CHAPTER 1

The Global Burden of Disease

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At the turn of the 20th century, the average woman born in the United States could expect to live for 51 years.[1] Fast-forward 100 years and the average life expectancy for an American woman was closer to 80 years. The nearly 30 years that American women have gained in life expectancy is a testament to the great strides that have been made in modern medicine and public health. This progress, however, has hardly been uniform, even within our country. Today, life expectancy for a Native American male in South Dakota, for instance, is a mere 58 years. On average, a nearly 35-year gap in life expectancy exists between the most and least healthy populations in the United States.[2] Looking beyond U.S. borders and comparing the health status among countries, the data reveal striking gaps in the distribution of health globally. In the 21st century, a girl born in Sierra Leone can expect to live less than an American girl could 100 years ago; life expectancy in Sierra Leone is a shocking 41 years. The political, social, and economic determinants of health all drive this vastly heterogeneous, checkered, and complex global burden of disease (GBD).

More than 99 percent of the burden of maternal and early childhood diseases is concentrated in developing countries; at the same time, communities around the globe increasingly are burdened with a silent epidemic of noncommunicable chronic diseases. Emerging nations, typified by India and China, rapidly are urbanizing and maturing their economies and, in turn, driving a new global picture of disease burden. Highly processed and fast food, staples of Western Hemisphere life, have arrived in the far corners of the earth, from Delhi to Djibouti, making high-fat, cheap foods the easy choice for billions of people. The effect of this and other related trends is predictable: more and more people will suffer from diseases traditionally associated with the Western Hemisphere. Already, cardiovascular disease, often thought of as a disease restricted to affluent populations, is the leading cause of death in the world—with almost a full 80 percent of these deaths concentrated in developing countries.[3] When the more recent epidemic of noncommunicable disease is added to the persistent plagues of communicable diseases,

including malaria, tuberculosis (TB), hookworm, and HIV/AIDS, the task of assuaging disease rationally and strategically becomes most confusing, if not downright daunting.

The focus of this chapter is to highlight the salient features of the GBD, including its distribution and changing patterns over time. The reader seeking more detailed or specific information is encouraged to consult the Disease Control Priorities Project of the World Health Organization (WHO).[1] We hope to give the reader a perspective on both historical and contemporary views of the burden of disease, outline the current data on disease prevalence and impact, and introduce a fuller discussion of future directions for the study of the global burden on disease.

HOW TO DEFINE THE 'BURDEN'

Although the "burden" of a disease can be defined in a variety of senses, the consensus definition, particularly from the WHO, is a fairly specific one. GBD is defined by the WHO as a comprehensive regional and global assessment of mortality and disability from 136 diseases and injuries and 19 risk factors. It accounts for the morbidity and mortality to an individual that is caused by a specific disease.[4] This information is aggregated into country level data to form the "burden," which can be viewed as the gap between current health status and an ideal situation in which everyone lives to old age free of disease and disability.

Economic and social determinants and the effect of individual disease on an individual's community and society (apart from "ill health") are not included in this definition. As the currency in the public health literature is limited to the parameters of the WHO definition, burden of disease in this chapter is defined in the above sense. We do return, however, to alternative, if not complementary, ways to capture this "burden" later.

THE EPIDEMIOLOGIC AND ECONOMIC TRANSITION

The GBD can be divided into three distinct buckets (see figure 1.1).[3] The first set of diseases includes the communicable, maternal, perinatal, and nutritional conditions, which, unsurprisingly, predominate in lower-income countries (for example, those in Sub-Saharan Africa and Southeast Asia). As a country develops, a well-documented epidemiologic transition takes place. Here, traditional risk factors for infectious diseases (poor food, limited access to good water, inadequate sanitation) are supplanted by risk factors for more chronic, lifestyle diseases (for example, workplace-associated pollution, smoking, high-fat diets). In addition, with a reduction in

1. See the Disease Control Priorities Project Web site, http://www.dcp2.org/main/Home.html, or the WHO Global Burden of Disease Web site http://www.who.int/topics/global_burden_of_disease/en/, for up-to-date information and raw data. In addition, the following texts on the Global Burden of Disease will be of particular use to readers:
Lopez AD, Disease Control Priorities Project. *Global Burden of Disease and Risk Factors.* New York, Washington, DC: Oxford University Press; World Bank; 2006.
Jamison DT, World Bank, Disease Control Priorities Project. *Disease Control Priorities in Developing Countries*. New York, Washington, DC: Oxford University Press; World Bank; 2006.

