

# Health Determinants, Measurements, and Trends

## LEARNING OBJECTIVES

By the end of this chapter the reader will be able to:

- Describe the determinants of health
- Define the most important health indicators and key terms related to measuring health status and the burden of disease
- Discuss the concepts of health-adjusted life expectancy (HALE), disability-adjusted life years (DALYs), and the burden of disease
- Describe the leading causes of death and the burden of disease in low-, middle-, and high-income countries
- Describe the leading risk factors for key causes of death and the burden of disease in low-, middle-, and high-income countries
- Describe the demographic and epidemiologic transitions

## VIGNETTES

Shawki is a 60-year-old Jordanian man who lives in Jordan's capital of Amman. Unfortunately, Shawki's health has deteriorated in the last year. His blood pressure and cholesterol are too high. He has developed diabetes. He is sometimes short of breath. What are the causes of his ill and declining health? Do these problems stem from any genetic issues? Could they come from a lack of understanding about a healthy lifestyle and diet? Could it be that Shawki lacks the income he needs to eat properly and to ensure that he gets health checkups when he needs them?

Life expectancy in Botswana prior to the spread of HIV/AIDS was about 65 years.<sup>1</sup> In 2013, life expectancy in Botswana was 47 years.<sup>2</sup> Life expectancy in Russia in 1985 was about 64 years for males and 74 years for females. It

then fell by 2001 to about 59 years for males and 72 years for females,<sup>3</sup> before rising again by 2013 to 64 for males and 76 for females.<sup>2</sup> What does life expectancy measure? What are the factors contributing to its decline in both of these countries? What has happened to trends in life expectancy in other countries? Which countries have the longest and shortest life expectancies, and why?

In Cambodia in 2012, families had, on average, 3 children, and their life expectancy was about 62 years.<sup>4</sup> Thirty years ago, the demographic and epidemiologic profile of Thailand looked a lot like Cambodia looks today. In 2012, however, Thai families had on average about 1.6 children and those children on average will live 74 years.<sup>4</sup> What causes these shifts in fertility and mortality? Do they occur consistently as countries develop economically? How long will it take before Cambodia has the same fertility and disease burden that Thailand has today?

In Peru, poor people tend to live in the mountains and be indigenous, less educated, and have worse health status than other people. In Eastern Europe, the same issues occur among their ethnic groups that are of lower socioeconomic status, such as the Roma people. In the United States, there are also enormous health disparities, as seen in the health status of African Americans and Native Americans, compared to white Americans. If one wants to understand and address differences in health status among different groups, then how do we measure health status? Do we measure it by age? By gender? By socioeconomic status? By level of education? By ethnicity? By location?

## THE IMPORTANCE OF MEASURING HEALTH STATUS

If we want to understand the most important global health issues and what can be done to address them, then we must understand what factors have the most influence on health status, how health status is measured, and what key trends in health status have occurred historically. We must, in fact, be able to answer the questions that are posed in the narratives at the beginning of the chapter.

This chapter, therefore, covers four distinct, but closely related topics. The first section concerns what are called “the determinants of health.” That section examines the most important factors that relate to people’s health status. The second section reviews some of the most important indicators of health status and how they are used. The third section discusses the burden of disease worldwide and how it varies across countries. The last section looks at how fertility and mortality change as countries become more developed and what this means for the types of health problems countries face.

## THE DETERMINANTS OF HEALTH

Why are some people healthy and some people not healthy? When asked this question, many of us will respond that good health depends on access to health services. Yet, as you will learn, whether or not people are healthy depends on a large number of factors, many of which are interconnected, and most of which go considerably beyond access to health services.

There has been considerable writing about the determinants of health, and one way of depicting these determinants is shown in **Figure 2-1**. This next section largely follows the approach to the determinants of health that is discussed in *What Determines Health* by the Public Health Agency of Canada.<sup>5</sup>

The first group of factors that helps to determine health relates to the personal and inborn features of individuals. These include genetic makeup, sex, and age. Our genetic makeup has much to do with what diseases we get and how healthy we live. One can inherit, for example, a genetic marker for a particular disease, such as Huntington’s disease, which is a neurological disorder. One can also inherit the genetic component of a disease that has multiple causes, such as breast cancer. Sex also has an important relationship with health. Males and females are physically different, for example, and may get different diseases. Females face the risks involved in childbearing. They also get cervical and uterine cancers that males do not contract. Females also have higher rates of certain health conditions, such as thyroid and breast

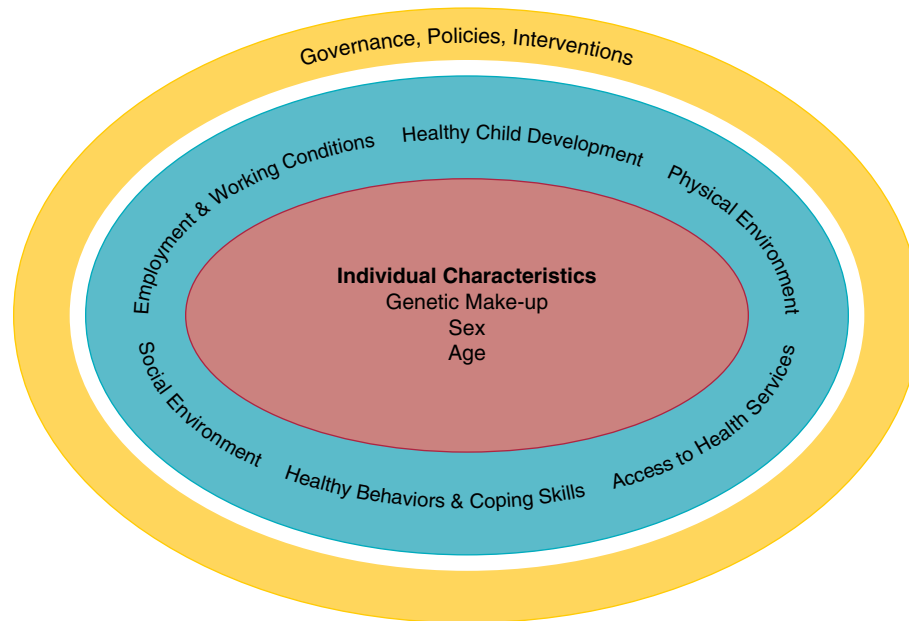
cancers. For similar reasons, age is also an important determinant of health. Young children in low- and middle-income countries often die of diarrheal disease, whereas older people are much more likely to die of heart disease, to cite one of many examples of the relationship between health and age.

Socioeconomic status, which refers to a person’s economic, social, and work status, is an important health determinant. People with higher educational attainment have higher socioeconomic status and more control over their lives than people of lower status. As one’s socioeconomic status improves, so does his/her health.<sup>6</sup>

The extent to which people get social support from family, friends, and community also has an important link with health.<sup>7</sup> The stronger the social networks and the stronger the support that people get from those networks, the healthier people will be. Of course, culture is also an extremely important determinant of health.<sup>5</sup> Culture helps to determine how one feels about health and illness, how one uses health services, and the health practices in which one engages. In addition, the gender roles that are ascribed to women in many societies also have an important impact on health. In such environments, women may be less well treated than men and this, in turn, may mean that women have less income, less education, and fewer opportunities to engage in employment. All of these militate against their good health.

The environment, both indoor and outdoor, is a powerful determinant of health. Related to this is the safety of the environment in which people work. Although many people know about the importance of outdoor air pollution to health, few people are aware of the importance of indoor air pollution to health. In many low- and middle-income countries, women cook indoors with poor ventilation, thereby creating an indoor environment that is full of smoke and that encourages respiratory illness and asthma. The lack of safe drinking water and sanitation is a major contributor to ill health in poor countries. In addition, many people in those same countries work in environments that are unhealthy. Because they lack skills, socioeconomic status, and opportunities, they may work without sufficient protection from hazardous chemicals, in polluted air, or in circumstances that expose them to occupational accidents.

Education is a powerful determinant of health for several reasons. First, it brings with it knowledge of good health practices. Second, it provides opportunities for gaining skills, getting better employment, raising one’s income, and enhancing one’s social status, all of which are also related to health. Studies have shown, for example, that the single best predictor of the birthweight of a baby is the level of educational attainment of the mother.<sup>8</sup> Most of us already know

**FIGURE 2-1** Key Determinants of Health

Data from the Public Health Agency of Canada. What Determines Health. Available at: <http://www.phac-aspc.gc.ca/ph-sp/determinants/index-eng.php#determinants>. Accessed April 28, 2015.

that throughout the world, there is an extremely strong and positive correlation between the level of education and all key health indicators. People who are better educated eat better, smoke less, are less obese, have fewer children, and take better care of their children's health than do people with less education. It is not a surprise, therefore, that they and their children live longer and healthier lives than do less well educated people and their children.

Of course, people's own health practices and behaviors are also critical determinants of their health. Being able to identify when you or a family member is ill and needs health care can be critical to good health. As noted previously, however, one's health also depends on how one eats, or if one smokes, drinks too much alcohol, or drives safely. We also know that being active physically and getting exercise regularly is better for one's health than is being sedentary.

Another important determinant of future health is the way in which families nourish and care for infants and young children. Being born premature or of low birthweight can have important negative consequences on health. There is a strong correlation between the nutritional status of infants

and young children and the extent to which they meet their biological potential, enroll in school, or stay in school. In addition, poor nutritional status in infancy and early childhood may be linked with a number of noncommunicable diseases later in life, including diabetes and heart disease.<sup>9</sup>

Of course, one's health does depend on access to appropriate healthcare services. Even if one is born healthy, raised healthy, and engages in good health behaviors, there will still be times when one has to call on a health system for help. The more likely you are to access services of appropriate quality, the more likely you are to stay healthy. To address the risk of dying from a complication of pregnancy, for example, one must have access to health services that can carry out an emergency cesarean section if necessary. Even if the mother has had the suggested level of prenatal care and has prepared well in all other respects for the pregnancy, in the end, certain complications can only be addressed in a healthcare setting.

The approach that governments take to different policies and programs in the health sector and in other sectors also has an important bearing on people's health. People living in a country that promotes high educational attainment, for

example, will be healthier than people in a country that does not promote widespread education of appropriate quality, because better-educated people engage in healthier behaviors. A country that has universal health insurance is likely to have healthier people than a country that does not insure its entire population because the uninsured may lack needed health services. The same would be true, for example, for a country that promoted safe water supply for its entire population, compared to one that does not.

In fact, increasing attention is being paid to the social determinants of health. From 2005 to 2008 the World Health Organization (WHO) constituted a Commission on the Social Determinants of Health. WHO published the commission's report in 2008. Some of the important themes related to the report are:<sup>10</sup>

- Health status is improving in some places in the world but not in others.
- There are enormous differences in the health status of individuals within countries as well as across countries.
- The health differences within countries are closely linked with social disadvantage.
- Many of these differences should be considered avoidable, and they relate to the way in which people live and work and the health systems that should serve them.
- In the end, people's life circumstances, and therefore their health, are profoundly related to political, social, and economic forces.
- Countries need to ensure that these forces are oriented toward improving the life circumstances of the poor, thereby enabling them to enjoy a healthier life, as well. The global community should also work toward this end.

## KEY HEALTH INDICATORS

It is critical that we use data and evidence to understand and address key global health issues. Some types of health data concern the health status of people and communities, such as measures of life expectancy and infant and child mortality, as discussed further hereafter. Some concern health services, such as the number of nurses and doctors per capita in a country or the indicators of coverage for certain health services, such as immunization. Other data concern the financing of health, such as the amount of public expenditure on health or the share of national income represented by health expenditure.

There are a number of very important uses of data on health status.<sup>11</sup> We need data, for example, to know from what health conditions people suffer. We also need to know the extent to which these conditions cause people to be sick, to be disabled, or to die. We need to gather data to carry out disease surveillance. This helps us to understand if particular health problems such as influenza, polio, or malaria are occurring, where they are infecting people, who is getting infected, and what might be done to address these conditions. Other forms of data also help us to understand the burden of different health conditions, the relative importance of them to different societies, and the importance that should be attached to dealing with them.

If we are to use data in the previously mentioned ways, then it is important that we use a consistent set of indicators to measure health status. In this way, we can make comparisons across people in the same country or across different countries. There are, in fact, a number of indicators that are used most commonly by those who work in global health and in development work, as well, as noted later. These are listed and defined in **Table 2-1** and are discussed briefly next.

Among the most commonly used indicators of health status is *life expectancy at birth*. Life expectancy at birth is “the average number of additional years a newborn baby can be expected to live if current mortality trends were to continue for the rest of that person's life.”<sup>12,p58</sup> In other words, it measures how long a person born today can expect to live, if there were no change in their lifetime in the present rate of death for people of different ages. The higher the life expectancy at birth, the better the health status of a country. In the United States, life expectancy at birth in 2013 was about 79 years; in a middle-income country, such as Jordan, life expectancy was 74 years; in a very poor country, such as Sierra Leone, life expectancy was 46 years.<sup>13</sup> **Figure 2-2** shows life expectancy at birth by World Bank region and for high-income countries.<sup>13</sup>

Another important and widely used indicator is the *infant mortality rate*. The infant mortality rate is “the number of deaths of infants under age 1 per 1,000 live births in a given year.”<sup>12,p28</sup> This rate is expressed in deaths per 1,000 live births. In other words, it measures how many children younger than 1 year of age will die for every 1,000 who were born alive that year. Each country seeks as low a rate of infant mortality as possible, but we will see that the rate varies largely with the income status of a country. Afghanistan, for example, had an infant mortality rate in 2013 of 70 infant deaths for every 1,000 live births, whereas in Sweden only about 2 infants die for every 1,000 live births.<sup>14</sup> (See **Figure 2-3**.)

