Chapter 2

Trends in Morbidity and Mortality Attributable to Injuries and Selected Environmental Hazards

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INTRODUCTION

The effects of globalization on low- and middle-income countries (LMICs) have led to major changes in the disease burden attributable to injuries and environmental risks. On the one hand, rapidly developing regions face a rising number of road traffic injuries (RTIs) and fatalities, as well as health effects from increasingly polluted air. On the other hand, economic development has led to greater availability of water, sanitation, and hygiene (WASH) services and a reduced burden of diarrheal and helminthic illness in many settings. These trends are heterogeneous, however, and very poor countries, and regions within populous countries such as India, exhibit slower progress.

This chapter presents an overview of trends in the burden of injuries and environmental health issues in LMICs. We focus on five major groups of conditions, presented as they appear in this volume and not in order of importance:

- Unintentional injuries, which include RTIs and those resulting from other causes
- Interpersonal and collective violence
- Occupational hazards
- WASH-related illnesses
- Health effects of air pollution.

Self-harm is not covered in detail in this chapter because it is covered in volume 4, chapter 9, of *Disease Control Priorities* (third edition) (Vijayakumar and others 2015). Although the conditions presented above are seemingly very different, a common feature links them: they can all be addressed through multisectoral interventions, including legal and regulatory frameworks and public works investments. These interventions are assessed further in the subsequent chapters of this volume.

This chapter presents two types of burden estimates. For injuries, we present deaths and disability-adjusted life years (DALYs). For occupational and environmental hazards, we present attributable deaths and DALYs. The distinction between these two types of estimates is that the former are related to specific causes of death, such as RTIs, whereas the latter are related to risk factors, such as unimproved water, for specific causes of death, such as diarrheal disease. Attributable deaths and DALYs are estimated using the comparative risk assessment (CRA) methodology rather than mortality analysis. They often total greater or less than 100 percent owing to multiple risk factors (or no known risk factors) for various causes of death. Hence, estimates of the burden of environmental and occupational risk factors cannot be directly compared to estimates of the burden of injuries.

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This chapter presents estimates from two sources of data. Mortality and morbidity data on injuries are taken from the World Health Organization's (WHO) Global Health Estimates database, most recently updated in 2014 (WHO 2016). Details on the methods for estimating cause-specific mortality and DALYs—including calculation of years of life lost and disability weights—are available in the relevant documentation from the WHO. Attributable mortality and morbidity data on occupational and environmental risks are taken from the Global Burden of Disease 2013 Study (GBD 2013) because similar data were not available from the WHO. Details on the methods for estimating attributable mortality and DALYs using CRA are provided in Forouzanfar and others (2015).

We compare trends in total deaths with trends in age-standardized mortality rates. For injuries, we calculated age-standardized rates based on the global population structure in 2012 and compared mortality in 2000 to mortality in 2012. For occupational and environmental risks, we used age-standardized attributable rates from GBD 2013, which based calculations on the global population structure in 2013 and compared attributable mortality in 1990 to attributable mortality in 2013.

UNINTENTIONAL INJURIES

Road Traffic Injuries

Among unintentional injuries, RTIs remain the most common cause of deaths and DALYs. RTIs cause the single-highest number of injuries worldwide in any category, and their number continues to increase. RTIs caused 1.1 million deaths and 70 million DALYs in 2012, accounting for 3 percent of total deaths and DALYs in LMICs. RTIs rank among the top 10 causes of death globally, and LMICs constitute a higher proportion of deaths. Most deaths occur among vulnerable road users, such as pedestrians, motorcyclists, and cyclists. Poor design, traffic congestion, and lack of road maintenance and safety systems in many LMICs make prevention more challenging (Peden and others 2004).

The United Nations Road Safety Collaboration has highlighted the unequal effect of RTIs by socioeconomic status, age, and gender. In general, adolescent and younger working-age adult males are most affected by RTIs, and the increase in deaths between 2000 and 2012 has been largest in this group (table 2.1). Yet many countries do not regularly collect data on RTIs, thereby limiting awareness of the problem and potential interventions, such as speed limits, seat belt enforcement, and impaired-driving laws (WHO 2013).

