



## The Story So Far

*He who has health has hope  
He who has hope has everything.*  
—Arabic proverb

**Health lies at the heart of human development. Our most basic personal and collective decisions reflect our wish to live long, comfortable, and active lives. Yet, for most of human history, the average person's life has been difficult, constrained, and short. When John Graunt first constructed the *Bills of Mortality* for the city of London in 1650, he found that life expectancy was about 27 years (Graunt 1662).<sup>1</sup> In general, up to the time of the industrial revolution in Great Britain, human life displayed a Malthusian pattern of high mortality with transitory deviations, upwards in times of plenty and downwards in times of want or plague.<sup>2</sup>**

Since the mid-1700s, however, there has been incredible ongoing advance in human health—Great Britain itself has gained more than one year of life expectancy for every

seven calendar years since 1650. Extensions in the length and quality of life first moved across Europe. Especially since World War II, health improvements have spread throughout the world, and the pace has advanced further. Global life expectancy rose from 46 years in 1950 to 69 years in 2007.<sup>3</sup>

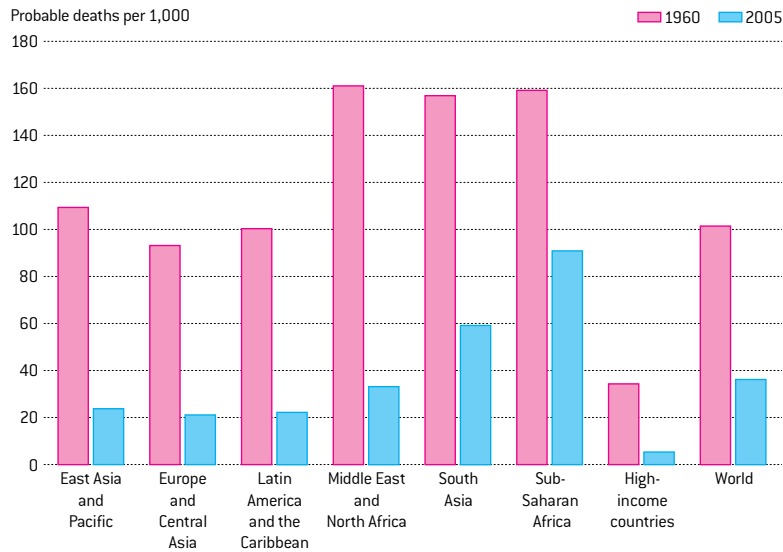
This volume explores the story of changes in human health as it might continue to unfold in coming decades. We consider also the variations in that possible story, many associated with human choices. This chapter introduces the foundations of the story and our approach to elaborating it.

### **Recent Progress and Significant Challenges**

Consider what the world has accomplished in recent decades and the challenges that remain, beginning with infant and child mortality. A major reason behind the low life expectancy in Graunt's London was that about 300 per 1,000 children died before the age of five. Between

● *Since World War II, health improvements have spread across the world at an unprecedented pace.* ●

**Figure 1.1 Infant mortality rates by region (1960 and 2005)**



*Note: Infant mortality refers to children dying before their first birthday; the rates are deaths per 1,000 live births. Throughout this volume, unless otherwise noted, regions are the World Bank geographical groupings of developing countries plus a single high-income category; see Box 4.2 for discussion of country groupings and volume Appendix for lists of region members.*

*Source: IFs Version 6.32 using data from the World Bank's World Development Indicators (hereafter referred to as WDI).*

