040	0.033	0.044
PCV (%)	12	17	31	8
MOR	1.44	1.42	1.38	1.45
Outer regional				
1st quartile (ref)	1	–	1	–
2nd quartile	0.95 (0.63–1.45)	1	1.27 (0.9–1.81)	–
3rd quartile	0.86 (0.54–1.39)	0.74 (0.52–1.05)	1.66 (1.20–2.30)	–
4th quartile	0.67 (0.42–1.07)	0.62 (0.44–0.87)	–	–
p-value for term	0.405	0.022	0.009	–
ICC	0.039	0.032	0.031	–
PCV (%)	12	28	30	–
MOR	1.42	1.37	1.36	–

Notes:

1. OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full time equivalent per capita; OOP, out-of-pocket; ICC; intra-class coefficient; PCV; proportional change in variance. Reported change from model adjusted for sociodemographic and need variables (model 2); MOR, median odds ratio.
2. P-value, Wald test of significance for addition of area variable. Significant terms bolded.
3. There were no areas in regional areas that were in the 4th quartile for *bulk-billing*. In addition, there were no areas in outer regional areas that were in the 1st quartile for *OOP expenses*.
4. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.

Table C35. Model 4: cross-level effect modification, long consult. OR (95% CIs) for area PHC service characteristics (continuous) and as interaction with income

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	1.944 (1.337–2.826)	2.182 (1.077–4.420)	0.409 (0.201–0.832)
<\$20kXAIHW FTE	1	1	1
\$20–<\$30kXAIHW FTE	0.962 (0.680–1.361)	0.961 (0.725–1.273)	1.171 (0.809–1.696)
\$30–<\$40kXAIHW FTE	1.084 (0.765–1.538)	0.847 (0.624–1.149)	1.353 (0.892–2.051)
\$40–<\$50kXAIHW FTE	0.707 (0.500–1.000)	0.831 (0.600–1.151)	1.885 (1.219–2.915)
\$50–<\$70kXAIHW FTE	0.810 (0.607–1.082)	0.882 (0.660–1.180)	1.259 (0.844–1.879)
>\$70kXAIHW FTE	0.726 (0.579–0.910)	1.005 (0.788–1.282)	1.368 (0.968–1.934)
missingXAIHW FTE	0.760 (0.593–0.976)	0.923 (0.730–1.167)	1.159 (0.853–1.574)
p-value for interaction	0.025	0.829	0.142
<i>OOP expenses (Model 4b)</i>	1.040 (1.022–1.058)	–	0.852 (0.806–0.901)
<\$20kXOOP expenses	1	–	1
\$20–<\$30kXOOP expenses	0.995 (0.979–1.010)	–	1.025 (0.994–1.057)
\$30–<\$40kXOOP expenses	0.992 (0.977–1.008)	–	1.008 (0.974–1.044)
\$40–<\$50kXOOP expenses	0.980 (0.965–0.995)	–	1.028 (0.991–1.066)
\$50–<\$70kXOOP expenses	0.989 (0.976–1.002)	–	1.042 (1.007–1.078)
>\$70kXOOP expenses	0.976 (0.966–0.987)	–	1.042 (1.012–1.072)
missingXOOP expenses	0.979 (0.968–0.990)	–	1.046 (1.019–1.073)
p-value for interaction	<.001	–	0.015
<i>Bulk billing (Model 4c)</i>	–	1.009 (0.995–1.024)	1.039 (1.025–1.052)
<\$20kXbulk-billing	–	1	1
\$20–<\$30kXbulk-billing	–	1.006 (1.000–1.013)	0.994 (0.987–1.002)
\$30–<\$40kXbulk-billing	–	1.003 (0.996–1.010)	0.997 (0.989–1.005)
\$40–<\$50kXbulk-billing	–	1.006 (0.998–1.013)	0.994 (0.985–1.002)
\$50–<\$70kXbulk-billing	–	1.004 (0.998–1.011)	0.989 (0.981–0.997)
>\$70kXbulk-billing	–	1.003 (0.998–1.009)	0.989 (0.982–0.996)
missingXbulk-billing	–	1.004 (0.999–1.01)	0.991 (0.985–0.997)
p-value for interaction	–	0.583	0.012

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>After-hours care (Model 4d)</i>	0.967 (0.943–0.992)	1.053 (1.011–1.097)	–
<\$20kX <i>after-hours care</i>	1	1	–
\$20–<\$30kX <i>after-hours care</i>	0.984 (0.963–1.006)	1.008 (0.987–1.028)	–
\$30–<\$40kX <i>after-hours care</i>	1.002 (0.980–1.024)	1.001 (0.980–1.023)	–
\$40–<\$50kX <i>after-hours care</i>	1.004 (0.982–1.027)	1.008 (0.985–1.032)	–
\$50–<\$70kX <i>after-hours care</i>	1.001 (0.982–1.021)	0.995 (0.975–1.015)	–
>\$70kX <i>after-hours care</i>	1.015 (0.999–1.031)	0.996 (0.980–1.012)	–
missingX <i>after-hours care</i>	1.013 (0.997–1.029)	1.006 (0.989–1.022)	–
p-value for interaction	0.056	0.785	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; OOP, out-of-pocket.
2. P-value, Wald test of joint significance for addition of cross-level interaction term. Significant terms bolded.
3. Models 4a–d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given, followed by odds ratio for interaction term for each education level,
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. *After-hours care* not tested in outer regional/ remote areas due to unreliability of this estimate in this region..

Table C36. Model 4: cross-level effect modification, long consult. OR (95% CIs for area PHC service characteristics (continuous) and as interaction with continuous education

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	1.099 (1.023–1.180)	1.087 (0.982–1.204)	0.870 (0.757–0.999)
Cont. educationX <i>AIHW FTE</i>	0.964 (0.915–1.016)	0.975 (0.937–1.015)	1.017 (1.015–1.132)
p-value for interaction	0.167	0.214	0.012
<i>OOP expenses (Model 4b)</i>	1.078 (1.017–1.143)	–	0.727 (0.629–0.84)
Cont. educationX <i>OOP expenses</i>	0.967 (0.929–1.007)	–	1.062 (0.988–1.141)
p-value for interaction	0.102	–	0.103
<i>Bulk-billing (Model 4c)</i>	–	1.184 (1.019–1.377)	1.258 (1.094–1.447)
Cont. educationX <i>bulk-billing</i>	–	0.993 (0.929–1.067)	0.989 (0.923–1.060)
p-value for interaction	–	0.833	0.761
<i>After-hours care (Model 4d)</i>	0.945 (0.870–1.025)	1.202 (1.076–1.344)	–
Cont. educationX <i>after-hours care</i>	0.993 (0.938–1.052)	0.925 (0.878–0.975)	–
p-value for interaction	0.812	0.003	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent per capita; OOP, out-of-pocket.
2. P-value, wald test of joint significance for addition of cross-level interaction term.
3. Model 4a-d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given followed by odds ratio for interaction term for each education level.
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. After-hours care not tested in outer regional/ remote areas due to unreliability of this estimate in this region.
5. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end