**TABLE 2-1** Key Health Status Indicators

**Infant mortality rate**—The number of deaths of infants under age 1 per 1,000 live births in a given year

**Life expectancy at birth**—The average number of years a newborn baby could expect to live if current mortality trends were to continue for the rest of the newborn's life

**Maternal mortality ratio**—The number of women who die as a result of pregnancy and childbirth complications per 100,000 live births in a given year

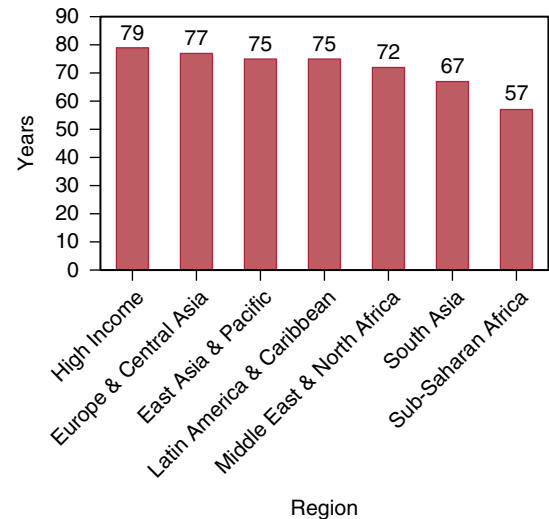
**Neonatal mortality rate**—The number of deaths to infants under 28 days of age in a given year per 1,000 live births in that year

**Under-5 mortality rate (child mortality rate)**—The probability that a newborn baby will die before reaching age 5, expressed as a number per 1,000 live births

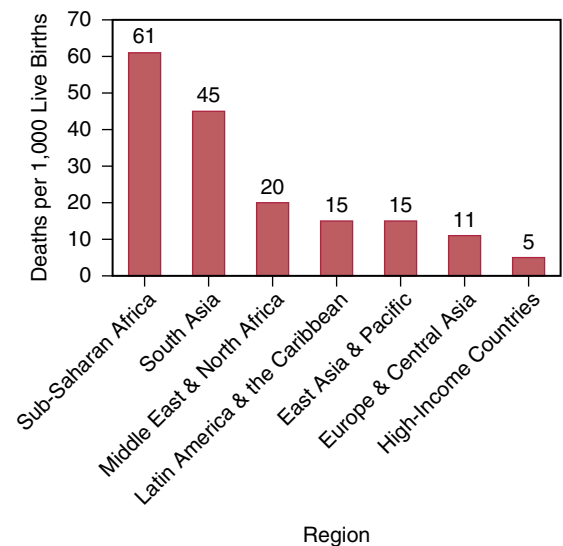
Data from Haupt, A., & Kane, T. T. (2004). *Population handbook*. Washington, DC: Population Reference Bureau; World Bank. *Beyond economic growth: Glossary*. Retrieved April 15, 2007, from <http://www.worldbank.org/depweb/english/beyond/global/glossary.html>.

Although the infant mortality rate is a powerful indicator of health status of a country, most children younger than 1 year of age who die actually die in the first month of life. Thus, the *neonatal mortality rate* is also an important health status indicator. This rate measures “the number of deaths to infants younger than 28 days of age in a given year, per 1,000 live births in that year.”<sup>12,p60</sup> Like the infant mortality rate, this rate will generally vary directly with the level of income of different countries. Poorer countries will usually have a much higher neonatal mortality rate than the richer countries. Sierra Leone, among the poorest countries in the world, has a neonatal mortality rate of 44 per 1,000 live births. In Norway, one of the highest income countries in the world, the rate is 2.<sup>14</sup> The neonatal mortality rate by World Bank region and for high-income countries is portrayed in **Figure 2-4**.

The under-5 child mortality rate is also called the *child mortality rate*. This is “the probability that a newborn will die before reaching age five, expressed as a number per 1,000 live births.”<sup>15</sup> Like the infant mortality rate, this rate is expressed

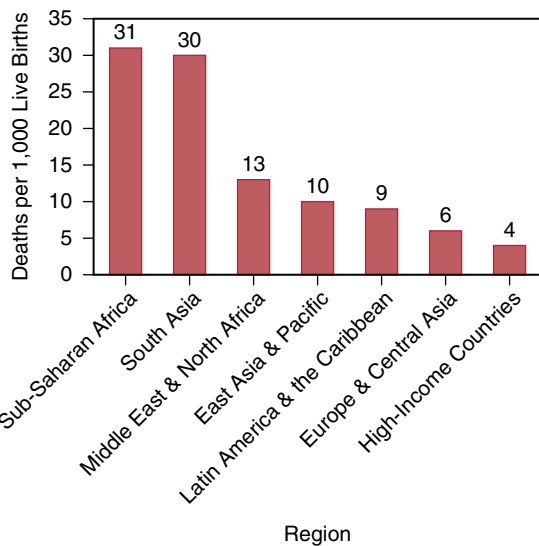
**FIGURE 2-2** Life Expectancy at Birth, by World Bank Region and for High-Income Countries, 2013

Data from the World Bank. Life expectancy at birth, total (years). Retrieved March 7, 2015, from <http://data.worldbank.org/indicator/SP.DYN.LE00.IN/countries/1W-ZG-ZJ-ZQ?display=graph>

**FIGURE 2-3** Infant Mortality Rates, by World Bank Region and for High-Income Countries, 2013

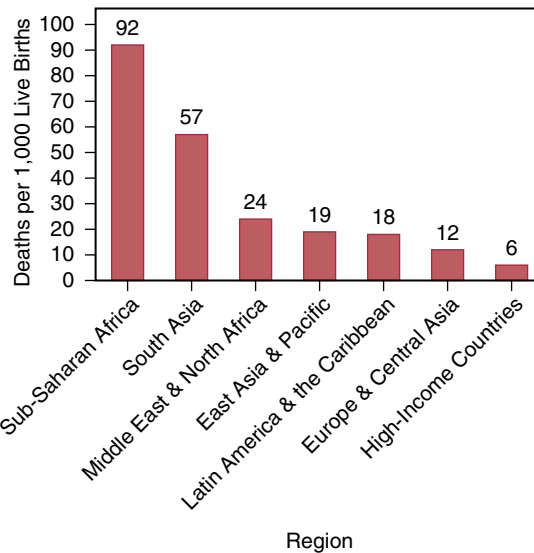
Data from the World Bank. World Development Indicators: Mortality. <http://data.worldbank.org/indicator/SH.DYN.MORT/countries/1W-Z4-ZQ-Z7?display=graph>. Accessed February 22, 2015.

**FIGURE 2-4 Neonatal Mortality Rates, by World Bank Region and for High-Income Countries, 2013**



Data from the World Bank. World Development Indicators: Mortality. <http://data.worldbank.org/indicator/SH.DYN.MORT/countries/1W-Z4-ZQ-Z7?display=graph>. Accessed February 22, 2015.

**FIGURE 2-5 Under-5 Mortality Rates, by World Bank Region and for High-Income Countries, 2013**



Data from World Bank. 2013. World Development Indicators: Mortality. Available at: <http://wdi.worldbank.org/table/2.21>. Accessed March 20, 2014.

per 1,000 live births. This rate also varies largely with the wealth of a country. In the highest-income countries, the rate is generally about 3–5 per 1,000 live births. However, in some of the poorest countries, such as Angola and Chad, the rate can be over 150 per 1,000 live births.<sup>15</sup> The under-5 child mortality rate is depicted in **Figure 2-5** by World Bank region and for high-income countries. The relative standing of different regions in under-5 child mortality, as shown in **Figure 2-5**, looks very similar to that for neonatal mortality and for infant mortality.

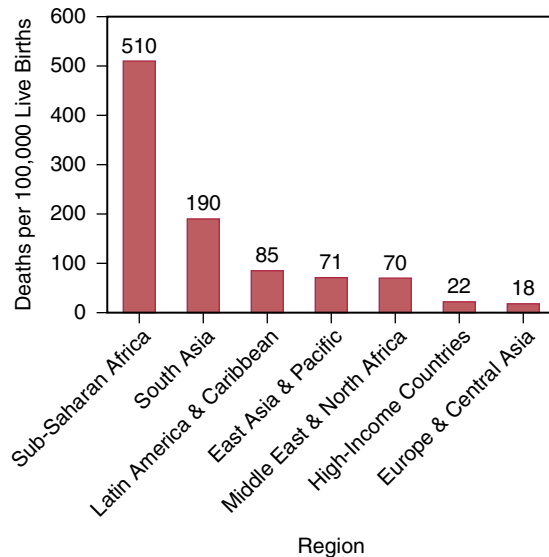
The maternal mortality ratio is a measure of the risk of death that is associated with childbirth. Because these deaths are more rare than infant and child deaths, the maternal mortality ratio is measured as “the number of women who die as a result of pregnancy and childbirth complications per 100,000 live births in a given year.”<sup>12,p28</sup> The rarity of maternal deaths and the fact that they largely occur in low-income settings also contribute to maternal mortality being quite difficult to measure. Very few women die in childbirth in rich countries; for example, the maternal mortality ratio in Sweden is 4 per 100,000 live births. On the other hand, in very poor countries, in which women have low status and there

are few facilities for dealing with obstetric emergencies, the ratios can be over 500 per 100,000 live births, as they are, for example, in Mali, Niger, and Nigeria. In the worst-off country for maternal health, Sierra Leone, the maternal mortality ratio is estimated to be 1,100 per 100,000 live births.<sup>16</sup> As you can see in **Figure 2-6**, the maternal mortality ratio is also very strongly associated with a country’s income.

A few other concepts and definitions are important to understand as we think about measuring health status. The first is *morbidity*. Essentially, this means sickness or any departure, subjective or objective, from a psychological or physiological state of well-being. Second is *mortality*, which refers to death. A *death rate* is the number of deaths per 1,000 population in a given year.<sup>12,p25</sup> The third is *disability*. Although some conditions cause people to get sick or die, they might also cause people to suffer the “temporary or long-term reduction in a person’s capacity to function.”<sup>17,p51</sup>

There will also be considerable discussion in most readings on global health of the *prevalence* of health conditions. This refers to the number of people suffering from a certain health condition over a specific time period. It measures the chances of having a disease. For global health work, one usually

**FIGURE 2-6** Maternal Mortality Ratio, by World Bank Regions and for High-Income Countries, 2013



Data from World Bank. Data: Maternal mortality ratio. Data from the World Bank. <http://data.worldbank.org/indicator/SH.STA.MMRT/countries/1W-85-Z4-ZJ-XD-Z7-ZG?display=graph>. Accessed March 10, 2015.

refers to “point prevalence” of a condition, which is “the proportion of the population that is diseased at a single point in time.”<sup>12,p31</sup> The point prevalence of HIV/AIDS among adults in South Africa, for example, is estimated to be 19.1. This means that today 19.1 percent of all adults between the ages of 15 and 49 in South Africa are estimated to be HIV-positive.<sup>18</sup>

The *incidence rate* is also a very commonly used term. This measures how many people get a disease, for a specified number of people at risk, for given period of time.<sup>12</sup> The denominator for the rate usually depends on how commonly the disease occurs in a year and is often per 1,000 or 100,000 people. In India, for example, the incidence rate for tuberculosis (TB) in 2013 was 171, per 100,000.<sup>19</sup> This means that for every 100,000 people in India, 171 got sick from TB in 2013.

Many people confuse incidence rate and prevalence rate. It may be convenient to think of prevalence as the pool of people with a disease at a particular time and incidence as the flow of new cases of people with that disease each year into that pool. You should note, of course, that the size of the pool will vary as new cases flow into the pool and old cases flow out, as they die or are cured.

Finally, one needs to be familiar with how diseases get classified. When you read about health, there will be

discussions of communicable diseases, noncommunicable diseases, and injuries. Communicable diseases are also called infectious diseases. These are illnesses that are caused by a particular infectious agent and that spread directly or indirectly from people to people, animals to people, or people to animals.<sup>17</sup> Examples of communicable diseases include influenza, measles, and HIV. Noncommunicable diseases are illnesses that are not spread by any infectious agent, such as hypertension, coronary heart disease, and diabetes. Injuries include, among other things, road traffic injuries, falls, drownings, poisonings, and violence.<sup>20</sup>

## VITAL REGISTRATION

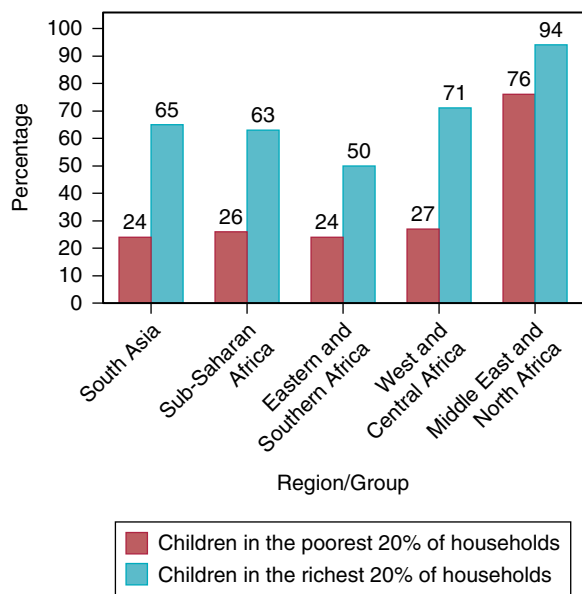
The quality of data on population and health depends in many ways on the extent to which countries maintain a system of vital registration that can accurately record births, deaths, and the causes of death. Unfortunately, this is not the case in many low- and lower-middle-income countries.<sup>21</sup> They generally have only rudimentary systems for vital registration, which cannot fulfill either their statistical or their legal purposes. In addition, access to vital registration systems is highly inequitable, with higher income groups enjoying much better access than less well-off people (Figure 2-7).