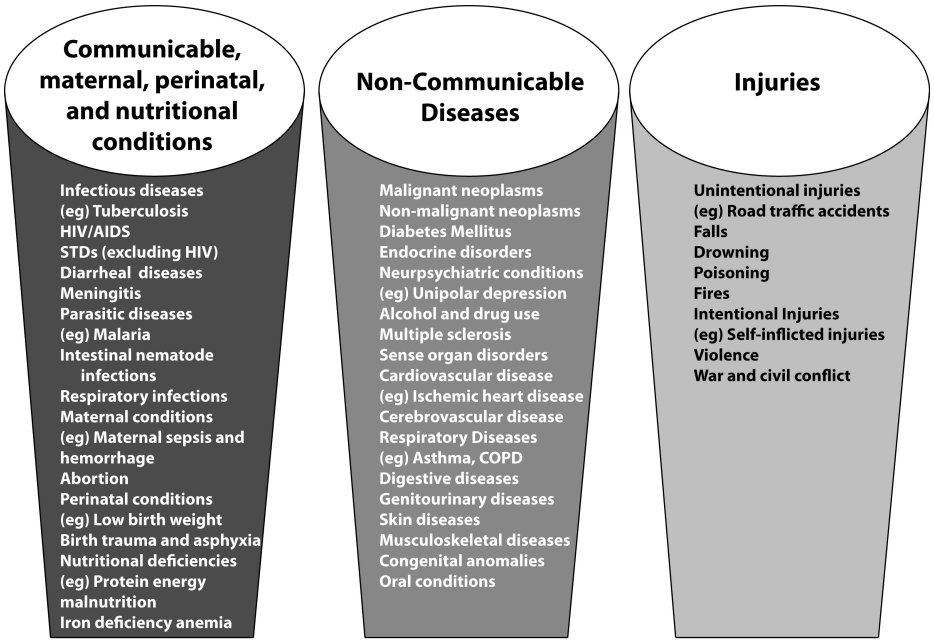

Figure 1.1 "Buckets" of diseases surveyed globally.

childhood mortality, populations collectively age, meaning that they experience disease risks for longer periods of time, particularly in urban environments.[5]

The result is as would be expected: people from countries with transitional economies begin to develop noncommunicable diseases, including diabetes, cancer, and heart disease. A final category of the burden, often neglected by health practitioners, is injuries—either intentional (violence, war) or unintentional (road traffic accidents).

The epidemiological and economic transition began in countries around the North Atlantic in the late-19th century. Since this time, the transition has diffused globally, fundamentally altering the demographic structure of countries.[6, 7] Maximum life expectancy has increased 2.5 years per decade for the past 160 years, along with declines in fertility and death rates.[4] The change in life expectancy affects economic growth dramatically; it is estimated that each additional year of life expectancy per person raises the gross domestic product (GDP) per capita by 4 percent in the long run.[8] Naturally, increasing longevity has resulted in an explosion of diseases associated with longer lives.[7] It is projected that by 2030, two-thirds of the global burden will be chronic diseases, and that communicable diseases will decline from affecting 41 percent to 20 percent of the global population.[9] The combination of persistent risk factors for communicable disease together with the emergent risks for noncommunicable diseases, including tobacco use, lack of physical activity, and poor diet, drive a so-called dual burden of disease in countries going through the epidemiologic transition (see figure 1.2).[10]

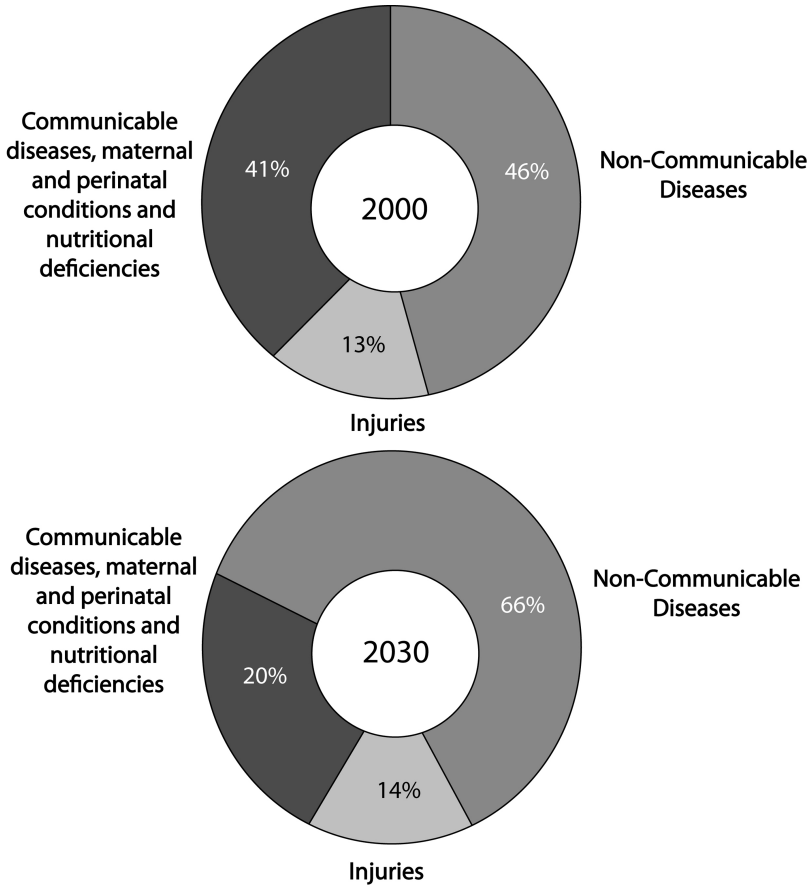

Figure 1.2 The Global Burden of Disease: 2000–2030.

HOW TO MEASURE THE BURDEN: THE OLD, THE NEW, AND THE UNEXPLORED

The most straightforward way to measure and present data on the burden of disease is to use statistics that quantitatively describe the proportion of a population with a particular illness, or the number of individuals negatively affected by a given risk factor. However, demographers, policy makers, and epidemiologists have recognized that aggregate statistics are difficult to compare across time, space, and differing conditions. Separate measures for mortality, morbidity, incidence, and prevalence make policy evaluation and intervention analysis problematic.