Table C37. Model 4: cross-level effect modification, continuity of care. ORs (95% CIs) for area PHC service characteristics (continuous) and as interaction with income

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	–	0.562 (0.328–0.961)	0.879 (0.436–1.77)
<\$20kXAIHW FTE	–	1	1
\$20–<\$30kXAIHW FTE	–	1.031 (0.769–1.381)	0.918 (0.627–1.345)
\$30–<\$40kXAIHW FTE	–	1.116 (0.814–1.530)	0.551 (0.360–0.845)
\$40–<\$50kXAIHW FTE	–	0.909 (0.648–1.275)	0.561 (0.361–0.873)
\$50–<\$70kXAIHW FTE	–	1.041 (0.771–1.407)	0.594 (0.395–0.895)
>\$70kXAIHW FTE	–	0.914 (0.709–1.177)	0.585 (0.410–0.836)
missingXAIHW FTE	–	0.961 (0.753–1.226)	0.777 (0.566–1.067)
p-value for interaction	–	0.897	0.007
<i>OOP expenses (Model 4b)</i>	0.98 (0.967–0.994)	1.026 (0.989–1.064)	0.972 (0.900–1.050)
<\$20kXOOP expenses	1	1	1
\$20–<\$30kXOOP expenses	0.989 (0.973–1.006)	0.973 (0.95–0.997)	0.998 (0.967–1.031)
\$30–<\$40kXOOP expenses	0.999 (0.983–1.016)	0.990 (0.965–1.016)	1.005 (0.970–1.042)
\$40–<\$50kXOOP expenses	0.999 (0.983–1.016)	0.989 (0.964–1.016)	1.004 (0.967–1.042)
\$50–<\$70kXOOP expenses	1.001 (0.987–1.015)	0.990 (0.967–1.012)	1.034 (0.999–1.071)
>\$70kXOOP expenses	1.000 (0.988–1.011)	0.986 (0.968–1.005)	0.988 (0.958–1.018)
missingXOOP expenses	0.996 (0.984–1.008)	0.982 (0.962–1.002)	0.999 (0.972–1.026)
p-value for interaction	0.824	0.438	0.410
<i>ulk billing (Model 4c)</i>	1.008 (1.003–1.012)	0.992 (0.981–1.004)	1.000 (0.98–1.021)
<\$20kXbulk-billing	1	1	1
\$20–<\$30kXbulk-billing	1.005 (0.999–1.011)	1.007 (1.000–1.014)	1.002 (0.994–1.009)
\$30–<\$40kXbulk-billing	1.001 (0.995–1.007)	1.001 (0.993–1.008)	1.002 (0.994–1.010)
\$40–<\$50kXbulk-billing	1.002 (0.996–1.008)	1.001 (0.993–1.009)	0.999 (0.990–1.008)
\$50–<\$70kXbulk-billing	1.001 (0.996–1.006)	1.002 (0.995–1.009)	0.993 (0.985–1.001)
>\$70kXbulk-billing	1.002 (0.998–1.006)	1.004 (0.998–1.009)	1.005 (0.998–1.013)
missingXbulk-billing	1.002 (0.998–1.006)	1.004 (0.998–1.010)	1.001 (0.995–1.008)
p-value for interaction	0.724	0.539	0.218

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>After-hours care (Model 4d)</i>	1.001 (0.98–1.023)	–	–
<\$20kX <i>after-hours care</i>	1	–	–
\$20–<\$30kX <i>after-hours care</i>	1.012 (0.988–1.036)	–	–
\$30–<\$40kX <i>after-hours care</i>	0.999 (0.976–1.023)	–	–
\$40–<\$50kX <i>after-hours care</i>	0.998 (0.975–1.022)	–	–
\$50–<\$70kX <i>after-hours care</i>	1.007 (0.986–1.028)	–	–
>\$70kX <i>after-hours care</i>	1.001 (0.984–1.018)	–	–
missingX <i>after-hours care</i>	1.001 (0.984–1.019)	–	–
p-value for interaction	0.950	–	–
<i>CD care (Model 4e)</i>	1.007 (1–1.014)	0.995 (0.984–1.005)	1.003 (0.988–1.019)
<\$20kXCD <i>care</i>	1	1	1
\$20–<\$30kXCD <i>care</i>	1.007 (0.999–1.016)	0.997 (0.99–1.003)	0.999 (0.994–1.004)
\$30–<\$40kXCD <i>care</i>	1.000 (0.992–1.008)	0.994 (0.987–1.001)	1.000 (0.994–1.005)
\$40–<\$50kXCD <i>care</i>	0.999 (0.991–1.007)	0.993 (0.986–1.000)	0.993 (0.986–0.999)
\$50–<\$70kXCD <i>care</i>	1.001 (0.994–1.008)	0.999 (0.993–1.005)	0.992 (0.987–0.998)
>\$70kXCD <i>care</i>	1.003 (0.997–1.008)	0.997 (0.992–1.003)	1.003 (0.998–1.008)
missingXCD <i>care</i>	0.999 (0.994–1.005)	0.999 (0.993–1.004)	0.999 (0.995–1.004)
p-value for interaction	0.416	0.381	0.011

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and welfare; FTE, full-time equivalent per capita; OOP, out-of-pocket; CD, chronic disease
2. P-value, Wald test of joint significance for addition of cross-level interaction term.
3. Model 4a-d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given followed by odds ratio for interaction term for each education level.
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. After-hours care not tested in outer regional/ remote areas due to unreliability of this estimate in this region.

Table C38. Model 4: cross-level effect modification, continuity of care. ORs (95% CIs) for area PHC service characteristics (continuous) and as interaction with continuous education.