There are also cultural barriers to timely vital registration because people in many countries wait until a child is a certain age before registering the birth. Coupled with the lack of access to vital registration, this means the existence of some children is never officially known, because they die before their births are registered. There are also enormous difficulties with accurate indications of causes of death in countries that have weak health systems and a limited number of well-trained physicians. This is especially so for causes of death of adults.

The former director-general of WHO, Lee Jong-Wook, noted in a speech to his colleagues: “To make people count, we first need to be able to count people.”<sup>22,p1569</sup> To overcome the lack of effective vital registration systems in many low- and middle-income countries, a number of tools, such as surveys and projection models, have been developed. Some, like the Demographic and Health Surveys, have become an important source of information about health, population, nutrition, and HIV in low-income countries.

In the longer term, however, the world would be better served by helping countries further develop their own vital registration systems. This would allow countries and their development partners to more accurately gauge the nature of key demographic and health issues and the progress made toward resolving them. Moving in this direction will require assessments of vital registration systems. It will also require

**FIGURE 2-7 Percentage of Children Under 5 Whose Births Have Been Registered, by Income Quintile, for Selected UNICEF Regions, 2005–2012**



Data from UNICEF. 2013. Every Child's Birth Right: Inequities and trends in birth registration. Retrieved April 27, 2015, from [http://www.unicef.org/media/files/Embargoed\\_11\\_Dec\\_Birth\\_Registration\\_report\\_low\\_res.pdf](http://www.unicef.org/media/files/Embargoed_11_Dec_Birth_Registration_report_low_res.pdf).

programs to improve the organization and functioning of vital registration departments. This will have to include, among other things, strengthening their methods to improve the quality of vital statistics, including for the causes of death, and enhancing their approach to publishing data.<sup>21</sup>

## MEASURING THE BURDEN OF DISEASE

The WHO definition of health is “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”<sup>23</sup> Those who work on global health have attempted for a number of years to construct a single indicator that could be used to compare how far different countries are from the state of good health. Ideally, such an index would take account of morbidity, mortality, and disability; allow one to calculate the index by age, by gender, and by region; and allow one to make comparisons of health status across regions within a country and across countries.<sup>24</sup> This kind of index would measure what is generally referred to as “the burden of disease.”

One such indicator is *health-adjusted life expectancy*, or HALE. It is a health expectancy measure. HALE is the number of years a person of a given age can expect to live in good

health, taking account of mortality and disability.<sup>25,p9</sup> This can also be seen as “the equivalent number of years in full health that a newborn can expect to live, based on current rates of ill health and mortality.”<sup>26</sup> To calculate the HALE, “the years of ill health are weighted according to severity and subtracted from the overall life expectancy.”<sup>27</sup>

WHO has calculated HALEs for most countries, using a standard methodology. **Table 2-2** shows life expectancy at birth in 2010 for a number of low-, middle-, and high-income countries and how it compares with HALEs for those countries in the same year. As you can see from Table 2-2, the greater the number of years that people in any population are likely to spend in ill health or with disability, the greater the difference will be between life expectancy at birth and health-adjusted life expectancy.

The composite indicator of health status that is most commonly used in global health work is called the *disability-adjusted life year*, or DALY. This indicator was first used in conjunction with the *1993 World Development Report* of the World Bank and is a health gap measure. It is now used consistently in burden of disease studies. In the simplest terms, a DALY is:

The sum of years lost due to premature death (YLLs) and years lived with disability (YLDs). DALYs are also defined as years of healthy life lost.<sup>26,p9</sup>

The DALY is a summary measure of losses due to premature death and years lived with disability in a given population. The calculation of years lost to premature death takes account of the highest life expectancy globally at every age. If a 20-year-old male died in a car accident in Malawi in 2010, for example, he would have 66 years of life lost. This is calculated based on the highest life expectancy for anyone 20 years old, which is 86 years for 20-year-old females in Japan.<sup>26</sup>

The value of years lived with disability is calculated by weighting these years by a disability index. For the *Global Burden of Disease Study 2010*, 14,000 people were surveyed directly and 16,000 people were involved via the Internet in establishing disability weights. If someone lived 30 years with a disability that was given a weight of 0.5, for example (but died at the highest life expectancy possible), then they would have 30 times 0.5, or 15 years of life lived with disability.<sup>27</sup>

If the two people described previously lived in the same society, then the total DALYs for that society would be the total of the years of life lost due to premature death of the first person and the years lived with disability of the second. In this case, the total DALYs lost due to premature death and years lived with disability would be 66 plus 15, or 81.



**TABLE 2-2** Life Expectancy at Birth and Health-Adjusted Life Expectancy, Selected Countries, 2010

Country	Life Expectancy/ Health-Adjusted Life Expectancy	Life Expectancy/ Health-Adjusted Life Expectancy
	Males	Females
Afghanistan	58.2/48.5	57.3/46.2
Bangladesh	67.2/57.1	71.0/59.8
Bolivia	69.7/60.1	71.7/61.5
Brazil	70.5/61.1	77.7/66.6
Cambodia	64.6/55.9	70.1/60.0
Cameroon	57.1/49.0	61.1/51.4
China	72.9/65.5	79.0/70.4
Costa Rica	77.1/67.3	81.9/70.5
Cuba	76.1/63.5	79.8/66.9
Denmark	76.8/66.3	81.0/69.5
Ethiopia	59.5/51.4	62.3/53.5
Ghana	63.2/54.5	66.7/56.1
India	63.2/54.9	67.5/57.7
Indonesia	67.7/59.3	71.8/62.5
Jordan	75.7/64.8	75.1/63.2
Malaysia	71.3/62.6	76.5/66.4
Nepal	67.7/57.6	70.6/59.9
Niger	56.9/48.5	58.7/49.4
Nigeria	58.8/50.0	60.4/50.8
Peru	75.2/64.8	77.6/66.6
Philippines	66.6/57.4	73.8/63.2
Sri Lanka	71.6/62.3	79.8/68.6
Turkey	71.2/61.8	77.7/66.0
United States of America	75.9/66.2	80.5/69.5
Vietnam	71.6/62.6	79.6/69.1

Data from Salomon, J. A., Wang, H., Freeman, M. K., et al. (2013). Healthy life expectancy for 187 countries, 1990-2010: A systematic analysis for the Global Burden Disease Study 2010. *Lancet*, 380(9859), 2144-2162.

In reality, of course, many health conditions produce both disability and premature death. Let us suppose that a man with diabetes has to have a leg amputated at age 45, that the disability index is 0.5 for this condition, and that the man dies at age 47. In this case, he loses 0.5 times 2 years lived with disability, which would be equal to 1 year of life lived with disability. If the longest known life expectancy for a 47 year old were, say, 87, then he would also have 40 years lost due to premature death. This person would have contributed 1 year of life lived with disability, plus 30 years of life lost due to premature death, or 31 total DALYs.

A society that has more premature death, illness, and disability has more DALYs than a society that is healthier and has less illness, disability, and premature death. One of the goals of health policy is to avert these DALYs in the most cost-efficient manner possible. If, for example, a society has many hundreds of thousands of DALYs due to malaria that is not diagnosed and treated in a timely and proper manner, what steps can be taken to avert those DALYs at the lowest cost?

An important point to remember when considering DALYs, compared to measuring deaths, is that DALYs take account of periods in which people are living with disability. By doing this, DALYs and other composite indicators try to give a better estimate than measuring deaths alone of the true health of a population. This is easy to understand. Most mental health problems, for example, are not associated with deaths. However, they cause an enormous amount of disability. Several parasitic infections, such as schistosomiasis, also cause very few deaths, but enormous amounts of illness and disability. If we measured the health of a population with an important burden of schistosomiasis and mental illness only by measuring deaths, we would miss a major component of morbidity and disability and would seriously overestimate the health of that population. The next section on the global burden of disease elaborates on the concept of DALYs and how DALYs compare to deaths for a number of health conditions.

A number of critiques of DALYs have been written.<sup>28</sup> Nonetheless, this text repeatedly refers to DALYs because this measure is so extensively used in global health work. In addition, a considerable amount of important analysis has been carried out that is based on the use of DALYs for measuring overall health status and assessing the most cost-effective approaches to dealing with various health problems.

## BURDEN OF DISEASE DATA

As you start a review of global health, it is important to get a clear picture of the leading causes of illness, disability, and death in the world. It is also very important to understand how they vary by age, sex, ethnicity, and socioeconomic

status, both within and across countries. Additionally, it is essential to understand how these causes have varied over time and how they might change in the future. These topics are examined next.

A collaboration of seven institutions has taken the lead over the last several years in collecting, analyzing, and disseminating data on the burden of disease globally. The partners in this effort have been Harvard University; Imperial College, London; the Institute for Health Metrics and Evaluation (IHME), the University of Washington; the Johns Hopkins University; the University of Queensland; the University of Tokyo; and the World Health Organization. In late 2012, the *Lancet* published in seven papers the key findings from the *Global Burden of Disease Study 2010* (GBD 2010).<sup>29</sup> In 2013, the IHME published a companion report to the *Lancet* papers: *The Global Burden of Disease: Generating Evidence, Guiding Policy*.<sup>26</sup>

Much of the data in this chapter is based on the findings of the *Global Burden of Disease Study 2010* and the related IHME study.<sup>26,29</sup> It also heavily uses data from interactive data visualizations that IHME has posted on its website. Some of the data used here refer to deaths and some to DALYs. References to the “burden of disease” refer to DALYs. Those readers who wish to explore the burden of disease further are encouraged to review the range of IHME visualizations on this topic. This text will refer to the *Lancet* series and the related IHME paper as the *Global Burden of Disease Study 2010*.

It is important to note that the *Global Burden of Disease Study 2010* categorized its data in a number of ways. This included by country income group, for which it showed at the highest-level data for developing countries, developed countries, and high-income countries. The data from this study that it labeled developing countries is consistently referred to here as data for low- and middle-income countries. The data that it referred to as for high-income countries is referred to by the same name here. This approach has been taken to make the nomenclature of data categories as consistent as possible across this chapter and the book as a whole.

Earlier burden of disease studies broke causes of death and DALYs into three categories:

- Group I—communicable, maternal, and perinatal conditions (meaning in the first week after birth) and nutritional disorders
- Group II—noncommunicable diseases
- Group III—injuries, including, among other things, road traffic accidents, falls, self-inflicted injuries, and violence

The *Global Burden of Disease Study 2010* did not use the groupings as extensively as they had been used earlier.

Nonetheless, such groupings can be valuable to those who are new to the study of the burden of disease. Thus, they are used occasionally here.

## Overview of Patterns and Trends in the Burden of Disease

Understanding the patterns and trends in the burden of disease is central to understanding and dealing with key issues in global health. As one examines some of the key data on the burden of disease, therefore, it is critical to understand a number of points:

- People in much of the world are living longer than before
- People in much of the world are dying at lower rates than earlier
- As people live longer, there is an increase in the years people live with disability
- The burden of disease is predominantly noncommunicable in all World Bank regions, except sub-Saharan Africa
- Over the last few decades, the burden of disease has shifted increasingly toward noncommunicable diseases in all World Bank regions
- This shift has been fueled, among other things, by a reduction in communicable diseases and the aging of populations.

## The Leading Causes of Deaths and DALYs

**Table 2-3** shows the 10 leading causes of death and the 10 leading causes of DALYs for low- and middle-income countries and for high-income countries in 2010. Both deaths and DALYs are ranked in order of importance.

About 58 percent of the deaths in low- and middle-income countries for both sexes and all age groups are from noncommunicable causes, 31 percent from communicable causes, and 11 percent from injuries.<sup>30</sup> Stroke and ischemic heart disease are the leading causes of death in low- and middle-income countries. They are followed by chronic obstructive pulmonary disease (COPD), lower respiratory infections, and diarrheal diseases. HIV/AIDS, malaria, road traffic injury, tuberculosis and diabetes make up the remainder of the 10 leading causes.<sup>31</sup> The importance of noncommunicable diseases is clear, even in low- and middle-income countries. At the same, however, there remains an important unfinished agenda of communicable diseases in these countries. For example, lower respiratory infections, as well as diarrhea, malaria, and HIV/AIDS are still important killers of young children in these countries. Noncommunicable

diseases are also the leading causes of deaths in high-income countries for both sexes and all age groups. However, in other respects, the picture of deaths that emerges in high-income countries is quite different from that in low- and middle-income countries. In high-income countries almost 87 percent of the deaths are from noncommunicable causes, about 7 percent are from communicable diseases, and about 6 percent are due to injuries.<sup>30</sup>

In high-income countries, the first three leading causes of death are stroke, ischemic heart disease, and lung cancer. The fourth, and the only communicable cause among the leading causes of death, is lower respiratory infections, which are associated in high-income countries mostly with death from pneumonia of older people. This is followed by COPD, Alzheimer's disease, colorectal cancer, diabetes, other cardiovascular and circulatory diseases, and chronic kidney disease.<sup>31</sup>

If we look at DALYs, rather than deaths, for both sexes and all age groups for low- and middle-income countries, noncommunicable diseases make up 49 percent of total DALYs, communicable diseases 40 percent, and injuries 11 percent. In this case, communicable diseases are substantially more important and noncommunicable diseases less important in percentage terms than they are for deaths.<sup>30</sup>

The leading individual causes of DALYs for both sexes and all age groups in low- and middle-income countries are lower respiratory infections, diarrheal diseases, and ischemic heart disease. This is followed by malaria, stroke, HIV/AIDS, preterm birth complications, road injury, COPD, and low back pain.<sup>31</sup> This ranking is significant for several reasons. First, it contains four communicable diseases. Second, it reflects the high burden of conditions related to birth in low-resource settings. Third, despite the number of communicable diseases in this ranking, noncommunicable diseases are also significant. Fourth, it is substantially different from the 10 leading causes of DALYs in high-income settings.

