Morbidity

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BACKGROUND

One of the great achievements of humankind in the past 150 years has been the rapid increase in life expectancy that has occurred in almost all countries (Oeppen and Vaupel 2002). As detailed in the Mortality Chapter, humans are living longer than ever before largely because of declines in child mortality, infectious disease mortality and, in higher-income countries, non-communicable disease mortality. These trends have resulted in the compression of mortality, where an increasingly high proportion of deaths are occurring at old ages.

Although it is clear that, on average, people are living longer, there is much debate about whether there is a trend towards people living healthier lives. An understanding of morbidity – the measurement of disease, injury and disability – is becoming increasingly important when studying population health. As people increasingly live to older ages, they are likely to be at risk of longer periods of morbidity. Globally, there are an increasing proportion of deaths from chronic diseases, which typically affect a person for significant periods of time before they die. These trends have consequences for individuals, their families and care-givers, governments and health care providers, who need to provide and fund for the treatment and care of people who spend significant parts of their lives in ill health.

Traditionally, demographers have typically studied mortality rather than morbidity. This is firstly because mortality is a component of population change and therefore is a key determinant of the size, growth and structure of a population. It is also because it is easier to measure mortality, for which data are widely available from vital registration systems, censuses and surveys that have been collected for decades or, in some countries, centuries. Morbidity data do exist but are commonly from disparate sources which are not necessarily complete nor use consistent definitions. However, morbidity is an important subject matter for demographers because it is a key measure of population-level health and can be measured using indicators that are combined with widely used measures of mortality; these include disability-adjusted life years (DALYs) and health-adjusted life expectancy (HALE). Some Sustainable Development Goals (SDGs) also measure morbidity, recognising its increasing importance as a measure of population health. For example, Target 3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases (WHO 2018).

This chapter will firstly review different measures of morbidity, sources of morbidity data and then discuss theories of morbidity. Next, it explores a range of evidence of trends, and demographic, socio-economic and geographic differentials in morbidity from around the world. The chapter concludes by discussing some emerging and persistent health issues related to morbidity.

Measuring morbidity

Morbidity is defined as 'any departure, subjective or objective, from a state of physiological or psychological well-being' (Porta 2014: 189). As mentioned, it is more difficult to measure than mortality. Unlike death, which has a clear definition and occurs at a distinct point in time, measurement of morbidity needs to clearly define morbidity, measure its severity and account for its duration.

Two common measures of morbidity are incidence and prevalence. **Incidence** is defined as 'the number of instances of illness commencing, or of persons falling ill, during a given period in a specified population' (Porta 2014:144). **Prevalence** is 'the total number of individuals who have the condition (e.g., disease, exposure, attribute) at a particular time (or during a particular period) divided by the population at risk of having the condition at that time or midway through the period' (Porta 2014:223). While these are useful summary measures of a specific disease within a population, such as an infectious disease, on their own they do not provide much information on the extent of morbidity that that these diseases cause and provide limited insight into their impact on the populations affected.

Years lived with a disability (YLD) is an indicator that provides a better understanding of the severity of the morbid condition. YLDs measure the number of years lived with any health loss, weighted by severity (Vos et al 2012). It is calculated as the prevalence of the condition (i.e. illness, injury or disability) multiplied by a disability weight that measures the severity of that condition (Vos et al 2012). Total YLDs for a population are calculated by summing the calculation from this equation for each age-sex grouping. Disability weights measure, on a scale of 0 to 1 where 0 equals a state of full health and 1 equals death, the extent of "health loss" associated with a certain condition (Salomon et al 2015). For example, stroke with severe long-term consequences is rated as 0.552 and mild hearing loss is rated as 0.010 (Salomon et al 2015). These disability weights are derived from surveys of the public in different countries of the world. YLDs are used by the Global Burden of Disease (GBD) study, and also national burden of disease studies, to gain an accurate picture of the relative importance of different conditions as causes of morbidity (GBD 2016 Disease and Injury Incidence and Prevalence Collaborators 2017, AIHW 2016).

A primary use of YLDs is a component of the summary health indicator disability-adjust life years (DALY). DALYs are a measure of total disease burden in a population – they are the sum of the non-fatal burden, as measured by YLDs, and

the fatal burden, as measured by years of life lost (YLLs) (AIHW 2016).[1] The number of DALYs is the number of years lost in the population due to living with a disability and early death. As an indicator of both mortality and morbidity, DALYs are a comprehensive measure of population health and a key output of burden of disease studies. The percentage of DALYs that comprise YLDs is a valuable measure of the relative importance of morbidity compared with mortality in a population.

Another widely-used indicator that combined morbidity and mortality is health-adjusted life expectancy (HALE). HALE measures the average length of time a person can expect to life without illness, injury or disability, and is very similar to the conventional life expectancy measure (GBD 2016 DALYs and HALE Collaborators 2017). HALE was originally developed by Sullivan in the 1970s, who used life table measures of mortality with morbidity prevalence (Sullivan 1971). An extension of Sullivan's method that is used by the Global Burden of Disease incorporates information of both prevalence and disability weights to measure average health (i.e. YLDs) in each life table age interval (GBD 2016 DALYs and HALE Collaborators 2017). HALE is particularly useful at measuring, for specific ages, life expectancy without health loss remaining in their life, assuming current levels of morbidity and mortality. It is also the most appropriate measure of the compression of morbidity. The difference between life expectancy and HALE is termed non-healthy life expectancy.