The number of RTI-related deaths and DALYs in LMICs increased by 36 percent and 23 percent, respectively, between 2000 and 2012 (table 2.1). This increasing burden of RTIs is independent of demographic changes and is related to increasing age-specific mortality rates: the age-standardized mortality rate from RTIs increased 17 percent from 18 per 100,000 persons to 21 per 100,000 persons in LMICs (table 2.2). Notably, no

Table 2.1 Road Traffic Injuries: Deaths and DALYs in LMICs by Age and Gender, 2000–12

Gender	Age	Deaths		Change	DALYs		Change
		2000	2012	(%)	2000	2012	(%)
Both genders	Total	836,500	1,134,800	36	57,241,000	70,385,200	23
(percentage of total deaths or DALYs)		(2.0)	(2.6)		(2.3)	(3.0)	
Male	0–27 days	1,300	1,300	0	120,000	117,000	–3
	1–59 months	30,800	27,100	–12	2,820,000	2,485,000	–12
	5–14 years	48,600	50,200	3	4,453,000	4,532,000	2
	15–29 years	199,700	232,800	17	15,664,000	18,038,200	15
	30–49 years	197,200	260,200	32	13,289,000	16,760,000	26
	50–59 years	53,900	102,900	91	2,808,000	4,948,000	76
	60–69 years	42,400	73,400	73	1,655,000	2,626,000	59
	70+ years	41,800	78,500	88	952,000	1,600,000	68
	Total	615,700	826,400	34	41,761,000	51,106,200	22

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Table 2.1 Road Traffic Injuries: Deaths and DALYs in LMICs by Age and Gender, 2000–12 (continued)

Gender	Age	Deaths		Change (%)	DALYs		Change (%)
		2000	2012		2000	2012	
Female	0–27 days	1,400	1,300	–7	128,000	120,000	–6
	1–59 months	23,400	20,200	–14	2,137,000	1,847,000	–14
	5–14 years	29,500	30,500	3	2,680,000	2,751,000	3
	15–29 years	49,900	61,000	22	4,351,000	5,264,000	21
	30–49 years	50,300	70,900	41	3,820,000	5,160,000	35
	50–59 years	20,000	37,900	90	1,066,000	1,905,000	79
	60–69 years	20,700	36,900	78	768,000	1,289,000	68
	70+ years	25,600	49,700	94	530,000	943,000	78
	Total	220,800	308,400	40	15,480,000	19,279,000	25

Source: WHO 2016.
Note: DALYs = disability-adjusted life years; LMICs = low- and middle-income countries. Estimates and percentage changes may vary slightly because of rounding.

Table 2.2 Injuries: Deaths and Mortality Rates by Cause in LMICs, All Ages and Both Genders, 2000–12

Cause	2000		2012		Change (%)	
	Total deaths (thousands)	ASMR per 100,000 persons	Total deaths (thousands)	ASMR per 100,000 persons	Deaths	ASMR
All causes	41,800	1,050	44,200	880	6	–16
Injuries (unintentional and intentional)	4,130	93	4,410	81	7	–13
Unintentional injuries	2,920	66	3,220	60	10	–9
Road traffic injuries	800	18	1,140	21	43	17
Poisonings	220	5	160	3	–27	–40
Falls	440	12	580	12	32	0
Burns (fire, heat, and hot substances)	240	5	250	4	4	–20
Drownings	390	8	340	6	–13	–25
Exposures to forces of nature	0	0	0	0	0	100
Other unintentional injuries	830	18	750	14	–10	–22
Intentional injuries	1,210	27	1,190	21	–2	–22
Self-harm	680	16	610	11	–10	–30
Interpersonal violence	420	9	460	8	10	–11
Collective violence and legal intervention	110	2	120	2	9	0

Source: WHO 2016.
Note: ASMR = age-standardized mortality rate; LMICs = low- and middle-income countries. Percentages may vary slightly because of rounding.

apparent age-specific peak occurred in female deaths from RTIs. Finally, although RTIs frequently lead to premature mortality, nonfatal outcomes contribute a substantial proportion of total DALYs (Peden and others 2004). The majority of RTI-related DALYs occurs among males ages 15–49.