Perhaps a better measurement of the GBD is one that integrates morbidity, mortality, incidence, and prevalence into a single common metric that can be compared across time, space, and interventions. In 1990, recognizing the need for such a common metric, the World Bank, in concert with the WHO and the Harvard School of Public Health launched a study to assess and quantify the GBD. Out of this study came a new metric, the Disability-Adjusted Life Year (DALY), which is a summary measure of population health, measured in units of

time (years), combining estimations of both fatal and nonfatal health outcomes (morbidity and mortality) to calculate the number of years of fully healthy life lost by an individual with a particular illness or condition.[11]

The DALYs for a specific cause are calculated as the sum of the years of life lost due to premature mortality (YLL) resulting from that cause, and the years of healthy life lost as a result of disability (YLD), with the disability weights factored in, for incident causes of the health condition as follows:

$$\mathrm{DALY} = \mathrm{YLL} + \mathrm{YLD} \tag{1.1}$$

YLL is the number of cause specific deaths, multiplied by the standard life expectancy at age of death in years, and YLD is the number of incident cases multiplied by the average duration of the disease weighted by a disability factor.[11]

The disability factors, a way to include morbidity in estimations of burden of disease, are a source of much debate among critics of the DALY.[2] The DALYs are calculated in such a way that years lived at older and younger ages are given less weight. With these calculations, a death in infancy corresponds to 33 DALYs, and deaths at ages 5–20 account for around 36 DALYs.[4] To quote Christopher Murray, the architect of the DALY: "A disease burden of 3,300 DALYs is equivalent to 100 deaths in infancy or 5,500 people aged 50 living for one year with blindness."[13] Measurements in units of time, such as years, are practical because they can easily be converted to economic estimates for cost-effectiveness analysis, for example, to decide that effective interventions are those that cost a certain percentage of GDP per capita per DALY averted.

In addition to measuring the burden of DALYs of each specific disease, much recent work has been done on developing a better understanding of the burden of disease attributable to major risk factors, such as smoking, malnutrition, or environmental factors. The standard measurement to quantify the contribution of a risk factor to a disease is the population attributable fraction (PAF). PAF measures the estimated reduction in disease or mortality that would result, in the absence of the specific risk factor. For example, PAF for tobacco use would be the percentage reduction in DALYs to be expected if nobody in that population was exposed to tobacco smoke. It should be noted that risk factors are not necessarily additive—one risk factor can cause multiple diseases, and diseases can be caused by multiple risk factors—therefore the risk factor PAFs for a given disease often add up to more than 100 percent.[9] The DALY—along with summary health statistics on morbidity, mortality, life expectancy, and PAF for risk factors—are now viewed as important

2. Disability weights arose out of a notion that there is a cross-cultural single and quantifiable negative effect for each adverse, nonfatal health event. While proponents of the DALY have argued that this is the most equitable way to measure the burden of disease, because the loss of an eye, for example, is not worth less or more to an individual depending on where the individual lives, others have argued that it is impossible to equate health states in such varying environments. For example, the argument goes, paraplegia in Australia is altogether different from paraplegia in Cameroon given the vastly different infrastructure and social service support available in the two countries, and it is therefore inequitable to use uniform disability weights.[12] The debate continues, but for the moment, disability weights do take into account age and gender but do not adjust for environmental factors, such as where an individual lives.

measures of burden of disease.[3] Are there "problems" with a DALY index? Yes, of course. As this metric gains greater acceptance, it is important to understand that there are alternative ways, albeit largely untested, to measure the burden. 3

WHO MONITORS AND UPDATES THE BURDEN?

The World Bank and the WHO have been largely responsible for the current information available on the GBD. They have teamed up to conduct a series of surveys synthesizing information available globally in 1996, 2001, and 2004 to estimate mortality, morbidity, incidence, prevalence, and DALYs for 136 diseases and injuries over seven economic and geographic groups. In addition, mortality and population attributable risk is estimated for 26 separate risk factors.[9, 11, 14] A fourth global survey of the burden of disease is planned for 2010. The most up-to-date statistics on the burden of disease are available at the WHO Web site.[4] Information for the estimation of the GBD is drawn from a vast variety of sources, including regular reporting information submitted to the WHO; WHO- and United Nations Children's Fund (UNICEF)-funded country-level surveys; in-country surveillance systems; ministries of health and country census data; U.S. government–funded demographic and health surveys; verbal autopsy data; academic epidemiological studies; and specifically developed modeling programs to extrapolate information available from incomplete or outdated data sources.[14, 15]

THE GLOBAL BURDEN OF DISEASE

This section compares the burden in terms of mortality (death), DALYs (death and disability = "ill health") and causes of death across all incomes, using the most updated WHO GBD data from 2004, published in 2008.[9, 14][4] A summary of key findings is provided in box 1.1. 4

Mortality Patterns

Historically, mortality has been used to estimate the GBD, with reporting on the patterns of global deaths in adults and children, and by geographic region. In 2004, there were an estimated 58.8 million deaths or 1 percent global mortality. Overall, of every 10 deaths globally, six are due to noncommunicable diseases; three to communicable diseases, reproductive, and nutritional conditions; and one to injuries. Cardiovascular diseases are the leading cause of death in the world, followed by infectious and parasitic diseases and cancers. HIV/AIDS remains a high on the mortality list, and it is a leading cause of death in adults ages 15 to 59 in

3. In high-income countries, an alternative measurement of disease burden, the Quality-Adjusted Life Year (QALY) is often used, especially for cost-effectiveness analysis. The QALY is a measurement of the number of years of life in perfect health gained by avoiding a given adverse condition, as compared to a DALY, which measures the number of years of life *lost* by having that same condition. QALYs, like DALYs, assess both the quality and quantity of life lived. While DALYs are calculated with specific disability weights for specific diseases, QALYs are based on the measurement of overall health status, and so the two are not easily compared.[4]
4. Available on the WHO Web site, http://www.who.int/topics/global_burden_of_disease/en/.