Data sources

There are a wide range of potential data sources to use to measure morbidity. Some of the challenges of using these data to develop a picture of population-level mortality levels, trends and differentials are accessibility and availability of the data, how representative the data are of morbidity (which is often hidden, unlike deaths), the consistency of definitions of different conditions, and how to measure the severity of different conditions.

Data sources include:

- Hospital data: This comprises data on episodes of care in hospitals. The Australian National Hospital Morbidity Database, for example, collects data on the International Classification of Diseases (ICD) code of the condition, duration of stay, information on the hospital, and demographic and socio-economic information of the patient (AIHW 2018a). Hospital information, while having strengths in terms of accuracy, will not identify morbidity of people who do not visit hospitals.

[1] YLLs are a measure of premature mortality. At each age, they are calculated as the difference between age at death and the standard life expectancy at that age. The standard life expectancy is the lowest observed death rate for any age group in countries of more than 5 million in population (GBD 2016 Causes of Death Collaborators 2017). Total YLLs in a population are calculated by summing the YLLs for each age group.

- Disease registries: These are data on specific notifiable diseases within a population. In Australia, cancer is a disease that legislation requires must be notified to each State/Territory's cancer registry. The Australian Cancer Database compiles all notified cancer cases, including ICD code of the disease, data of diagnosis, and demographic and socio-economic information of the individual (AIHW 2018b). As well as hospitals, such information can come from pathology laboratories and radiotherapy centres.
- Health surveys: Surveys that use a representative sample of the population can be valuable sources of morbidity data. The Australian Health Survey of 2011-12, for example, asks respondents to report on any condition(s) they have been told by a doctor or nurse that they have, they currently have the condition, and it has lasted at least 6 months or is expected to last at least 6 months more (ABS 2013a). Common conditions are diabetes, heart disease and kidney disease. Although the representativeness of such surveys is an advantage, the self-reported nature of the data provide problems regarding accuracy of the results and comparability between populations. Increasingly, such surveys are also collecting biomedical information to provide more accurate data on certain conditions. For example, the Australian Health Survey of 2011-12 collected data on diabetes (fasting plasma glucose test and a glycated haemoglobin test), cardiovascular disease (e.g. blood pressure and cholesterol), chronic kidney disease and liver function (ABS 2013b).
- Epidemiological studies: Published epidemiological studies are a valuable source of information on the prevalence of diseases. Challenges regarding the utility of these data include the generalisability to the population level and the case definitions used.
- Administrative data: Data of claims from public and private insurance schemes (e.g. Medicare in Australia) are useful indirect data on the prevalence of conditions, but should be used to complement other sources.
- Mortality data: Data on causes of death, particularly multiple causes of death, can provide an indirect estimate of the prevalence of certain diseases in a population.

The Global Burden of Disease Study and national burden of disease studies make morbidity estimates using indicators described above and data from many of these sources, together with sophisticated statistical models to address the limitations of each data source and standardise measurements across locations. These are a reliable standardised measurement of morbidity. Global Burden of Disease YLD and HALE estimates are publicly available from for 195 locations, by age and sex, annually since 1990 (http://ghdx.healthdata.org/gbd-results-tool). The GBD data are particularly important for countries that lack comprehensive morbidity data.

Theory of morbidity

The primary theory of morbidity is that of **compression of morbidity**, which was first postulated by James Fries in 1980 (Fries 1980). Compression of morbidity refers to a reduction of the average proportion of a person's life is spent in a state of morbidity (Porta 2014: 53). In the context of increasing longevity, it means that the average age of the onset of disease, injury and disability is increasing more quickly than life expectancy, due to declines in morbidity prevalence and severity (Fries 2011, Stallard 2016). Fries developed this hypothesis at a time when population ageing was becoming a major demographic reality in high-income countries, and there were concerns among many public health practitioners and academics that the success of rapid increases in life expectancy would simply lead to the elderly suffering longer periods with chronic illness with severe economic consequences for individuals, families, the government and the health system more generally (Fries 2011). Evidence from the over 1984-2004, for example, supports the theory of compression of morbidity by showing that declines in morbidity, as measured by limitations in activities of daily living (ADL) and cognitive impairment were greater than increases in survival over the same period (Stallard 2016).

However, there is evidence that compression of morbidity is not occurring. Crimmins and Beltran-Sanchez (2010), for example, used empirical evidence from a study in the US to show that from 1998 to 2008 the number of years lived with disease and loss of mobility functioning increased. Reasons for this, for example, include declines in hearts disease and stroke mortality but stabilisation or even increases in prevalence of these conditions (Crimmins and Beltran-Sanchez 2010, Crimmins 2004). Authors of the Global Burden of Disease study, using data to be presented in the next section, argue that YLDs in fact come from a wide range of conditions that have not benefitted from large-scale preventative measures (Salomon et al 2012). There are also problems created by saving lives from certain conditions; for example, saving lives of diabetics from cardiovascular disease can mean that they will then develop other diabetes-related conditions which may require long-term management. There is also an intermediate scenario where mortality decline is accompanied by decreases in severe disability but increases in moderate disability, analysis by Cai and Lubitz (2007) found the US from 1992-2003 GBD (Salomon et al 2012).

