1 Global burden of NCDs

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This chapter describes the disease burden of the four NCDs considered in this book – cardiovascular disease (CVD), cancer, diabetes and chronic respiratory diseases (CRD), and their common set of shared risk factors – tobacco use, harmful use of alcohol, unhealthy diet, physical inactivity and air pollution.

Mortality and morbidity can be expressed as 'incidence' (new cases in a given period) or 'prevalence' (number of cases at one moment in time). Incidence and prevalence can be described in absolute numbers (e.g. total numbers of cases in a population) or as rates, frequently per 100,000 population per year.

Assessment of mortality is not straightforward as data are often not collected/registered systematically and the cause of death is frequently unknown/inaccurately recorded. Overall, a little less than half of deaths in the world are registered with their cause, and in Africa, only four countries have national death registration data. Calculating rates is a challenge when the size and age distribution of the population is not known precisely.

Accurate morbidity data are even less available/reliable. Indicators such as numbers of years of life lost (YLLs) and disability-adjusted life years lost (DALYs) rely on complex diagnostic criteria and usually require modelling of some inputs, as well as a number of methodological choices.[1]

Morbidity data can be collected more easily at the health facility level but are not representative of the whole population.

Examples of measures used to describe NCD mortality and morbidity are shown in Box 1.1.

BOX 1.1 EXAMPLES OF MEASURES USED TO DESCRIBE THE NCD BURDEN

Crude estimates

Total numbers (incidence or prevalence) provide information on the actual burden of a particular disease or risk factor in a population. Crude estimates are important for defining public health and health service needs

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for this population (e.g. how many people in a country have hypertension or diabetes, how many die from a heart attack or different cancers). Where a population size is increasing and/or ageing (as is the case in most countries, particularly low- and middle-income countries, numbers (both incidence and prevalence) will inevitably increase over time, particularly for NCDs, given that they tend to occur later in life.

Age-standardized rates

Age-standardized incidence or prevalence is calculated by weighting crude estimates against a 'standard' age distribution.[2] This enables us to directly compare incidence or prevalence estimates across different populations and over time, irrespective of differences in population size and age distribution between populations or over time. Age-standardized rates inform us as to whether a disease (or a risk factor) increases or decreases in the population irrespective of demographic changes (i.e. whether differences occur because of different/changing exposures to risk factors and/or prevention/treatment interventions).

Population attributable fractions (PAF)

PAF is the estimated fraction of a disease (based on mortality or other metrics, e.g. DALYs) that would not have occurred if there had been no exposure to one (or several) risk factor(s) in a population.[3] PAF (or population-attributable risk) provides information on the potential public health impact of reducing risk factors in the population. For example, knowing that in a particular country 16% of all deaths are due to tobacco use or that 21% are due to hypertension provides a strong rationale for the need to prioritize and/or strengthen tobacco and hypertension prevention and control interventions.

Years of life lost (YLL) and disability-standardized years of life lost (DALYs)

These metrics integrate morbidity and mortality. Estimation is more complex and requires additional data and a number of assumptions.

Notes:

- The PAF of a disease attributable to several risk factors may be larger when calculated as the sum of PAFs calculated separately for each risk factor than when measured by taking all risk factors together because risk factors may not be fully independent of each other (e.g. PAF of CVD attributable to raised BMI and low physical activity).

- PAFs differ across populations according to the prevalence of risk factors but the impact also varies according to the absolute risk of a disease in a particular population.[4]

Data can be presented at a global, regional, country, or local level. Data can also be disaggregated by age, gender, socio-economic position and/or other variables.