Box 1.1. Key Points for the Global Burden of Disease

1. Around 10 million children under the age of five die each year. 99 percent of under five deaths occur in lower- and middle-income countries. Of these deaths, undernutrition is the underlying cause for at least 30 percent of all children under age five. Seven out of every 10 child deaths (under age 18) are in Africa and Southeast Asia.
2. Complications of pregnancy account for almost 15 percent of deaths in women of reproductive age worldwide.
3. The disease burden is uneven across regions. Southeast Asia and Africa together bore 54 percent of the total global burden of disease while accounting for only 40 percent of the world's population. 90 percent of DALYs lost worldwide are in low- and middle-income countries; 44 percent in low income countries alone.
4. Rapidly industrializing countries are suffering a dual burden of disease with high DALYs lost from both communicable and noncommunicable diseases. 40 percent of deaths in lower-income countries are caused by category 1 diseases (infection, undernutrition, maternal complications), while non-communicable diseases such as cardiovascular disease and stroke account for another 50 percent of deaths.
5. Cardiovascular diseases are the leading cause of death in the world. 80 percent of all deaths are in developing countries. High-fat diets, inadequate physical activity and smoking account for this trend.
6. Population aging globally is contributing to the rise in cancer as well with lung cancer as the most common cause of death from cancer in the world. Tobacco use, it was estimated, is a major driver of mortality, accounting for 1 out of every 10 deaths globally.
7. Mental disorders such as depression along with hearing loss and vision problems are among the top 20 leading causes of disability worldwide.
8. Injuries from road traffic accidents are a top 10 cause of death globally and expected to be the fifth leading cause of death by 2050.

Africa. Almost three-quarters of the deaths in the developing regions of Asia and Western Pacific are now due to noncommunicable chronic diseases. Malaria and self-inflicted injuries such as suicides each account for approximately 1.4 percent of global mortality. Figure 1.3 shows the breakdown of global mortality for adults and children.

Eighteen percent of all deaths are in children less than five years of age, with more than 99.9 percent of these deaths occurring in developing countries, which constitute 85 percent of the global population. Nearly half of all deaths in Africa were in children age 15 and under (largely due to communicable diseases, malnutrition, and poverty) and only 20 percent of deaths were in people age 60 years and over. In contrast, in high-income countries, only 1 percent of deaths were in children under 15 years and 84 percent of deaths were in people age 60 years and older. Overall, the importance of child mortality to the disease burden is underscored by factoring in age of death; when years of life lostYLL is used as a mortality metric, the leading cause of death shifts to perinatal conditions, while noncommunicable diseases decrease significantly in their contribution to the global burden. Moreover, complications of pregnancy still account for almost 15 percent of deaths in women of reproductive age worldwide. Maternal morbidity and mortality rates vary among countries, and causes of high morbidity and mortality also vary.[16] Medical