For both sexes and all age groups in high-income countries, noncommunicable diseases make up 85 percent of the DALYs, communicable diseases 5 percent, and injuries 10 percent. This is significantly different from the share of deaths by these cause groups only for injuries, whose share of DALYs is greater than the share of deaths.<sup>30</sup> The ranking of the causes of DALYs is especially significant because of the extent to which it reflects the aging of those populations. Musculoskeletal issues and falls, for example, make up 4 of the top 10 causes of DALYs in these settings.<sup>30</sup> The fact that major depressive disorder is the fourth leading cause of DALYs is also especially important and highlights the importance of mental health issues to overall ill health and disability.<sup>31</sup>

**TABLE 2-3** Leading Causes of Deaths and DALYs for Low- and Middle-Income and High-Income Countries, 2010

Leading Causes of Deaths			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	Stroke	1	Ischemic heart disease
2	Ischemic heart disease	2	Stroke
3	Chronic obstructive pulmonary disease (COPD)	3	Trachea, bronchus, and lung cancers
4	Lower respiratory infections	4	Lower respiratory infections
5	Diarrheal diseases	5	COPD
6	HIV/AIDS	6	Alzheimer's disease
7	Malaria	7	Colorectal cancer
8	Road injury	8	Diabetes
9	Tuberculosis	9	Other cardiovascular and circulatory diseases
10	Diabetes	10	Chronic kidney disease
Leading Causes of DALYs			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	Lower respiratory infections	1	Ischemic heart disease
2	Diarrheal diseases	2	Low back pain
3	Ischemic heart disease	3	Stroke
4	Malaria	4	Major depressive disorder
5	Stroke	5	Trachea, bronchus, and lung cancers
6	HIV/AIDS	6	COPD
7	Preterm birth complications	7	Other musculoskeletal disorders
8	Road injury	8	Diabetes
9	COPD	9	Neck pain
10	Low back pain	10	Falls

Data from Institute for Health Metrics and Evaluation (IHME). (2013). *GBD heat map*. Seattle, WA: IHME, University of Washington. Retrieved April 28, 2015, from <http://vizhub.healthdata.org/iran/heat.php>.

## Trends in the Cause of Deaths and DALYs, 1990–2010

**Table 2-4** indicates changes that have occurred between 1990 and 2010 in the leading causes of deaths and DALYs globally. The table indicates the important extent to which the burden of deaths globally, when considering all age groups and both sexes, has shifted increasingly toward noncommunicable diseases. Road injuries have also become more important. The trend has been similar when looking at this from the point of view of DALYs, with some significant shifts from communicable diseases and other Group I causes to noncommunicable diseases and injuries.

### Causes of Death and DALYs by Region

As you would expect, the causes of death and burden of disease vary by region, as shown in **Table 2-5**. In general, the higher the level of income of the countries in a region, the more likely it is that the leading causes of death and DALYs will be noncommunicable. The lower the level of income, the more likely it is that communicable diseases will be important. What is most essential to note is the extent to which the burden of disease in the sub-Saharan Africa region remains dominated by communicable diseases and the continuing importance of communicable diseases in the South Asia region. Of course, these are in the face of a growing burden, even in these regions, of noncommunicable diseases.<sup>31</sup>

### Causes of Death by Age

**Table 2-6** shows the leading causes of death for children aged 0 to 5 years for low- and middle-income countries and for high-income countries. The leading causes of death of under-5 children in low- and middle-income countries are generally related to conditions of newborns, infections to which newborns are particularly susceptible, or communicable diseases. The leading causes of death of under-5 children in high-income countries are dominated by conditions related to newborns. However, they also include road injury, drowning, and interpersonal violence.<sup>31</sup>

**Table 2-7** shows the leading causes of death for children aged 5 to 14. It is striking how the leading causes of death of children 5 to 14 in low- and middle-income countries are preventable or treatable communicable diseases, such as malaria, HIV/AIDS, and diarrheal diseases. Nutritional issues are also prominent. By contrast, in high-income countries, children who die in this age group overwhelmingly die of injuries, cancer, or leukemia.<sup>31</sup>

**Table 2-8** examines the leading causes of death and DALYs for both sexes for the age group 15 to 49. In low- and

middle-income countries, the leading causes of death are HIV/AIDS, road injury, and tuberculosis. Lower respiratory infections, malaria and maternal causes are also in the top 10 leading causes of death. The importance of stroke, ischemic heart disease, and self-harm must also be noted. When one considers DALYs for both sexes for this age group, HIV/AIDS, TB, and maternal disorders remain important. However, road injury, low back pain, depressive disorders, and interpersonal violence are also important causes of DALYs.<sup>31</sup>

The picture of deaths and DALYs for both sexes in this age group in high-income countries varies substantially from that in low- and middle-income countries. Only one of the top 10 causes of deaths is communicable: HIV/AIDS. The others are all noncommunicable or injuries. In fact, self-harm is the leading cause of death in this age group in high-income countries. When we look at DALYs for both sexes in this age group, the importance of musculoskeletal disorders, neuropsychiatric disorders, and substance abuse disorders is clear and contrasts sharply with the pattern in low- and middle-income countries.<sup>31</sup>

### Causes of Death and DALYs by Sex

It is also important to examine deaths and DALYs by sex, as shown in **Table 2-9**, for low- and middle-income countries and for high-income countries for all age groups. It is striking to note that five of the ten leading causes of deaths of females in low- and middle-income countries are communicable and that another leading cause is maternal complications. By contrast, the leading causes of deaths of females in high-income countries are all noncommunicable, except lower respiratory infections, which is overwhelmingly among older people in these countries. The leading causes of DALYs among females in low- and middle-income countries is similar to that for deaths, but also includes preterm birth complications, related to the deaths of so many young people in these countries, major depressive disorders, and low back pain. The leading causes of DALYs among females in high-income countries is again similar to the causes of death, but also includes low back pain and neck pain and major depressive disorder and anxiety disorders.<sup>31</sup>

The leading causes of death among males in low- and middle-income countries is similar to that for females, but road injury is a leading killer of males but not females. The leading causes of death among males in high-income countries is similar to those for females in those countries, but includes self-harm. The leading cause of DALYs for males in low- and middle-income countries is similar to that for deaths but includes preterm birth complications, again related to young deaths, and low back pain. The leading

**TABLE 2-4** Changes in the Leading Causes of Deaths and DALYs Globally, 1990 and 2010

<i>Leading Causes of Deaths in 1990</i>		<i>Leading Causes of Deaths in 2010</i>	
Rank	Cause	Rank	Cause
1	Ischemic heart disease	1	Ischemic heart disease
2	Stroke	2	Stroke
3	Lower respiratory infections	3	COPD
4	COPD	4	Lower respiratory infections
5	Diarrheal diseases	5	Lung cancer
6	Tuberculosis	6	HIV/AIDS
7	Preterm birth complications	7	Diarrheal diseases
8	Lung cancer	8	Road injury
9	Malaria	9	Diabetes
10	Road injury	10	Tuberculosis
<i>Leading Causes of DALYs in 1990</i>		<i>Leading Causes of DALYs in 2010</i>	
Rank	Cause	Rank	Cause
1	Lower respiratory infections	1	Ischemic heart disease
2	Diarrheal diseases	2	Lower respiratory infections
3	Preterm birth complications	3	Stroke
4	Ischemic heart disease	4	Diarrheal diseases
5	Stroke	5	HIV/AIDS
6	COPD	6	Malaria
7	Malaria	7	Low back pain
8	Tuberculosis	8	Preterm birth complications
9	Protein-energy malnutrition	9	COPD
10	Neonatal encephalopathy	10	Road injury

Data from Institute for Health Metrics and Evaluation (IHME). (2013). *GBD heat map*. Seattle, WA: IHME, University of Washington. Retrieved April 28, 2015, from <http://vizhub.healthdata.org/irank/heat.php>.

**TABLE 2-5** Leading Causes of DALYs by World Bank Regions and for High-Income Countries, 2010

East Asia and Pacific		Latin America and Caribbean	
<i>Rank</i>	<i>Cause</i>	<i>Rank</i>	<i>Cause</i>
1	Stroke	1	Ischemic heart disease
2	Ischemic heart disease	2	Exposure to forces of nature
3	Road injury	3	Interpersonal violence
4	COPD	4	Road injury
5	Low back pain	5	Major depressive disorder
6	Major depressive disorder	6	Low back pain
7	Trachea, bronchus, and lung cancers	7	Stroke
8	Lower respiratory infections	8	Lower respiratory infections
9	Diabetes	9	Diabetes
10	Liver cancer	10	Preterm birth complications
Europe and Central Asia		Middle East and North Africa	
<i>Rank</i>	<i>Cause</i>	<i>Rank</i>	<i>Cause</i>
1	Ischemic heart disease	1	Ischemic heart disease
2	Stroke	2	Lower respiratory infections
3	Low back pain	3	Stroke
4	Major depressive disorder	4	Low back pain
5	Lower respiratory infections	5	Major depressive disorder
6	Road injury	6	Preterm birth complications
7	HIV/AIDS	7	Congenital anomalies
8	COPD	8	Road injury
9	Self-harm	9	Diabetes
10	Trachea, bronchus, and lung cancers	10	Diarrheal diseases

(continues)

**TABLE 2-5** Leading Causes of DALYs by World Bank Regions and for High-Income Countries, 2010 (*continued*)

South Asia		South Asia	
Rank	Cause	Rank	Cause
1	Lower respiratory infections	6	Neonatal encephalopathy
2	Preterm birth complications	7	Tuberculosis
3	Diarrheal diseases	8	Sepsis and other infectious disorders of the newborn
4	Ischemic heart disease	9	Iron-deficiency anemia
5	COPD	10	Road injury
Sub-Saharan Africa		Sub-Saharan Africa	
Rank	Cause	Rank	Cause
1	Malaria	6	Preterm birth complications
2	HIV/AIDS	7	Sepsis and other infectious disorders of the newborn
3	Lower respiratory infections	8	Meningitis
4	Diarrheal diseases	9	Neonatal encephalopathy
5	Protein-energy malnutrition	10	Road injury
High-Income Countries		High-Income Countries	
Rank	Cause	Rank	Cause
1	Ischemic heart disease	6	COPD
2	Low back pain	7	Other musculoskeletal disorders
3	Stroke	8	Diabetes
4	Major depressive disorder	9	Neck pain
5	Trachea, bronchus, and lung cancers	10	Falls

Data from Institute for Health Metrics and Evaluation (IHME). (2013). *GBD heat map*. Seattle, WA: IHME, University of Washington. Retrieved April 28, 2015, from <http://vizhub.healthdata.org/irank/heat.php>.



**TABLE 2-6** Leading Causes of Death in Children Under 5, Low- and Middle-Income Countries and High-Income Countries, 2010

Low- and Middle-Income Countries	High-Income Countries
1. Lower respiratory infections	1. Preterm Birth Complications
2. Preterm birth complications	2. Congenital anomalies
3. Malaria	3. Neonatal encephalopathy
4. Diarrheal diseases	4. SIDS
5. Sepsis and other infectious disorders of the newborn	5. Sepsis and other infectious disorders of the newborn
6. Neonatal encephalopathy	6. Lower respiratory infections
7. Congenital anomalies	7. Road injury
8. Protein-energy malnutrition	8. Drowning
9. Meningitis	9. Interpersonal violence
10. HIV/AIDS	10. Meningitis

Data from Institute for Health Metrics and Evaluation (IHME). (2013). *GBD heat map*. Seattle, WA: IHME, University of Washington. Retrieved April 28, 2015, from <http://vizhub.healthdata.org/irank/heat.php>.

**TABLE 2-7** Leading Causes of Death in Children Ages 5–14, Low- and Middle-Income Countries and High-Income Countries, 2010

Low- and Middle-Income Countries		High-Income Countries	
Rank	Cause	Rank	Cause
1	Diarrheal diseases	1	Road injury
2	HIV/AIDS	2	Leukemia
3	Road injury	3	Brain and nervous system cancers
4	Malaria	4	Congenital anomalies
5	Lower respiratory infections	5	Drowning
6	Drowning	6	Self-harm
7	Typhoid and paratyphoid fevers	7	Interpersonal violence
8	Meningitis	8	Lower respiratory infections
9	Congenital anomalies	9	Fire
10	Protein-energy malnutrition	10	Other transport injuries

Data from Institute for Health Metrics and Evaluation (IHME). (2013). *GBD heat map*. Seattle, WA: IHME, University of Washington. Retrieved April 28, 2015, from <http://vizhub.healthdata.org/irank/heat.php>.