Other Unintentional Injuries

Although RTIs are the single leading cause of death by injury, nontransport unintentional injuries collectively—including poisonings, falls, burns, and drownings—account for twice the number of deaths and DALYs as do RTIs (tables 2.2 and 2.3). The proportion of deaths and DALYs as a result of unintentional injuries is higher in LMICs than in high-income countries. Nontransport unintentional injuries account for more than 6,700 deaths per day and 2.4 million deaths annually—almost twice the number of deaths from transport injuries and twice the number of deaths from intentional injuries. Nontransport unintentional injuries also account for over 128 million DALYs annually—almost twice the number from transport injuries and from intentional injuries. Trends across individual causes vary: deaths from falls and burns are increasing, while deaths from poisonings and drownings are decreasing (table 2.2). At the same time, age-standardized mortality rates for nontransport unintentional injuries are all declining substantially with the exception of falls.

Poisonings

The burden of unintentional poisoning is declining, with age-standardized mortality rates declining 40 percent from 2000 to 2012. In 2012, LMICs experienced an estimated 163,000 deaths and 9.3 million DALYs. Most poisoning cases continue to occur among children who have unintentionally gained access to toxic chemicals (Balan and Lingam 2012).

Falls

After RTIs, falls are the most frequent cause of death and DALYs owing to unintentional injury, resulting in 577,000 deaths and 33.5 million DALYs in LMICs in 2012. Age-standardized mortality rates from falls have stagnated since 2000 in contrast to other unintentional injuries. A high incidence of falls has been observed in South-East Asia. Most falls occur among the elderly, even in LMICs (Kalula and others 2011; Ranaweera and others 2013). The burden of falls is also being driven by population aging and is exacerbated by lack of treatment for cognitive problems and by unsafe living environments (Lau and others 2001). Work-related falls and other injuries are also a major problem in LMICs.

Table 2.3 Injuries: DALYs by Cause in LMICs, All Ages and Both Genders, 2000–12

Cause	2000		2012		Change (%)
	Total DALYs (thousands)	Percentage of all DALYs	Total DALYs (thousands)	Percentage of all DALYs	
All causes	2,486,000	100	2,355,000	100	–5
Injuries (unintentional and intentional)	266,000	11	264,000	11	–1
Unintentional injuries	197,000	8	197,000	8	0
Road traffic injuries	57,000	2	70,000	3	23
Poisonings	13,000	1	9,000	0	–31
Falls	28,000	1	33,000	1	18
Burns (fire, heat, and hot substances)	17,000	1	17,000	1	0
Drownings	28,000	1	22,000	1	–21
Exposures to forces of nature	0	0	0	0	0
Other unintentional injuries	54,000	2	46,000	2	–15
Intentional injuries	69,000	3	67,000	3	–3
Self-harm	36,000	1	31,000	1	–14
Interpersonal violence	26,000	1	29,000	1	12
Collective violence and legal intervention	7,000	0	7,000	0	0

Source: WHO 2016.
Note: DALYs = disability-adjusted life years; LMICs = low- and middle-income countries. Percentages may vary slightly because of rounding.

Burns

In 2012, an estimated 245,000 deaths and 16.8 million DALYs in LMICs were attributable to burns. Deaths from burns have remained stable since 2000, especially in Sub-Saharan Africa, South-East Asia, Europe, and the Eastern Mediterranean. Age-standardized mortality rates from burns declined 20 percent, suggesting that increases in numbers of deaths are being driven by population growth or increases in death rates in specific groups only. Among injuries, burns are uniquely more prevalent among females. This pattern is due to differential exposure to unsafe cooking appliances and other hazards in households in LMICs (Ahuja and Bhattacharya 2002; Ahuja, Bhattacharya, and Rai 2009; Ahuja, Dash, and Shrivastava 2011; Hyder and others 2009; Mabrouk, El Badawy, and Sherif 2000). Another important etiology of burns among women is acid attacks, which have received particular media attention in the past few years and seem to be more frequent in South Asia (Acid Survivors Foundation 2014).