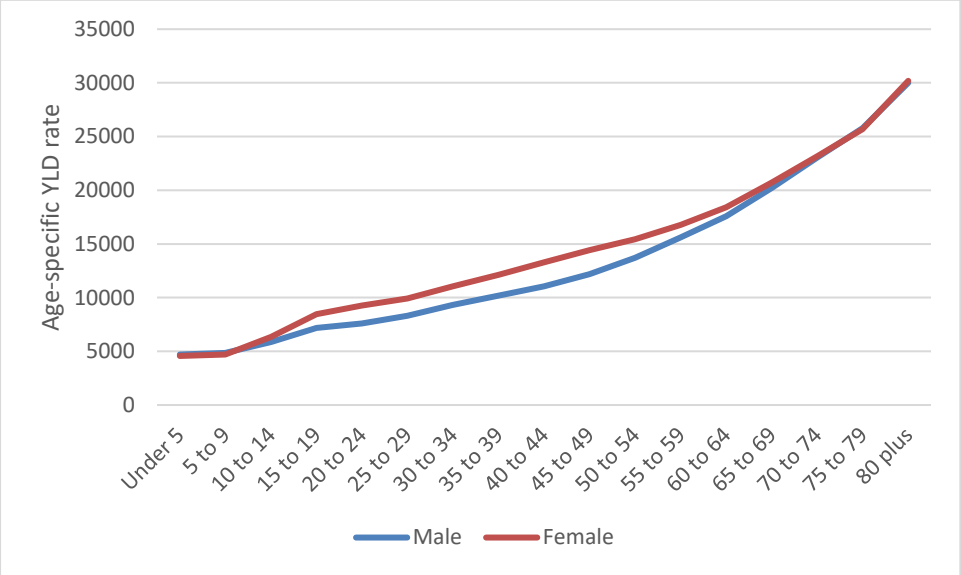
EVIDENCE

This section makes extensive use of data from the Global Burden of Disease study (IHME 2018).

Levels, trends and differences in morbidity

A clear characteristic of morbidity is that it increases with age. Figure 1 presents global data that shows how YLDs increase with age. Notably, YLDs are higher for women than men during adulthood. The increase in morbidity with age is not as sharp as for mortality, which increases exponentially with age.

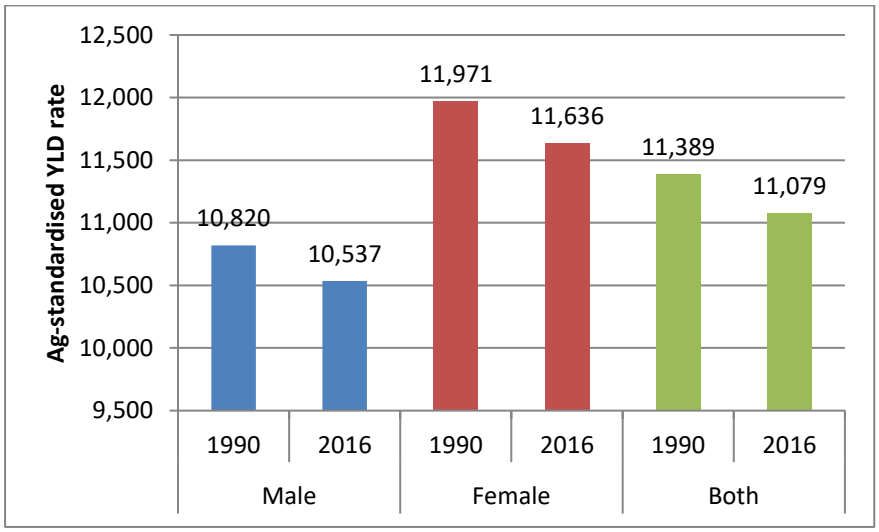
Figure 1: Age-specific YLD rate (per 100,000), by sex, global, 2016



Source: GBD 2016 DALYs and HALE Collaborators (2017)

Globally, morbidity as measured by age-standardised YLDs has fallen by 2.7% from 1990 to 2016 (Figure 2). Age-standardised YLDs are approximately 10% higher in women than men, in contrast to mortality which is consistently higher for men across all ages. The fall in YLDs since 1990 has been approximately similar for both males and females.

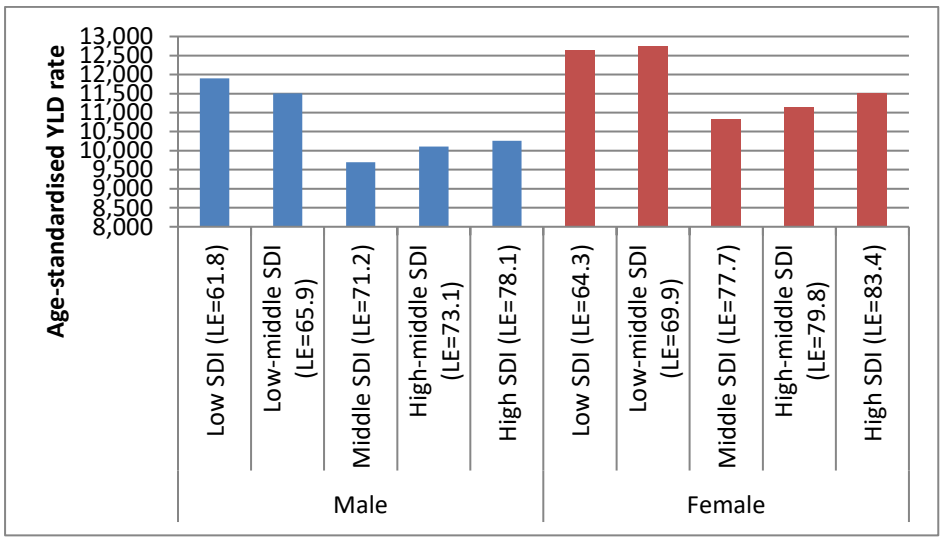
Figure 2: Age-standardised YLD rate (per 100,000), by sex, global, 1990-2016