**TABLE 2-8** Leading Causes of Deaths and DALYs Ages 15–49, Low- and Middle-Income Countries and High-Income Countries, 2010

Leading Causes of Deaths			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	HIV/AIDS	1	Self-harm
2	Road injury	2	Road injury
3	Tuberculosis	3	Ischemic heart disease
4	Self-harm	4	Cirrhosis
5	Ischemic heart disease	5	Interpersonal violence
6	Interpersonal violence	6	Drug use disorders
7	Stroke	7	Trachea, bronchus, and lung cancers
8	Lower respiratory infections	8	Stroke
9	Maternal disorders	9	Breast cancer
10	Malaria	10	HIV/AIDS
Leading Causes of DALYs			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	HIV/AIDSs	1	Low back pain
2	Road injury	2	Major depressive disorder
3	Low back pain	3	Drug use disorders
4	Major depressive disorder	4	Road injury
5	Tuberculosis	5	Neck pain
6	Self-harm	6	Self-harm
7	Ischemic heart disease	7	Other musculoskeletal disorders
8	Interpersonal violence	8	Anxiety disorders
9	COPD	9	Migraine
10	Maternal disorders	10	Ischemic heart disease

Data from Institute for Health Metrics and Evaluation (IHME). (2013). *GBD heat map*. Seattle, WA: IHME, University of Washington. Retrieved April 28, 2015, from <http://vizhub.healthdata.org/iran/heat.php>.

**TABLE 2-9** Leading Causes of Deaths and DALYs by Sex, Low- and Middle-Income Countries and High-Income Countries, 2010

Deaths			
Females			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	Stroke	1	Ischemic heart disease
2	Ischemic heart disease	2	Stroke
3	Lower respiratory infections	3	Lower respiratory infections
4	COPD	4	Alzheimer's disease
5	Diarrheal diseases	5	COPD
6	HIV/AIDS	6	Trachea, bronchus, and lung cancers
7	Diabetes	7	Breast cancer
8	Malaria	8	Colorectal cancer
9	Tuberculosis	9	Other cardiovascular and circulatory diseases
10	Preterm birth complications	10	Diabetes
DALYs			
Females			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	Lower respiratory infections	1	Ischemic Heart Disease
2	Diarrheal diseases	2	Low back pain
3	HIV/AIDS	3	Major depressive disorder
4	Malaria	4	Stroke
5	Stroke	5	Other musculoskeletal disorders
6	Ischemic heart disease	6	COPD
7	Preterm birth complications	7	Neck pain
8	Major depressive disorder	8	Alzheimer's disease
9	COPD	9	Breast cancer
10	Low back pain	10	Diabetes

(continues)

**TABLE 2-9** Leading Causes of Deaths and DALYs by Sex, Low- and Middle-Income Countries and High-Income Countries, 2010 (*continued*)

Deaths			
Males			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	Ischemic heart disease	1	Ischemic heart disease
2	Stroke	2	Stroke
3	COPD	3	Trachea, bronchus, and lung cancers
4	Lower respiratory infections	4	COPD
5	Road injury	5	Lower respiratory infections
6	HIV/AIDS	6	Colorectal cancer
7	Tuberculosis	7	Prostate cancer
8	Diarrheal diseases	8	Alzheimer's disease
9	Malaria	9	Self-harm
10	Lung cancer	10	Cirrhosis
DALYs			
Male			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	Lower respiratory infections	1	Ischemic heart disease
2	Ischemic heart disease	2	Low back pain
3	Road injury	3	Lung, trachea, and bronchus cancers
4	Stroke	4	Stroke
5	Diarrheal diseases	5	COPD
6	Malaria	6	Road injury
7	Preterm birth complications	7	Self-harm
8	HIV/AIDS	8	Diabetes
9	COPD	9	Falls
10	Low back pain	10	Major depressive disorder

Note: Alzheimer's disease includes other dementias

Data from Institute for Health Metrics and Evaluation (IHME). (2013). GBD Heat map. Seattle, WA: IHME, University of Washington, 2013. Available from <http://vizhub.healthdata.org/irank/heat.php>. Accessed April 28, 2015.

causes of DALYs in high-income countries include low back pain, self-harm, falls, and major depressive disorder that are not among the leading causes of death in this group.<sup>31</sup>

### The Burden of Deaths and Disease Within Countries

As you consider causes of death and the burden of disease globally and by region, age, and sex, it is also important to consider how deaths and DALYs would vary within countries, by gender, ethnicity, and socioeconomic status, among other things. In most low- and middle-income countries, the answer to this is relatively simple. Generally speaking:

- Rural people will be less healthy than urban people.
- Disadvantaged ethnic minorities will be less healthy than majority populations.
- Females will suffer a number of conditions that relate to their relatively weak social positions.
- Poor people will be less healthy than better-off people.
- Uneducated people will be less healthy than better-educated people.

In addition, people of lower socioeconomic status will have higher rates of communicable diseases, illness, and death related to maternal causes and malnutrition than will people of higher status. Lower socioeconomic status people will also suffer from a larger burden of disease related to smoking, alcohol, and diet than would be the case for better-off people. These points are fundamental to understanding global health.

### RISK FACTORS

As we discuss the determinants of health and how health status is measured, there will be many references to *risk factors* for various health conditions. A risk factor is “an aspect or personal behavior or life-style, an environmental exposure, or an inborn or inherited characteristic, that, on the basis of epidemiologic evidence, is known to be associated with health-related condition(s) considered important to prevent.”<sup>17,p51</sup> Risks that relate to health can also be thought of as “a probability of an adverse outcome, or a factor that raises this probability.”<sup>32,p7</sup> We are all familiar with the notion of risk factors from our own lives and from encounters with health services. When we answer questions about our health history, for example, we are essentially helping to identify the most important risk factors that we face ourselves. Do our parents suffer from any health conditions that might affect our own health? Are we eating in a way that is conducive to good health? Do we get enough exercise and enough sleep? Do we smoke or drink alcohol excessively? Are there any special stresses in our life? Do we wear seat belts when we drive?

If we extend the idea of risk factors to poor people in low- and middle-income countries, then we might add some other questions that relate more to the ways that they live. Does the family have safe water to drink? Do their house and community have appropriate sanitation? Does the family cook indoors in a way that makes the house smoky? Do the father and mother work in places that are safe environmentally? We might also have to ask if there is war or conflict in the country, because they are also important risk factors for illness, death, and disability.

If we are to understand how the health status of people can be enhanced, then it is very important that we understand the risk factors to which their health problems relate. **Table 2-10** shows the relative importance of different risk factors to deaths and DALYs in low- and middle-income countries, compared to high-income countries. These are shown in the table in order of their importance by category of risk.

When we consider low- and middle-income countries, the most striking point is the extent to which matters related to nutrition are risk factors for deaths, including dietary risks, high blood pressure, high-fasting plasma glucose, high body mass index, physical inactivity, and high cholesterol. If we extended the list beyond the 10 leading risk factors, we would see that childhood underweight is the next most important risk factor. Smoking tobacco and indoor and outdoor air pollution are also in the top 10 risk factors for deaths. A similar pattern emerges for DALYs, but in this case childhood underweight, iron deficiency, and suboptimal breastfeeding are of increased importance compared to their association with deaths.<sup>31</sup>

When we look at the risk factors for deaths in high-income countries, the pattern of risks is similar in many ways to that for low- and middle-income countries. Most of the risk factors have to do with diet, physical activity, pollution, or smoking. However, lead also appears as an important risk factor. The risk factors for DALYs are similar to that for deaths but drug use is the 10th leading risk factor for DALYs in high-income countries and was not one of the top 10 risk factors for deaths.<sup>31</sup>

In high-income countries, there is little deficiency in protein, energy, or micronutrients, but there is a considerable amount of overweight and obesity. It is not surprising, therefore, that some of the most important risk factors for both deaths and DALYs in high-income countries are high body mass index, high blood pressure, high total cholesterol, high fasting blood glucose, and physical inactivity. Nor is it surprising that, despite important progress in reducing the prevalence of smoking in some countries, tobacco remains the leading risk factor for both deaths and DALYs in high-income countries.<sup>31</sup>

**TABLE 2-10** Leading Risk Factors for Deaths and DALYs, Low- and Middle-Income Countries and High-Income Countries, 2010

Deaths			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Risk Factor	Rank	Risk Factor
1	Dietary risks	1	Dietary risks
2	High blood pressure	2	High blood pressure
3	Smoking	3	Smoking
4	Household air pollution	4	High body-mass index
5	Ambient particulate matter pollution	5	Physical inactivity
6	High fasting plasma glucose	6	High fasting plasma glucose
7	Physical inactivity	7	High total cholesterol
8	High body-mass index	8	Ambient particulate matter pollution
9	Alcohol use	9	Alcohol use
10	High total cholesterol	10	Lead
DALYs			
<i>Low- and Middle-Income Countries</i>		<i>High-Income Countries</i>	
Rank	Cause	Rank	Cause
1	Dietary risks	1	Dietary risks
2	High blood pressure	2	Smoking
3	Smoking	3	High body-mass index
4	Household air pollution	4	High blood pressure
5	Childhood underweight	5	Physical inactivity
6	High fasting plasma glucose	6	High fasting plasma glucose
7	Ambient particulate matter pollution	7	Alcohol use
8	Alcohol use	8	High total cholesterol
9	Occupational risks	9	Ambient particulate matter pollution
10	High body-mass index	10	Drug use

Data from Institute for Health Metrics and Evaluation (IHME). (2013). *GBD heat map*. Seattle, WA: IHME, University of Washington. Retrieved April 28, 2015, from <http://vizhub.healthdata.org/irank/heat.php>.

## DEMOGRAPHY AND HEALTH

There are a number of points related to population that are extremely important to people's health. Among the most important of these are:

- Population growth
- Population aging
- Urbanization
- The demographic divide
- The demographic transition

These are briefly discussed next, along with their implications for health. Other important matters related to population, such as the relationship between fertility and the health of women and children, are discussed in other chapters.

### Population Growth

The population of the world is about 7.2 billion<sup>33</sup> and is still growing. As shown in **Figure 2-8**, it is estimated that by 2050 the population of the world will be about 9.2 billion. As also shown in the figure, the overwhelming majority of population growth in the future will occur in low- and middle-income countries.<sup>4</sup> This reflects the fact that fertility is falling slowly in many countries that have had high fertility rates historically, whereas many of the high-income countries already have very low fertility. At a minimum, we should expect that increasing population growth in low-income countries will put substantial pressure on the environment,

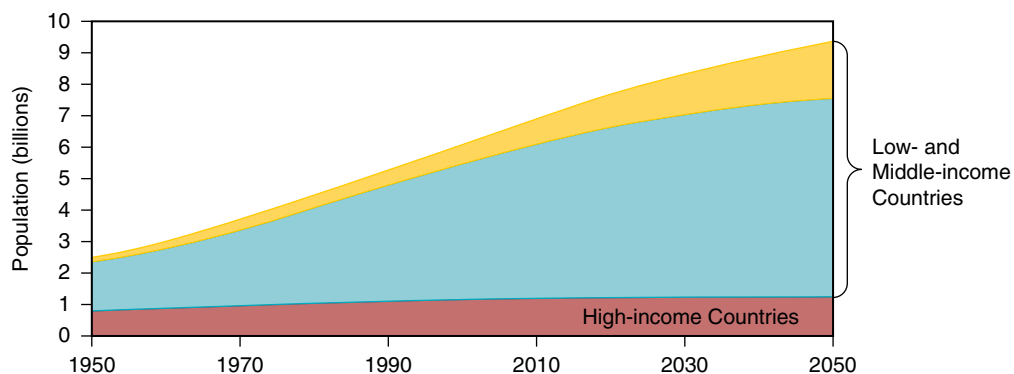
with its attendant risks for health. It will also mean that infrastructure, such as water supply and sanitation, will have to be provided to an increasing number of people in the countries that have the largest service gaps and can least afford to expand such services. This could cause these countries to face substantial impacts on health as a result. Increasing population will also make it more difficult for low-income countries to provide education and health services, with additional consequences for the health of their people in the future.

### Population Aging

As shown in **Table 2-11**, the population of the world is aging. This is especially true in high-income countries that have low fertility, but this is occurring in other countries as well. One impact of population aging is that it changes the ratio between the number of people that are 15–64 years of age, compared with the number that are 65 years of age or more. This is called the *elderly support ratio*. In Niger, with high fertility and a growing population, only 3 percent of the population is over 65 years of age, and there are 15 times more people between 15 and 65 than over 65. By contrast, in Japan, with very low fertility and a shrinking population, 24 percent of the population is over 65 and the number of people 15 to 65 is only about 2.5 times the number of people over 65.<sup>4</sup>

Population aging and the shift in the elderly support ratio have profound implications for the burden of disease and for health expenditures and how they will be financed.

**FIGURE 2-8** World Population 1950 to 2050



Modified from Haub, Carl and Population Reference Bureau. 2012 World Population Data Sheet. [http://www.prb.org/pdf12/2012-population-data-sheet\\_eng.pdf](http://www.prb.org/pdf12/2012-population-data-sheet_eng.pdf). Retrieved April 29, 2015.

**TABLE 2-11** Percentage of the Population Over 65 Years of Age

	2010	2050
High-income countries	15.9	26.2
Low- and middle-income countries	5.8	14.6

Adapted from Haub, C., & PRB. Data from United Nations Population Division. *World population prospects. The 2008 revision*. Retrieved December 4, 2010, from [http://www.un.org/esa/population/publications/wpp2008/wpp2008\\_highlights.pdf](http://www.un.org/esa/population/publications/wpp2008/wpp2008_highlights.pdf). Data is shown only for the medium population variant of the UN.