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	0.964 (0.906–1.026)	0.923 (0.854–0.997)	0.999 (0.870–1.147)
Cont. educationX <i>AIHW FTE</i>	1.034 (0.977–1.094)	0.996 (0.955–1.038)	0.968 (0.916–1.024)
p-value for interaction	0.245	0.844	0.259
<i>OOP expenses (Model 4b)</i>	0.938 (0.974–0.981)	1.066 (0.951–1.194)	0.889 (0.743–1.065)
Cont. educationX <i>OOP expenses</i>	0.975 (0.933–1.018)	0.992 (0.925–1.064)	1.067 (0.990–1.150)
p-value for interaction	0.246	0.826	0.091
<i>Bulk-billing (Model 4c)</i>	1.066 (1.019–1.114)	0.933 (0.824–1.05)	1.043 (0.872–1.249)
Cont. educationX <i>bulk-billing</i>	1.040 (0.996–1.087)	0.98 (0.914–1.05)	0.943 (0.877–1.013)
p-value for interaction	0.078	0.567	0.110
<i>After-hours care (Model 4d)</i>	1.023 (0.953–1.098)	1.038 (0.943–1.144)	–
Cont. educationX <i>after-hours care</i>	0.975 (0.916–1.037)	0.968 (0.916–1.022)	–
p-value for interaction	0.416	0.241	–
<i>CD care (Model 4e)</i>	1.026 (0.975–1.079)	0.923 (0.851–1.000)	1.022 (0.873–1.174)
Cont. educationX <i>CD care</i>	1.048 (1.002–1.097)	1.031 (0.988–1.075)	0.968 (0.911–1.029)
p-value for interaction	0.042	0.157	0.296
<i>Health assessments (Model 4f)</i>	0.988 (0.933–1.046)	0.979 (0.904–1.060)	1.053 (0.918–1.209)
Cont. educationX <i>health assessments</i>	1.004 (0.956–1.055)	0.988 (0.947–1.031)	0.972 (0.914–1.034)
p-value for interaction	0.871	0.575	0.372

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; OOP, out-of-pocket; CD chronic disease; cont., continuous.
2. P-value, Wald test of joint significance for addition of cross-level interaction term.
3. Model 4a-d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given followed by odds ratio for interaction term for each education level.
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. After-hours care not tested in outer regional/ remote areas due to unreliability of this estimate in this region.
5. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end.

Table C39. Model 4: cross-level effect modification, care planning. OR(95%CI)s for area PHC service characteristics (continuous) and as interaction with income

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	0.87 (0.484–1.563)	–	–
<\$20kX <i>AIHW FTE</i>	1	–	–
\$20–<\$30kX <i>AIHW FTE</i>	0.732 (0.465–1.150)	–	–
\$30–<\$40kX <i>AIHW FTE</i>	0.725 (0.445–1.180)	–	–
\$40–<\$50kX <i>AIHW FTE</i>	0.532 (0.310–0.915)	–	–
\$50–<\$70kX <i>AIHW FTE</i>	0.760 (0.485–1.189)	–	–
>\$70kX <i>AIHW FTE</i>	0.617 (0.437–0.872)	–	–
missingX <i>AIHW FTE</i>	0.598 (0.426–0.838)	–	–
p-value for interaction	0.042	–	–
<i>OOP expenses (Model 4b)</i>	0.962 (0.941–0.984)	–	0.897 (0.835–0.963)
<\$20kX <i>OOP expenses</i>	1	–	1
\$20–<\$30kX <i>OOP expenses</i>	0.992 (0.972–1.013)	–	1.001 (0.961–1.043)
\$30–<\$40kX <i>OOP expenses</i>	0.987 (0.966–1.009)	–	0.988 (0.940–1.039)
\$40–<\$50kX <i>OOP expenses</i>	0.972 (0.949–0.995)	–	0.997 (0.943–1.054)
\$50–<\$70kX <i>OOP expenses</i>	0.990 (0.970–1.010)	–	1.026 (0.972–1.083)
>\$70kX <i>OOP expenses</i>	0.965 (0.949–0.981)	–	0.979 (0.931–1.030)
missingX <i>OOP expenses</i>	0.971 (0.956–0.986)	–	1.002 (0.967–1.038)
p-value for interaction	<.001	–	0.902
<i>Bulk billing (Model 4c)</i>	1.017 (1.009–1.025)	1.021 (1.005–1.038)	1.031 (1.013–1.049)
<\$20kX <i>bulk-billing</i>	1	1	1
\$20–<\$30kX <i>bulk-billing</i>	1.002 (0.995–1.009)	0.998 (0.989–1.007)	0.999 (0.989–1.009)
\$30–<\$40kX <i>bulk-billing</i>	1.004 (0.996–1.011)	1.003 (0.992–1.014)	1.005 (0.993–1.017)
\$40–<\$50kX <i>bulk-billing</i>	1.011 (1.002–1.020)	0.995 (0.983–1.008)	1.003 (0.990–1.016)
\$50–<\$70kX <i>bulk-billing</i>	1.003 (0.996–1.011)	1.000 (0.990–1.012)	0.999 (0.986–1.012)
>\$70kX <i>bulk-billing</i>	1.013 (1.007–1.019)	0.995 (0.985–1.004)	1.013 (1.001–1.026)
missingX <i>bulk-billing</i>	1.009 (1.003–1.014)	1.000 (0.992–1.008)	0.998 (0.990–1.006)
p-value for interaction	<.001	0.871	0.344

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>After-hours care (Model 4d)</i>	1.032 (0.993–1.073)	–	–
<\$20k <i>After-hours care</i>	1	–	–
\$20–<\$30k <i>After-hours care</i>	0.978 (0.951–1.006)	–	–
\$30–<\$40k <i>After-hours care</i>	0.991 (0.961–1.023)	–	–
\$40–<\$50k <i>After-hours care</i>	1.020 (0.986–1.055)	–	–
\$50–<\$70k <i>After-hours care</i>	1.011 (0.981–1.043)	–	–
>\$70k <i>After-hours care</i>	1.026 (1.000–1.052)	–	–
missing <i>After-hours care</i>	1.017 (0.996–1.039)	–	–
p-value for interaction	0.042	–	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent; OOP, out-of-pocket.
2. P-value, wald test of joint significance for addition of cross-level interaction term.
3. Model 4a-d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given followed by odds ratio for interaction term for each education level.
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. After-hours care not tested in outer regional/ remote areas due to unreliability of this estimate in this region.

Table C40. Model 4: cross-level effect modification, care planning. OR(95%CI) for area PHC service characteristics (continuous) and as interaction with continuous education

PHC characteristic and interaction terms	Cities OR (95%CI)	Inner regional OR (95%CI)	Outer regional/ remote OR (95%CI)
<i>AIHW FTE (Model 4a)</i>	0.899 (0.792–1.020)	–	–
Cont. educationX <i>AIHW FTE</i>	1.051 (0.962–1.126)	–	–
p-value for interaction	0.324	–	–
<i>OOP expenses (Model 4b)</i>	0.837 (0.770–0.909)	–	0.798 (0.669–0.952)
Cont. educationX <i>OOP expenses</i>	0.944 (0.887–1.005)	–	0.974 (0.875–1.084)
p-value for interaction	0.071	–	0.633
<i>Bulk-billing (Model 4c)</i>	1.247 (1.150–1.352)	1.283 (1.063–4.548)	1.249 (1.055–1.478)
Cont. educationX <i>bulk-billing</i>	1.035 (0.971–1.103)	0.924 (0.834–1.025)	1.076 (0.970–1.194)
p-value for interaction	0.294	0.137	0.168
<i>After-hours care (Model 4d)</i>	1.211 (1.058–1.386)	–	–
Cont. educationX <i>after-hours care</i>	0.984 (0.899–1.076)	–	–
p-value for interaction	0.718	–	–