Databases available for understanding the epidemiology of NCDs

National governments, UN/intergovernmental, academic and other agencies publish data on NCDs at a local, national, regional and global level using reported or published data from multiple sources such as civil registration, health facilities and population surveys at national and local levels. Lack of available/reliable data for the reasons described above, means that statistical models are required to prepare mortality, morbidity and PAF estimates for these and other health indicators so that they be compared across countries and/or over time in a meaningful way. Different sources of data, assumptions and modelling explain why estimates can differ between agencies.[5]

Two important global health databases, that include NCDs, are the WHO Global Health Observatory (GHO) and the Institute for Health Metrics and Evaluation (IHME) Global Disease Burden project (GBD). GHO is the WHO's gateway to health-related statistics for its 194 Member States, while GDB is an independent entity. There are differences between GHO and GBD in terms of data sources, funding and models used.[6] As with all databases, there are limitations. They include:

- Extensive statistical modelling, including a number of assumptions for handling missing and poor-quality data, which are not always easy to understand and/or only partially reported. This is particularly the case for morbidity estimates.
- Modelling is inevitably greater for low- and middle-income countries. However, as these countries strengthen their ability to collect data, these limitations are decreasing over time.

The IHME Global Disease Burden project (GBD)

GBD was established as a collaboration between WHO, the World Bank and Harvard University in the 1980s.[7] The GBD 2010 study was set up as a collaboration between IHME and Harvard University, WHO, Johns

Hopkins University and the University of Queensland, as well as drawing on the expertise of around 40 expert working groups. Subsequent rounds of the GBD study were carried out under the auspices/guidance of the IHME alone with inputs from expert groups. Considerable financial and technical resources are used to obtain and generate up-to-date data. GBD also provides estimates of years of life lost and disability-standardized years of life lost. GBD also provides PAFs for around 80 modifiable behavioural, metabolic and environmental risk factors. Updated GBD estimates are published regularly, along with details on methodology.[8,9] The internet-based GBD Compare tool allows users to interrogate the GBD database, including crude and age-standardized mortality as well as PAFs, at country, regional and global levels, by age, sex and year since 1990.

The WHO Global Health Observatory (GHO) and Global Health Estimates (GHE)

GHO provides health-related statistics for WHO Member States. GHO provides GHE on mortality and burden of disease (including NCDs), prevalence of NCD risk factors, and national capacity to prevent and control NCDs' mortality and burden of disease.[10,11] Estimates are based on data from multiple consolidated sources, including national vital registration data, latest estimates from WHO technical programmes, United Nations partners and inter-agency groups, as well as GBD and other scientific studies. GHE data are used across a large number of WHO publications. Data and methods used for preparing these estimates have been described.[12] GHO is used as the source of data for 'NCD Countdown 2030', a collaborative effort that includes WHO, NCD Alliance, Imperial College and *The Lancet* to provide an independent mechanism for countries to monitor their progress toward the SDG 3.4 (reduction in premature mortality from the four major NCDs).[13]

Why this compendium primarily displays mortality data

GBD's crude and age-standardized mortality data (in 2019 and 1990), and PAFs for 2019 are the predominant data displayed in this chapter, as well as in other chapters in this compendium, with breakdown by World Bank income groups. Estimates of morbidity are not systematically included in this compendium, given the lack of space and because, for the reasons described above, they are based on further, often weaker, assumptions than those for mortality. However, as the four NCDs considered in the compendium tend to occur later in life, morbidity estimates generally correlate fairly well with those for mortality, particularly for those that have a high case fatality, but estimates (e.g. number of years lived with disease) can be proportionately larger for those NCDs that have larger survival such as diabetes, stroke and some cancers, partly due to improving treatments and health care.

Why this book primarily displays GBD estimates

The reasons for using GBD data in this chapter, as well as in other chapters of this book, include:

- Data are internally consistent, i.e. have been adjusted to ensure, among other considerations, that the total number of cases (e.g. deaths) amount to the estimated actual total number for a given year and because the same methods are used for national and global estimations, including the way that missing data are managed.
- Data are collated from a large number of sources, from both government and non-government agencies, including universities.
- Data can be freely and easily generated through the web-based GBD Compare tool. This means that figures used in this compendium can be reproduced by readers.
- PAFs can be generated for approximately 300 diseases and 80 risk factors, using internally consistent methods for all risk factors and diseases. GBD continually reviews the evidence on the associations between these risk factors and diseases.