Source: GBD 2016 DALYs and HALE Collaborators (2017)

Interestingly, there is no clear gradient of morbidity according to the level of a country's Socio Demographic Index (SDI) (Figure 3).[2] Age-standardised YLDs are highest in countries within the lowest two quintiles of SDI but lowest in the middle quintile. However, they then increase again in the high-middle and then highest SDIs. This is different from mortality, which consistently shows a strong negative relationship with country-level SDI. This evidence demonstrates how morbidity can be higher even in countries with lower mortality.

Figure 3: Age-standardised YLD rates (per 100,000) and life expectancy, by sex and SDI, global, 2016

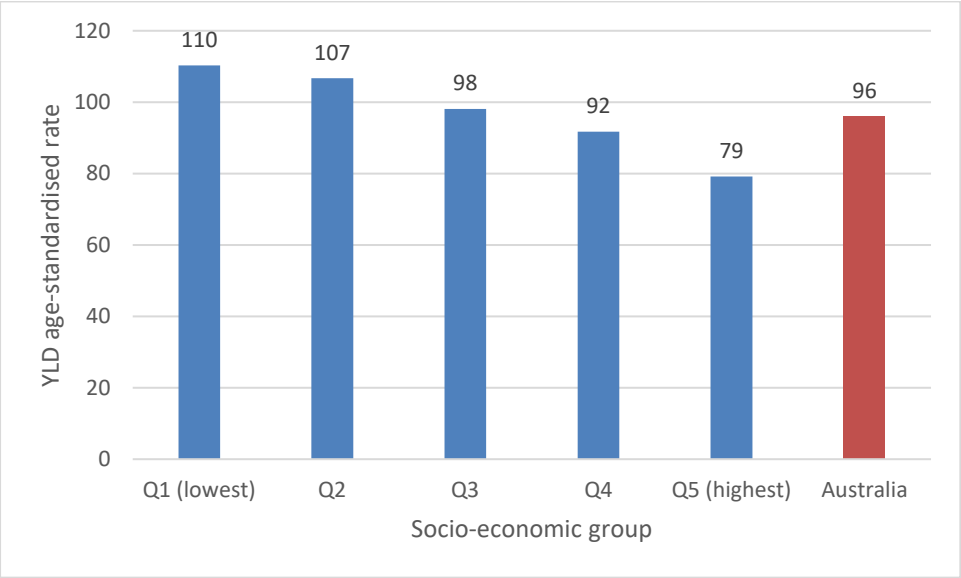


Source: GBD 2016 DALYs and HALE Collaborators (2017)

[2] This SDI is an index measured for each country based on its average income per person, educational attainment and total fertility rate (GBD 2015 Mortality and Causes of Death Collaborators 2016)

There can be significant differences within countries, which a country-level measure of socio-economic status can mask (Figure 4). Within Australia, a relatively low mortality country, there is a clear decline in YLDs from lower to higher levels of socio-economic group. Those in the lowest quintile have am age-standardised YLD rate which is 39% higher than in the highest quintile.

Figure 4: YLD by socioeconomic group (per 1,000), Australia, 2011

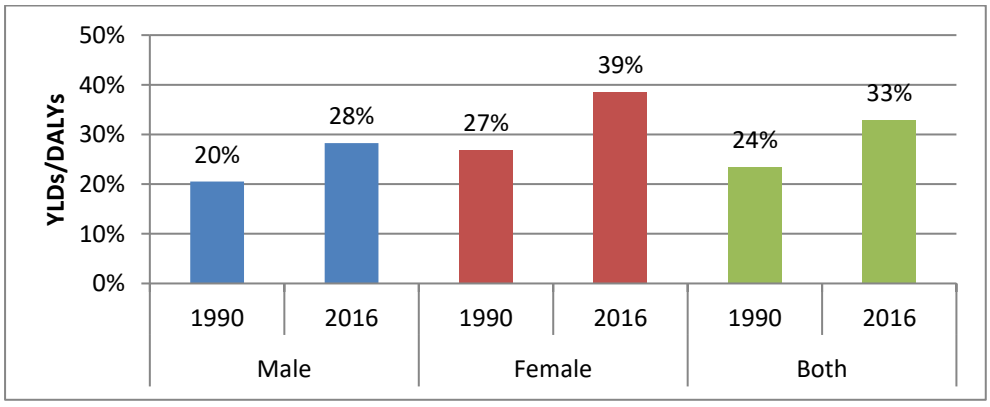


Source: AIHW (2016):98

Levels, trends and differences in morbidity compared with mortality

Morbidity is becoming a larger proportion of total global disease burden, as demonstrated by YLDs becoming a higher percentage of DALYs (Figure 5). From 1990 to 2016, this proportion increased from 20% to 28% for males and from 27% to 39% for females. The higher percentage for women is due to women having lower mortality but higher morbidity than men.