Notes:

1. PHC, primary health care; OR, odds ratio; CI, confidence interval; AIHW, Australian Institute of Health and Welfare; FTE, full-time equivalent (per capita); OOP, out-of-pocket.
2. P-value, Wald test of joint significance for addition of cross-level interaction term.
3. Model 4a-d, adjusted for sociodemographic and need covariates. Continuous variable and interaction term for each area PHC characteristic added to Model 2. One area characteristic tested at a time. Odds ratio for area characteristic as a continuous variable given followed by odds ratio for interaction term for each education level.
4. Terms not reported did not have a monotonic relationship as a categorical variable with outcome. After-hours care not tested in outer regional/ remote areas due to unreliability of this estimate in this region
5. Continuous education, ranked cumulative proportion of the population from the theoretical lowest end of the education continuum to the theoretical highest end

Additional Tables for Specialist Use

Table C41. Percentage of participants in each outcome category, by region

Region	No (%)	Yes (%)	Total (n)
Major cities	39.4	60.6	98,149
Inner regional	47.2	52.8	96,880
Outer regional/ remote	50.9	49.1	70,054
Total	45.3	54.7	265,083

Notes:

1. %, percentage; n, population; sd, standard deviation; ns, not significant
2. Row totals given.
3. P-value <.001, Chi-squared test of trend

Table C42. Full model results for specialist use

Model 2, Specialist use	Cities	Inner regional	Outer regional/ remote
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Constant	0.34 (0.31–0.37)	0.24 (0.22–0.26)	0.21 (0.19–0.24)
No school certificate	1	1	1
School certificate	1.05 (0.99–1.10)	1.07 (1.02–1.12)	1.00 (0.95–1.05)
Apprentice/ diploma	1.10 (1.05–1.16)	1.08 (1.03–1.14)	1.00 (0.95–1.05)
University	1.17 (1.11–1.24)	1.17 (1.11–1.23)	1.05 (0.99–1.11)
Male	1	1	1
Female	1.22 (1.18–1.25)	1.14 (1.11–1.17)	1.09 (1.05–1.13)
43-54	1	1	1
55-64	1.49 (1.44–1.55)	1.49 (1.44–1.54)	1.49 (1.43–1.56)
65-74	2.69 (2.58–2.81)	2.59 (2.48–2.69)	2.50 (2.38–2.62)
75-84	3.20 (3.04–3.37)	3.43 (3.26–3.61)	3.18 (2.99–3.37)
85 plus	1.74 (1.61–1.89)	1.99 (1.81–2.18)	1.87 (1.65–2.12)
Australia/NZ	1	1	1
Europe/N. America	0.89 (0.86–0.93)	0.92 (0.89–0.96)	0.95 (0.9–1.00)
Asia	0.71 (0.67–0.75)	0.82 (0.72–0.94)	0.83 (0.68–1.00)
Africa/Mid East	1.11 (1.03–1.20)	1.11 (0.95–1.29)	0.91 (0.73–1.14)
Other	0.87 (0.78–0.97)	1.05 (0.85–1.29)	1.54 (1.10–2.15)
Not married/not de facto	1	1	1
Married/de facto	1.26 (1.22–1.31)	1.22 (1.18–1.26)	1.21 (1.17–1.26)
Excellent	1	1	1
Very good	1.04 (1.00–1.09)	1.17 (1.13–1.23)	1.17 (1.11–1.24)
Good	1.18 (1.12–1.23)	1.35 (1.29–1.41)	1.33 (1.26–1.41)
Fair	1.36 (1.27–1.44)	1.73 (1.63–1.84)	1.59 (1.48–1.71)
Poor	1.52 (1.35–1.71)	1.79 (1.59–2.02)	1.73 (1.51–1.98)
Missing (self-rated health)	1.27 (1.16–1.38)	1.48 (1.36–1.62)	1.39 (1.25–1.54)
No conditions	1	1	1
1-2 conditions	1.57 (1.52–1.62)	1.46 (1.41–1.51)	1.49 (1.43–1.55)
3 or more conditions	2.50 (2.38–2.61)	2.16 (2.06–2.25)	2.24 (2.12–2.36)
No limitation	1	1	1
Minor limitation	1.14 (1.10–1.18)	1.08 (1.04–1.12)	1.07 (1.02–1.12)
Moderate limitation	1.41 (1.35–1.47)	1.38 (1.33–1.44)	1.38 (1.31–1.45)
Severe limitation	1.52 (1.43–1.61)	1.58 (1.49–1.67)	1.68 (1.57–1.80)
Missing (functional limitation)	1.29 (1.22–1.36)	1.25 (1.19–1.32)	1.35 (1.28–1.44)

Notes:

1. OR, odds ratio; CI, confidence interval; NZ, New Zealand; N. north.
2. Wald test of significance for education term $p < .001$ major cities and inner regional, not significant in outer regional and remote areas.

Appendix D: Supplementary Figures for Chapter 6

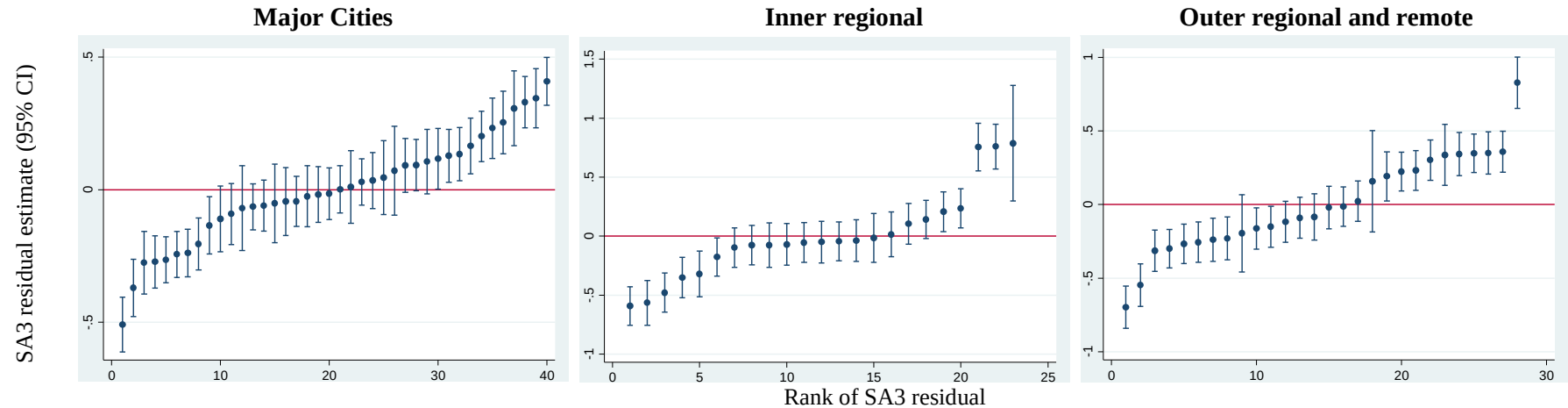


Figure D1. Difference between the mean for each SA3 and the mean across all areas in the log odds of a long consultation (95%CI) for each SA3, by region

