FIGURE 1.1 People at work

Each day millions of workers in America enter a battlefield, but they fight no foreign enemy and conquer no lands. No borders are in dispute. The war they are fighting is against the poisonous chemicals they work with and the working conditions that place serious mental and physical stress upon them. The battlefield is the American workplace, and the casualties of this war are higher than those of any other in the nation's history.

—Jeanne M. Stellman and Susan M. Daum, in the 1973 edition of their book, *Work Is Dangerous to Your Health*[1(p. 3)]

CHAPTER 1

Introduction to Occupational Health and Safety

Learning Objectives

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

- Define the term *occupational health.*
- State five historical developments in occupational health.
- Explain the social and economic significance of workers' illnesses and injuries for society.
- Describe at least three current issues in the field of occupational health and safety.
- Explain how the core functions of public health (assessment, policy development, and assurance) may be applied to occupational health.

Chapter Outline

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Introduction

Occupational health is concerned with protecting the health of workers from diseases and injuries associated with hazardous work-related exposures; in addition, the field pursues the improvement of the work environment and the promotion of workers' health in general. As applied to individuals, occupational health is "the ability of a worker to function at an optimum level of well-being at a worksite as reflected in terms of productivity, work attendance, disability compensation claims, and employment longevity."[2]

Occupational health and safety are significant to society in view of the large percentage of the population that is currently employed and the numerous waking hours that the typical employed person spends on the job. Given the scale of the workforce, then, occupational health constitutes a major public health issue. Also, occupational health issues can extend beyond the time of active employment. In particular, retired persons may be afflicted by the sequelae of work-related conditions acquired when they were actively employed.

Since the formation of complex human societies supported by farming and nonagricultural activities, the relationship between work and the health of workers has been a concern for many people:

> Throughout recorded history, there have been references to work under a variety of conditions. The Old Testament includes rules about safe practices with regards to agriculture and how to treat workers. The Greeks and Romans used slaves, generally those captured in battle, to do both domestic work and to work in especially hazardous conditions, such as mining. The writings of the ancients even discussed some early preventive measures such as using pig bladders to breathe into to avoid dusty atmospheres.[3]

Occupational health emerged as an important issue for humanity beginning with ancient societies; it expanded as a concern in the Renaissance, during the Industrial Revolution, and into the 21st century. Unfortunately, society's attitudes toward occupational safety and health have evolved very slowly over time, with the economic viability of industry sometimes at odds with workers' health.[4]

During the 21st century, global trends such as rapid changes in the nature of work and technological advances are expected to have continuing impacts on occupational health. Adverse health outcomes and worker fatalities are significant issues for employees in both developed countries and the developing world. One of the most important policy statements for expressing occupational health goals for U.S. workers is *Healthy People 2020*.

Occupational Health

The field of **occupational health** is concerned with "identification and control of the risks arising from physical, chemical, and other workplace hazards in order to establish and maintain a safe and healthy working environment. These hazards may include chemical agents and solvents, heavy metals such as lead and mercury, physical agents such as loud noise or vibration, and physical hazards such as electricity or dangerous machinery."[5] In addition to identifying and controlling job-related risks, occupational health specializes in "the recognition, diagnosis, treatment, and prevention of illnesses, injuries resulting from hazardous exposures in the work-place."[6 (p. 3)] The field maintains an interdisciplinary approach, which includes the application of medicine, epidemiology, toxicology, engineering, and management to occupational health issues within an organizational context. [7] In addition, the field is closely aligned with the traditional concerns of preventive medicine and public health. Linked with occupational health is occupational medicine, "[t]he branch of medicine that deals with the prevention and treatment of diseases and injuries occurring at work or in specific occupations."[8] Other examples of related disciplines include occupational health nursing and industrial hygiene.

According to the Twelfth Session of the Joint International Labour Organization (ILO)/World Health Organization (WHO) Committee on Occupational Health (from 1995), occupational health has "three key objectives:

1. The maintenance and promotion of workers' health and working capacity;
2. The improvement of working environment and work, to become conducive to safety and health; and
3. The development of work organization and working cultures in a direction which supports health and safety at work, and in doing so also, promotes a positive social climate and smooth operation, and may enhance the productivity of the undertaking."[9(p. 2)]

Occupational Safety

The term *safety* refers to "the state of being safe; freedom from the occurrence or risk of injury, danger, or loss."[10] **Occupational safety** pertains to "the health and well-being of people employed in a work environment."[11] A safe work environment is free from hazardous conditions that might be linked with injuries and illnesses that originate from the workplace. One method to promote occupational safety is by formulating and enforcing

regulations such as those developed by the U.S. federal government—for example, the Occupational Health and Safety Act of 1970. Promotion of occupational safety is a systematic process that involves ongoing monitoring of occupational hazards (surveillance), hazard identification, communication of information about risks, and collaboration between employers and workers.

Occupational Exposures and Hazards

Some types of occupational health specialists attempt to find linkages between specific exposures and adverse health outcomes in the workplace. **Occupational exposures** "include physical conditions (for example, structural insecurity or deficient lighting), physical stress (for example, lifting heavy weights or repetitive strain injuries), physical agents (for example, noise, vibration, or radiation), chemicals (for example, dusts or solvents), biological agents (for example, bacteria or viruses) and psychosocial stressors."[12(p. 7)]

An exposure "that may adversely affect health" is called a *hazard*.[13] Hazard identification is "the process of determining whether exposure to an agent can cause an increase in the incidence of a health condition (cancer, birth defect, etc.)"[14(p. 19)] According to the National Institute of Environmental Health Sciences, nearly all work settings have associated hazards, even though in some cases they can be minimal.[15] **EXHIBIT 1.1** provides an example of job-related hazards.

Work-Related Diseases

The term **work-related diseases** (or injuries or illnesses) refers to adverse health events that arise from the work environment. The Occupational Safety and Health Administration classifies an injury or illness as work-related "if an event or exposure in the work environment either caused or contributed to the resulting condition or significantly aggravated a pre-existing condition."[16] Examples of the main work-related diseases include "occupational lung diseases, dermatological conditions, cardiovascular diseases, musculoskeletal injuries, disorders of reproduction and development, noise induced hearing loss, occupational cancer, neurological disorders, and psychological disorders."[12(p. 7)] The National Library of Medicine points out that in addition to the foregoing adverse health outcomes, other conditions associated with occupations can include lacerations, fractures, amputations, sprains, and vision problems as severe as loss of sight. Also, a wide range of work-related hazardous exposures can occur—for example, to germs, unsafe substances, and radiation.[17]

EXHIBIT 1.1 Job-Related Hazards

Every job has certain hazards. Even a writer can get a paper cut. But did you know that about 137 workers die from job-related diseases every day? This is more than eight times the number of people who die from job-related accidents. Many of these illnesses are caused by chemicals and other agents present in the workplace. Factories in scientific laboratories can contain poisonous chemicals, dyes and metals. Doctors and other health workers have to work with radiation. People who work in airports or play in rock concerts can suffer hearing loss from loud noise. Some jobs involve extreme heat or cold. Workers can protect themselves from hazards by wearing special suits and using goggles, gloves, ear plugs, and other equipment.