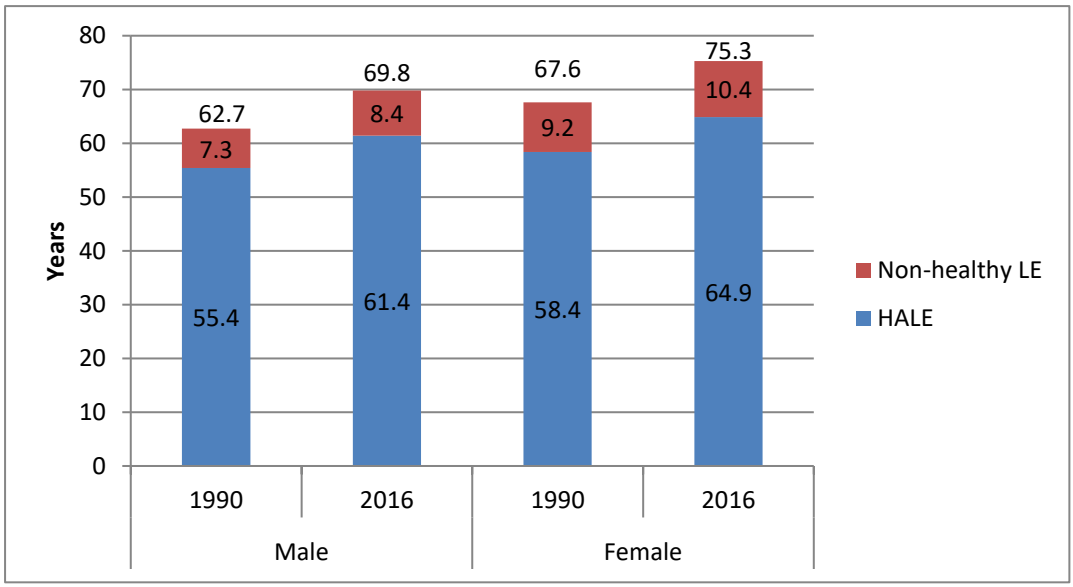
Figure 5: YLDs as a percentage of DALYs (age-standardised rates), by sex, global, 1990 and 2016



Source: GBD 2016 DALYs and HALE Collaborators (2017)

Compression of morbidity can be measured both as in relative terms, by comparing HALE or non-healthy life expectancy with overall life expectancy. HALE increased from 1990 to 2016 by 6.0 years for men and 6.5 years for women, while non-healthy life expectancy has increased by 1.1 years for men and 1.2 years for women (Figure 6). While this shows a greater absolute increase in HALE than non-healthy life expectancy, in relative terms the proportion of LE that is non-healthy increased slightly from for males 11.6% to 12.0% and for females from 13.6% to 13.8%. This shows that, globally, there is no evidence of morbidity compressing to older ages.

Figure 6: HALE, non-healthy life expectancy and life expectancy, by sex, global, 1990 and 2016

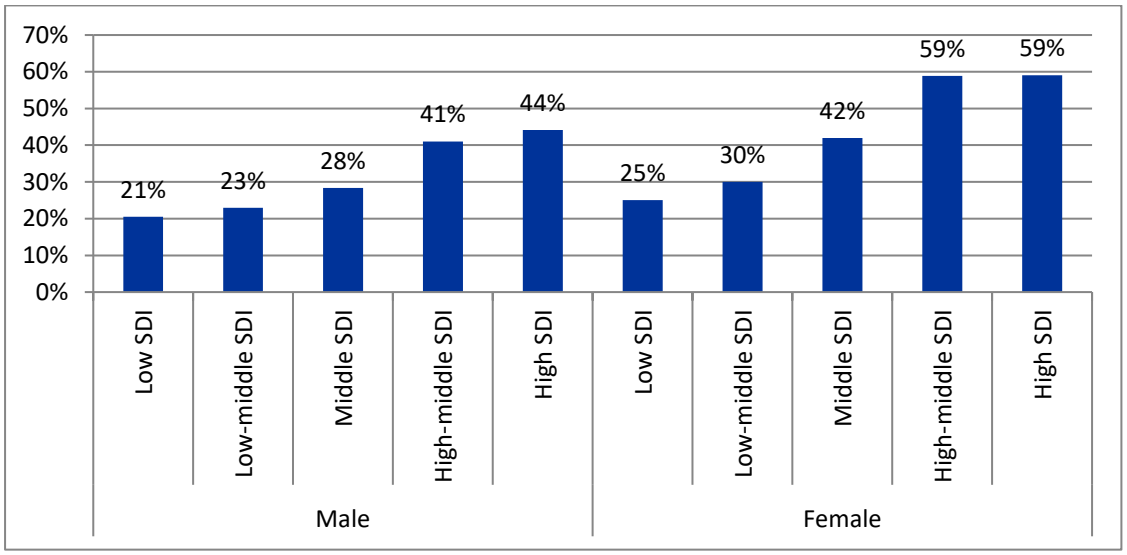


Source: GBD 2016 DALYs and HALE Collaborators (2017)

YLDs by country socio-demographic index

Morbidity is a larger proportion of total disease burden in richer countries, with YLDs comprising 44% of male and 59% of female DALYs in the highest SDI quintile countries, but only 21% of male and 25% of female DALYs in the lowest SDI quintile countries. This demonstrates that while morbidity is a relatively important health issue in richer countries, mortality (as measured by YLLs) are far more important in poorer countries.