- Notes:
1. GP, General Practitioner; CI, confidence interval; SA3, statistical area 3.
 2. Estimates from Model 2, i.e. adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation.
 3. Mean log odds of a long consultation across all areas for that region set at 0 and given by the horizontal red line.
 4. Each dot represents the mean for each SA3 of the difference in log odds of a long consultation for each person in that SA3 from the mean log odds of a long consultation for all areas (i.e. the mean of the residuals by SA3). Bars are the 95% confidence intervals around the mean for each SA3. Those SA3 values that lie above and below the red with CIs that do not cross the red line, are significantly different from the mean log odds of a long consultations for all SA3s in that region. A person living in an area above the line has a higher probability of a long consultation than the overall sample mean, irrespective of their individual characteristics.

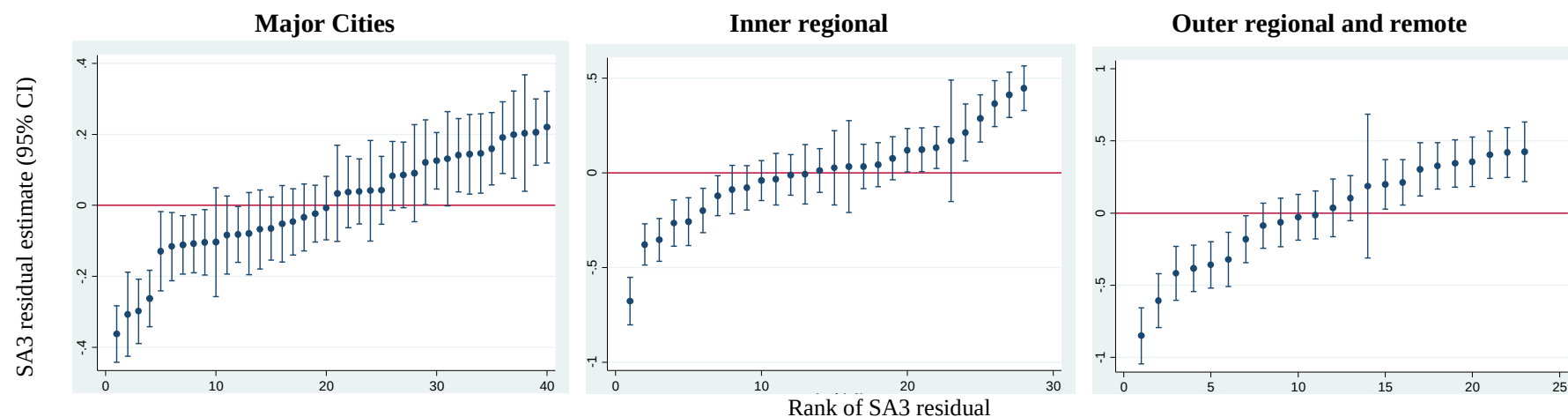


Figure D2. Difference between the mean for each SA3 and the mean across all areas in the log odds of continuity of care index >70% (95%CI) for each SA3, by region

Notes:

1. GP, General Practitioner; CI, confidence interval; SA3, statistical area 3.
2. Estimates from Model 2, i.e. adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation.
3. Mean log odds of continuity of care across all areas for that region set at 0 and given by the horizontal red line.
4. Each dot represents the mean for each SA3 of the difference in log odds of continuity of care for each person in that SA3 from the mean log odds of continuity of care for all areas (i.e. the mean of the residuals by SA3). Bars are the 95% confidence intervals around the mean for each SA3. Those SA3 values that lie above and below the red with CIs that do not cross the red line, are significantly different from the mean log odds continuity of care for all SA3s in that region. A person living in an area above the line has a higher probability of continuity of care than the overall sample mean, irrespective of their individual characteristics.

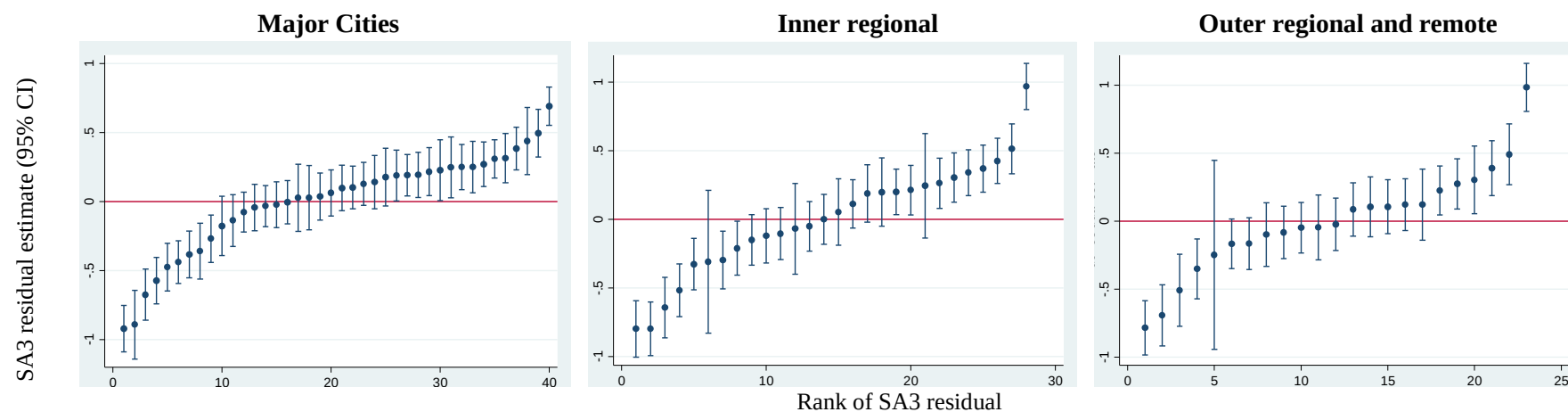


Figure D3. Difference between the mean for each SA3 and the mean across all areas in the log odds of care planning (95%CI) for each SA3, by region

Notes:

1. GP, General Practitioner; CI, confidence interval; SA3, statistical area 3.
2. Estimates from Model 2, i.e. adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation.
3. Mean log odds of care planning across all areas for that region set at 0 and given by the horizontal red line.
4. Each dot represents the mean for each SA3 of the difference in log odds of a long consultation for each person in that SA3 from the mean log odds of care planning for all areas (i.e. the mean of the residuals by SA3). Bars are the 95% confidence intervals around the mean for each SA3. Those SA3 values that lie above and below the red with CIs that do not cross the red line, are significantly different from the mean log odds of care planning for all SA3s in that region. A person living in an area above the line has a higher probability of care planning than the overall sample mean, irrespective of their individual characteristics.