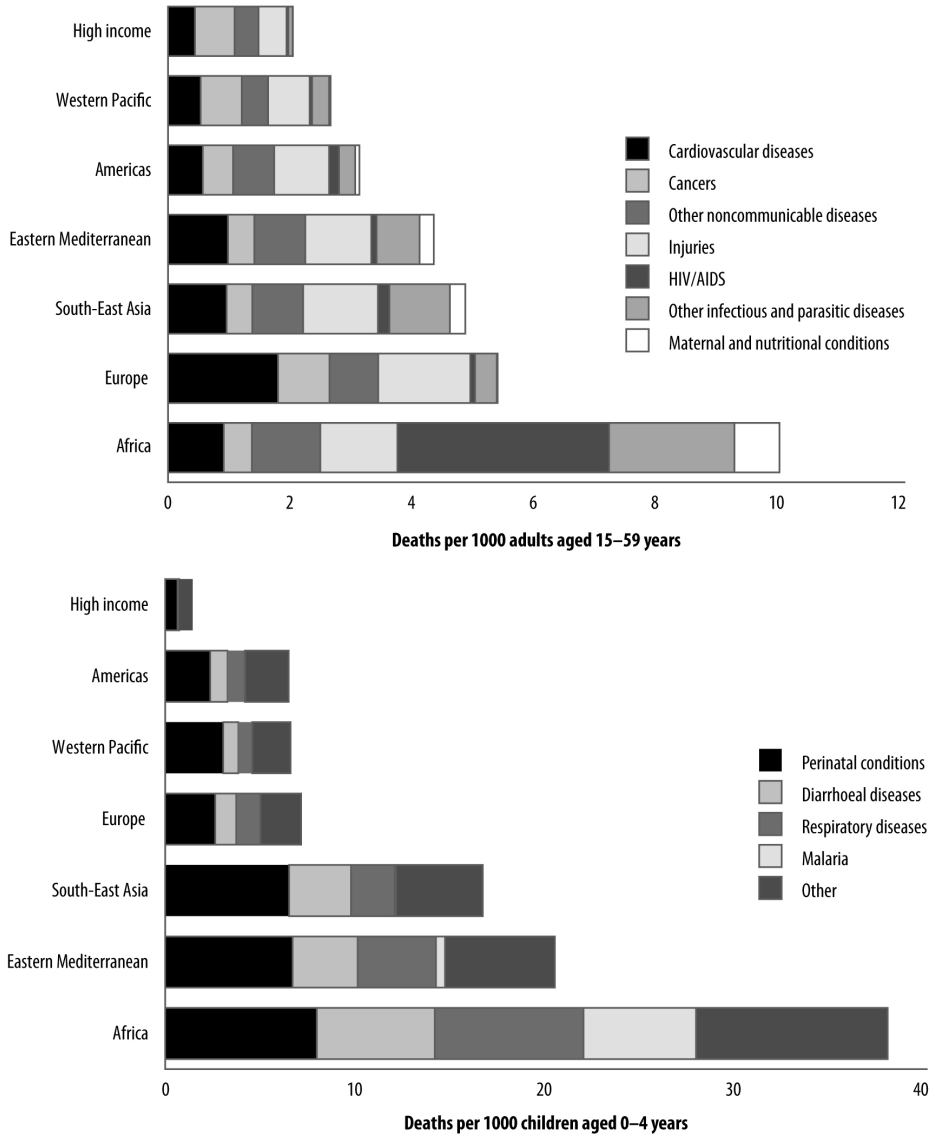

Figure 1.3 Adult (top) and child (bottom) mortality per 1000 persons. (Adapted from the 2004 WHO Global Burden of Disease.)

conditions such as hemorrhage, preeclampsia and eclampsia, obstructed labor, and complications after abortion are the primary causes of maternal death worldwide. In instances in which maternal mortality is greater than 20 per 100,000 live births, numerous nonmedical factors (such as socioeconomic, educational, and nutritional factors) usually compound the situation.[17] Although life expectancy gaps between countries, on average, have narrowed in the past 50 years, considerable variability remains in life expectancy within different social, economic, and cultural groups within countries.

Global Disease Burden

When DALYs are used to estimate the GBD, communicable diseases displace noncommunicable diseases as leading drivers of illness. Other nonfatal health outcomes emerge as important causes of disease burden: 60 percent of DALYs lost are due to premature mortality, while 40 percent are attributable to nonfatal health conditions. Globally, the two leading causes of DALYs lost are infectious diseases: lower respiratory infections and diarrheal diseases. The silent epidemic of unipolar depression is the third leading driver of DALYs lost worldwide, with the burden eighth in low-income countries and steadily rising in middle- and high-income countries. Ischemic heart disease and HIV/AIDS are the fourth and fifth leading drivers of the burden, respectively (see figure 1.3). Road traffic accidents are now the ninth leading overall cause of DALYs lost globally. The incidence of diseases related to tobacco smoking continue to rise, particularly in rapidly developing countries; chronic obstructive pulmonary disease (COPD) now ranks fifth as a cause of DALYs lost.

The greatest burden of disease is concentrated in Africa, where twice as many DALYs are lost as compared with any other region. More generally, across low-income settings, infectious diseases account for 8 of the top 10 diseases in these countries. A collection of infectious diseases including at least 13 parasitic, helminthic and bacterial infections (for example, lymphatic filiraisis, hookworm, and

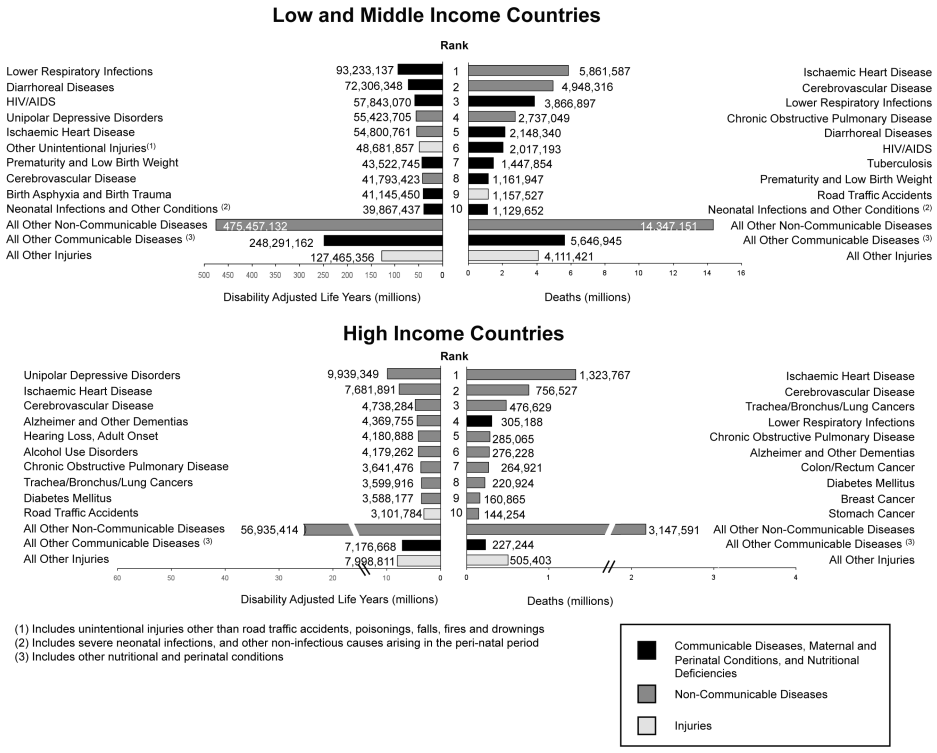

Figure 1.4 Burden of Disease in detail.