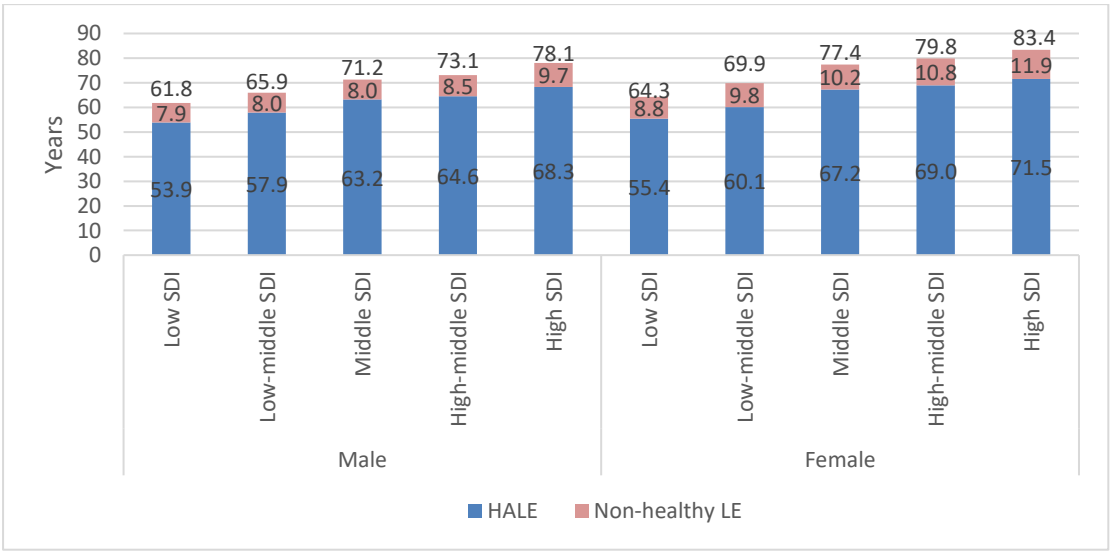
Figure 7: YLDs as % of DALYs, by sex and country socio-demographic index (SDI), global, 2016



Source: GBD 2016 DALYs and HALE Collaborators (2017)

As expected, HALE is substantially higher among high SDI than low SDI countries (Figure 8). However, non-healthy LE is also higher, being 1.8 years higher for males and 3.1 years in high SDI than low SDI countries globally. The proportion of life expectancy that is non-healthy only decreases slightly for males from 12.8% in low SDI countries to 12.4% in high SDI countries and increases slightly for females from 13.7% in low SDI countries to 14.3% in high SDI countries. This shows that there is no clear evidence of morbidity compression from poorer to richer countries.

Figure 8: HALE and non-healthy LE by sex and country socio-demographic index (SDI), by sex, global, 2016

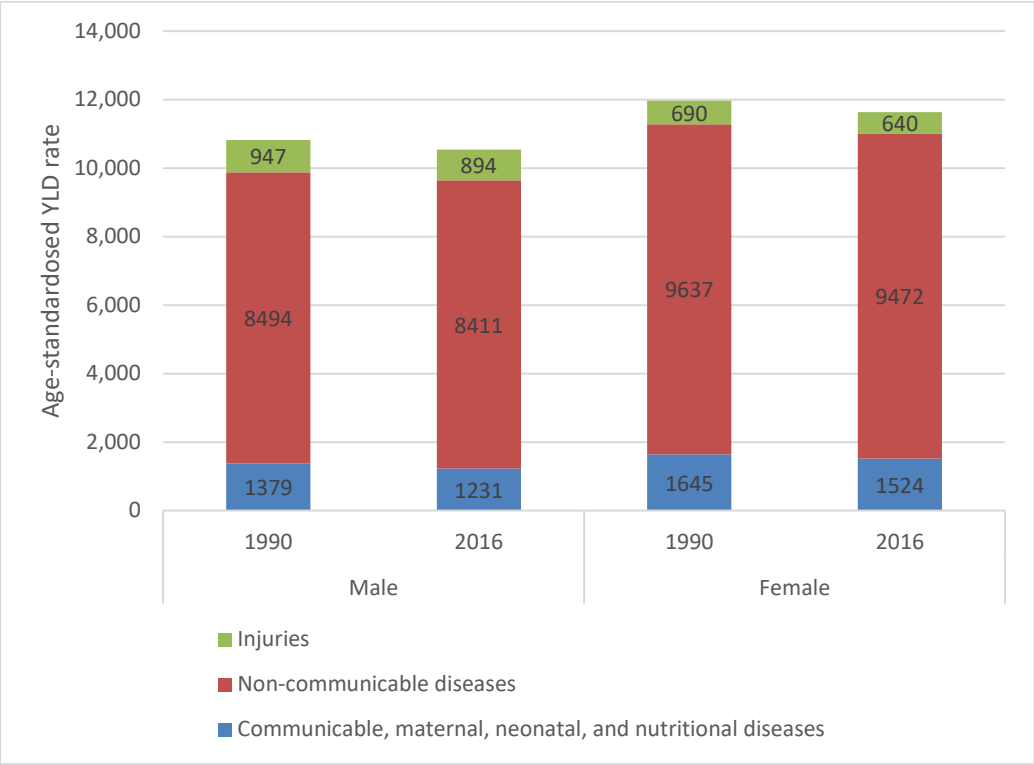


Source: GBD 2016 DALYs and HALE Collaborators (2017)

Causes of morbidity

Non-communicable diseases comprise the vast majority of YLDs (Figure 9). They have only decreased slightly since 1990.