GBD estimates

Table 1.1 summarizes NCD mortality data by World Bank country income category for 1990 and 2019 using IHME data (GBD Compare). Supplement 1 to this compendium provides a set of graphic illustrations on changes incrude and age-standardized mortality according to World Bank country income categories over this time period. The supplement can be accessed at www.routledge.com/9781032307923. As can be seen from the table, a large proportion (generally >75%) of all CVD deaths are attributable to ischemic heart disease and stroke (and a substantial proportion to hypertensive heart disease [Hyp HD]). A large proportion of all chronic respiratory disease (CRD) deaths is attributable to chronic obstructive pulmonary disease (COPD).

Table 1.2 provides global estimates of PAFs for 2019 using IHME data (GBD Compare). The Supplement described above also includes a set of graphical illustrations that show mortality attributable to risk factors in Table 1.2 between 1990 and 2019 according to World Bank country income categories.

Key messages from the GBD tables

Global burden in 2019

- CVD, cancer, CRD and diabetes caused around 60% of deaths worldwide in 2019.

Table 1.1 Total deaths and age-standardized rates (per 100,000) for mortality of the four major NCDs by World Bank country income category for 1990 and 2019 (IHME)

Country income level	*CVD*	IHD	Stroke	Hyp HD	*Cancer*	*CRD*	COPD	*Diabetes*	*Total*
Global (population: 7.7 billion)									
% from all deaths in 2019	32.8	16.2	11.6	2.1	17.8	7.0	5.8	2.7	60.4
# (million) in 2019	18.6	9.1	6.6	1.2	10.1	4.0	3.3	1.6	34.2
# among <70 yrs in 2019	6.4	3.2	2.2	0.3	5.2	1.1	0.8	0.7	13.4
% among <70 yrs	34.5	35.5	33.7	27.8	51.3	28.1	24.1	45.6	39.9
# (million) in 1990	12.1	5.7	4.6	0.7	5.8	3.1	2.5	0.7	21.6
Relative change 2019 vs 1990 (%)	*54*	*60*	*43*	*77*	*75*	*29*	*30*	*134*	*58*
Age-standardized mortality rates in 2019	240	118	85	15	125	51	43	19	436
Age-standardized mortality rates in 1990	354	170	132	19	148	88	73	18	608
Relative change 2019 vs 1990 (%)	*-32*	*-31*	*-36*	*-21*	*-15*	*-42*	*-42*	*9*	*-28*
Low- and middle-income countries (population: 6.5 billion)									
% from all causes in 2019	29.7	14.3	10.3	2.0	17.3	6.2	5.1	2.3	55.6
# (million) in 2019	15.0	7.4	5.6	0.9	6.9	3.3	2.8	1.3	26.6
# among <70 yrs in 2019	3.6	2.9	2.1	0.3	4.1	1.0	0.7	0.6	9.3
HICs (pop: 1.2 B; age 70+: 13%)									
% from all causes in 2019	32.5	16.4	8.4	1.9	28.9	5.8	4.9	2.4	69.6
# (million) in 2019	3.5	1.8	0.9	0.2	3.1	0.6	0.5	0.3	7.5
# among <70 yrs in 2019	0.6	0.4	0.1	0.0	1.1	0.1	0.1	0.1	1.9
# (million) in 1990	3.6	2.1	1.0	0.1	2.1	0.4	0.3	0.2	6.3
Relative change 2019 vs 1990 (%)	*-2*	*-15*	*-9*	*107*	*47*	*59*	*69*	*43*	*20*
Age-standardized mortality rates in 2019	134	68	34	7.7	135	24	53	35	327
Age-standardized mortality rates in 1990	283	164	79	8.1	168	30	65	36	518
Relative change 2019 vs 1990 (%)	*-53*	*-58*	*-56*	*-4*	*-20*	*-20*	*-18*	*-5*	*-37*
Upper MICs (population: 2.6 billion; age 70+: 7%)									
% from all causes in 2019	40.7	18.8	16.6	2.6	22.1	7.5	6.9	2.6	72.9
# (million) in 2019	7.9	3.7	3.2	0.5	4.3	1.5	1.3	0.5	14.2
# among <70 yrs in 2019	0.2	1.1	1.0	0.1	2.3	0.3	0.2	0.2	3.1