African river blindness) is a major cause of disability that often is not fatal but results in long-term disability and ill-health.

Risk Factors

The single leading global cause of health loss is undernutrition, responsible for 9.5 percent of the GBD, or more than 140 million DALYs. Underweight is almost exclusively a problem of low- and middle-income countries, where it is responsible for nearly 15 percent of the burden of disease in DALYs. Notably, an additional 15 percent of global DALYs lost are attributable to diet-related (overnutrition) risk factors, such as high blood pressure, high cholesterol, high Body Mass Index (BMI), heart disease, and low fruit and vegetable consumption. Among the other risk factors assessed (physical activity, addictive substances, environmental risks, and occupational risks), sexual and reproductive health is the second most important risk factor.

Unsafe sex, mainly linked to the prevalence of HIV-1 and other sexually transmitted diseases (STDs), is responsible for 6.3 percent of the GBD. The greatest burden of the risk of unsafe sex is concentrated in high-mortality, developing countries. The importance of undernutrition and unsafe sex as risk factors for disease is so staggering it is worth emphasizing; childhood and maternal underweight and unsafe sex in high-mortality developing regions of the world, which make up 38 percent of the global population, contribute as much to the loss of healthy life years as do all the injuries and diseases in the developed world combined.

In high-income countries, tobacco is a leading cause of the burden of disease (12.2 percent) along with other more proximal risk factors driving noncommunicable diseases and injuries: high blood pressure (10.9 percent), alcohol (9.2 percent), high cholesterol (7.6 percent), and high BMI (7.4 percent). Critically, these risk factors alone contribute more to the GBD than the most common noncommunicable diseases (heart disease, depression, and stroke), highlighting the major health gains that can be realized through vigorous risk reduction and preventive efforts.

Burden of Diseases within Countries

Although most of the WHO burden data are reported on a country level and not disaggregated by wealth quintile or ethnic group, tremendous inequality often exists in the distribution of diseases within a given country. Within-country burden data are included because this information is largely missing from the country-aggregated data that most commonly are associated with the burden. It is important to appreciate the critical role that social and economic circumstance, in addition to geography and gender, play in determining the distribution and severity of disease states.

As we have discussed, developing countries shoulder a disproportionate burden of the global share of disease. Likewise, within individual countries, the burden of disease in general falls inequitably on the poorer and less advantaged populations.[18] Several groups, most notably the WHO Committee on the Social Determinants of Health, have been vocal in highlighting these within-country health inequities. As an example of within-country differences in the distribution of disease, figure 1.5 shows the rate of under-five mortality across 4 countries (Brazil,

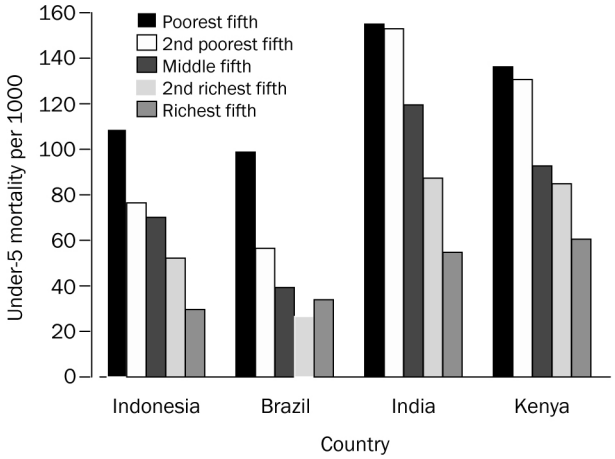

Figure 1.5 Under-5 mortality rates by socioeconomic quintile of the household for selected countries. (Adapted from Victora CG et al., Lancet, 2003.)

India, Indonesia, and Kenya). The mortality rate is over twice as high in the poorest quintile group than it is in the richest quintile group in all four study countries.[19] Such disparities, however, also are found in high-income countries such as the United States. In a landmark paper, McCord and Freeman found that mortality rates for African American males living in Harlem were at least twice the national average, and indeed, that these men were less likely than men living in Bangladesh to reach the age of 65.[20] Furthermore, diabetes and cardiovascular disease and their associated risk factors such as obesity show a general trend of higher incidence and prevalence in the lower socioeconomic quintiles.[21–23].

Indigenous populations may be at particular risk for a greater burden of disease than country averages. A recent study, for example, determined that indigenous Australians have a 60 percent higher disease burden (in DALYs) than the average for the white Australian population. Most of this additional burden is from increased susceptibility to noncommunicable diseases, to which indigenous Australians are 40 percent more susceptible than the white Australian average.[24]

PROJECTIONS OF THE BURDEN: WHAT WILL 2030 BRING?