Reprinted from National Institutes of Health. National Institute of Environmental Health Sciences (NIEHS). Environmental diseases from A to Z. NIH Publication No. 96-4145.

Landmarks in the History of Occupational Health

Occupational hazards have been noted since the classical period of human history and, in fact, were a subject of early Greek and Roman writers. However, during the Dark Ages, humankind's attention to health issues temporarily became quiescent. A resurgence of interest in the topic occurred later, during the early and late Renaissance periods, when Agricola wrote about the dangers that affected workers in trades such as metal working. Paracelsus elaborated some of the crucial principles of toxicology, a field that now makes vital contributions to occupational health. Ramazzini, who is often called the father of occupational medicine, expounded upon the diseases of workers. Toward the end of the 17th century, Pott described the occurrence of scrotal cancer among chimney sweeps. Awareness of the growing tide of occupational illnesses grew during the 19th-century Industrial Revolution. Since the early 1900s, several major industrial calamities have elicited public alarm and riveted the attention of policy makers on occupational hazards. The 20th century was a time of great expansion of medical knowledge: "More medical advances have been made during the 20th century than in all the other centuries combined."[18 (p. 171)] **TABLE 1.1** provides an abridged list of noteworthy figures in the history of occupational health.

Occupational Health During the Classical Period (500 BCE–500 CE)

The classical period, which spanned approximately 500 BCE to 500 CE, marked the time when the ancient Greeks and Romans made important contributions to the history of occupational health. In addition to theorizing about the causes of disease, a major contribution of the ancients was the recognition of the hazards of chemicals used in the production of metals.

TABLE 1.1 Abridged List of Noteworthy Figures in the History of Occupational Health

Name	Dates (Birth–Death)	Contribution
Hippocrates	460–370 BCE	Discussed hazards of metal working and lead
Pliny the Elder	23–79 CE	Described hazards of dust
Galen	129–200 CE (estimated)	Described hazards to miners
Paracelsus	1493–1541	Wrote book on occupational diseases
Agricola	1494–1555	Described hazards of mining and producing gold and silver
Bernardino Ramazzini	1633–1714	"Father of occupational medicine"
Sir Percival Pott	1714–1788	Identified scrotal cancer among chimney sweeps
Dr. Alice Hamilton	1869–1970	Publicized dangerous occupational conditions (e.g., phossy jaw)
Charles Turner Thackrah	1795–1833	Among the first to recommend the principle of substitution for hazardous agents

Hippocrates (460–370 BCE)

Hippocrates wrote about the role of environmental and climatic factors in human health. These factors were thought to include weather, seasons, prevailing winds, the quality of air and water, and geographic location. Hippocrates's theories regarding the influence of environment were expressed in his work titled *On Airs, Waters, and Places*, published around 400 BCE. He is also said to have recognized the toxic properties of lead. At present, in agreement with the prescient thinking of Hippocrates, occupational health specialists have determined that many environmental exposures are salient for workers' health.

Pliny the Elder (23–79 CE)

During the first century, Pliny noted the toxic properties of sulfur and zinc. In addition, he invented a mask constructed from the bladder of an animal for protection against dusts and metal fumes.

Galen (129–200 CE)

Galen, a renowned Greek physician, outlined the pathological aspects of lead toxicity and suggested that mists from acids could endanger the health

of copper miners. His work advanced the field of occupational medicine and contributed ideas that influenced the field for 1500 years.

Occupational Health Developments from 1500 to the Mid-1800s

From about 1500 to the mid-1800s, recognition grew regarding the contribution of occupationally related exposures to adverse health conditions. During this era, many investigators examined the impacts of unsafe and hazardous working environments on the health of workers, especially the effects of exposures to toxic metals and hazards that occurred among miners. Among the historically important figures in occupational health were Paracelsus (1493–1541), Agricola (1494–1555), Bernardino Ramazzini (1633–1714), Percival Pott (1714–1788), Charles Turner Thackrah (1795–1833), and Alice Hamilton (1869–1970). Although his contributions were not limited specifically to occupational health, John Graunt (one of the early compilers of vital statistics data) published *Natural and Political Observations Made upon the Bills of Mortality* in 1662. Sometimes Graunt is referred to as "the Columbus of statistics" because his book made a fundamental contribution by attempting to demonstrate the quantitative characteristics of birth and death data.

Paracelsus (1493–1541)

Paracelsus (**FIGURE 1.2**) is regarded as the founder of toxicology, a discipline that examines the toxic effects of chemicals found in environmental venues such as the workplace. A contemporary of da Vinci, Martin Luther, and Copernicus,[19] Paracelsus was active during the early 16th century. Among his contributions was the concept of a dose-response relationship, meaning that the effects of a poison are related to the amount of the dose that has been administered. Another conceptual breakthrough was Paracelsus's notion of target organ specificity of chemicals.

FIGURE 1.2 Paracelsus (1493-1541)

Agricola (1494–1555)

Georgius (Georg) Agricola (**FIGURE 1.3**) lived in Germany. In 1556, *De Re Metallica*, his book that described the environmental and occupational hazards of mining, was published posthumously (**FIGURE 1.4**).

FIGURE 1.3 Georg Agricola (1494-1555)

Courtesy of National Library of Medicine.

FIGURE 1.4 Interior view of a workshop showing four men at various stages of the metallurgical process during the mid-fourteenth century.

Courtesy of National Library of Medicine.

Ramazzini (1633–1714)

Bernardino Ramazzini (**FIGURE 1.5**) has been called the father of the field of occupational medicine.[20] "The name of Ramazzini marks the beginning of society's concern with the well-being and physical and emotional health of its workers from the shops of the crafts to the offices of the executives." [21(p. 167)] In his seminal works, Ramazzini created elaborate descriptions of the manifestations of occupational diseases among many different types of workers.[22] His descriptions covered a plethora of occupations, ranging from miners to cleaners of privies to fabric workers. Ramazzini is also considered to be a pioneer in the field of ergonomics, as he pointed out the hazards associated with postures assumed in various occupations. Ramazzini authored *De Morbis Artificum Diatriba (Diseases of Workers)*, published in 1700 (**FIGURE 1.6**), which highlighted the risks posed by hazardous chemicals, dusts, and metals used in the workplace.