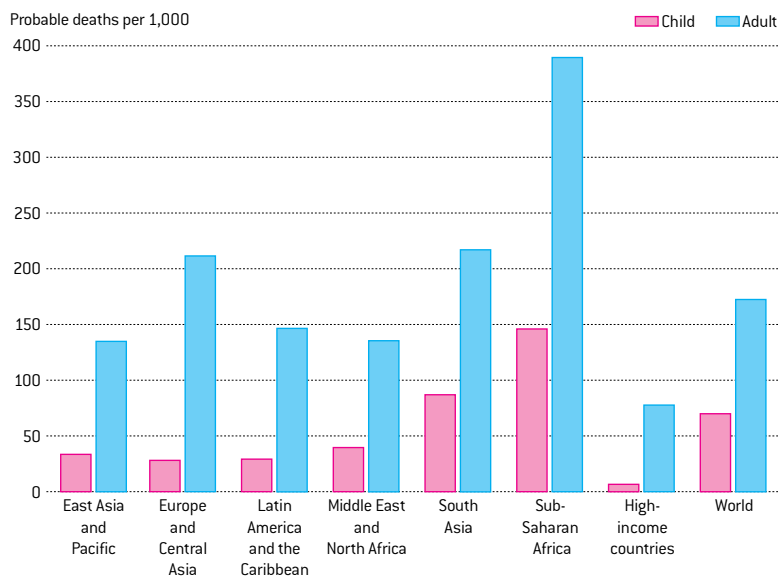
1950 and 2006, however, the world's infant mortality rate dropped from 153 to 36 deaths per 1,000 (see Figure 1.1 for regional progress since 1960), and the number of children who die before reaching five years of age has fallen to about 70 per 1,000. This global pace of improvement is unprecedented.

Still, global health problems remain daunting. We estimate that in 2005 about 10.1 million children died before their fifth birthdays, with 99 percent of those deaths occurring in developing countries. That distribution of child deaths illustrates a critical health issue: the great disparity that exists in health prospects across the regions of the world (see Figures 1.1 and 1.2). Had children in poorer countries died at the same rate as those in high-income countries, there would have been about 9 million fewer child deaths (out of the about 10 million globally). The distributions of deaths within countries are also very unequal across income, education, ethnicity, and other social divisions (CSDH 2008: 29).

Communicable diseases claimed about 17 million lives globally in 2005, and they accounted for the vast bulk of child deaths. The communicable disease burden for adults and the elderly is also large. The AIDS epidemic (accounting for about 2 million deaths) heavily affects adults; it lowered life expectancy in all of sub-Saharan Africa by 0.25 years between 1990 and 2000 and contributed to declines of more than 14 years in Botswana and 15 years in Zimbabwe. AIDS is not, however, the only culprit in such setbacks—even with low HIV rates, countries such as Afghanistan and Sierra Leone have experienced recent sustained declines in life expectancy, largely attributable to conflict, political disorganization, and the eventual unwinding of disease control mechanisms (Jamison 2006).

Noncommunicable diseases were responsible for about 32 million deaths globally in 2005; injuries killed another 5 million, and those deaths are rising rapidly with the spread of vehicle ownership. These categories are the primary causes of the death of adults, and they are by far the largest killers in high-income countries. Many developing countries, however, increasingly face a double burden of premature deaths—unnecessarily high rates of both communicable and noncommunicable diseases.

**Figure 1.2 Probability of child and adult mortality by region (2005)**



*Note: Child mortality is expressed as the number of children per 1,000 expected to die before their fifth birthday, assuming current age-specific death rates; adult mortality is expressed as the number of 15-year-olds per 1,000 expected to die before age 60, assuming current age-specific death rates.*

*Source: IFs Version 6.32 using data from multiple sources (see Chapter 3).*

In combination, differences in child and adult mortality probabilities (see Figure 1.2) create a nearly 28-year gap in life expectancy between sub-Saharan Africa and the high-income countries of the world.

A substantial burden of unnecessary mortality and disability also remains in high-income countries. As Figure 1.2 shows, in those countries—where death before the age of retirement is now considered very premature—77 of 1,000 15-year-olds still die before reaching their 60th birthdays. Great effort and investment flow into extending life expectancy everywhere and at all ages, and the story of disease and mortality decline is, hopefully, far from over.

### Understanding the Story So Far

Abdel Omran’s theory of the epidemiologic transition (Omran 1971) elegantly describes the story of modern improvements in global health. According to this theory, societies experience a transition from high to low levels of population mortality risk concurrent with processes of economic, social, and political development (see Figure 1.3). Economic and educational progress is viewed as resulting in better public health, and vice versa. In other words, the theory asserts that the epidemiologic transition is not merely a result of economic and social change but very much an integrated, dynamic part of it. And in fact, considerable evidence suggests the profound shift from omnipresent mortality risks to delayed and more predictable risks is essential to broader processes of social and economic transformation, including fertility decline, educational investment, better health throughout the course of life, and economic growth (Fogel 1994; Fogel and Costa 1997; Sen 1985; 1987; 1998).