In the simplest terms, people will live longer and spend more years with morbidities and disabilities related to noncommunicable diseases. This will raise the costs of health care. In addition, the large numbers of older adults for every working person will make it difficult for countries to finance that health care.

### Urbanization

In the last decade, the majority of the world's population has lived in urban areas for the first time in world history. People are continuing to move from rural to urban areas, especially in low- and middle-income countries in which important shares of the population have continued to live in rural areas until recently. Continuing urbanization will also put enormous pressure on urban infrastructure, such as water and sanitation, schools, and health services, which are already in short supply in many countries. Gaps in such infrastructure, as well as the development of crowded and low-standard housing, for example, could have substantial negative consequences for health.

### The Demographic Divide

There is an exceptional difference in the demographic indicators and future demographic paths of the best-off and the least-well-off countries, as suggested in the two previous sections. The highest income countries generally have very low fertility, declining populations, and aging populations. By contrast, fertility in the lowest income countries is generally still high, although it is declining slowly. In addition, the population is still growing in these countries and will continue to grow for some time. There is also an enormous difference in the health circumstances of the high- and low-income countries. **Table 2-12** portrays the demographic divide.

**TABLE 2-12** The Demographic Divide: The Example of Nigeria and Japan

	Nigeria	Japan
Population 2012 (millions)	170.1	127.6
Population 2050 (millions)	402.4	95.5
Lifetime births per woman	5.6	1.4
Annual number of births (millions)	6.2	1.1
Births per 1,000 population	40	9
Percentage of population below age 15	44	13
Percentage of population age 65+	3	24
Life expectancy at birth	51	83
Infant deaths per 1,000 births	77	2.3
Annual number of infant deaths	465,000	2,900
Percentage of adults with HIV/AIDS, males/females	2.9/4.4	< 0.1/< 0.1
Percentage of deaths due to noncommunicable diseases (2008)	27	80

Data from Population Reference Bureau. (2012). *2012 world population data sheet*. Retrieved September 16, 2013, from [http://www.prb.org/pdf12/2012-population-data-sheet\\_eng.pdf](http://www.prb.org/pdf12/2012-population-data-sheet_eng.pdf); Population Reference Bureau. (2009). *2009 world population data sheet*. Retrieved April 9, 2011, from [http://www.prb.org/pdf09/09wpds\\_eng.pdf](http://www.prb.org/pdf09/09wpds_eng.pdf).



### The Demographic Transition<sup>34</sup>

One important demographic trend of importance is called the *demographic transition*. This is the shift from a pattern of high fertility and high mortality to low fertility and low mortality, with population growth occurring in between.

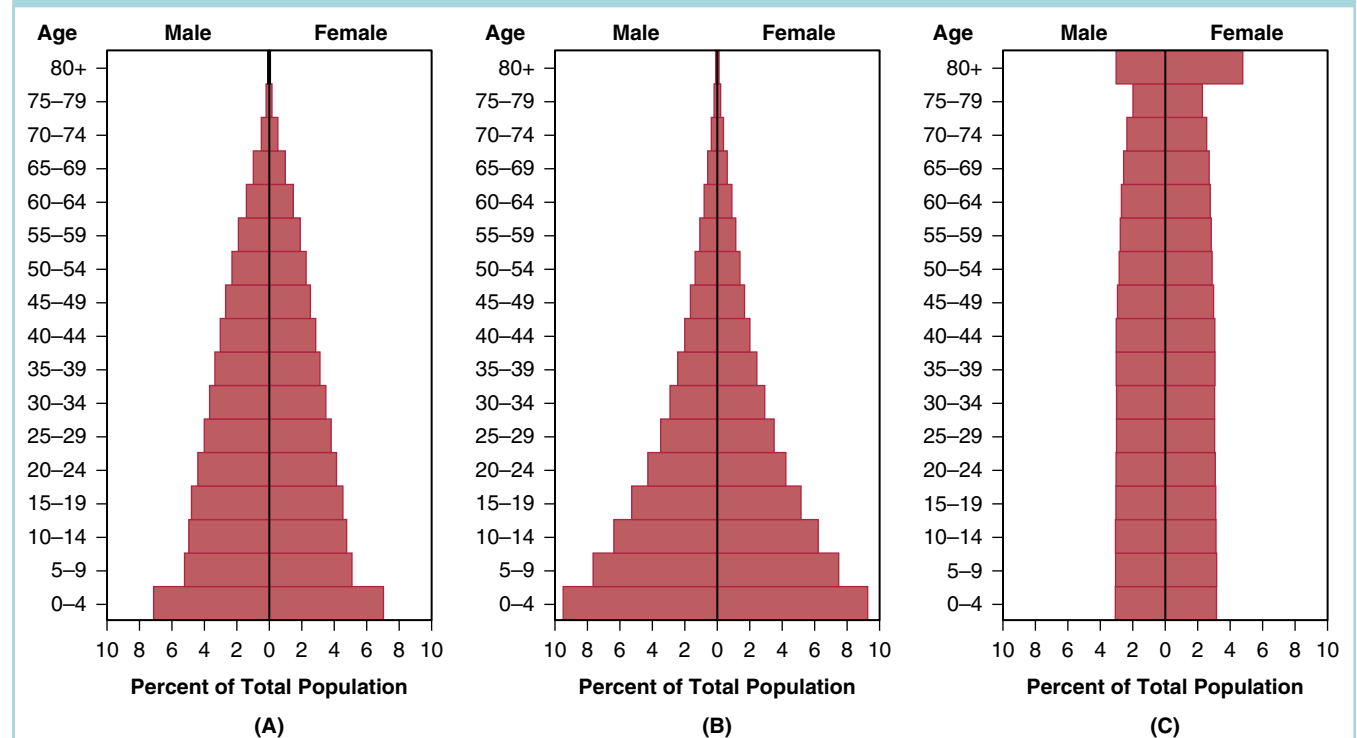
When we look back historically at the countries that are now high-income, we can see that they had long periods historically when fertility was high, mortality was high, and population growth was, therefore, relatively slow, or might even have declined in the face of epidemics. Beginning around the turn of the 19th century, however, mortality in those countries began to decline as hygiene and nutrition improved and the burden of infectious diseases became less. In most cases, this decline in mortality started before much decline in fertility. As mortality declined, the population increased and the share of the population of younger ages also increased. Later, fertility began to decline and, as births and deaths became more equal, population growth slowed.

As births and deaths stayed more equal, the share of the population that was of older ages increased.

The demographic transition is shown graphically in **Figure 2-9**.

The first population pyramid reflects a country with high fertility and high mortality. The second population pyramid is indicative of a country in which mortality has begun to decline but fertility remains high. This would be similar to the demographics one would find, for example, in a number of countries in sub-Saharan Africa that are undergoing demographic transition. The third pyramid looks more like a cylinder than a pyramid. This reflects a population in which fertility has been reduced for a substantial period of time and in which there is a much larger share of older people in the population than in the first and second pyramids. This would be similar to the demographics that one would find in a number of low-fertility, aging populations in Western Europe.

**FIGURE 2-9** The Demographic Transition: (A) High Fertility/High Mortality, (B) Declining Mortality/High Fertility, (C) Reduced Fertility/Reduced Mortality



## The Epidemiologic Transition<sup>35</sup>

The epidemiologic transition is closely related to the demographic transition, as suggested throughout the previous discussion. Historically there has been a shift in the patterns of disease that follows these trends:

- First, high and fluctuating mortality, related to very poor health conditions, epidemics, and famine
- Then, progressive declines in mortality as epidemics become less frequent
- Finally, further declines in mortality, increases in life expectancy, and the predominance of noncommunicable diseases

Figure 2-10 shows the distribution by cause group of deaths and the burden of disease for low- and middle-income countries and high-income countries.

You can see in Figure 2-10 how the pattern of deaths and DALYs differs between the low-, middle-, and high-income countries. You can also see the changes that will occur over time, as the burden of disease in low- and middle-income countries moves from one with a substantial share of communicable diseases to one in which noncommunicable diseases are very predominant.

The pace of the epidemiologic transition in different societies depends on a number of factors related to the determinants of health that were discussed earlier. In its early stages, the transition appears to depend primarily on improvements in hygiene, nutrition, education, and socioeconomic status. Some improvements also stem from advances in public health and in medicine, such as the development of new vaccines and antibiotics.<sup>36</sup>

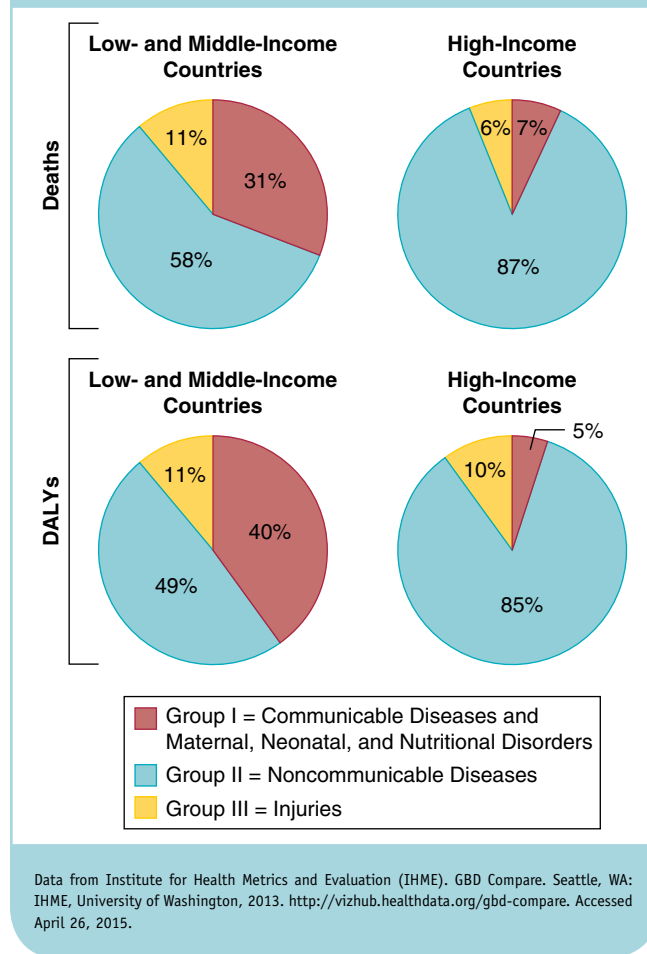
Most of the countries that are now high-income went through epidemiologic transitions that were relatively slow, with the exception of Japan. Most low- and middle-income countries have already begun their transition; however, it is still far from complete in many of them.

In fact, most low-income countries are in an ongoing epidemiologic transition and many of them, therefore, face significant burdens of communicable and noncommunicable diseases and injuries at the same time. This strains the capacity of the health system of many of these countries. It is also expensive for countries that are resource poor to address a substantial burden of all three of these types of conditions simultaneously.

## PROGRESS IN HEALTH STATUS

There has been substantial progress in improving health and raising life expectancy in many parts of the world. However, as also noted, those gains have not been uniform across regions. Rather, life expectancy in sub-Saharan Africa and

**FIGURE 2-10** Deaths and DALYs by Group of Causes for Low- and Middle-Income and High-Income Countries, 2010



South Asia continues to substantially lag behind that in other regions. In addition, for countries that had a life expectancy in 1960 of less than 50 years, the pace of improvements in life expectancy in sub-Saharan Africa has been much slower than in any other region.

Table 2-13 shows life expectancy in 1960, 1990, and 2013 by World Bank region, including for high-income countries. The table also shows the percentage gain in life expectancy over three different periods, 1960 to 2008, 1960 to 1990, and 1990 to 2013.

Life expectancy grew over each period in each region; however, the increases in Europe and Central Asia were very small in the period 1990–2013, largely reflecting the social and economic consequences of the breakup of the former

**TABLE 2-13** Life Expectancy and Percentage Gain in Life Expectancy, by World Bank Region, 1960–2013

World Bank Region	Life Expectancy (Years)			Percentage Gain (1960–2013)	Percentage Gain (1960–1990)	Percentage Gain (1990–2013)
	1960	1990	2013			
East Asia and Pacific	46	67	75	63%	46%	12%
Europe and Central Asia	—	69	77	—	—	12%
Latin America and the Caribbean	56	68	75	34%	21%	10%
Middle East and North Africa	47	64	72	53%	36%	13%
South Asia	43	58	67	56%	35%	16%
Sub-Saharan Africa	41	50	57	39%	22%	14%
High-income	69	76	79	14%	10%	4%

Data from the World Bank. *World development indicators, data query*. Retrieved September 17, 2013, from <http://databank.worldbank.org>. No data for Europe and Central Asia for 1960.

Soviet Union and the impact of changes on the health system as well. The slow progress in improving life expectancy in sub-Saharan Africa between 1990 and 2013 mostly reflects the negative impact on life expectancy of the HIV/AIDS epidemic, as well as slow economic progress in some countries and political conflict. By contrast, the dramatic increases in life expectancy from 1960 to 2013 in the East Asia and Pacific region reflect the rapid pace of economic development in that region, usually accompanied by improvements in infrastructure, nutrition, education, and health. The region was also relatively free of conflict.

The factors that lead to improvements in health are complex, as suggested by the determinants of health that you reviewed earlier in this chapter. Additional comments are made at the end of this chapter about these factors, including the role, for example, of nutrition, education, political stability, and scientific improvements. Many other chapters also include comments on the progress in improving the health of women and children and in addressing particular causes of illness, disability, and death.