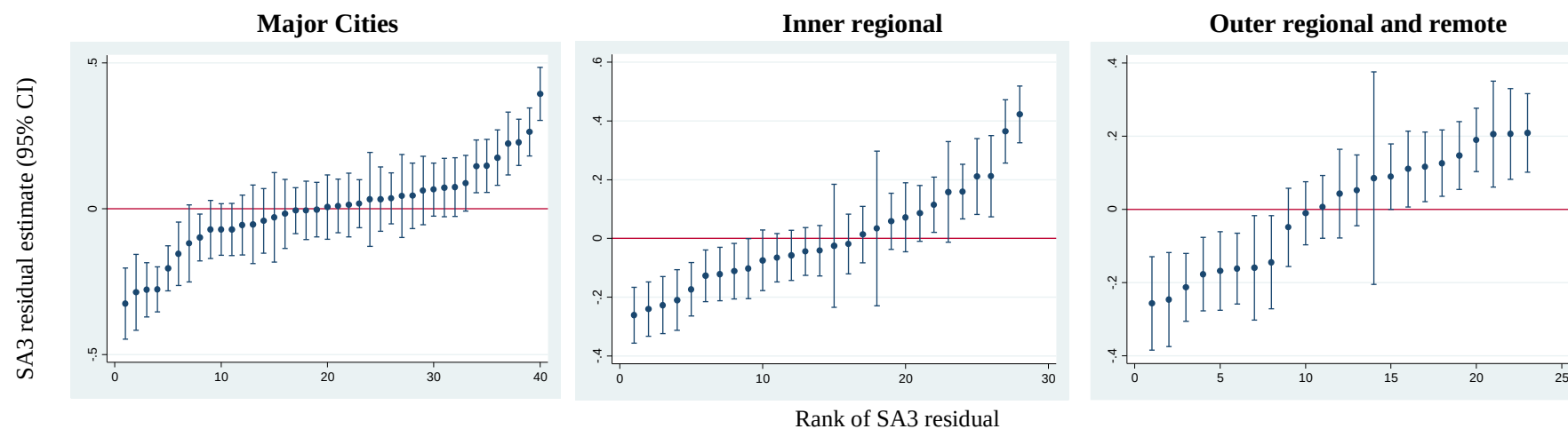


Figure D4. Difference between the mean for each SA3 and the mean across all areas in the log odds of specialist use (95%CI) for each SA3, by region

Notes:

1. GP, General Practitioner; CI, confidence interval; SA3, statistical area 3.
2. Estimates from Model 2, i.e. adjusted for education, age, sex, country of birth, marital status, self-rated health, chronic disease and physical functional limitation
3. Mean log odds of a long consultation across all areas for that region set at 0 and given by the horizontal red line
4. Each dot represents the mean for each SA3 of the difference in log odds of specialist use for each person in that SA3 from the mean log odds of specialist use for all areas (i.e. the mean of the residuals by SA3). Bars are the 95% confidence intervals around the mean for each SA3. Those SA3 values that lie above and below the red with CIs that do not cross the red line, are significantly different from the mean log odds of specialist use for all SA3s in that region. A person living in an area above the line has a higher probability of seeing a specialist in that year than the overall sample mean, irrespective of their individual characteristics.

Appendix E: Model Diagnostics for Chapter 6

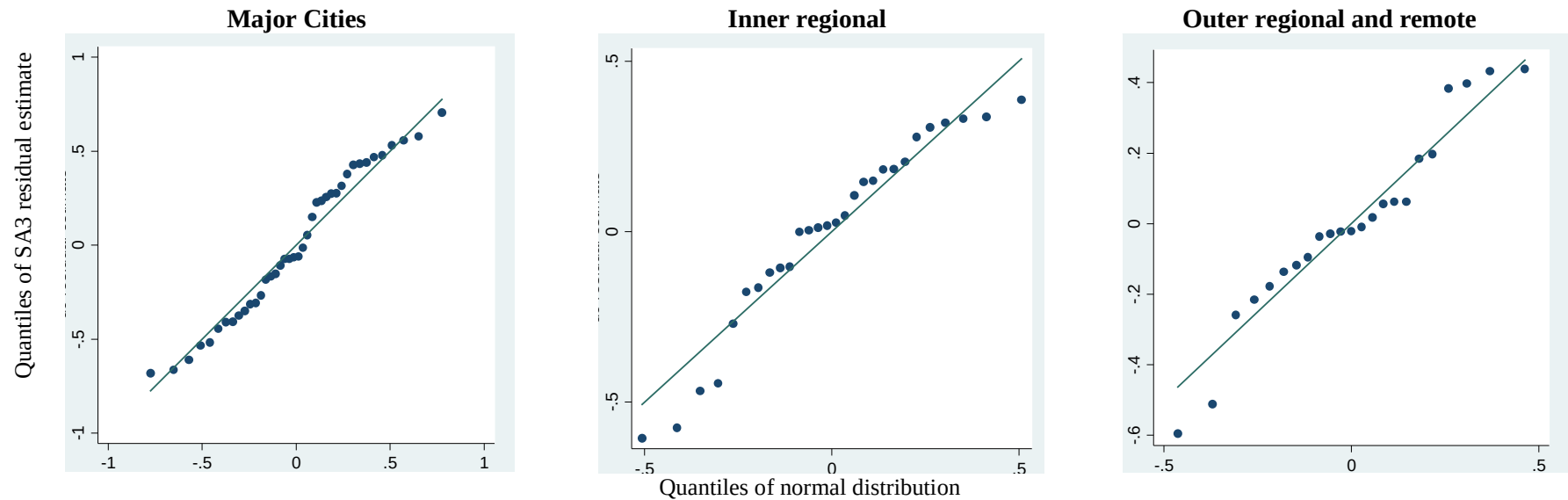


Figure E1. Quantile-Quantile plot of estimated area-level residuals for each SA3 for null model and normal distribution, above-average GP use by region

Notes:

1. Standardised residual estimates for each SA3 plotted against their normal score
2. Line of normal distribution given by blue line (45 degrees). If estimates are normally distributed they should all be plotted on the 45 degree line. In this case, estimates for SA3s lie close to the line suggesting the predicted effects are approximately normally distributed.