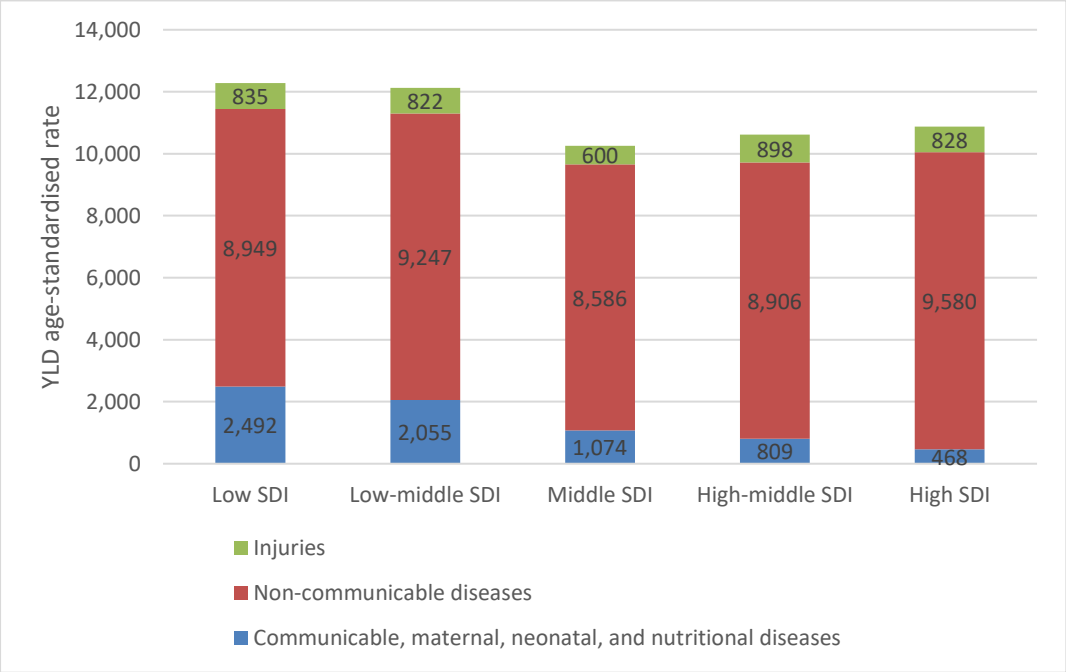
Figure 9: Age-standardised YLD rate (per 100,000), by broad cause and sex, global, 1990 and 2016



Source: GBD 2016 DALYs and HALE Collaborators (2017)

Communicable, maternal, neonatal and nutritional diseases are far more common causes of morbidity in poorer than richer countries (Figure 10). However, NCDs are clearly the largest source in all countries, while injuries only comprise a minority.

Figure 10: Age-standardised YLD rate (per 100,000), by broad cause and country socio-demographic index, global, 2016



Source: GBD 2016 DALYs and HALE Collaborators (2017)

The leading causes of both male and female morbidity is low back and neck pain, followed by sense organ diseases i.e. hearing and sight diseases), skin diseases, depressive disorders and migraine (Table 1). None of these causes of morbidity are leading causes of mortality, showing that interventions to address morbidity are likely different from mortality. Of these listed causes of morbidity, only diabetes, stroke, and chronic obstructive pulmonary disease and falls are major causes of mortality. The vast majority of these are non-communicable diseases, with mental and substance abused disorders quite prominent.

Table 1: Leading causes of YLDs (rate per 100,000, GBD cause level 3), by sex, global, 2016

Male		Female	
Cause	**Rate**	**Cause**	**Rate**
	1,03		1,31
Low back and neck pain	1	Low back and neck pain	4
Sense organ diseases	873	Sense organ diseases	932
Skin and subcutaneous diseases	682	Skin and subcutaneous diseases	797
Depressive disorders	469	Migraine	793
Migraine	431	Depressive disorders	729
Diabetes mellitus	397	Dietary iron deficiency	610
Dietary iron deficiency	332	Other musculoskeletal disorders	468
Other musculoskeletal disorders	316	Anxiety disorders	445
Anxiety disorders	271	Diabetes mellitus	376
Falls	270	Gynecological diseases	278
Chronic obstructive pulmonary disease	256	Oral disorders	274
Drug use disorders	244	Osteoarthritis	269
Oral disorders	240	Falls	243
Alcohol use disorders	191	Stroke	216
Autistic spectrum disorders	186	Asthma	198

Source: GBD 2016 DALYs and HALE Collaborators (2017)

An example of subnational differences in the causes of morbidity is shown by differences between Indigenous and non-Indigenous Australia. Age-standardised YLD among Indigenous Australians are approximately double that of non-Indigenous Australians. Over one-third of the difference is due to mental and substance abuse disorders (35%), with respiratory diseases (13%), injuries (11%), musculoskeletal (9%) and neurological diseases (9%) also significantly contributing to morbidity differences.