## THE BURDEN OF DISEASE: LOOKING FORWARD

The burden of disease in the future will be influenced by a number of factors that will continue to change. Some of these will relate to the determinants of health discussed earlier in

the chapter. Some will relate to the demographic forces just discussed, including population growth, population aging, and migration. The burden of disease in the future will also be driven, among other things, by:

- Economic development
- Scientific and technological change
- Climate change
- Political stability
- Emerging and reemerging infectious diseases
- Food security

These are discussed very briefly in the following sections.

### Economic Development

The economies of low-income countries will need to grow if those countries are to generate the income they need to invest in improving people's health. The impact of economic development on health will depend partly on the extent to which economic growth is equitable across population groups. It will also depend on the extent to which countries are able—or choose—to use their increased income to invest in other areas that improve health, such as water, sanitation, hygiene, food security, and education. The extent and appropriateness of their investments in health, such as in low-cost, high-yielding efforts in health, will also be critical.

## Scientific and Technological Change

Scientific and technological change has had an enormous impact on health and will continue to do so in the future. This is easy to understand, as one considers the development of vaccines or new drugs, such as antibiotics or antiretroviral therapy. The development of new diagnostics for TB, for example, would have an enormous impact on the health of the world, as would the development of a vaccine against HIV or malaria. The impact of scientific and technological change on the low-income countries of today will depend to a large extent on the pace at which they are able to effectively adopt any improvements when they are developed.

## Climate Change

The impact of climate change on health is not clear; however, it is anticipated that climate change and its attendant impact on weather and rising sea levels could directly and indirectly have an important impact on health. On the indirect side, climate change could alter the nature of the food crops that can be grown in different places and lead to migration from some places to others that are deemed more habitable. On the more direct side, climate change could lead to weather changes and adverse weather that harm people's health. It could also lead to the disappearance of disease vectors in some places as the weather is no longer hospitable to them, while allowing the emergence or reemergence of disease vectors in other places.

## Political Stability

In low-income countries, political stability appears to be necessary for achieving long-term gains in health. There is substantial evidence, for example, that the lack of political stability has been a major impediment to progress in achieving the Millennium Development Goals in a number of countries. It is not hard to imagine, for example, how conflicts that occurred in Liberia, Sierra Leone, and the Democratic Republic of the Congo could set back health status for many years. These conflicts led directly to substantial illness, disability, and death. In addition, by causing a breakdown in infrastructure, such as water, sanitation, and electricity, as well as the erosion of health services, they also had enormous indirect impacts on health.

## Emerging and Reemerging Infectious Diseases

It is not possible to predict if and when new diseases will emerge or diseases already known will reemerge. It is also not possible to know how well individual countries and the world will do in recognizing any such problems and addressing them quickly and effectively. What is clear is that pandemic flu, for example, could have a major impact on future disease

patterns. It is also clear, for example, that if the growth of drug resistance for, say, malaria, outpaced our ability to produce safe and effective drugs to fight malaria, this, too, could have a substantial impact on the burden of disease.

## Projecting the Burden of Disease

Given the complex array of factors that influence health status and will drive future changes in the burden of disease, it is difficult to predict with any certainty how the burden of disease will evolve in different countries in the next 2 decades. Nonetheless, it is possible, using models, to project the future burden of disease, given assumptions about key health determinants and how they will evolve in different parts of the world.

The *Global Burden of Disease Study 2010* did not include projections of the future burden of disease. However, in 2008, WHO developed projections of the burden of disease, based on data that was collected in 2004. These projections included information on both deaths and DALYs. WHO more recently produced projections for 2030, but they only have data on deaths. The data that follows is from the earlier WHO projections since information about DALYs that this data uniquely contains is still enlightening and of more value, in many ways, than information solely on deaths.

**Table 2-14** highlights the leading causes of the burden of disease in DALYs, as WHO projected them to 2030. These projections of percentage of total DALYs at that time are on the basis of data on the burden of disease from 2004. The data is presented by World Bank country income group for low-, lower-middle-, upper-middle-, and upper-income countries.

The main message of the table is clear: over the period to 2030, it is projected that there will be substantial changes in the burden of disease in all country income groups. In the simplest terms, low- and lower-middle-income countries will see a substantial shift away from communicable diseases and toward noncommunicable diseases and injuries. HIV/AIDS is projected to be the only communicable disease in the top 10 causes of DALYs in low-income countries, and no communicable diseases are predicted to be in the top 10 for lower-middle-income countries. Unipolar depressive disorders, ischemic heart disease, and cerebrovascular disease become more important causes of DALYs for both income groups. Some causes we associate with aging populations, such as hearing loss and refractive errors, also become more prominent, even in low-income countries. The projected growth of diabetes in all income groups is also evident in the table.

For the upper-middle-income countries, the burden would continue to shift in similar ways, as noted previously.

**TABLE 2-14** Projections to 2030 for the 10 Leading Causes of the Burden of Disease by World Bank Income Group

Projected in 2030	Percentage of Total DALYs	Projected in 2030	Percentage of Total DALYs
<b>Low-income countries</b>		<b>Upper-middle-income countries</b>	
1. Perinatal conditions	8.6	1. Ischemic heart disease	8.2
2. Unipolar depressive disorders	5.8	2. HIV/AIDS	6.2
3. Road traffic accidents	5.5	3. Unipolar depressive disorders	6.0
4. Ischemic heart disease	5.2	4. Cerebrovascular disease	5.6
5. Lower respiratory infections	5.0	5. Diabetes	4.2
6. Cerebrovascular disease	3.1	6. Interpersonal violence	3.9
7. HIV/AIDS	3.1	7. Alcohol use disorders	3.1
8. Other unintentional injuries	3.1	8. Road injury	3.0
9. Chronic obstructive pulmonary disease (COPD)	3.1	9. Hearing loss, adult onset	2.8
10. Hearing loss, adult onset	2.6	10. Osteoarthritis	2.3
<b>Lower- middle-income countries</b>		<b>High-income countries</b>	
1. Unipolar depressive disorders	6.4	1. Unipolar depressive disorders	8.5
2. Cerebrovascular disease	6.0	2. Ischemic heart disease	6.5
3. COPD	5.9	3. Alzheimer's and other dementias	5.5
4. Ischemic heart disease	5.2	4. Hearing loss, adult onset	4.1
5. Road traffic accidents	5.0	5. Cerebrovascular disease	3.8
6. Refractive errors	3.3	6. Alcohol use disorders	3.3
7. Hearing loss, adult onset	3.1	7. Osteoarthritis	2.8
8. Perinatal conditions	2.9	8. Trachea, bronchus, and lung cancers	2.7
9. Diabetes	2.7	9. Refractive errors	2.4
10. Alcohol use disorders	2.7	10. Self-harm	2.4

Note: Perinatal conditions include prematurity and low birth weight; birth asphyxia and birth trauma; and neonatal infections and other conditions. Some cause definitions differ from the GBD heat map. In some cases, the GBD category was used for consistency. Please see source for more information on methods on how these projections were calculated and cause definitions.

Data from World Health Organization. Global Burden of Disease (GBD). Available at: [http://www.who.int/healthinfo/global\\_burden\\_disease/en](http://www.who.int/healthinfo/global_burden_disease/en). Accessed September 14, 2010.

TB, which was the 11th leading cause of DALYs, would decline in relative importance, and no communicable disease would be in the top 10. Adult-onset hearing loss and arthritis, however, would join the top 10 leading causes of DALYs, clearly reflecting the aging populations in these countries.

The projected burden of disease in high-income countries also suggests an increase in burdens associated with aging, such as dementias, hearing loss, and refractive disorders.

Mental health issues are projected to increase in importance in all income groups over the period 2004 to 2030. The largest percentage increases will occur in low-income countries, probably reflecting the extent to which these issues arise as people lose connections with their families and their culture group, as often occurs in modernizing and globalizing economies in which people leave their native places to migrate to cities in search of employment. The neglected tropical diseases are not treated as a group in the burden of disease data, so each disease tends to be fairly low in rankings of DALYs. However, we should anticipate that the burden of these diseases will remain substantial for many years to come,

but that their burden will decline consistently between 2004 and 2030.

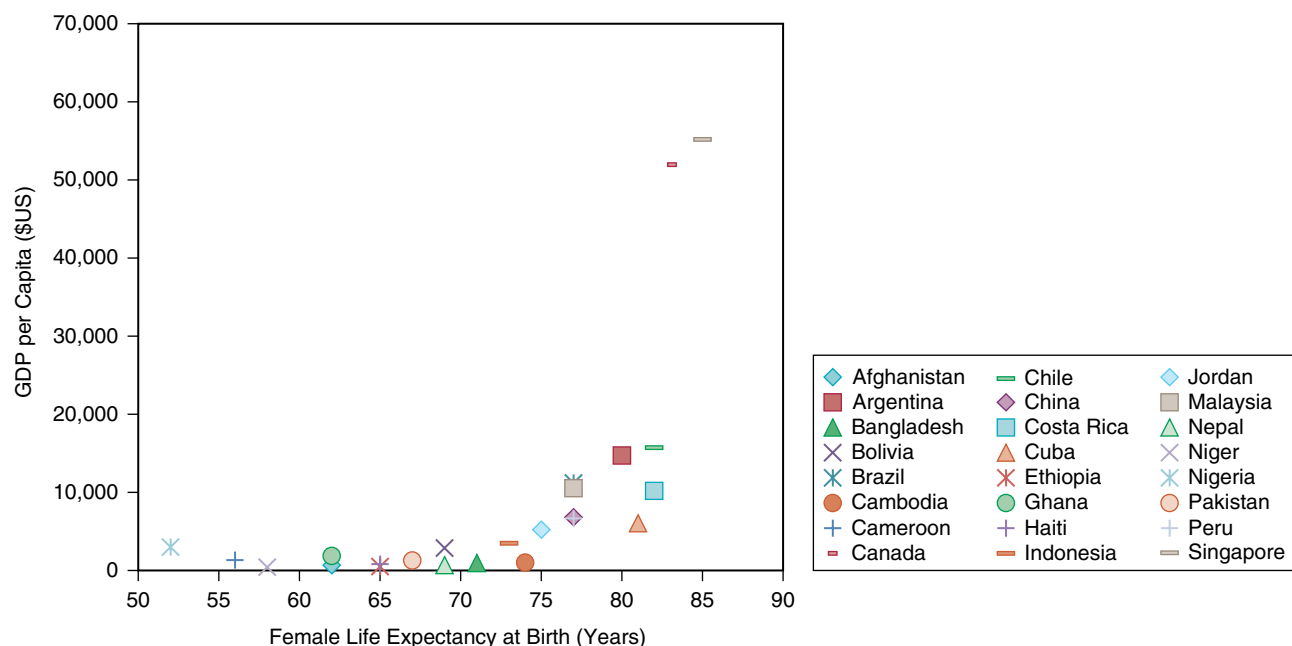
## THE DEVELOPMENT CHALLENGE OF IMPROVING HEALTH

One of the key development challenges facing policymakers in low-income countries is how they can speed the demographic and epidemiologic transitions at the lowest possible cost. How can Niger, for example, improve its health status as rapidly as possible and at the least possible cost? Will it be possible for the people of Niger to enjoy the health status of a middle-income country, even if Niger remains a low-income country?

Figure 2-11 shows national income of a sample of countries, plotted against life expectancy at birth for females in those countries.

From this figure, one can see that, generally, the health of a country does increase as national income rises. However, one can also see that there are some countries, such as China, Costa Rica, Cuba, and Sri Lanka, that have achieved higher

**FIGURE 2-11** Gross Domestic Product per Capita and Female Life Expectancy at Birth, Selected Countries



Data from World Bank. Data: Life expectancy at birth (female). <http://data.worldbank.org/indicator/SP.DYN.LE00.FE.IN>. Accessed March 11, 2015; World Bank. Data: GDP per capita (current US\$). <http://data.worldbank.org/indicator/NY.GDP.PCAP.CD>. Accessed March 21, 2015.

average life expectancies at birth than one would have predicted for countries at their level of income.

To a large extent, countries like those above achieved these important health gains as a result of:

- Focusing on investing in nutrition, health, and education, particularly of their poor people
- Improving people's knowledge of good hygiene
- Making selected investments in health services that at low cost could have a high impact on health status, such as vaccination programs for children and TB control

Indeed, in the long run, economic progress *will* help to bring down fertility, reduce mortality from communicable diseases, and help to produce a healthier population. However, at the present rates of progress in improving health in most low-income countries, these changes will take a very long time to occur. One great public policy challenge for these countries and their governments, therefore, is how they can short-circuit this process and reach reduced levels of fertility, lower mortality, and better health for their people, even as they remain relatively poor.

## POLICY AND PROGRAM BRIEF

### The Million Death Study on India

#### *The Aims of the Study*

The Centre for Global Health Research, at the University of Toronto, Canada, is carrying out the Million Death Study in India, in conjunction with the Registrar General of India. This study is one of the largest research efforts ever undertaken on the causes of premature mortality. Led by Professor Prabhat Jha, the study aims to help India improve the documentation of the underlying causes and risk factors of mortality, as a basis for enhancing investments in health, reducing premature death, and improving the health of India's people.<sup>37</sup>

Vital statistics, such as fertility and mortality data, are crucial for identifying major health issues, identifying new health problems as they arise, making cost-effective public health investments, and evaluating the progress of public health interventions. Yet, reliable mortality statistics are rare. A total of 75 percent of global deaths occur in low- and middle-income countries and the majority of these lack medical supervision and official certification of cause of death.<sup>38</sup> In India, for example, 70 percent of deaths go unreported or misclassified.<sup>39</sup> Previous mortality estimates for India were largely based on data from the limited spectrum of deaths that occur in hospitals and were consequently biased toward

causes of death that affect urban populations more than rural populations. They were also biased toward conditions that are more urgent and lead to hospitalization, rather than taking sufficient account of chronic health problems.<sup>40</sup> Moreover, in India and in many other middle- and low-income countries, there is a general dearth of knowledge around the causes of deaths, especially for middle-aged adults, and the corresponding risk factors leading to premature death.