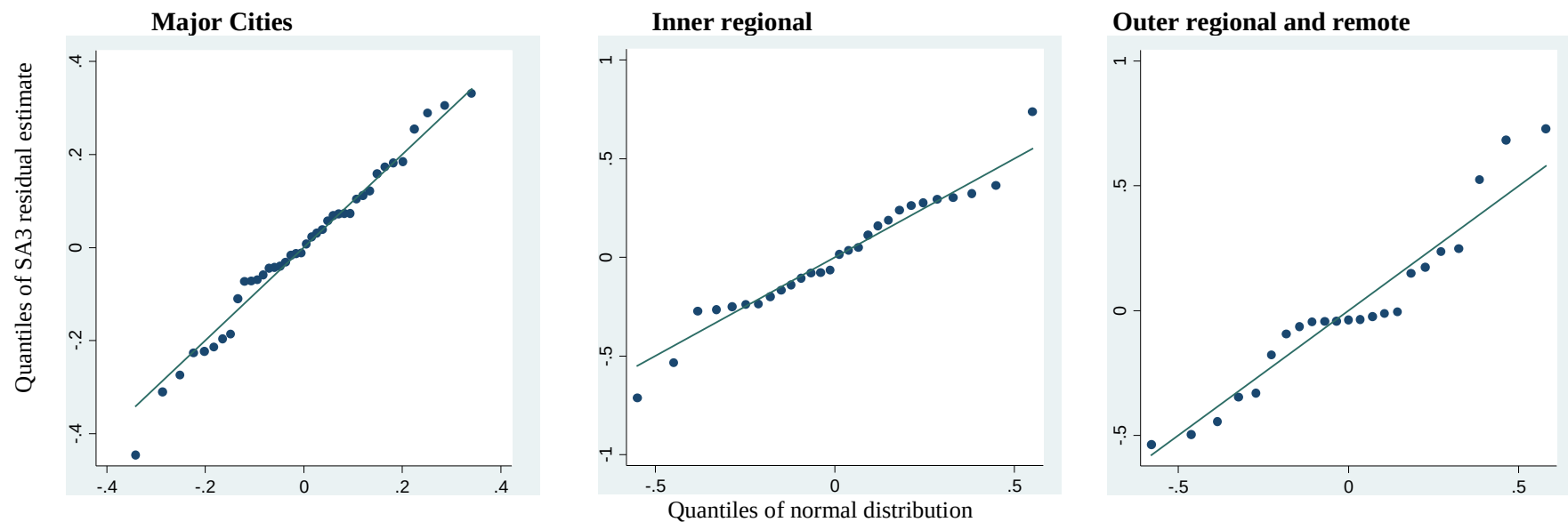


Figure E2. Quantile-Quantile plot of estimated area-level residuals for each SA3 for null model and normal distribution, long consults by region

Notes:

1. Standardised residual estimates for each SA3 plotted against their normal score
2. Line of normal distribution given by blue line (45 degrees). If estimates are normally distributed they should all be plotted on the 45 degree line. In this case, estimates for SA3s lie close to the line suggesting the predicted effects are approximately normally distributed.

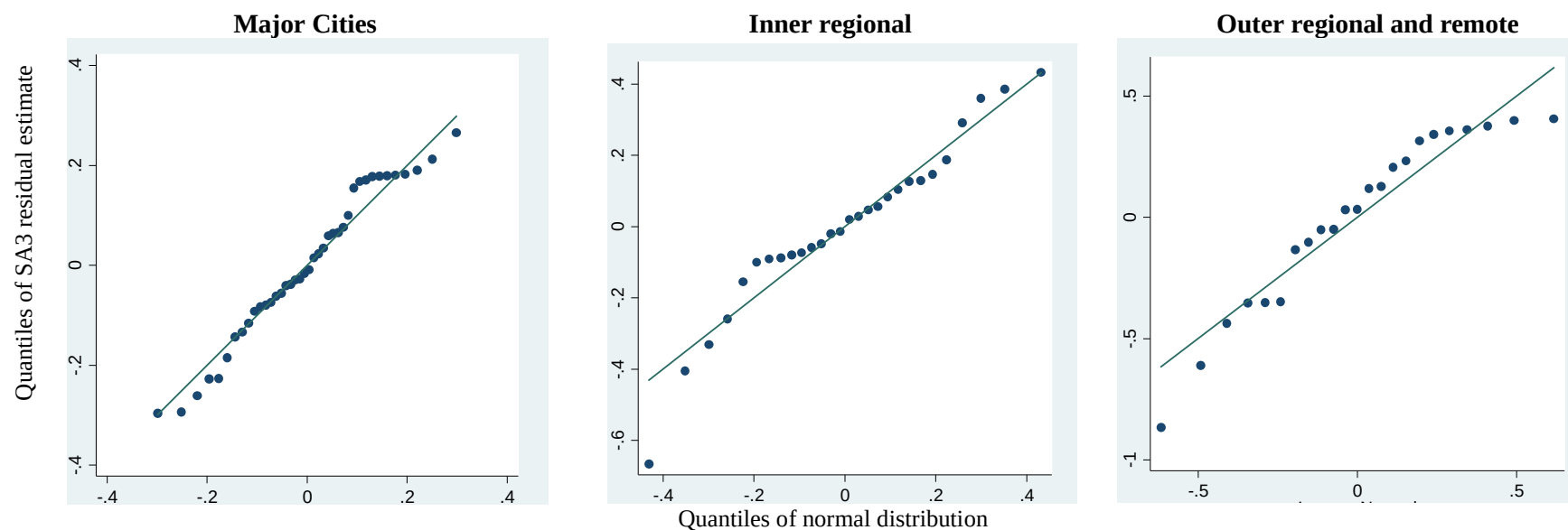


Figure E3. Quantile-Quantile plot of estimated area-level residuals for each SA3 for null model and normal distribution, continuity of care by region

Notes:

1. Standardised residual estimates for each SA3 plotted against their normal score
2. Line of normal distribution given by blue line (45 degrees). If estimates are normally distributed they should all be plotted on the 45 degree line. In this case, estimates for SA3s lie close to the line suggesting the predicted effects are approximately normally distributed.