FIGURE 1.5 Bernardino Ramazzini, father of occupational medicine, 1633–1714

Courtesy of National Library of Medicine.

Percival Pott (1714–1788)

Sir Percival Pott (**FIGURE 1.7**), a London surgeon, made the astute observation in 1775 that chimney sweeps had a high incidence of scrotal cancer. He argued that chimney sweeps were prone to this malady as a consequence of their contact with soot. "Sagely, he connected this observation to their occupational history. 'Climbing boys,' Pott knew, were recruited at ages as young as five to eight. . . . From this fact, he further deduced that the continuous exposure to soot implied a long latency period. (*3-4 Benzpyrene*, the responsible chemical agent in soot, was identified a century and a half later, in 1934.)" [23(pp. 28–29)] After reaching his conclusions about the relationship between scrotal cancer and chimney sweeping, Pott established an occupational hygiene control measure—the recommendation that chimney sweeps bathe once a week. **EXHIBIT 1.2** describes chimney sweepers' cancer (scrotal cancer).

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FIGURE 1.6 *De Morbis Artificum Diatriba* by Ramazzini

FIGURE 1.7 Percival Pott, FRS (1714–1788)

Charles Turner Thackrah (1795–1833)

Thackrah was an early-19th-century innovator in occupational health. His book *The Effects of the Principal Arts, Trades and Professions . . . on Health and Longevity* (abridged title) raised the public's awareness of the difficult conditions under which factory workers labored. Examples of the adversities experienced by these workers included the deleterious effects of child labor, exposures to hazardous dusts in mines and metal working factories, the connection between occupational exposures to dusts and tuberculosis, and the consequences of workers' contact with lead. Thackrah also noted the general

EXHIBIT 1.2 Sir Percival Pott (1714–1788) Chimney Sweepers' Cancer

In a book entitled *Chirurgical Observations Relative to the Cataract, the Polypus of the Nose, the Cancer of the Scrotum, the Different Kinds of Ruptures, and the Mortification of the Toes and Feet,* Pott developed a chapter called "A Short Treatise of the Chimney Sweeper's Cancer." This brief work of only 725 words is noteworthy because "it provided the first clear description of an environmental cause of cancer, suggested a way to prevent the disease, and led indirectly to the synthesis of the first known pure carcinogen and the isolation of the first carcinogenic chemical to be obtained from a natural product. No wonder therefore that Pott's observation has come to be regarded as the foundation stone on w[h]ich the knowledge of cancer prevention has been built!"[24 (p. 521)] In Pott's own words:

> [E]very body . . . is acquainted with the disorders to which painters, plummers, glaziers, and the workers in white lead are liable; but there is a disease as peculiar to a certain set of people which has not, at least to my knowledge, been publickly noteced; I mean the chimney-sweepers' cancer. . . . The fate of these people seems singularly hard; in their early infancy, they are most frequently treated with great brutality, and almost starved with cold and hunger; they are thrust up narrow, and sometimes hot chimnies, where they are bruised, burned, and almost suffocated; and when they get to puberty, become peculiary [sic] liable to a noisome, painful and fatal disease. Of this last circumstance there is not the least doubt though perhaps it may not have been sufficiently attended to, to make it generally known. Other people have cancers of the same part; and so have others besides lead-workers, the Poictou colic, and the consequent paralysis; but it is nevertheless a disease to which they are particularly liable; and so are chimney-sweepers to the cancer of the scrotum and testicles. The disease, in these people . . . seems to derive its origin from a lodgment of soot in the rugae of the scrotum.[24(pp. 521–522)]

social and economic distresses that confronted many factory workers. In addition, he was among the first occupational health experts to advocate for the substitution of more hazardous materials with less dangerous ones. Substitution is regarded as the first principle of industrial hygiene, meaning that substitution is one of the most important procedures for protecting workers from hazardous materials and remains relevant today.

At the young age of 31, Thackrah established the Leeds University School of Medicine, which provided an alternative to London's medical schools. These institutions dominated English medical education at that time.[22]

Unusual Occupational Diseases of the Past

Some of the occupational illnesses and injuries that were common in the past occurred in jobs that have, for the most part, fallen by the wayside in the modern world. To illustrate, work-associated lung conditions such as coal workers' pneumoconiosis and byssinosis in the textile industry occur much less frequently now than they did in the past; in their place, asthma, dermatoses, and injuries have risen to the forefront as important occupational conditions.[25] Names of occupational disorders from the past include "coal miners' nystagmus, scrotal cancer in chimney sweeps, phossy jaw, hatters' shakes, painters' colic, potters' rot, chauffers' knee, glanders, [and] caisson disease."[26] Coal miners' nystagmus is an example of an occupational disease that became unusual after the mid-20th century. This condition "was one of the first occupational illnesses ever recognized as being due to a hazardous working environment. It aroused great concern and much controversy in Great Britain in the first half of the 20th century but was not seen in the United States."[27] Another occupational condition, mule spinner's disease, referred to scrotal cancer from exposure to mineral oils among textile workers who operated textile spinning machines called "mules."[28] **TABLE 1.2** lists examples of other unusual occupational conditions from past eras.

Industrial Revolution and Early 20th Century

During the Industrial Revolution in England, when the population moved to cities in search of employment and large numbers of persons toiled for long hours in crowded factories, health issues connected with the work environment became apparent. Later, in the early 20th century, awareness grew regarding occupational illnesses associated with workers' exposure to hazardous chemicals (e.g., white phosphorus, mercury, and lead) and work environments.

Working conditions during the Industrial Revolution were deplorable for many types of employees, as the following graphic description illustrates.

TABLE 1.2 Names of Classic Occupational Diseases Found in the Historical Literature

Name of Disease	Definition/Etiology
Miners' asthma	The common name for pneumoconiosis among miners who were exposed to dusts such as coal dust.
Coal miners' nystagmus	A visual disturbance that occurred among underground miners who worked under low light levels for a period of years.
Potters' rot, miners' phthisis	Silicosis, respiratory disease from inhalation of silica dust.
Brass-founders' ague	A type of metal fume fever caused by inhalation of fumes from welding brass. This self-limiting condition is associated with fever and other symptoms that resolve after 24 hours.
Filecutters' paralysis	Paralysis of the hands caused by lead exposure.
Painters' colic	Abdominal pain associated with anemia caused by exposure to white lead in paint.
Bakers' itch	A skin reaction (eczema) caused by contact with the components of baked goods (e.g., sugar).
Mule spinners' cancer, also known as mule spinners' disease	The mule was a textile spinning machine; the disease referred to scrotal cancer that occurred among male cotton textile workers who were exposed to mineral oils over long time periods as they used the mule.
Hatters' shakes; mad hatter's disease	Mercury poisoning among millinery workers.
Caisson disease (decompression sickness)	A disease caused by decompression when workers emerged from caissons, which were used to construct the anchoring piers for the Brooklyn Bridge in New York City and for similar projects. The laborers were exposed to air under very high pressures for extended time periods.
Phossy jaw	Phosphorus necrosis of the jaw.
Chauffeurs' knee	Damage to the right knee caused by operating the engine crank of a motor vehicle.
Glanders	A zoonotic disease (disease transmitted from animals) that occurred among horsemen in Europe. Glanders caused lung diseases, skin problems, bone damage, and harm to other bodily organs. The chronic form was usually fatal.