# (million) in 1990	4.8	1.9	2.2	0.3	2.3	1.6	1.4	0.2	8.9
Relative change 2019 vs 1990 (%)	*64*	*93*	*46*	*52*	*88*	*-7*	*-7*	*142*	*60*
Age-standardized mortality rates in 2019	267	124	107	18	131	50	46	16	464
Age-standardized mortality rates in 1990	401	163	180	29	158	132	123	15	706
Relative change 2019 vs 1990 (%)	*-33*	*-24*	*-41*	*-39*	*-17*	*-62*	*-62*	*4*	*-34*
Lower MICs (population: 3.2 billion; age 70+: 4%)									
% from all causes in 2019	29.7	16.0	9.8	1.7	10.7	8.1	6.0	2.8	51.2
# (million) in 2019	6.3	3.4	2.1	0.4	2.3	1.7	1.3	0.7	11.0
# among <70 yrs in 2019	3.0	1.6	1.0	0.1	1.5	0.6	0.4	0.4	5.5
# (million) in 1990	3.2	1.6	1.2	0.2	1.0	1.0	0.7	0.2	5.5
Relative change 2019 vs 1990 (%)	*97*	*117*	*79*	*108*	*118*	*68*	*85*	*208*	*100*
Age-standardized mortality rates in 2019	313	168	104	18	97	89	68	33	532
Age-standardized mortality rates in 1990	384	191	140	22	98	122	87	25	629
Relative change 2019 vs 1990 (%)	*-18*	*-12*	*-26*	*-15*	*-1*	*-27*	*-22*	*33*	*-15*
LICs (population: 0.7 billion; age 70+: 2%)									
% from all causes in 2019	16.1	6.2	6.5	1.7	7.5	3.7	2.5	1.4	28.6
# (million) in 2019	0.79	0.31	0.32	0.09	0.37	0.18	0.13	0.10	1.4
# among <70 yrs in 2019	0.40	0.15	0.16	0.04	0.26	0.08	0.05	0.05	0.8
# (million) in 1990	0.44	0.16	0.19	0.05	0.19	0.12	0.07	0.05	0.8
Relative change 2019 vs 1990 (%)	*79*	*97*	*72*	*77*	*93*	*56*	*74*	*96*	*80*
Age-standardized mortality rates in 2019	304	121	123	35	114	72	53	35	524
Age-standardized mortality rates in 1990	355	132	149	41	120	95	65	36	607
Relative change 2019 vs 1990 (%)	*-14*	*-8*	*-18*	*-16*	*-5*	*-25*	*-18*	*-5*	*-14*

Age-standardized rates are per 100,000 population.

Table 1.2 Fractions of the global mortality from the four major NCDs that are attributable to modifiable behavioural, metabolic and environmental risk factors (IHME)

	CVD	*Cancer*	*CRD*	*Diabetes*
Behavioural risk factors				
Tobacco	17.2	25.8	45.4	
Dietary risks	37.0	6.0		25.2
Low physical activity	3.4	0.7		8.1
Alcohol use	2.3	4.9		
Unsafe sex (e.g. leading to HPV transmission, causing cervical cancer)		2.8		
Drug use		5.2		
Metabolic factors				
High blood pressure	53.8			
High blood LDL-cholesterol	23.7			
High fasting blood glucose	20.3	4.2		
High body mass index	17.4	4.6	1.9	40.7
Environmental factors				
Air pollution	19.1	3.9	33.1	19.3
Other	4.6			
Occupational risks		3.3	14.6	

- A total of 40% of all these deaths were premature (before the age of 70 years), which highlights the significant potential for prevention and control strategies.
- CVD accounted for more than half of all NCD deaths globally.