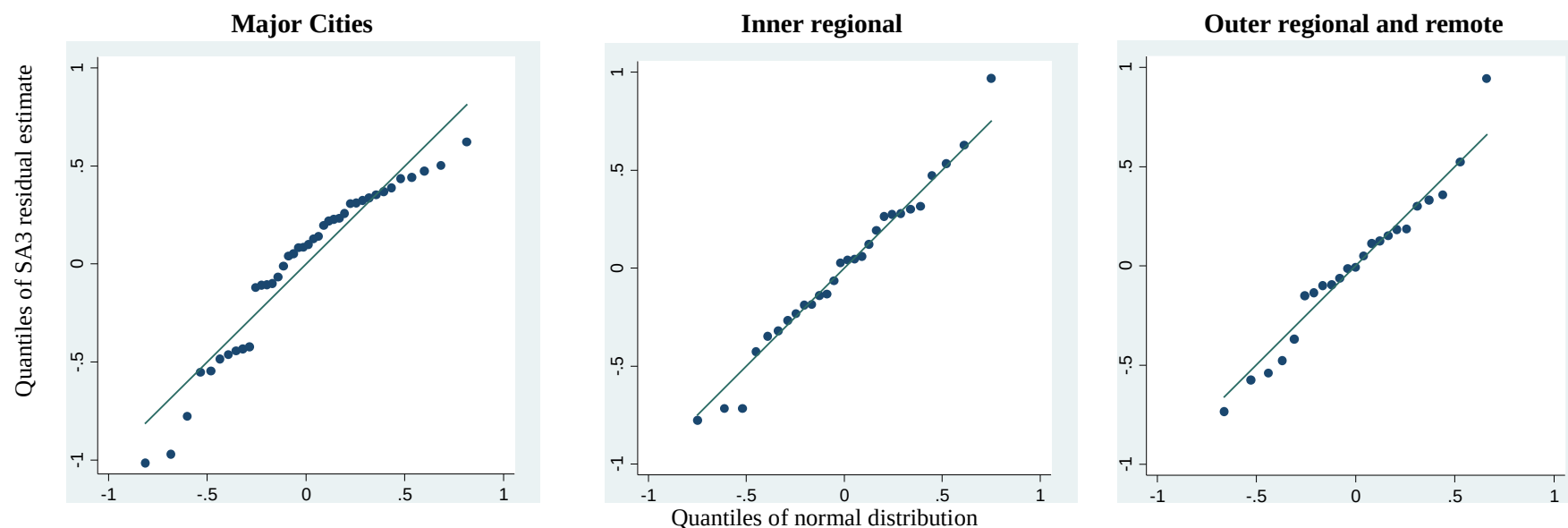


Figure E4. Quantile-Quantile plot of estimated area-level residuals for each SA3 for null model and normal distribution, care planning by region

Notes:

1. Standardised residual estimates for each SA3 plotted against their normal score
2. Line of normal distribution given by blue line (45 degrees). If estimates are normally distributed they should all be plotted on the 45 degree line. In this case, estimates for SA3s lie close to the line suggesting the predicted effects are approximately normally distributed.

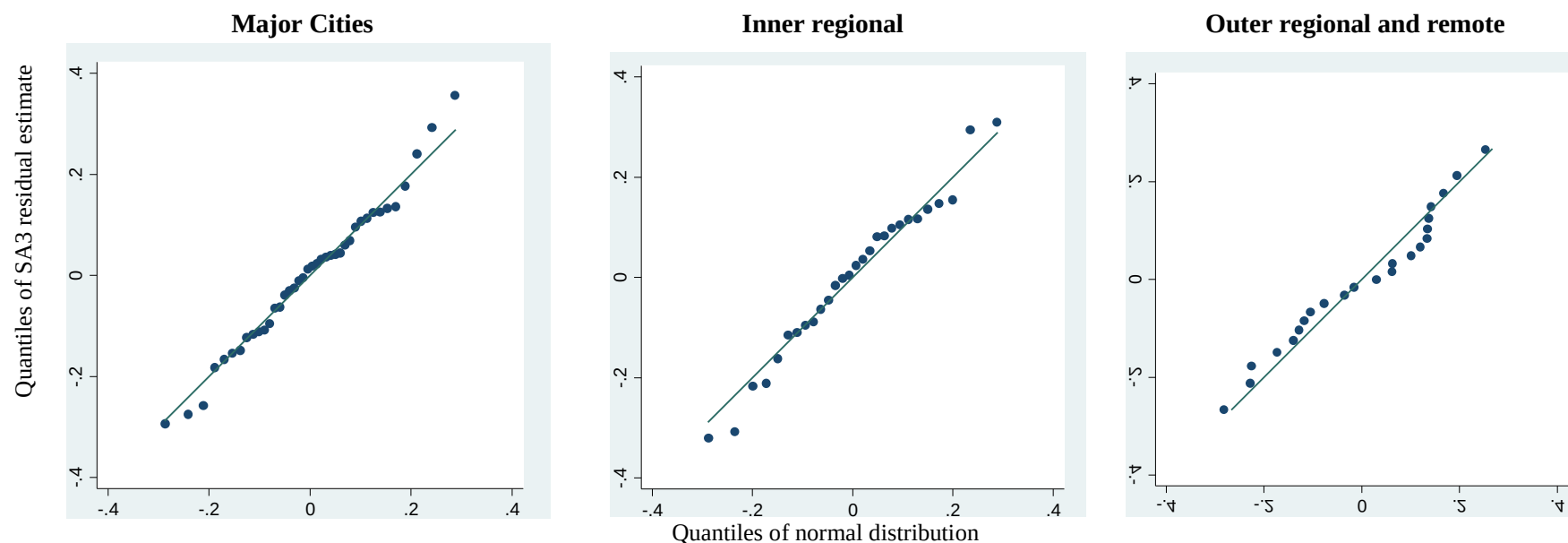


Figure E5. Quantile-Quantile plot of estimated area-level residuals for each SA3 for null model and normal distribution, specialist use by region

Notes:

1. Standardised residual estimates for each SA3 plotted against their normal score
2. Line of normal distribution given by blue line (45 degrees). If estimates are normally distributed they should all be plotted on the 45 degree line. In this case, estimates for SA3s lie close to the line suggesting the predicted effects are approximately normally distributed.

Table E1. Model diagnostics for random intercept effects for each outcome, by region: P-value for random intercept parameter and DIC for single level and 2-level random intercept model given

Outcome	Region	p-value for random intercept parameter (null model)	DIC for single-level model	DIC for model with random intercept	Decrease in DIC from single level to random intercept (null model)
<i>Above-average use</i>					
	Major cities	<.001	133840.02	130702.37	3137.65
	Inner regional	<.001	126690.02	124946.93	1743.09
	Outer regional/remote	<.001	88153.59	87035.38	1118.21
<i>Continuity of care</i>					
	Major cities	<.001	119429.95	118928.09	501.86
	Inner regional	<.001	118050.25	116946.42	1103.83
	Outer regional/remote	<.001	83283.81	82022.82	1260.99
<i>Long consult</i>					
	Major cities	<.001	135063.34	134293.52	769.82
	Inner regional	<.001	129733.69	127964.61	1769.08
	Outer regional/remote	<.001	92764.28	91525.45	1238.83
<i>Care planning</i>					
	Major cities	<.001	68243.52	66512.8	1730.72
	Inner regional	<.001	69864.54	67926.62	1937.92
	Outer regional/remote	<.001	48729.27	47420.43	1308.84
<i>Specialist use</i>					
	Major cities	<.001	131631	131137	494
	Inner regional	<.001	133995.36	133448.03	547.33
	Outer regional/remote	0.002	97092.95	96750.23	342.72

Notes:

1. DIC, Deviance Information Criterion
2. Wald test that between-area variance for the null model is non zero (i.e. $\delta_u^2=0$)
3. Empty single-level and 2-level random intercept models run for each outcome with Monte Carlo Markov Chain estimation procedure. Bayesian DIC calculated for each model. The model with the lowest DIC is deemed the 'best' model.

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