Assuming that the trends continue, including enhanced control of communicable diseases and the increased diffusion of major risk factors for chronic diseases globally, WHO data have been used to project where the burden of disease will fall in the coming years.[3] As the recent pandemic threats of severe acute respiratory syndrome (SARS) and H1N1 swine flu) highlight, projections do not account for emerging infectious threats. Furthermore, these projections are rough and essentially are based on estimates of estimates. The data indicate that the collective burden of disease is projected to decline by 10 percent from 2004 to 2030 (1.53 billion DALYs to 1.36 billion) even with a population increase of roughly 25 percent over the same period. This represents a significant reduction in the global per capita burden. It is estimated that the decrease will be driven by global reduction in diarrheal

diseases, lower respiratory infections, and HIV/AIDS (drops from fifth leading cause to ninth leading cause of death). In 2030, the three leading causes of DALYs lost are projected to be unipolar depressive disorders, ischemic heart disease, and road traffic accidents. This is quite a change from 50 years ago.

In light of the increased risk factor development for chronic diseases, in terms of mortality, the four leading causes of death globally are projected to be ischemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, and lower respiratory infections. Large declines are projected for the main maternal, perinatal, and nutritional causes, including HIV/AIDS, TB, and malaria. Global HIV/AIDS deaths are projected to rise from 2.2 million in 2008 to a maximum of 2.4 million in 2012 and then decline to 1.2 million in 2030 (assuming coverage with antiretrovirals continues at present rates). Aging of the population in low- and middle-income countries also will increase deaths due tononcommunicable diseases in 2030. Cancers will rise from 7.4 million deaths to 11.8 million; cardiovascular deaths will rise from 17.1 million to 23.4 million deaths.

THE BURDEN AND THE DALY: WHAT ARE WE REALLY MEASURING?

What are the issues with the DALY? A common critique, though difficult to address, is the limitation of the raw data, which is uneven, and often unavailable for many countries.[4] Another issue is the decision to use a single disability weight across all regions of the world (with the assumption that paraplegia in Australia and Cameroon mean the same thing) discussed in a footnote 2.[12] A third issue is the failure of the DALY to capture comorbidities; In the United States, for example, 61 percent of women and 47 percent of men ages 70 to 79 suffer from at least two chronic conditions, and it is likely that these conditions together are a greater burden on the individual than each condition separately would be.[25] Likewise, in developing world populations polyparasitization can compound illness significantly. The main critique we explore below is that the DALY is more a measure of physical ill health than it is the actual burden of disease, which accounts for a much richer understanding of the social, economic, and communal aspects of the burden.

Anand and Hanson have argued that a real burden of disease metric should include calculations about the circumstances, stigmas, support services, incomes, family, and friends of individuals with the illness, rather than simply taking into account age and gender.[26] This expanded definition has important intervention allocation implications. For example, if the true economic cost of the lost productivity due to poor nutrition or parasitic diseases in early childhood were taken into account, de-worming or nutritional interventions targeting these vulnerabilities might acquire renewed significance on the global agenda. Many of the parasitic diseases, in particular, account for enormous losses in economic productivity, especially in agriculture, the most prevalent economic engine in rural parts of the globe. Pediatric infections in children with soil transmitted helminthes (hookworm) are associated with a reduction in education and school performance and attendance with adverse effects on future earnings that in aggregate can be considerable.[27] Yet, these social and economic parameters are not part of the estimation of the GBD in official reports.

The recent work done by the WHO Commission on the Social Determinants of Health has been crucial in bringing to the forefront the important contributions that the physical and social environment makes to health. Recognizing the considerable importance and contribution of the current GBD work, we hope that the future for GBD research and reporting will herald an increased accounting of the wider burden of disease, as well as the social protection approaches that can address these causes, rather than a focus on physical illness alone.

LEVERAGING THE BURDEN DATA FOR POLICY CHANGE: HOW IS IT USED?

The GBD and especially the DALY have been used to highlight existing gaps and realign prioritization of health care expenditures—the mostly revealing of which is that, when compared with their global impact, noncommunicable diseases traditionally have been underfunded.

Overall, noncommunicable chronic diseases receive about $3 per annual death compared with $1,030 per death for HIV from the World Bank, Bill & Melinda Gates Foundation, the U.S. government, and the Global Fund, as shown in figure 1.6, constituting less than 0.01 percent of overseas donor assistance (ODA).[28, 29]

Injuries and violence, expected to become the fifth leading cause of death in 2030, receive less than 1 percent of WHO funds. Nearly 87 percent of the WHO budget was directed toward combating communicable diseases, with about 12 percent going toward noncommunicable diseases.[30] Worldwide, ODA by donor countries for the reduction in tobacco use was a paltry $2.3 million.[30] No one should argue that less funds be directed toward the prevention and treatment of infectious diseases;