To summarize the health impacts of the epidemiologic transition very briefly, its early stages involve a reduction in infectious and communicable diseases, such as diarrheal and respiratory infections, which largely affect young children and other vulnerable populations. The resulting increased survival of children through the highly vulnerable years of early childhood sets the stage for the large majority of most populations to survive well into adulthood, absent high levels of exposure to violence, accidents, infections of adulthood such as HIV/

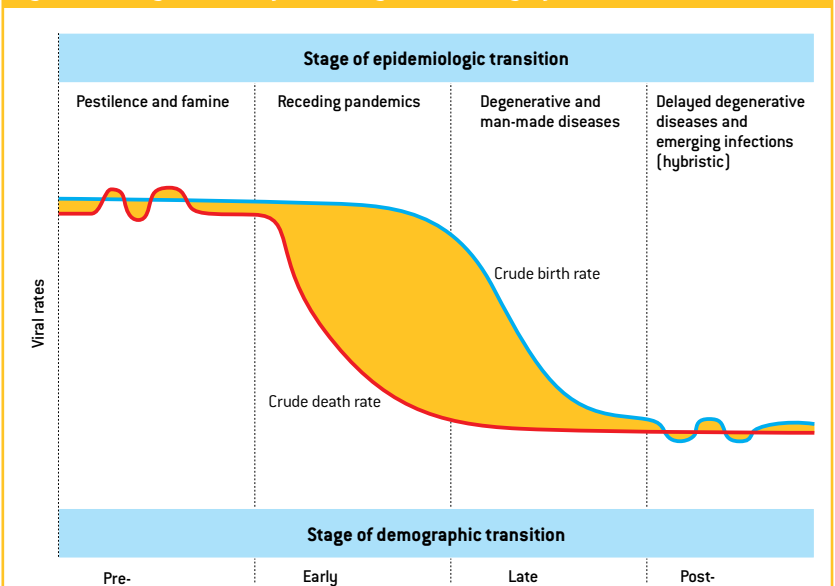
AIDS, or the early onset of chronic disease. Thus, the epidemiologic transition implies a shift in the predominant causes of death and morbidity to noncommunicable conditions such as cardiovascular disease, diabetes, and cancer, mostly affecting people at older ages and creating new and different health challenges for society (Omran 1971; Yach et al. 2004).

Near the end of his life, Omran revisited his original 1971 three-stage representation of the epidemiologic transition and added fourth and fifth stages (Omran 1998). He observed a fourth stage (which developed countries began to reach in the 1970s), in which mortality from certain noncommunicable diseases (notably cardiovascular diseases at that time), began to level off and then to decline due to changes in behavior and in medical practice. Omran also envisioned a fifth stage, in which medical advances and declining health differences across social groups could further boost life expectancy, potentially also creating a variety of social challenges associated with prolonged morbidity.<sup>4</sup>

Almost all countries are at least well into the stage of receding communicable disease pandemics, and conditions have rapidly converged in recent decades for all but a small number of countries. For example, in 1950 the gap in life expectancy between the median

■ *Despite remarkable global improvements, great disparity remains in health prospects across the regions of the world and across social groups within countries.* ■

**Figure 1.3 Stages of the epidemiologic and demographic transitions**



Source: Rockett (1999: 9). Copyright 1999 by Population Reference Bureau, Inc.; reproduced with permission of Population Reference Bureau, Inc.

● The epidemiologic transition describes changes in health risks and patterns as societies experience the demographic, economic, and social changes that characterize development. ●

country and the country at the 75th percentile stood at about 20 years (45 years to 65 years). By 2000, the margin separating them was a mere five years (69 years to 73 years), and life expectancy in countries at the 25th percentile was 64 years (Jamison 2006). Put another way, people in the world's poorer countries in 2000 were longer-lived than those in wealthier countries of 1950.

Still, very significant gaps remain in health between countries (see again Figures 1.1 and 1.2). At one end, fewer than three of 1,000 infants in Japan die in the first year of life, and a female child born in today's Japan can expect to live 86 years, a level well past what was once thought to be a hard limit to the human life span (Fries 1980), continuing the quite steady growth in life expectancy of women in "best practice societies" (see Figure 1.4).<sup>5</sup> At the other end of the spectrum, in sub-Saharan Africa, more than 90 of every 1,000 infants die in the first year of life, and a female child born in today's sub-Saharan Africa can expect to live only 53 years. And even as we celebrate the tremendous global gains against communicable diseases, we are confronted with the HIV/AIDS epidemic, some endemic diseases, and the possibility of other new or reemerging communicable diseases.