Data from Cherniack, MG, Diseases of unusual occupations: an historical perspective, Occup Me, 1992;7(3):369–384.

During the industrial revolution, the population of England more than doubled. Men, women and children unable to find work on farms moved to towns and cities to seek work in factories, mills, mines and shops. Working conditions and crowded unsanitary housing took a terrible toll on workers who toiled long hours, being poorly fed, poorly housed, and poorly paid. (Women and boys working the cotton mills in dreadful conditions were paid two shillings to two shillings and sixpence, a pittance, per week.) Working conditions were dangerous, accidents were rife, and workers were afflicted by industrial disease. Long shifts of 12 hours or more led to chronic fatigue that caused terrible accidents, especially for tired children working around machines with no guard rails.[29]

Alice Hamilton (1869–1970)

Dr. Alice Hamilton (**FIGURE 1.8**) created awareness of phosphorus necrosis of the jaw (phossy jaw) through her writings on this disabling condition. During the early 20th century, many countries passed laws that prohibited the use of white phosphorus in matches. Another one of Hamilton's crusades was to call attention to industrial plumbism (lead poisoning), which affected employees in pottery factories and battery factories as well as plumbers and painters.[30] By creating awareness of occupational hazards such as these, Hamilton became a renowned contributor to occupational health and is regarded as the mother of occupational medicine.

Phossy Jaw/Phosphorus Necrosis

Phosphorus necrosis of the jaw (phossy jaw) was a condition that became prevalent starting about 1858, but subsequently became very uncommon by 1906.[31] Although phosphorus necrosis once reached epidemic proportions, it is now almost extinct. [32] This condition, which affected the victims' jawbones, was accompanied by severe pain and abscesses that drained fetid-smelling pus. Over time, as the disease process unfolded, the victim gradually became disfigured; surgery—the only means available to save the life of the patient—entailed removal of the jaw bone and further disfigurement.

Phossy jaw was caused by exposure to white phosphorus among workers who used

FIGURE 1.8 Alice Hamilton

it in the manufacture of matches. Affected workers were those who dipped matchsticks into white phosphorus paste. Many of the workers were children who labored in vapor-filled, poorly ventilated rooms. The condition, which developed slowly over a period of years, produced debilitation, neurologic disturbances, and lung hemorrhages. Remarkably, phossy jaw was a completely avoidable condition, because red phosphorus worked as well in matches as white phosphorus but was much safer.

Caisson Disease

Caisson disease is a form of decompression sickness that occurs among workers who have been laboring in underground pressurized chambers used in construction projects.[33] It is described further in the chapter *Physical Hazards in the Workplace*.

Historically Significant Incidents in Occupational Health and Safety, 1800s and Later

An example of a historically significant event for occupational health and safety was the Great Railroad Strike of 1877, which represented labor's response to the hazardous and unjust working conditions in the U.S. railroad industry at that time. Occupational hazards continued to plague workers into the early 20th century. A report in *Morbidity and Mortality Weekly Report* observed: "At the beginning of this century [the 20th century], workers in the United States faced remarkably high health and safety risks on the job."[34(p. 461)] Many workers remained on the job for 16-hour periods during 6- and 7-day workweeks.[35] Two major incidents—the Triangle Shirtwaist Company fire and the Gauley Bridge disaster—illustrated the deplorable conditions that workers were often forced to endure. These poor environmental conditions included contact with hazardous machinery, crowding, lack of ventilation, poor lighting, and infrequent protection against hazards. Such dangerous working conditions inspired reforms that resulted eventually in the improvement of workers' environments.

The Great Railroad Strike of 1977

The United States' railways expanded rapidly following the Civil War and continuing into the early 20th century. During this era, vast contingents of workers constructed thousands of miles of new track. At the onset of World War I, the railroads provided work for one out of every 25 employees in this country.[36]

Railway work—building new lines and operating the trains—was extremely dangerous. Construction tasks required that employees endure exceedingly harsh and demanding conditions. In the 1860s, immigrant

Chinese laborers from Canton Province provided much of the railway construction workforce for the Central Pacific Railroad in California. They demonstrated an excellent work ethic and completed some of the more difficult construction tasks with admirable diligence.[37]

During the 19th and early 20th centuries in the United States, examples of injustice abounded in railway work. One of the landmarks in workers' disgruntlement regarding these conditions was the Great Railroad Strike of 1877, the first major national railway strike, which set the stage for subsequent labor unrest toward the end of the 19th century.[16] Following the Financial Panic of 1873, several railroads in 1877 initiated substantial wage cuts, reduced work hours, and increased workloads. Workers responded with the Great Railroad Strike, a national general strike that spread to major cities including Baltimore, Chicago, Kansas City, Philadelphia, Pittsburgh, St. Louis, and San Francisco. Some workers abandoned their jobs or blocked freight trains. In Baltimore, the Maryland National Guard killed 10 rioters who were among an angry mob of 14,000 demonstrators. Violence erupted also in Pittsburgh in response to the Philadelphia National Guard's firing into crowds of protestors and killing at least 20 persons. After enraged demonstrators set railroad facilities alight, the conflagration spread to other sections of Pittsburgh (**FIGURE 1.9**).

FIGURE 1.9 The Great Railroad Strike of 1877, steeple view of conflagration

Courtesy of Library of Congress.