Table 2: Age-standardised YLDs (per 1,000) for leading causes, and contribution to health gap between Australian Indigenous v non-Indigenous, Australia 2011

Cause	Indigenous YLD rate	Non-Indigenous YLD rate	Rate difference	% of YLD health gap
Cardiovascular	9.1	5.3	3.8	4.2
Mental/ substance abuse	54.7	22.9	31.8	35.4
Injuries	13.0	3.5	9.4	10.5
Respiratory	23.2	11.3	11.9	13.3
Cancer	1.7	2.1	–0.4	–0.5
Endocrine	4.8	2.0	2.9	3.2
Kidney/urinary	4.9	0.7	4.2	4.7
Neurological	14.4	6.7	7.7	8.6
Gastrointestinal	2.4	2.4	0.0	–0.1
Musculoskeletal	29.0	21.3	7.7	8.6
Infectious diseases	4.3	1.1	3.2	3.6
Infant/congenital	1.6	0.8	0.7	0.8
Blood/metabolic	2.9	0.8	2.1	2.3
Hearing/vision	6.4	3.9	2.4	2.7
All other disease groups	11.3	9.0	2.3	2.6
All diseases	183.6	94.0	89.6	100.0

Source: AIHW (2017), Table S8.4

Risk factors

The leading risk factors (i.e. potentially modifiable causes) of morbidity as measured by YLDs are high fasting plasma glucose (or high blood sugar), child and maternal malnutrition, high body-mass index, occupational risks and alcohol and drug use (Table 3). It is noticeable how many of these risk factors relate to chronic non-communicable diseases, for example, high fasting plasma glucose, high body-mass index, alcohol and smoking, and high blood pressure and cholesterol. These risk factors can help prioritise interventions to reduce morbidity.

Table 3: Leading risk factors of age-standardised YLDs, global, 2016

1. High fasting plasma glucose	9. Impaired kidney function
2. Child and maternal malnutrition	10. Air pollution
3. High body-mass index	11. High total cholesterol
4. Occupational risks	12. Unsafe water, sanitation, and handwashing
5. Alcohol and drug use	13. Low bone mineral density
6. Dietary risks	14. Unsafe sex
7. Tobacco	15. Sexual abuse and violence
8. High systolic blood pressure	16. Other environmental risks

Source: IHME (2016)

Emerging health and policy issues

The evidence shows that as humans are living longer, they are spending more years in morbidity, i.e. there is no compression of morbidity at the oldest ages. This trend has significant implications for populations and their governments. The increasingly long period that populations are spending in ill health, injury or disability requires often expensive funding of treatment and care. It also creates a significant burden on families to provide unfunded care for their loved ones.

Prioritisation of policy responses to reduce the burden of morbidity can be informed by the leading risk factors. Behavioural risk factors that are related to changing lifestyles are having an impact on morbidity. An example is smoking which, despite reductions in many high-income countries are increasing is prevalence in other parts of the world and which are related to cardiovascular and respiratory diseases and cancers. Smoking has high prevalence levels in large populations such as China, Indonesia and Russia, and “Big Tobacco” has a significant presence in these counties (GBD 2015 Tobacco Collaborators, 2017). The successful policy interventions that have reduced tobacco consumption drastically in many high-income countries, such as taxes, advertising bans and smoke-free workplaces, have not been replicated in many of these populations.

Another change that has affected both high-income and low- and middle-income countries is the increasingly sedentary nature of lifestyle as well as changing to Western diets with high fat and sugar contents. This is shown by leading risk factors of morbidity including high body-mass index, high blood sugar, blood pressure and cholesterol, and dietary risks, which can lead to cardiovascular diseases, cancers and musculoskeletal conditions. Unlike smoking, for which there are many successful examples of policy interventions to reduce its prevalence, there are fewer prominent examples of policies to improve diets and exercise. Many national and subnational governments have taxed sugar content in drinks (e.g. Mexico) and banned trans fats in restaurants (e.g. New York City); the latter reduced strokes and hospitalisations (Brandt et al 2017).

Other important causes of morbidity include mental health disorders, which are related to alcohol and drug abuse. The example of Indigenous Australia shows how marginalised populations are particularly at risk of these conditions. Morbidity from depressive disorders and anxiety, globally, have only declined slightly since 1990, demonstrating the policy challenge in addressing these conditions (GBD 2016 DALYs and HALE Collaborators 2017).

While communicable diseases are becoming proportionally less of a cause of morbidity over time, diseases such as malaria, HIV/AIDS and tuberculosis remain a significant burden in many low- and middle-income countries, especially of those in adult ages. The re-emergence of infectious diseases, such as cholera in Yemen,

demonstrates the risks these diseases still pose especially in low-resourced or poorly governed settings. Environmental factors such as air pollution are also a leading risk factor of morbidity, particularly in South and East Asia, and are another policy area of major public health importance.

The burden of morbidity on many low- and middle-income countries has significant public health implications, not only for the health of the population but the ability of often under-resourced health systems to treat chronic conditions. Although many of these countries have been successfully reducing mortality in childhood, they are proceeding through the epidemiological transition towards a phase where chronic conditions become more prevalent and where the populations are ageing. However, the growing importance of morbidity is not reflected in priority setting or in development spending. The only Sustainable Development Goals are focussed on morbidity are Target 3.3 to reduce infectious diseases such as AIDS, tuberculosis and malaria, Target 3.6 to reduce road traffic accident injuries, and Target 3.9, to reduce illnesses from environmental pollution; none of which are specifically aimed at non-communicable diseases (World Health Organization 2018).[3] Additionally, global development assistance in health for non-communicable diseases is low compared with infectious disease (Global Burden of Disease Health Financing Collaborator Network 2018: Figure 2). These impediments need to be overcome if the challenge of reducing morbidity is to be addressed.

[3] Target 3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases. Target 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents. Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination. Target 3.4 aims to reduce premature mortality from non-communicable diseases, but not morbidity (World Health Organization 2018).

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