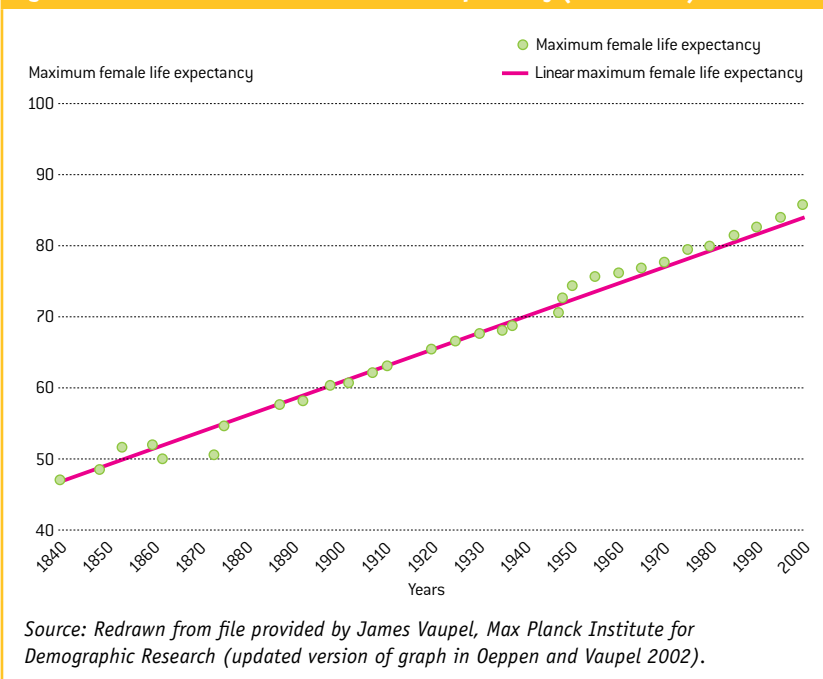
## Understanding and Shaping the Story Going Forward

Debates over what determines the health status of individuals and of populations tread on some of the most contested questions of our times, including "nature versus nurture," "individual versus state," and "optimist versus pessimist" (Kunitz 1987; Oeppen and Vaupel 2002). More concretely, some analysts argue that advances in economic growth inevitably lead to longer, healthier lives (McKeown 1976; Pritchett and Summers 1996). The epidemiologic transition might suggest such a relatively automatic process, and economic growth and other deep-driving variables—often called the *distal drivers* of health outcomes—are, in fact, very powerful.

Still, these distal drivers of health leave considerable unexplained variation in health outcomes across countries (Cutler, Deaton, and Lleras-Muney 2006; Preston 1975). Largely preventable diseases continue to kill millions of people each year. Malaria and type 2 diabetes, for instance, do not require expensive or sophisticated cures—the widespread use of bed nets could dramatically decrease malaria, while dietary changes could prevent many cases of type 2 diabetes. Recognizing uncertainties around these and other more immediate causes of health outcomes—typically referred to as *proximate drivers* (which the distal drivers affect but do not fully determine)—alerts us to the substantial difficulties inherent in any attempt to forecast health outcomes. Indeed, the focus of most modern global health action lies with addressing many of these proximate drivers through vaccination, disease eradication, and delivery of basic disease-prevention services, including health education.

Even with the identification of distal and proximate drivers, the picture of changing health remains incomplete. Much of what we want to understand about change in the distal and proximate drivers and the relationships among and between them lies still deeper, at the level of what might be called *super-distal drivers*. Human activity that builds this still-deeper context includes such things as technological advance; human-based change in the natural environment and our exposure to it (including water and sanitation systems, air pollution, and climate change); and change within the social environment (including the development and

**Figure 1.4 Trends in maximum female life expectancy (1840–2000)**



character of health care systems and even the maintenance of efficient markets that may lower drug prices).