Triangle Shirtwaist Company Fire

March 25, 1911, marks the date of New York City's worst factory fire, which occurred at a 10-story structure formerly named the Asch building (**FIGURE 1.10**). The disaster—one of the worst industrial accidents in U.S. history—claimed the lives of 146 women within the brief time span of 15 minutes. Several hundred women labored on the top three floors used by the Triangle Shirtwaist Factory. Doors were locked to prevent the women from leaving their sewing machines; fire escapes were nonfunctional. As a result, when a fire erupted about 4:30 in the afternoon, many of the women (especially on the ninth floor) perished from the fire when they were unable to escape or were killed when they jumped from windows or attempted to slide down elevator cables.[38, 39]

Gauley Bridge Disaster

Beginning about 1931, workers began the Hawk's Nest Tunnel project near the small town of Gauley Bridge, West Virginia. During tunneling operations, workers were exposed to high levels of silica dust from which they did not have adequate protection. Estimates indicate that as many as 1500 workers contracted the lung disease known as silicosis and that 1000 ultimately died from this cause.[40]

FIGURE 1.10 Triangle Shirtwaist Fire, March 25, 1911

Significance of the Occupational Environment for Health

Occupational health hazards and job-associated injuries affect workers in all countries around the world. Unhealthful working conditions are found in many developing countries and impact developed European countries as well as the United States. Currently, fatal and nonfatal occupational illnesses and injuries exact a significant social and economic toll in the United States.[41]

International Significance of Occupational Health and Safety

The international significance of occupational health and safety is reflected in the working conditions for many adults and children who labor in less developed countries. Occupational illnesses and injuries contribute substantially to global morbidity and mortality. Migration of persons in search of employment has become a global phenomenon. Often, immigrant workers experience increased risks of injuries and disease from their employment in host countries.[42]

Employment Conditions in Developing Countries

Employment conditions in some of the world's developing regions tend to be much more dangerous than in the United States, European countries, and other economically mature nations. According to the International Labour Organization, "Occupational deaths and injuries and work-related diseases take a particularly heavy toll in developing countries, where large numbers of workers are concentrated in primary and extractive activities. . . . [Examples are agriculture, construction, mining, breaking apart old ships.] It often happens that these countries are also those without adequate technical and economic capacities to maintain effective national OSH [occupational safety and health] systems, particularly regulatory and enforcement mechanisms."[43]

Media reports have documented dangerous working conditions in the developing world, particularly disasters in factories. For example, two incidents riveted global attention in 2013: A conflagration in a factory accompanied by the collapse of a building killed more than 1000 workers in Bangladesh, and an explosion and fire prompted a worker stampede in a Chinese poultry factory, resulting in the deaths of 119 trapped employees. **EXHIBIT 1.3** describes these horrific incidents.

Global Burden of Occupationally Related Morbidity and Mortality

The number of work-related deaths that occurs worldwide is estimated at approximately 2 million annually, with disease likely to be the cause of most of these deaths.[44] As a result of the imprecision of available data

EXHIBIT 1.3 Case Studies in Factories in Developing Countries

Case Study 1: Factory Collapse in Bangladesh, April 2013

When an eight-story factory building collapsed near Dhaka, more than 1000 people were killed and 2500 injured. The factory building was home to five garment factories that employed several thousand workers. One day before the collapse, cracks appeared in the walls of the building, which was evacuated briefly. Later, the employees returned to work inside the building. The factories located in the building supplied garments to some of the world's major retailers. After this incident, the Accord on Fire and Building Safety in Bangladesh was created. This accord, which is designed to improve safety of working conditions, had been signed by several global apparel companies—with Wal-Mart and Gap being notable exceptions—as of May 17, 2013.

Data from Barbara Demick, Poultry workers tell of stampede, Los Angeles Times, June 4, 2013:A3

Case Study 2: Fire and Stampede in Chinese Poultry Factory, June 2013

An explosion and fire in a poultry factory in northeastern China killed 119 workers and injured 54. The explosion, which was triggered by ammonia used as a refrigerant, caused a stampede. People were unable to escape through building entrances and the fire door, which had been blocked. According to a *Los Angeles Times* report, "Chinese workers often endure conditions more akin to those at military barracks than factories, with restrictions on their freedom of movement. . . . Workers, who made about $325 a month, were 'strictly controlled.'"

Source: Demick B. Poultry workers tell of stampede. *Los Angeles Times*, June 4, 2013: A3.

sources regarding occupational mortality, this figure is likely to be a major underestimate of the actual number of deaths.

Regarding occupational morbidity, five major occupationally associated risk factors are "workplace carcinogens, airborne particulates, hazards for injuries, ergonomic stressors for back pain, and noise."[45] These five risk factors contribute to a large percentage of the overall global burden of disease from back pain, hearing loss, chronic obstructive pulmonary disease, asthma, lung cancer, injuries, and leukemia. Sharps injuries among healthcare workers are a significant contributor to hepatitis and other blood-borne diseases. In summary, exposures to occupational hazards are important determinants of morbidity worldwide. According to Nelson et al., this burden "could be substantially reduced through replication of proven risk prevention strategies."[46]

The Burden of Occupational Illness and Injuries in the United States

Occupational illnesses and injuries are an important contributor to morbidity and mortality in the United States. Not only do they inflict suffering

upon affected individuals, but also they disrupt the lives of the workers' family members. Loss of a wage earner from occupationally associated illnesses and injuries can result in economic impoverishment of workers and their families. In turn, such illnesses and injuries can produce devastating losses for society and for businesses.

In 2007, there were approximately 5600 work-related injury deaths and 8.6 million nonfatal injuries in the United States.[47] The number of fatal and nonfatal illnesses were approximately 53,000 and 427,000, respectively. In that same year, the total costs for occupational illnesses and injuries were estimated to be $250 billion—almost as great as the associated costs of cancer.

According to the Bureau of Labor Statistics (BLS), the number of cases of occupational illnesses and injuries reported by private industry employers has been declining since 2003.[48] For 2012 (the most recently available information from the BLS), private industry employers reported about 3.0 million workplace injuries and illnesses. Most of these cases (94.8%) involved injuries. Service-providing industries were responsible for approximately three-fourths of all injuries and employed about 80% of the private industry workforce; the remainder of injuries occurred in goods-producing industries.

Approximately 5.2% of workplace injury and illness cases in the United States involve workplace illnesses. These illnesses have the following distribution:

- Goods-producing industries: 34.3% of cases (29.5% of all illness cases in the manufacturing industry sector)
- Service-providing industries: 65.5% of cases (23.4% of all illness cases in the health care and social assistance sectors)

The direct costs of all occupational injuries and illnesses amounted to $45.8 billion and the indirect costs were as much as $229 billion.

Occupational Mortality and Fatal Occupational Injuries

Occupational deaths are regarded as an "epidemic" and "a pressing public issue in the United States and throughout the world."[49 (p. 541)] Mortality from occupational causes is the eighth leading cause of death in this country.[50] As a representative case, consider the 2013 deaths of 19 Arizona firefighters. A violent wind gust caused a wildfire to change direction and overtake the crew. The fire fighters, known as Hotshots, were attacking the conflagration in the town of Yarnell, Arizona.[51] Another example of work-related mortality is the death of six people and injury of two others from an explosion of a grain elevator in Atchison, Kansas, on October 30, 2011.[52]

Data on fatal occupational injuries are collected via the BLS's Census of Fatal Occupational Injuries (CFOI). The number of deaths from all work-related injuries and illnesses is difficult to determine precisely because of underreporting, underdiagnosis, and deficiencies of reporting mechanisms. One estimate of mortality from all work-related injuries and illnesses in the United States during the early 1990s was that 65,000 deaths occurred from such causes.[49(p. 541)] Other estimates have placed the total at 55,200 deaths, with a range of 32,200 to 78,200.[41] The BLS indicates that a total of 4690 workers died from occupational injuries in 2010.[53] **FIGURE 1.11** shows the number of fatal work injuries in the United States from 1992 through 2010.