Drownings

Drowning-related deaths (337,000) and DALYs (21.8 million) in LMICs are decreasing. Death rates declined by 13 percent and age-standardized mortality rates by 25 percent. Drowning continues to be most common among children, adolescents, and young adult males. It often occurs as a result of risky behaviors and the exacerbating effects of harmful alcohol use (Peden and McGee 2003). Drowning among children under age five occurs most frequently in settings where swimming education and child supervision are inadequate, such as rural areas (Rahman and others 2012).

Other Causes

Exposures to forces of nature and other unintentional injuries (not elsewhere classified) account for a substantial additional fraction of total deaths and DALYs. Because interventions for these conditions are not specifically addressed in *Disease Control Priorities* (third edition), they are not discussed further here.

INTERPERSONAL AND COLLECTIVE VIOLENCE

In 2012, LMICs experienced 461,000 deaths and 29 million DALYs related to interpersonal violence. Although deaths from interpersonal violence, which is the major cause of intentional injury covered in chapter 5 of this volume (Mercy and others 2017), are increasing worldwide, the rate of increase was 9 percent in LMICs from 2000 to 2012, which was faster than the global average (table 2.2). At the same time, age-standardized mortality rates from interpersonal violence in LMICs remained stable, suggesting that the increase in violence-related deaths was due to demographic changes. A significant proportion of cases in LMICs are gender based (Jan and others 2010). Female infant deaths among infanticide victims are far more common. The mortality rates among males ages 15–29 are approximately five times those among females in the same age group. Collective violence, which tends to be episodic, accounts for a smaller fraction of total deaths and DALYs (less than 1 percent) compared with interpersonal violence.

OCCUPATIONAL HEALTH RISKS

Occupational health encompasses numerous issues, including chemical, biological, physical, and psychosocial hazards. Relatively more is known about occupational injuries because most countries track these in the aggregate, although some LMICs do not separate serious events and fatalities in the workplace from those of other origin. Substantially less information is available from LMICs regarding occupational health for many of the same reasons that control remains problematic: knowledge is limited; regulations are either nonexistent or unenforceable because of lack of trained personnel; and the research community has focused on more salient health issues, such as infectious diseases or the emerging epidemic of noncommunicable chronic diseases. Noncommunicable diseases may well have a workplace contribution, but this is unstudied. Infectious diseases, such as tuberculosis, have been linked to workplace exposures or living conditions, including migrant labor practices.

Existing estimates of occupational risks in LMICs suggest that they are generally increasing in parallel with global trends (table 2.4). From 1990 to 2013, attributable deaths and DALYs from occupational risks increased by 27 percent. They constituted 2.4 percent of total attributable deaths and 5.7 percent of total attributable DALYs in LMICs in 2013. The single-largest causes of attributable deaths were occupational particulate matter, gases, and fumes (196,000), occupational carcinogens (189,000), and occupational injuries (135,000). Health loss from carcinogens in particular increased dramatically from 1990 to 2013. However, age-standardized mortality rates from occupational risks decreased for all causes except occupational carcinogens, which increased 33 percent. This suggests that most of the increase in the number of attributable deaths is due to demographic changes, but that a real increase in exposure to carcinogens occurs independent of demographic patterns. Although occupational ergonomic

Table 2.4 Occupational Risks: Estimated Attributable Deaths, Mortality Rates, and DALYs in LMICs by Cause, All Ages and Both Genders, 1990–2013

	Deaths (thousands)			ASMR per 100,000 persons			DALYs (thousands)		
Cause	1990	2013	Change (%)	1990	2013	Change (%)	1990	2013	Change (%)
Total	18,700	23,800	27	729	597	–18	880,000	837,000	–5
Total environmental and occupational risks	7,600	7,400	–3	280	188	–33	378,000	271,000	–28
Occupational risks	460	580	26	17	13	–24	37,000	47,000	27
Occupational asthmagens	60	50	–17	3	1	–67	2,600	2,500	–4
Occupational carcinogens	80	190	138	3	4	33	1,800	4,000	122
Occupational ergonomic factors	—	—	—	—	—	—	13,000	18,000	38
Occupational injuries	130	140	8	3	2	–33	8,000	8,100	1
Occupational noise	—	—	—	—	—	—	4,000	6,500	63
Occupational particulate matter, gases, and fumes	190	200	5	8	5	–38	6,600	8,200	24

Source: IHME 2015.