Human agency around health often has the aim of providing or acquiring private goods (such as in the doctor-patient relationship). Much conscious and positive collective action, however, is motivated by the fact that a great many advances in health tend to have characteristics of public goods (that is, consumption by one does not preclude consumption by others, and denial to others is difficult). Moreover, there can be many positive social externalities from the good health of others, not least of which is less risk of infection to ourselves. Complicating the organization of human action concerning health is frequent struggle, such as that around intellectual property rights for new drugs or vaccines, over how to draw legal lines between private- and public-good characteristics. Globalization processes, including the spread of smoking and of fast and fatty foods and their obvious negative health consequences, further complicate the private-public debates and push a still broader set of health issues onto the potential global agenda.

A global health agenda has emerged and become more organized and explicit over time, beginning with the statement in the 1948 United Nations Declaration of Universal Human Rights of the right of all peoples to a standard of living adequate for health. A landmark initiative to further human health occurred that same year when the United Nations established the World Health Organization (WHO), whose objective, as stated in its constitution,<sup>6</sup> is the “attainment by all peoples of the highest possible level of health.” WHO pursues these goals through coordinating and collaborating with its 193 member governments and other multilateral agencies, by providing technical support, and by developing and maintaining global data systems. While responsive to and financially dependent on its membership, WHO’s constitution also mandates a normative role for the organization in developing global health policy (Magnusson 2009; Ruger and Yach 2008/2009). This increasingly includes the use of legal and regulatory mechanisms—such as the legally binding International Health Regulations for communicable disease

surveillance and the 2003 Framework Convention on Tobacco Control—to encourage compliance with international health norms and agreements (Aginam 2002; Magnusson 2009).

While WHO has the key formal leadership role with respect to the global health agenda, global health initiatives reflect a multitude of actors, approaches, and targets (Bettcher, Yach, and Guindon 2000; Brundtland 2004; McMichael 2000). The constituents of what is increasingly referred to as the “global health governance regime”—WHO, private donors and organizations (both formal and informal), and governments and other public entities—have developed a number of global health goals that offer some guideposts for our analysis. The earliest of these goals was the Alma Ata Declaration of 1978, which focused on primary health care and promised “health for all by the year 2000.” However, the Alma Ata Declaration offered few measurable objectives.

The global community incorporated a more explicit range of objectives into the Millennium Development Goals (MDGs) for 2015. The explicit MDG health goals include the reduction of infant and child (under-five) mortality rates by two-thirds relative to 1990 and of maternal mortality rates by three-fourths, as well as halting and then reversing growth in the incidence of HIV/AIDS, malaria, and other major diseases (such as tuberculosis). Other MDGs include targets or indicators with respect to proximate health drivers: the MDG for the eradication of extreme poverty and hunger calls for cutting in half between 1990 and 2015 the prevalence of underweight children and the proportion of the total population without access to adequate calorie intake, and the MDG for environmental sustainability calls for a 50 percent reduction in those without access to safe drinking water and improved sanitation over the same period.

The final report of a recent WHO commission, the Commission on Social Determinants of Health (CSDH 2008: 197), has more recently called for goals that both extend the time horizon to 2040 and that focus on the equitable distribution of health outcomes, as exemplified by reducing variations in life expectancy at birth (LEB) within and across countries. With respect to extension of the horizon of existing goals, the Commission urged that all countries reduce the under-five mortality rate by 90 percent between

■ *A complex interplay of underlying (“distal”) and more immediate (“proximate”) causes or drivers determine health outcomes.* ■

■ *Human activity with respect to technology, the natural environment, and the social environment is a powerful “super-distal” driver of health.* ■

■ *A global health agenda has emerged over the last several decades and is becoming increasingly organized and explicit.* ■

● *The Millennium Development Goals include ambitious targets for health outcomes by 2015.* ●

● *The recent Commission on Social Determinants of Health has added goals that focus specifically on the equitable distribution of health outcomes by 2040.* ●

● *This volume sets out to tell a story of possible futures for the health of peoples across the world, using the International Futures integrated modeling system.* ●

2000 and 2040 and the maternal death rate by 95 percent. With respect to new goals, the Commission urged reducing adult mortality rates in all countries and in all social groups within countries by 50 percent between 2000 and 2040 and reducing by 10 years the gap in LEB between the thirds of countries with the highest and lowest LEB values in 2000 (we estimate the 2000 gap was almost 19 years).