Trends

- Total mortality due to these four major NCDs (i.e. absolute numbers and proportions of all deaths due to these NCDs) has increased between 1990 and 2019, which is largely driven by increasing and aging populations (demographic transition). As mortality is a marker of disease burden, this indicates that most countries need to scale up NCD prevention, treatment and health care services to meet the needs of their populations.
- Age-standardized mortality rates for the four major NCDs have, with the exception of diabetes, decreased between 1990 and 2019 in most parts of the world. This can be explained by a reduction in the underlying causes (i.e. decreasing age-standardized prevalence of some of the risk factors for NCDs) as well as improved case management in many countries. This demonstrates the benefits of public health and healthcare interventions. This is particularly striking for CVD in high-income countries (HICs) and upper-middle-income countries (upper MICs), but also in low-income countries (LICs) to a lesser extent, which to a large extent reflects a reduction in tobacco use, healthier diet, lower cholesterol levels over time, as well as better treatment for some NCD conditions, such as hypertension and heart disease.

- Irrespective of the changes that arise from demographic transition, a decrease in age-standardized *incidence* (new cases) or *mortality* does not imply a decrease in age-standardized *prevalence* (i.e. number of persons living with a condition), particularly when life expectancy for many living with NCDs is increasing because of improved treatment and care. For example, age-standardized CVD *incidence* and *mortality* decreased by 46% and 33% respectively between 2000 and 2015 in Canada, but the age-standardized *prevalence* increased by 21%;[14] this has large implications for the provision of health care.

Geographic variations

- The large majority of deaths from these four major NCDs are in low- and middle-income countries. This is in line with the large majority of the world's population living in low- and middle-income countries and emphasizes that NCDs are a major problem for all countries, including low- and middle-income countries.
- The crude proportions and total numbers of deaths from these four major NCDs are higher in low- and middle-income countries than in HICs (mainly because the population is largest in the former).
- Age-standardized mortality rates for several of these four NCDs are also higher in low-and middle-income countries. For example, the age-standardized mortality rates of CRDs are several times higher reflecting much higher levels of ambient and household pollution and poorer access to effective healthcare.

Risk factors

- The large PAFs for several of these four major NCDs emphasize the large potential to reduce these diseases through risk factor reduction in the whole population. Benefits are largest for CVD, highlighting that CVD is largely preventable: much of the improved life expectancy in the world, including in low- and middle-income countries, is the result of decreasing age-standardized CVD rates.[15]
- Nearly one-quarter of cancer deaths and one-fifth of CVD deaths would be avoided if exposure to tobacco was eliminated.
- Nearly half of global diabetes deaths would be prevented if none of the world's population was overweight or obese.

GHO estimates

Although specific estimates inevitably differ from those from GBD for the reasons described above, the overall picture is the same.[16] A comparison between data from GHO and GBD and the challenges facing WHO and its Member States in collecting and reporting on global health statistics has been described.[17]

- Globally, 41 million of 55 million (71%) deaths in 2019 were due to NCDs, with 77% of these in low- and middle-income countries.
- More than 15 million people died from one of the four major NCDs between the ages of 30 and 69 years (defined by WHO as premature deaths, corresponding to a global target in the WHO Global NCD Action Plan) and 85% of these were in low- and middle-income countries.
- CVD accounted for most NCD deaths in 2019 (17.9 million people), followed by cancers (9.3 million), respiratory diseases (4.1 million) and diabetes (1.5 million).
- Up to 80% of premature deaths from heart disease and stroke, and a majority of deaths from type-2 diabetes, could be prevented.[18]

Further observations about the burden of these four major NCDs and their implications for prevention and control are provided in other chapters. As highlighted above, country-level estimates from global databases such as IHME and GHE are based on considerable assumptions and extrapolations. For countries where real data are lacking, efforts should be made to develop their surveillance systems to provide robust data on the incidence and prevalence of NCD mortality and morbidity (Chapters 4 and 5 on surveillance).

Notes

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