Note: ASMR = age-standardized mortality rate; DALYs = disability-adjusted life years; LMICs = low- and middle-income countries; — = not available. Each of the six major occupational hazards is listed as a subcategory of "occupational risks," which are a subset of "total environmental and occupational risks," which are a subset of "total" attributable deaths and DALYs. Data from the Global Burden of Disease Study 2013 (IHME 2015) were used because similar data were unavailable from the World Health Organization's Global Health Estimates database. Percentages may vary slightly because of rounding.

factors and occupational noise were not attributable to any deaths, they were substantial contributors to DALYs and appear to be a growing problem.

In congruence with these estimates, the handful of empirical studies on occupational health hazards in LMICs that appear annually suggest an acceleration in risks as more dangerous trades move in the global marketplace to regions of lower training and regulation. In particular, the emerging global supply chain in electronics, toys, and textiles is replete with chemical and physical hazards, including heavy metals, solvents, plastics, noise, and heat (see chapter 6 in this volume, Abdalla and others 2017). Further, a major factor driving occupational injury trends in LMICs is the export of hazardous industries to these countries because of lower wages. Workers in these hazardous positions number 1.52 billion—an increase of 23 million since 2009 (ILO 2012).

The gender and age distributions of occupational injuries are noteworthy. Women are at higher risk for injuries and experience more severe injuries than men in many high-income workplaces, after accounting for job tasks. Women also appear to be more severely affected by occupational risks in the Middle East and North Africa, although the data are less satisfactory (Abdalla and others 2017). However, many occupational injuries appear to implicate high-hazard sectors that tend to employ males, such as construction, fishing, and mining. These industries often lack safety equipment, training, and regulations. Decreasing gender gaps in many professions are leading to more women being injured in the workplace (Kelsh and Sahl 1996; Nordander 2008; Turgoose, Carter, and Stride 2006). Children are also at much greater risk in many LMICs: between 3 and 75 percent of children ages 7–14 years are informally employed, depending on the country and occupation (World Bank 2014). Child workers are at especially high risk because of growing bodies that are more susceptible to toxic and carcinogenic substances. Most child workers are employed in agriculture, where they are exposed to strenuous labor and pesticides (ILO 2011).

Finally, the number of people working in the informal sector worldwide is increasing, and such work is fraught with poor regulations, inadequate standards, and insufficient availability of protective equipment (Charmes 2012; ILO 2002). Although research on the informal sector is challenging, it clearly shows that informal workers frequently live in poverty, routinely face adverse working conditions (Muntaner and others 2010), and generally have limited access to health care (Noe and others 2004). Strategies for prevention and control of disease are generally very limited for this population of globally staggering proportion. Occupational health and safety are generally viewed as an area within the broad province of primary health care, rather than the focus of specialized, separate strategies, as in high-income countries. Expanded training of the health care workforce in this domain is essential.

WATER, SANITATION, AND HYGIENE–RELATED ILLNESSES

Health loss owing to unsafe water, poor sanitation, and poor handwashing practices is an important indicator of overall population health and poverty in LMICs. The Millennium Development Goal target for improved drinking water was met in 2010. However, many LMICs still lack WASH intervention coverage because countries have set different standards for improved water supply and sanitation (Roaf and Khalfan 2005). Disparities within countries persist, particularly in rural areas. In rural Sub-Saharan Africa, for example, many individuals must walk long distances to collect adequate drinking water, while piped water is readily available in urban areas.

Although the rate of open defecation has decreased globally, it is still common practice in many rural areas. Poor hygiene practices, such as infrequent use of soap for handwashing, exacerbate the spread of pathogens (Strickland 2000). Helminths are commonly transmitted through feces and drinking water sources and are particularly problematic for agricultural workers and children in rural areas (Lozano and Naghavi 2010). As a consequence, diarrheal illnesses are responsible for approximately 43 percent of under-five mortality in South and South-East Asia and Sub-Saharan Africa (Humphrey 2009; Petri and Miller 2008). Nonfatal enteric infections can have long-term health consequences as well: pathogenic bacteria can cause inflammation in children's intestines, reducing proper absorption of nutrition. This process generates a cycle of malnutrition and enteropathy, which then contributes further to under-five mortality and to chronic nutritional deficiency that can extend into adulthood (Black and others 2008; Black and Victora 2013).