### **Why This Volume?**

Looking forward, not only to the horizons of such goals but also well beyond them, major uncertainties complicate forecasting. A great debate rages about the biological potential of the human genome for continued advance in life expectancy at historical rates, and we certainly cannot rule out major new disease epidemics. A very large portion of our uncertainty, however, revolves around human action—for instance, the advance of our technology, the strength of our health care systems, our will and our access to means to change unhealthy lifestyles, the progress and character of globalization processes, and the extent and impact of environmental change, including air pollution and global warming (Fauci 2001; McMichael, Woodruff, and Hales 2006).

In spite of the complications, we deem the forecasting endeavor necessary. Forecasting helps shape goals that can be attained and then to direct action to them. It helps us anticipate and avoid negative scenarios and decisions that result in misdirected resources. It can also provide insight into the broader economic and social consequences of alternative health futures.

Thus, this volume sets out to tell a story of possible futures for the health of peoples across the world. While recognizing that any modeling approach has many inherent limitations, our dynamic tools allow us to address policy-relevant questions facing countries with differing disease burdens:

- What health outcomes would we expect given current patterns of human development?
- What opportunities exist for intervention and the achievement of alternate, improved health futures?
- How might alternative health futures affect broader economic, social, and political prospects of countries, regions, and the world?

The central tool in the analysis and forecasting of this volume, as in the earlier volumes of the Patterns of Potential Human Progress series treating poverty reduction and advance of education, is the International Futures (IFs) global modeling system. IFs is a computer software tool whose central purpose is to facilitate exploration of possible global futures through the creation and analysis of alternative scenarios. It includes an extensive database for 183 countries for the time period from 1960 to the present. In addition to health, the IFs system incorporates models of population, economics, education, energy, food and agriculture, aspects of the environment, and socio-political change and represents dynamic connections among them. Its interactive interface makes data and scenario analysis relatively straightforward. Chapter 3 will provide considerably more detail concerning the system (and at [www.ifs.du.edu](http://www.ifs.du.edu) we make IFs fully and freely available for use on the web or for download).

Our own health forecasting model within IFs depends heavily on the groundbreaking work of the WHO's Global Burden of Disease (GBD) project.<sup>7</sup> That project, whose first major report appeared in 1996,<sup>8</sup> set out to “provide a comprehensive set of estimates not only of number of deaths by cause but also of total disease burden including [the] burden from disability” (Jamison 1996: xvi). In fact, its forecasts have been the only published global forecasts of regional and cause-specific health outcomes to date (Mathers and Loncar 2006; WHO 2008a). The GBD project has been foundational to our work, and we discuss it at some length in Chapters 2 and 3.

The GBD founders did not, however, design their system to serve as a long-term integrated forecasting tool. Although the GBD project is currently preparing to look further ahead, its most-recent available analyses extend to 2030, now only 20 years distant. Its health forecasts rely on the exogenous input of other forecasts of population and economic growth and do not link health outcomes back to those systems in the feedback loops that we understand to characterize and give dynamic life to the epidemiologic transition. And although WHO has also given rise to the Comparative Risk Assessment project (Ezzati et al. 2004a), a

groundbreaking effort mapping key proximate drivers of health and analyzing the impact of reducing health risk factors, the GBD project forecasts rely almost exclusively on three distal drivers of health—income, education, and time (the GBD project treats time primarily as a proxy for technology). As foundational as those distal drivers are, it is attention to proximate drivers that provides most direct leverage of societies on health outcomes. Finally, the GBD forecasts involve limited scenario analysis of the wide range of uncertainty we know to characterize health futures.

In an effort to contribute to the understanding of potential global health futures, we build on and extend the work of the GBD project in a number of ways. The first is time horizon. While accuracy necessarily falls with extended projections, we forecast mortality out to the year 2100 for a number of reasons. One is the recognition that the ongoing epidemiologic transition is a fundamental element of the long-term demographic transition and will help shape the timing and peak of that transition. Another is that longer-term processes (such as global warming) may play an increasingly important part in health futures. More technically, looking at the results of forecasting with models in the longer term helps in understanding their structure and behavior even in the nearer term. Most fundamentally, however, we believe that the global community needs to begin looking and planning well beyond the horizon of the MDGs, at least to the 2040 horizon of the Social Determinants of Health analysis. In this volume we display results primarily for 50 years, to 2060.

Second, although the GBD project's analysis extends to the country level, its published results typically do not. IFs analysis is based at the country level and allows flexible aggregation of country-based results to any country grouping, including those of WHO. The forecasts associated with this volume (including the extensive end tables) add considerably to available health forecasts—in fact, they may be the only health forecasts to which many countries will have access.