Iceberg Concept of Occupational Illness and Injuries

The iceberg concept gives credence to the unrecognized nature of most occupational illnesses and injuries. The burden of conditions recognized as being "work-related" represents the tip of the iceberg (**FIGURE 1.12**).[6] The following passage from Franklin Wallick's classic book, *The American Worker: An Endangered Species,* reinforces this notion of the iceberg.

FIGURE 1.11 Number of fatal work injuries in the United States, 1992–2010

Courtesy of U.S. Bureau of Labor Statistics.

FIGURE 1.12 The "iceberg" of occupational disease

Reproduced from Levy BS, Wegman DH, Baron SL, Sokas RK, eds. Occupational and environmental health: twenty-first century challenges and opportunities. In: Levy BS, Wegman DH, Baron SL, Sokas RK Occupational and Environmental Health. 6th ed. New York, NY: Oxford University Press; 2011, p. 12.

> We are dealing here with the tip of a treacherous ecological iceberg. Few exact studies have been made to measure the full dimensions of occupational illness, occupational pollution, [and] occupational exposures. It is, unhappily, mostly guess work. We do know, for instance, how certain occupations lead to a high rate of specific kinds of cancer. But there are only scant and fragmentary epidemiological studies of the health effects of chemical or noise pollution on whole groups of workers. Most of the data consists [*sic*] of broad hints of a far flung, unfathomed problem yet to be accurately measured.[54(p. 4)]

Twenty-First-Century Occupational Trends and Challenges

Presently, nearly half of the U.S. population engages in some level of employment. Challenges confronting workers during the current century include globalization of employment, adoption of new technologies, and development of green jobs. One of the consequences of changes in employment trends in the workplace has been increased salary disparities between service occupations and highly compensated professional occupations.

Trends in Numbers of Employed Americans

A large proportion of the U.S. population is employed either full or part time. Consequently, work is a crucial aspect of most people's lives in the United States and has important implications for the health of workers. As of July 2013, 145.1 million persons aged 16 years and older were employed.[55] **FIGURE 1.13** presents information on the number of persons in the labor force according to job classification. The most common occupation categories in 2013 were service, professional and related occupations, and management, business, and financial.

Globalization and Global Outsourcing

Globalization of the world economy and global outsourcing are contemporary trends with important implications for the workplace. **Global outsourcing** refers to the transfer of manufacturing and other operations to countries where they can be performed less expensively. "The basic business idea of outsourcing is that if a firm does not specialize in a certain function it will be beneficial to transfer control of the function to a specialist organization that will be able to offer better cost and quality."[56 (p. 154)] Examples of functions that can be outsourced include manufacturing, information technology services, and customer support. Companies headquartered in the United States and other economically advanced countries such as those in Europe are able to gain economic advantages by relocating some of their activities to less developed regions, where wages and other costs are lower.

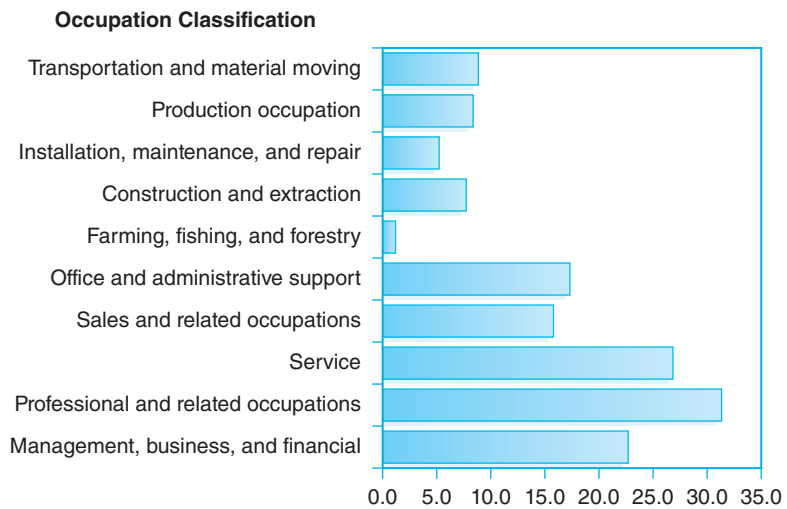

FIGURE 1.13 Number of persons in the labor force, U.S., July 2013

Data from U. S. Department of Labor. Bureau of Labor Statistics, The employment situation--July 2013. USDL-13-1527.

According to the European Agency for Safety and Health at Work (EU-OSHA), "This outsourcing trend [and] growing importance of supply chains has implications for the working conditions and health and safety of workers of supplier and contracting companies."[57] In developing countries, standards for occupational health and safety may be less rigorous than their counterparts in the developed world. In addition, child laborers may be involved with the manufacture of textiles and other goods and are required to labor under circumstances that would not be permitted in developed countries.

A potential impact of outsourcing in the United States is the weakening of labor unions and the rise of a generation of employees who have insecure employment situations (i.e., freelance workers, part-timers, and independent contractors). In the United States, greater integration of the domestic economy with the global economy has been accompanied by declining trends in rates of unionization.[58] This trend could weaken protections for U.S. workers.

Related to globalization of economic activities is the integration of regional economies. An example of economic integration is the North American Free Trade Agreement (NAFTA), which became effective on January 1, 1994, and created a free trade area among the United States, Canada, and Mexico (**FIGURE 1.14**).[59] Although NAFTA has had many

FIGURE 1.14 North American Free Trade Agreement (NAFTA)

positive effects, such as lowering the costs of imports, the Economic Policy Institute argues that imports of automobiles and electronics from Mexico have caused the loss of hundreds of thousands of manufacturing jobs in the United States.[60]

New Technologies: Nanotechnologies and Nanoparticles

New technologies such as nanotechnologies hold much potential for supporting groundbreaking progress in diverse fields—for example, medicine, energy production, and products for the consumer. In fact, nanotechnologies "may revolutionize life in the future."[61(p. vii)] The word **nanotechnology** denotes "the manipulation of matter on a near-atomic scale [1 to 100 nanometers in length] to produce new structures, materials and devices."[62] These near-atomic scale materials are called nanomaterials. Because of their tiny size, nanomaterials have unique effects in terms of their physical, chemical, and biological behaviors.