The social and psychological disadvantages of having poor access to WASH services are also noteworthy. Significant stress can be traced to lack of improved water sources and sanitation among the poor (Hutton and others 2014). Women generally bear the burden of collecting water. Children who have difficulty accessing water or practice open defecation can readily spread waterborne diseases to others. Infected children are less likely to attend school. Further, low WASH intervention coverage has a large environmental effect: elimination in bodies of water negatively affects ecosystems and disrupts natural resources (Corcoran and Nellemann 2011; Rabalais and Turner 2013).

Table 2.5 provides estimates of morbidity and mortality attributable to lack of WASH services. These estimates represent a lower bound, because many other health effects that are not easily measured but are nonetheless linked to WASH likely exist. The estimates demonstrate the effect of having met the Millennium

Table 2.5 Environmental Risks: Estimated Attributable Deaths, Mortality Rates, and DALYs in LMICs by Cause, All Ages and Both Genders, 1990–2013

	Deaths (thousands)			ASMR per 100,000 persons			DALYs (thousands)		
Cause	1990	2013	Change (%)	1990	2013	Change (%)	1990	2013	Change (%)
Total	18,700	23,800	27	729	597	–18	880,000	837,000	–5
Total environmental and occupational risks	7,600	7,400	–3	280	188	–33	378,000	271,000	–28
Air pollution	4,100	5,000	22	179	132	–26	145,000	133,000	–8
Ambient ozone pollution	100	180	80	6	6	0	2,000	4,000	100
Ambient particulate matter air pollution	1,600	2,400	50	68	62	–9	56,000	62,000	11
Household air pollution from solid fuels	2,800	2,900	4	122	79	–35	101,000	81,000	–20
Unsafe water, sanitation, and handwashing	2,700	1,400	–48	69	30	–57	190,000	83,000	–56
No handwashing with soap	1,000	500	–50	26	11	–58	70,000	31,000	–56
Unsafe sanitation	1,700	800	–53	45	17	–62	124,000	49,000	–60
Unsafe water source	2,400	1,200	–50	62	27	–56	169,000	75,000	–56

Source: IHME 2015.

Note: ASMR = age-standardized mortality rate; DALYs = disability-adjusted life years; LMICs = low- and middle-income countries. Each of the major environmental hazards is listed as a subcategory. Data from the Global Burden of Disease Study 2013 (IHME 2015) were used because similar data were unavailable from the World Health Organization's Global Health Estimates database. Percentages may vary slightly because of rounding.

Development Goal target; attributable deaths and DALYs have decreased by 48 percent and 56 percent, respectively, and age-standardized mortality rates have decreased by 57 percent. Nevertheless, the health effect remains significant: 6 percent of deaths and 10 percent of DALYs in LMICs in 2013 were attributable to WASH-related illnesses.

HEALTH EFFECTS OF AIR POLLUTION

Air pollution continues to have significant health effects in LMICs, where it accounted for nearly 21 percent of attributable deaths and 16 percent of attributable DALYs in 2013. Total attributable deaths from air pollution have increased 22 percent since 1990, while DALYs have decreased 8 percent. Further, age-standardized attributable mortality rates have decreased 26 percent (IHME 2015).

Table 2.5 shows recent estimates that about 2.5 million deaths in LMICs in 2013 were attributable to airborne pollutants in public settings. In the disease burden estimates, air pollution contributes a significant proportion of deaths as a result of respiratory infections; chronic obstructive pulmonary disease; cerebrovascular disease; ischemic heart disease; and cancers of the trachea, bronchus, and lung. The forms of air pollution that have been evaluated are (1) ambient particulate matter air pollution (approximately 2.6 million attributable deaths in LMICs) in the form of particle and ozone pollution and (2) household air pollution from solid fuels (approximately 2.9 million deaths in LMICs), although other categories have not yet been assessed globally. (Because of a degree of overlap, totals are less than the sum of individual components.)