#### *The Study Approach*

The Million Death Study seeks to assess the causes of death of one million people in India through monitoring 2.4 million households over two time periods: 1998–2003 and 2004–2014. The study is based on an approach called “verbal autopsy.” The study uses India's Sample Registration System as its sampling framework. Twice a year trained surveyors conduct surveys in order to identify households in which a death occurred. They then interview household members about the deaths in their families and record information on the events leading to death and the symptoms of the deceased. The verbal autopsies are sent to two independent physicians to be analyzed and ascertain the underlying cause of those deaths.<sup>37</sup>

By early 2015, 600,000 deaths have been surveyed and 400,000 deaths have been fully coded. The study is expected in the next 2 to 3 years to have carried out all of the planned interviews and assessed all of the deaths it will consider. Nonetheless, the study authors believe that the emerging data already provides compelling information about mortality trends in India.<sup>41</sup>

#### *Findings to Date*

The study thus far has exposed some mortality estimates and trends that deviate from those previously recognized.<sup>39</sup> First, the study has suggested that the top four causes of death in India are cardiovascular disease, chronic respiratory disease, TB, and cancer. Second, one of the most striking findings is related to the effects of tobacco. The average Indian smoker starts smoking later in life than in many other countries and often smokes hand-rolled locally manufactured cigarettes called bidis, which have a lower concentration of cancer-causing agents than commercially manufactured cigarettes. Nonetheless, this study showed that in India smoking is as much a risk for premature death as in Europe and the United States. Moreover, study findings suggest that smoking is a risk factor for TB in India and that 40 percent of all TB deaths in middle-aged men in India can be attributed to smoking.<sup>38</sup> Third, the study suggests that some estimates of the burden of disease might be quite different from what was previously thought and that the burden of disease pattern varies greatly

across the country. This study, for example, estimates that total malaria deaths are 10 times greater than the World Health Organization estimates, with over half of malaria deaths occurring in people 15–69 and the state of Odisha accounting for a quarter of India's annual malaria deaths.<sup>38</sup> On the other hand, the study suggests that mortality associated with HIV-related infections is lower than UNAIDS estimates, although the rural areas around Mumbai have a particularly high concentration of HIV-related deaths with an annual death rate of 56 per 100,000.<sup>38,39</sup>

### *Lessons of Experience*

The Million Death Study may offer a model for improving mortality information that is reliable, high impact, low cost, and replicable in other countries. The ideal system to measure mortality would depend on a well-functioning system of vital registration. However, in the absence of such comprehensive registration programs, this study suggests that verbal autopsies can reduce inaccurate data by correctly classifying the underlying causes of 90 percent of the deaths occurring before age 70, an order of magnitude better than the limited cause of death data previously available.<sup>40</sup> This can help derive the probable cause of death when one has not been reported and help us to understand the leading causes of death.<sup>37</sup> Importantly, this approach has also been shown to be cost-effective. India added recording the causes of death and risk factors to a low-cost, preexisting sample registration system, at a cost of less than \$2 per household.<sup>41,42</sup>

The long-term goal will always be universal civil registration of deaths with medical certification in order to best minimize misclassification and misrepresentation. However, approaches such as those applied in the Million Death Study offer an interim solution for better statistics on mortality for many low- and middle-income countries.

## **CASE STUDY**

### *The State of Kerala*

Having begun to review health status and how countries can speed improvements in health, it will be valuable to end this chapter by examining a well-known case of a place that improved health status considerably, even at relatively low levels of income. One of the best known of such success stories concerns Kerala State in India.

### *Introduction*

Kerala is a coastal state in Southwestern India with a population of more than 33 million people.<sup>43</sup> Despite earlier slow rates of economic growth and a state per capita income lower than that of many other states in India, the health indicators

for Kerala are the best in India and rival those in high-income countries. What approach did Kerala take historically to produce such high levels of health, even in the face of relatively low income? What factors contributed to improvements in health status? What lessons does the Kerala experience suggest for other countries and for other states within India?

### *The Kerala Approach*

One of the primary reasons why people in Kerala have such high levels of health has been the emphasis that the state put on education and the exceptionally widespread access to education in Kerala. The state introduced free primary and secondary education in the early part of 20th century.<sup>44</sup> In addition, Kerala has always put important emphasis on the education of females.

Kerala also made an early commitment to widespread health services for its people. The state created, for example, an extensive network of primary healthcare centers. This provided its citizens, throughout the state, with access to free basic health care and free family planning services. This was coupled with programs to promote exclusive breastfeeding and the improved nutrition of infants, children, and pregnant women. The central government supported the family planning program, the maternal and child health program, and the universal immunization program in all of India, but they were implemented far more effectively and efficiently in Kerala than in most other states of India.<sup>45</sup>

The place of women in Kerala society also contributed to the uptake of education by females and improvements throughout Kerala in nutrition and health status. The role of women in many communities in Kerala differs from the roles ascribed to women in many other parts of India. In much of the rest of India, especially in parts of North India, women are regarded by families as liabilities rather than as assets. In most of India, this is partly represented in cultural terms by the fact that the family of a bride must pay a dowry to the family of the groom. In Kerala, however, women have been treated differently for over a century. They have been seen culturally as assets to families and could inherit and own land, giving them a financial independence and power that has been unrivalled among women elsewhere in India.<sup>46</sup>

It is also important to note that Kerala has historically been run by a government that has traditionally placed a premium on community mobilization on important social issues, such as education, greater empowerment of women, health, nutrition, and land reform. Many of these efforts were carried out in ways that raised social awareness about health and nutrition. In 1989, Kerala launched a total literacy campaign, for example, and by the start of the World Literacy



Year in 1990, Ernakulam district in Kerala was declared India's first totally literate district.<sup>47</sup>

Given widespread education in Kerala and the place of women in society, it is not surprising that Kerala went through the demographic transition quite early and well before other places in India. Women with more education are more likely to work and marry later and thus have wider choice in economic and social pursuits. They also have a better knowledge of and easier access to family planning methods and lower fertility than do women with less education.<sup>48</sup>

### The Impact

What were the impacts on health status of the emphasis that Kerala placed on education, health, nutrition, and the empowerment of women? Although it is not possible to scientifically indicate which policy contributed what share of better health, we can say that for many years the people of Kerala have enjoyed the best educational attainment of any group within India. In the 2001 census, the literacy rates of people aged 7 years and above for India were about 65 percent on average, with about 76 percent for males and 54 percent for females. Kerala, however, had the highest literacy rate in the country, with about 91 percent overall and about 94 percent for males and 88 percent for females.<sup>49</sup> Kerala also boasted one of the highest newspaper readerships in the world, another feature that promotes the value of women, education, nutrition, and health. It also helps to raise political awareness and the demands of people for participation in and solutions to their concerns, such as education, health, and water.

Linked with this high level of education, especially of women, and the promotion of nutrition and health, infant mortality in Kerala in 2001 was 14 per 1,000, compared with 91 per 1,000 for low-income countries generally and 68 per 1,000 on average for India.<sup>49</sup> The national under-5 mortality rate for 1998–1999 was around 87 per 1,000 live births with a wide variation between states. In Kerala, however, the mortality of children under 5 years was the best in India with an impressive rate of only 19 such deaths per 1,000 births in 1998–1999.<sup>50</sup> In addition, maternal deaths in Kerala were much less common, at 87 per 100,000, than the Indian average of 407 per 100,000.<sup>51</sup> This partly reflects the extent to which deliveries take place in hospitals in Kerala. Indeed, Kerala's healthcare system garnered international acclaim when UNICEF and WHO designated it as the world's first baby-friendly state. This was in recognition of the fact that more than 95 percent of Keralite births are in hospitals.<sup>52</sup>

Finally, one should note that life expectancy for men and women in Kerala at the time of the 2001 census was 73

years. This was close to life expectancy in many high-income countries.<sup>53</sup>

### Lessons Learned

Kerala has long been cited, along with China, Costa Rica, Cuba, and Sri Lanka, as a model of a country or state within a country that has achieved high levels of education and health for its people, before achieving high levels of income. It appears that Kerala achieved these impacts by politically supporting widespread access to education, nutrition, and health; mobilizing communities around the importance of these areas and of women's empowerment; and investing in low-cost but high-yielding areas of education, nutrition, and health. In a manner much like Sri Lanka, Kerala has also managed to achieve high levels of health status at relatively low cost.

Have the high levels of health and education in Kerala, however, been associated with high levels of growth of income in the state? The answer to that question, at least until recently, was no. The annual per capita gross domestic product (GDP) for the state in year 2001 was \$469. This was close to the Indian average of \$460.<sup>54</sup> It appears that the economic policies held by the state for many years did not yield high rates of economic growth or produced an environment in which domestic and foreign investors were prepared to work. Rather, the overall income of the state remained quite dependent on the money that workers from Kerala living abroad, especially in the Middle East, send back to their families in Kerala.<sup>55</sup>

What, then, are the messages to take away from Kerala in terms of the link between health and development? First, it is possible, even in the absence of high levels of income, to achieve high levels of health through political commitment, sound investments, and social mobilization. Second, however, in the absence of sound economic policies, the presence of a literate and healthy population alone will not be sufficient to promote rapid economic growth.

## MAIN MESSAGES

To understand the most important global health issues, we must understand the determinants of health, how health status is measured, and the meaning of the demographic and epidemiologic transitions. There are a number of factors that influence health status, including genetic makeup, sex, and age. Social and cultural issues and health behaviors are also closely linked to health status. The determinants of health also include education, nutritional status, and socioeconomic status. The environment is also a powerful determinant of health, as is access to health services, and the policy approaches that countries take to their health sectors and to investments that could influence the health of their people.

Increasing attention is being paid to the social determinants of health.

There are a number of uses of health data including measuring health status, carrying out disease surveillance, making decisions about investments in health, and assessing the performance of health programs. Those working in health use a common set of indicators to measure health status, including life expectancy, infant and neonatal mortality, under-5 child mortality, and the maternal mortality ratio. They also use composite indices, such as DALYs, to measure the burden of disease. Vital registration systems are weak in low-income countries and need to be strengthened to improve the quality of health data.

There has been progress in all regions of the world in increasing life expectancy over the last several decades. In addition, the pace of those increases has been exceptionally rapid in East Asia and Pacific. However, it is clear that the basic health indicators are much worse in sub-Saharan Africa than in any other region and that these indicators also lag substantially in South Asia.

When considering the health status of a population, it is important to consider not only deaths, but also DALYs, which take account of premature death and years lived with disability. It is easy to understand this when examining causes of ill health that do not often lead to death but that, nonetheless, can lead to many years of disability, such as diabetes, depressive disorders, musculoskeletal disorders, and the neglected tropical diseases.

The leading cause of death worldwide for both sexes and all age groups is ischemic heart disease, followed by stroke. All of the other 10 leading causes, except lower

respiratory infections, HIV/AIDS, and TB are noncommunicable diseases. The leading cause of DALYs for both sexes and all age groups globally is also ischemic heart disease when looking at both sexes combined and all age groups combined. However, the 10 leading causes of DALYs also include several diseases that especially affect large numbers of children in lower income countries, such as diarrhea and malaria. The leading causes of DALYs also include road traffic injuries and low back pain.

The burden of disease is predominantly noncommunicable in all regions of the world except sub-Saharan Africa, and South Asia also continues to have a substantial burden of communicable disease. Over the last several decades, the burden of disease within regions and globally has continued to shift more and more toward a pattern dominated by noncommunicable diseases. Projections suggest that this trend will continue, especially in the face of populations that are aging.

It is also important to understand the most important risk factors that are associated with deaths and DALYs. In the low-income countries, some of the most important risk factors include a range of nutritional issues, the lack of safe water or appropriate sanitation, indoor air pollution, and tobacco smoking. Poor diets that relate to obesity, high blood pressure, high cholesterol, and cardiovascular disease are becoming increasingly important problems as well, even in low-income countries. In the higher income countries, the key risk factors for deaths and DALYs are overwhelmingly behavioral and have to do with what people eat, their levels of physical activity, and if they smoke tobacco, engage in excessive alcohol use, and drive safely.

## Study Questions

1. What are the main factors that determine your personal health?
2. What are the main factors that would determine the health of a poor person in a poor country?
3. If you could pick only one indicator to describe the health status of a poor country, which indicator would you use and why?
4. Why is it valuable to have composite indicators like DALYs to measure the burden of disease?
5. What is a HALE, and how does it differ from just measuring life expectancy at birth?
6. As countries develop economically, what are the most important changes that occur in their burden of disease?
7. Why do these changes occur?
8. In your own country, what population groups have the best health indicators and why?
9. In your country, what population groups have the worst health status and why?
10. How would the population pyramid of Italy differ from that of Nigeria and why?
11. How does the burden of disease differ from one region to another?
12. How will the burden of disease evolve in different regions over the next 20 years?

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