Those persons who are most likely to be first exposed to nanomaterials are research workers. It is possible that nanomaterials may affect human health adversely, as some preliminary evidence has suggested.[61] According to Engeman et al., "the potential adverse human health effects of manufactured nanomaterial exposure are not yet fully understood and exposures in humans are mostly uncharacterized."[63 (p. 487)] The National Institute of Occupational Safety and Health (NIOSH) has developed a list of 10 critical topic areas for research on nanotechnology (**FIGURE 1.15**). Among these critical research topics are toxicity of nanomaterials, risk assessments with respect to their use, and epidemiologic studies and surveillance of workplace exposures to nanomaterials.[64] In addition, several ethical issues will need to be resolved with respect to workers involved with nanoparticles. These ethical issues deal with "identification and communication of hazards and risks by scientists, authorities, and employers; acceptance of risk by workers; implementation of controls; choice of participation in medical screening; and adequate investment in toxicologic and exposure control research."[65(p. 5)]

Growing Employment in Green Jobs

A growing employment field known as "green jobs" promises opportunities in the sustainable, low-carbon sector. The category of **green jobs** encompasses "work in agricultural, manufacturing, research and development (R & D), administrative, and service activities that contribute substantially to preserving and restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and

FIGURE 1.15 Ten critical topic areas in nanotechnology

Reproduced from Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Nanotechnology: 10 critical topic areas, http://www.cdc.gov/niosh/topics/nanotech/critical.html. Accessed May 12, 2013.

biodiversity; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution."[66(p. 3)] **FIGURE 1.16** provides three examples of green jobs.

Although green jobs can contribute greatly to society, it will be necessary to assure the health and safety of the many workers who are likely to be employed in this new industry.[67] One category of green jobs focuses on the development of renewable energy sources and devices for increased energy efficiency. From the global perspective, the renewable energy sector has shown remarkable job growth, increasing by 21% each year and employing nearly 5 million persons early in the current decade.[68] However, green jobs are not without occupational health risks. For example, their installation of solar panels might expose workers to increased risks from electrical shocks and falls from working at heights. Occupational safety and health programs will need to identify hazards associated with green jobs and develop methods for controlling them.

Recycling operations help to preserve scarce resources and, therefore, can be considered part of the green economy. E-waste (electrical and electronic waste) is one of the fastest-growing categories of waste. This waste stream contains precious metals and other valuable materials; it is also contaminated

FIGURE 1.16 Examples of green jobs

with heavy metals and toxic chemicals. A large percentage of e-waste finds its way to developing nations, where recycling operations create employment for hundreds of thousands of impoverished people.[69] These individuals will need occupational safety and health protections from hazards in e-waste.

Child Labor in Developing Countries

Child labor was common in England during the 19th-century Victorian era when the Industrial Revolution was in full swing. At that time, orphans constituted a major proportion of workers in the textile industry.[70] Currently, child labor is a problem of particular concern for developing countries. In these countries, poor children are often forced to leave school to work and support their families. These child laborers may be exposed to hazardous materials and deleterious chemicals, and are at great risk of injuries. Also, they may be subjected to sexual, physical, and verbal abuse.[71] Children are more vulnerable to injury and the effects of toxic chemicals because of their behaviors and developmental stages. The fact that child laborers typically come from backgrounds of extreme poverty, where they experience poor housing and environmental conditions as well as insufficient caloric intake, increases the likelihood that their development will be impacted by poor working conditions.[72]

Women Workers

Globally, participation of women in the workforce has increased steadily, especially in rapidly industrializing Asian countries.[73] Occupations typically associated with women are in the fields of electronics, textiles, and manufacturing of light-industrial goods for export. The working conditions for women in crowded factories may expose them to injuries such as amputations and burns. Fires in factories that are packed with trapped female employees who do not have access to building exits have caused massive deaths from conflagrations. Women who work in factories and in healthcare facilities may be exposed to toxic chemicals and radiation. The impact of such exposures upon reproductive function is a vital area of concern for occupational health research and will be explored later in this text. Given the expectation that women will manage their households in addition to working outside of the home, many female workers also experience high stress levels that stem from their multiple role responsibilities. Much of the work out carried by women is not documented formally and is unpaid.[74]

Immigrant Workers

In the future, racial and ethnic minorities (in aggregate) are projected to become a numerical majority in the United States.[74] As immigration is one of the forces

driving population growth, immigrant workers are an important component of the U.S. labor force. Some groups of immigrant workers may be at increased risk for hazardous occupational exposures and working conditions; many of these exposures are thought to go unreported. For example, Southeast Asians employed in fields such as the electronics manufacturing industry are believed to have frequent and unreported exposures to hazardous dusts and solvents.[75] In the United States, many immigrants work less than full time[75] and may be employed as migrant and seasonal farm workers (MSFWs) who face frequent occupational hazards. These workers are confronted by cultural, legal, financial, and other barriers to obtaining health services.[76]

Occupational health hazards confronting MSFWs are noteworthy, as described by Hansen and Donohoe:

> MSFW's face numerous occupational hazards. Farm laborer is seasonal and intensive. Migrant workers labor in all seasons and weather conditions, including extreme heat, cold, rain, and bright sun. Work often requires stoop labor, working with soil and/or heavy machinery, climbing, and carrying burdensome loads, all of which lead to chronic musculoskeletal symptoms. Direct contact with plants can cause allergic rashes or, in the case of tobacco farmers, "green tobacco sickness" (i.e., transdermal nicotine poisoning).[77(p. 155)]

An Aging Workforce

The number of older workers (persons 55 years of age and older) in the U.S. labor force is increasing—a trend that is occurring in conjunction with the overall aging of the U.S. population. These older workers bring to the workplace a wealth of experience that is of great potential benefit to employees. Although occupational injuries and illnesses among older workers tend to be less frequent than among younger workers, older workers' injuries often are more serious.[78] Given increased number of older workers, comprehensive health promotion and health protection programs need to be developed for them to maximize the contribution of this cohort.[79]

The Public Health Model for Occupational Health and Safety

The field of **public health** is complex and has been defined in several ways. For example, Winslow, who founded the Yale University Department of Public Health, defined public health as follows:

> [T]he science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organized

> community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing service for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health.[80(p. 30)]

The field of public health has the following distinguishing characteristics:

- A focus on the health of entire populations rather than on the health of a single individual
- Emphasis on the prevention of disease
- Commitment to social justice as a core value

Occupational Health and Public Health

Occupational health experts recognize that occupational health is a part of public health.[81] The relevance of occupational health for public health stems from the fact that conditions in the work environment affect so many people in the United States (i.e., a large proportion of the population). In turn, the occupational environment is an important venue for health promotion.[82] Prevention of occupational illnesses and injuries can result from improving the work environment and educating employees and managers about work-related hazards.