Third, we build further on the important work done by GBD authors by embedding mortality and morbidity patterns within larger global systems. In Chapter 4 we explore expected health

futures under various conditions of economic growth, education attainment, and technological advance. In Chapter 7 we close the loops and consider the implications of alternative health futures for demographic, economic, and other key human systems. This integrated approach begins to allow a dynamic consideration of the entire human development system around health. Ultimately, a clearer picture of the feedback loops around health, population, and economic factors should allow better understanding of the costs and benefits of intervention, hopefully leading to improved policymaking and better human development outcomes.

Although by no means complete, a fourth way in which we go beyond earlier forecasting is via the important work of beginning to integrate the analysis of proximate drivers into the health forecasting system, resulting in a hybrid health modeling approach that Chapter 3 presents. Health futures for individual countries and the world could be quite significantly different, depending on human action with respect to key behavioral and social factors such as malnutrition, obesity, smoking rates, the extent of improved water and sanitation systems, and indoor or outdoor air pollution. Variation around the world on such proximate drivers is often extremely great, even after controlling for income levels. This suggests much leverage for health-related intervention, which Chapters 5 and 6 explore. Chapter 5 also considers the impact of different futures with respect to vehicle ownership and accident rates, and Chapter 6 further considers the impact of climate change.

The fifth extension of past efforts to forecast global health builds on the individual proximate-driver analyses of alternative potential patterns of health. Clearly, if human leverage is significant on many individual proximate drivers (as well as on the deeper drivers themselves), the aggregate of variation possible in health futures must be very substantial. We map some of that aggregate variation, the space of uncertainty for health futures, returning in doing so also to the uncertainty that surrounds the biological base of health prospects (in our genome and the evolution of pathogens). In Chapter 8 we also consider how our forecasts, rooted in the core GBD model, appear to sit within that space—how optimistic or pessimistic are they?

■ *Analysis with IFs extends the health forecast horizon to 2060 for 183 countries, combining distal, proximate, and super-distal drivers in the analyses.* ■

■ *IFs also explores health futures as they dynamically affect, and are affected by, economic growth scenarios and other components of human development systems.* ■

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## Conclusion

Considering the fundamental importance of health to humans, it may seem surprising that there has been little forecasting of alternative global health futures. Chapters 2 and 3 will make clearer why that is (for instance, only in recent years have the data become available that enable us to understand even the global health present). And, of course, the wide range of factors that disable or kill us, and the great extent of forces that strengthen or diminish

their roles, greatly complicates understanding of possible change. The modeling and analyses that underlie this volume therefore build on a foundation that has been built by others, slowly and laboriously. Our hope is that the dynamic representation of longer-term futures that is the heart of the IFs system will contribute to the understanding of the possible stories of continuing change in global health and to its continued improvement.

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- 1 Wrigley and Schofield (1981) estimated that life expectancy for the United Kingdom in 1700 was about 37 years at birth.
  - 2 Galor and Weil 2000; Oeppen and Vaupel 2002; Preston 1976. The first recorded systematic improvements in human survival were observed among noble populations in Britain in the mid-17th century and population-wide around 1750 (Fogel 1994; Riley 2001; Wrigley and Schofield 1981).
  - 3 Value for 1950 from United Nations Population Fund 1999; 2007 value from World Bank 2009.

- 4 Martens (2002) has also considered developments beyond the third stage, either in the form of an age of “sustaining health” or an age of medical technology. Simultaneously, Martens has also considered the possibility of a new age of emerging infectious diseases.
- 5 Life expectancy for men also typically advances in these societies, of course, but frontier analysis normally focuses on women since women’s life expectancies are typically longer than men’s in today’s societies.
- 6 Available at [http://www.who.int/governance/eb/who\\_constitution\\_en.pdf](http://www.who.int/governance/eb/who_constitution_en.pdf).

- 7 We especially appreciate the generosity of Colin Mathers, Mortality and Burden of Disease Coordinator, Department of Health Statistics and Informatics, World Health Organization, who shared with us the equations and much of the data used in the forecasting work of the GBD project.
- 8 The 1996 report included estimates for 1990 and projections for 2000, 2010, and 2020.