Overall, 90 percent of air pollution deaths are in LMICs. However, because household solid cookfuel use is essentially confined entirely to LMICs, essentially all effects occur in these settings. Ambient particulate matter air pollution occurs in both rural and urban areas and is related to a variety of emission sources, including motorized transport, power plants, industry, road and construction dust, brick kilns, garbage burning, and the like. Household air pollution occurs primarily in less urbanized areas and is related to the use of solid fuels for cooking and heat in homes. It is also a major source of ambient pollution, causing at least one-fourth of ambient pollution exposures in India and China, for example. Thus, perhaps 15 percent of the burden accounted to ambient pollution actually began in households in LMICs.

Ambient particulate matter air pollution accounts for a relatively larger proportion of cardiovascular and cerebrovascular diseases. Household air pollution accounts for a relatively larger proportion of chronic and acute respiratory disease, the latter affecting children.

Of all LMICs, India experiences the most significant effect from air pollution because of population size, weak regulation, and rapid industrialization; two-thirds of the population still uses solid fuels (Smith 2015). At the same time, the major source of air pollution in less urbanized areas is household air pollution, which results from the use of solid fuels for cooking and heat in homes (Smith 2015). In contrast to outdoor air pollution, morbidity from household air pollution appears to be decreasing in LMICs, as is suggested by a 20 percent reduction in DALYs from 1990 to 2013. However, most of this reduction is due to the decline in background child pneumonia rates related to improvements in health care and nutrition.

Surveillance of air pollution is challenging for several reasons. Measurement devices are typically located in urban areas, so less is known about air pollution in rural areas. Satellite observations combined with modeling, however, are becoming a major source of information on ambient air quality in rural and other unmonitored areas (Brauer and others 2016). Linking production, exposure, and health effects is problematic, because dispersion of particulate matter can be widespread. Health effects per unit of pollution emitted are thought to be greatest among people living close to household sources and roads (Smith 2015).

Integrated exposure-response relationships are now used to determine health burdens and suggest policies. These relationships link results from epidemiological studies across a wide range of exposures to combustion particles—from ambient air pollution, secondhand tobacco smoke, household air pollution, and active smoking (Burnett and others 2014). These are linked, in turn, to global models of population exposure based on a wide range of data sources. The analyses suggest that outdoor air pollution accounts for a relatively larger proportion of cardiovascular disease and cancer, while household air pollution accounts for acute (children only) and chronic respiratory disease (IHME 2015).

CONCLUSIONS

Recent decades have seen dramatic shifts in the patterns of health loss from injuries and occupational and environmental hazards in LMICs:

- The burden of RTIs and falls, in particular, is increasing substantially, resulting in a net increase in the overall burden of injuries despite a decline in the burden of drownings and poisonings.

- In keeping with trends in economic development in LMICs, health loss from occupational hazards is increasing. The rapid growth in the effect of occupational carcinogens in these settings is of particular concern.
- As a group, environmental risks are declining, in particular, risks related to unsafe water and poor sanitation.
- Household air pollution also appears to be declining, but it is being replaced by ambient particulate matter air pollution from vehicles and industrial sources, particularly in urban areas in populous countries such as India and China.

Designing interventions and policies to address injuries and occupational and environmental hazards requires up-to-date information on the relative magnitude of these conditions and their trends over time. Surveillance for many of these conditions is politically and technically challenging, so the estimates presented in this chapter likely reflect a lower bound on their total burden in LMICs. The need to set priorities around each of these conditions should be explicitly linked to efforts to improve information systems, both within the health sector and elsewhere, for example, in the labor and environment sectors.

The conditions presented in this volume are important contributors to the overall burden of disease in LMICs. Injuries are responsible for about 9 percent of deaths and 7 percent of DALYs, whereas occupational and environmental risks are responsible for about 29 percent of attributable deaths and 31 percent of attributable DALYs. With some notable exceptions, their importance continues to increase in parallel with economic development, urbanization, and the epidemiological transition. Hence, policies that focus on these conditions must also account for and attempt to address the complex social, demographic, and economic factors that are driving health trends.

NOTE

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  a) Lower-middle-income countries = US$1,046 to US$4,125
  b) Upper-middle-income countries (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

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