Exposures that occur in the work environment can affect the larger community when toxic substances from factories are emitted into the community. In addition, many health disparities stem from workers' exposures in the occupational environment. According to Murray, "Workers of color generally are underrepresented in professional categories and overrepresented in blue-collar and service jobs, especially in certain occupations."[83] People who work in blue-collar occupations—such as garbage collectors, nursing aides, and farm workers—are disproportionately affected by the effects of exposures to hazardous biological agents, chemicals, and pesticides.

Health disparities between African American and white men in terms of occupational risks for some form of cancers (for example, non-Hodgkin's lymphoma) have been reported.[84] Possibly these disparities result from differential exposure levels to occupational carcinogens among different racial groups. Increasing awareness of the effects of work on health has encouraged the recognition of environmental determinants of heath disparities. The fields of occupational safety and health hold promise as "a way to reach a large portion of the population experiencing these disparities."[85(p. 526)]

In many respects, the workforce is a captive audience required to be in a place of employment for at least 40 hours each week. The workplace is an ideal setting in which to introduce health promotion activities. One of the benefits of wellness programs for businesses is increases in worker productivity—for example, by slowing or preventing chronic illnesses that might develop during the working years.[86] The process of improving workers' health can be facilitated through partnerships between employers and public health departments.

The Core Functions of Public Health Applied to Occupational Health

The Institute of Medicine has identified **three core functions of public health**: assessment, policy development, and assurance (**FIGURE 1.17**).[87, 88] These functions are applicable to public health agencies at all levels of government, and they can be applied specifically to occupational health and safety. The assessment function pertains to the collection and analysis of health-related data. In occupational health, this function could involve the identification of populations and settings at high risk of adverse health conditions. The policy function is related to the development of health policies that limit occupational risks and promote workers' health. Finally, the assurance function means that needed occupational health regulations and health services for workers are being provided. Examples of these core functions of public health are emphasized throughout this text as they pertain to occupational health.

FIGURE 1.17 Three core functions of public health

Reproduced from Centers for Disease Control and Prevention, Environmental Health Services, Core functions of public health and how they relate to the 10 essential services, http://www.cdc.gov/nceh/ehs/ephli/core_ess.htm. Accessed August 17, 2013.

Healthy People 2020 Objectives for Occupational Health and Safety

The initiative known as Healthy People sets forth a comprehensive health promotion and disease prevention program for the United States. The publication *Healthy People 2020* identified a group of occupational safety and health objectives, shown in **EXHIBIT 1.4**.

EXHIBIT 1.4 *Healthy People 2020* Objectives for Occupational Safety and Health

- OSH-1 Reduce deaths from work-related injuries
  - OSH-1.1 Reduce deaths from work-related injuries in all industries
  - OSH-1.2 Reduce deaths from work-related injuries in mining
  - OSH-1.3 Reduce deaths from work-related injuries in construction
  - OSH-1.4 Reduce deaths from work-related injuries in transportation and warehousing
  - OSH-1.5 Reduce deaths from work-related injuries in agriculture, forestry, fishing, and hunting
- OSH-2 Reduce nonfatal work-related injuries
  - OSH-2.1 Reduce work-related injuries in private-sector industries resulting in medical treatment, lost time from work, or restricted work activity, as reported by employers
  - OSH-2.2 Reduce work-related injuries treated in emergency departments (EDs)
  - OSH-2.3 Reduce work-related injuries among adolescent workers aged 15 to 19 years
- OSH-3 Reduce the rate of injury and illness cases involving days away from work due to overexertion or repetitive motion
- OSH-4 Reduce pneumoconiosis deaths
- OSH-5 Reduce deaths from work-related homicides
- OSH-6 Reduce work-related assaults
- OSH-7 Reduce the proportion of persons who have elevated blood lead concentrations from work exposures
- OSH-8 Reduce occupational skin diseases or disorders among full-time workers
- OSH-9 (Developmental) Increase the proportion of employees who have access to workplace programs that prevent or reduce employee stress
- OSH-10 Reduce new cases of work-related, noise-induced hearing loss

OSH = Occupational safety and health (OSH).

Source: HealthyPeople.gov. Occupational safety and health: objectives. http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=30. Accessed May 13, 2013.

SUMMARY

Occupational health is concerned with protecting the health of workers from diseases and injuries associated with hazardous work-related exposures; in addition, the field pursues the improvement of the work environment and the promotion of workers' health in general. Work-related diseases are adverse health events that arise from the work environment. Occupational health hazards have been observed since the classical period of human history. Among the important names in occupational history are Hippocrates, Georg Agricola, Ramazzini, Paracelsus, Percival Pott, and Alice Hamilton. During the Industrial Revolution and the early 20th century, awareness of the causes and effects of hazardous working conditions increased.

Illnesses and injuries associated with work are leading sources of morbidity and mortality worldwide. Media reports have documented dangerous working conditions in the developing world, but occupational illnesses and injuries are significant concerns for the developed world as well. More than 50,000 deaths from work-related illness and 5000 deaths from injuries occur in the United States annually. Illnesses and injuries cost the U.S. economy approximately $250 billion per year. Among the forces that will continue to affect occupational health in the 21st century are changing trends in employment, adoption of new technologies, and alterations in the composition of the workforce.

With its potential to impact large numbers of people and aid in the prevention of disease, occupational health is closely allied with public health. In accordance with the goal to improve the health of employees, *Healthy People 2020* presents national objectives for occupational health.

STUDY QUESTIONS AND EXERCISES

1. Define the following terms:
   - **A.** Occupational health
   - **B.** Occupational safety
   - **C.** Occupational exposures
   - **D.** Work-related diseases
   - **E.** Caisson disease
2. From a global perspective, what are some examples of risk factors for occupational morbidity and mortality?
3. What is the significance of adverse health outcomes associated with work for the United States? Describe the social, economic, and personal dimensions of work-related illnesses and injuries.
4. Hippocrates, Ramazzini, and Hamilton were important historical figures for occupational health. Briefly describe their most important contributions to the field.
5. Describe five unusual occupational diseases of the past, giving their definitions and information about their etiology.
6. Describe the Triangle Shirtwaist Factory fire and the Gauley Bridge disaster. What was the importance of these events for occupational health?
7. Give examples of three current trends that are relevant to the contemporary work environment. You could use examples from the text or find some other examples on the Web.

8. Describe three *Healthy People 2020* goals for occupational health, giving an example of each goal.
9. State five adverse health outcomes that have been linked to the work environment. What are some examples of agent factors that have been linked to these outcomes?
10. Compare and contrast traditional public health concerns with those of occupational health. Provide some examples of the similarities and differences between the fields of public health and occupational health. The Institute of Medicine has delineated three functions of the field of public health. How might these be implemented in the field of occupational health?

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