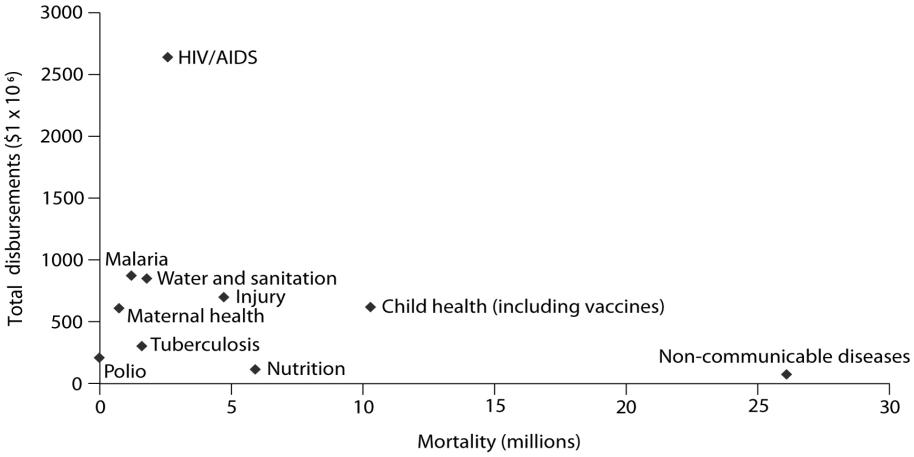

Figure 1.6 2001 worldwide mortality versus 2005 disbursements of World Bank, US Government, Bill & Melinda Gates Foundation, Global Fund to Fight HIV/AIDS, Tuberculosis and Malatia. Note: Health systems funding is not included in figure. (Adapted from Sridhar D et al., Lancet, 2008.)

yet, it is now painfully clear that more funds should be applied to chronic diseases—if only to mitigate the ongoing epidemic of chronic diseases in the future.

To address these misalignments between the GBD and public health spending, activists (including students) are working to make access to treatment and essential medicines reflective of the priorities outlined by the data. The striking uptake of life-saving cholesterol-lowering statin drugs, now a WHO essential medicine,[31] is a useful example of the progress that can be made. Large gains in statin utilization have been observed across Europe (from 4.6 percent to just over 55 percent in the Czech Republic in the 12-year interval since 1995 and 2007 associated with substantial reductions in serum cholesterol levels).[32] Increased secondary and high-risk primary prevention efforts as well as increased availability of cardioprotective medicines certainly have contributed to this achievement. Currently, discussions are ongoing to implement and promote access to an inexpensive, low-dose "polypill" (containing an aspirin, diuretic, beta blocker, and a statin), which is now in Phase IIb clinical trials with an estimated cost of $12 per patient per year ($0.03 per day).[33] As noncommunicable disease prevalence surely will continue to rise, it is essential to provide international funding to these important prevention programs.

Yet, if there is any doubt that infectious diseases are somehow no longer important, we have failed in our presentation. These diseases continue to pose huge threats to millions around the globe. Hookworm, for instance, infects upwards of 1 billion people—many of whom who live on less than $1 per day.[34] A collection of diseases, including the neglected tropical diseases (NTDs) along with the so-called Big Three (HIV/AIDS, TB, and malaria), requires constant surveillance and elimination measures to reach the eradication milestones of smallpox and guinea worm. Drugs for hookworm, as an example, cost as little as $0.50 per year per patient and can be adapted for inclusion in rapid high-impact packages with malaria control, making these interventions cost-effective.[34]

The challenge, then, is how best to deal with the double burden of disease. It is rapidly becoming clear that the best way forward is to invest in strengthening health systems. This is no small task. In Tanzania, there is1 doctor forevery 42,000 people, compared with 1 doctor per 500 people in the United States. Currently, more Ethiopian-trained physicians practice medicine in Chicago than in all of Ethiopia.[35] Nevertheless, the calls to actualize the Alma Ata Declaration made 30 years ago to scale up primary care are being heard.[36] Recently, the major global donors have begun to take action. The Global Fund for HIV/AIDS, TB, and Malaria has added a health systems categoryintended to fund infrastructure and cross-sectoral strengthening to improve fractured systems (including sustainable financing) as well as to provide a well-trained health workforce, ensure reliable access to medical products and technologies, and create a robust information system.[37, 38] Aligning health systems with priorities in the burden, including developing a primary care essential package of medicines, vaccines, and diagnostics, is rather complex and will be highlighted by other chapters in this volume.

Intriguingly, the persisting dual burden is opening all sorts of new research questions, including whether infectious diseases and malnutrition can drive noncommunicable diseases. Currently, it is estimated that just over 20 percent of cancers are infectious in origin (for example, human papillomavirus and cervical cancer). Conversely, chronic diseases themselves may predispose one to infectious

disease; a recent report shows that diabetic patients are at increased susceptibility to TB.[38] The links between chronic and infectious disease are many, from malnutrition to obesity, viruses to cancer, and infections to heart disease. The result is that poorer populations are at significantly higher risk of developing infectious diseases and also are at higher risk of suffering and dying from chronic diseases as they age.

The explosion of noncommunicable chronic diseases worldwide and the existing burden of communicable diseases pose a significant threat to the public's health. Now more than ever, the world needs continued investments in health interventions that are based on a sophisticated understanding of determinants of health and disease. Central to improving health is a better understanding of the distribution of disease both globally and locally and an improved reporting and surveillance that can direct interventions where and when they are most needed. Imagine a world in which community-trained health workers and volunteers can leverage technologies such as mobile phones, personal digital assistants, and online portals to report on disease incidence and prevalence in real time—a global mapping of disease. Although this is happening in bits and spurts, the incredible proliferation of information technology coupled with other advancements in public health just may make it possible for this century to be the one in which the greatest strides are made toward improving health in developed and developing countries alike.

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