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EDITION

Public HEALTH

An Introduction to the Science and Practice of Population Health

James M. Shultz

Lisa M. Sullivan

Sandro Galea

The background of the entire page is a green gradient. On the left side, there are several white concentric circles of varying radii, centered towards the left edge. A solid dark green vertical bar runs along the right edge of the page. A white horizontal band spans the width of the page, containing the text 'PUBLIC HEALTH' in orange.

PUBLIC HEALTH

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SECOND EDITION

PUBLIC HEALTH

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PREFACE

We all care about our health. We all want to be healthy individuals and want our children, parents, partners, and friends to be healthy. Public health aspires to create a world where we can all live our healthiest possible life, to realize our full human potential. This book aims to serve as an introduction to public health for anyone who is interested in this ideal.

Public Health: An Introduction to the Science and Practice of Population Health is designed to introduce the reader to the fundamentals that they will need either to build a career in public health, or simply to know enough about public health to inform a career in other sectors. The second edition builds on the first edition, incorporating feedback from readers, and evolving in the aftermath of the COVID-19 pandemic that has transformed public health and adding a series of new and timely case studies.

The name of the book is meant to illustrate our bringing together of science and practice. Population health science helps us understand how health is generated in populations. Population health science is the foundation of public health practice that takes that understanding and makes populations healthier. Therefore, this book serves as an introduction to the science of population health, leading directly to the practice of public health.

The book starts from one fundamental premise: our health is generated throughout our lives and by the world around us—by where we live, where we work, and who we interact with on a daily basis. Once we understand that, we can then understand the work of public health through the study of two types of factors. First are the influences of our behaviors: our interactions with our family, friends, and communities; the places where we live; and the policies and norms that shape all that we do. This is called the social ecological perspective. Second are the forces that affect our health as we experience them throughout our life, from infancy to old age. This is called the life course perspective.

A note about one notable change in this edition. In the first edition of *Public Health* we referred to the framework that guides our thinking as the eco-social model. On reflection, and upon receiving feedback from readers, we recognize that the eco-social model is best reserved for a more specific theoretical framework. Our intention was always to use a term to broadly conceptualize the relations among personal and environmental factors that shape health, without reliance on any specific theoretical model. As such, in the second edition we use the term social ecological to capture these relations.

This book is organized such that the reader is introduced to these factors in sequence, learning first about the influences across social ecological levels, and then about how health is generated throughout the life course. This serves to organize the student's thinking and also guide the student in learning how we can design interventions at each of these levels that can improve our health and the health of others.

Bookending our discussions of the social ecological and life course perspectives is a discussion of the foundational concepts of public health, including the central roles of prevention, health equity, quantitative methods, how we have to think of population health as a complex system to guide intervention, and how those interventions must engage communities to be effective. The book includes access to podcasts that illustrate the key points of each chapter.

We recognize that our approach in this book is different than that taken by most other textbooks of public health. Our hope here is that an approach grounded in social ecological and life course perspectives can uniquely introduce the student to the science and practice of public

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health, and provide the instructor with a framework that can organize a rich body of material efficiently. Our goal ultimately is to help prepare the next generation of population health scientists and public health practitioners. If this book can be part of that effort, it shall have achieved its purpose.

Thank you for joining us on this journey.

James M. Shultz, Lisa M. Sullivan, Sandro Galea

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CASE STUDY PODCASTS

The authors of *Public Health: An Introduction to the Science and Practice of Population Health* have recorded a set of podcasts to illustrate the key points of each chapter. These podcasts are narrated by graduate students of public health and feature case studies pertinent to the chapter themes, most of which appear in the chapter text. It is our intention that they pique students' interests and inspire discussion both inside and outside of the classroom.

- CASE STUDY 1.1** Population Health Thinking (HIV/AIDS)
- CASE STUDY 1.2** COVID-19 and the Susceptibility of the Human Population
- CASE STUDY 2.1** Falling Life Expectancy in the United States
- CASE STUDY 2.2** The Life Course Perspective on Multigenerational COVID-19 Transmission
- CASE STUDY 3.2** Fortification as a Health-Equitable Prevention Method
- CASE STUDY 4.3** COVID-19 and the Multifaceted Assault on Health Equity for Black Americans
- CASE STUDY 5.3** Cigarette Smoking: Considering the Social Ecological and Life Course Dimensions Together
- CASE STUDY 6.2** Meeting the Challenges of Obesity
- CASE STUDY 7.1** Evolving Directions in Social Networks: Health Implications for Active Users of Social Media
- CASE STUDY 7.3** The Health of Boston Neighborhoods
- CASE STUDY 8.1** Mass Incarceration as a Social Justice Issue and a Public Health Crisis
- CASE STUDY 9.5** Separating Children and Parents at the Border: When Scaling Up a Government Program Is Antithetical to Population Health
- CASE STUDY 9.6** Adolescent Suicide: Rising Rates and Proliferating Risks
- CASE STUDY 10.3** Depression in Adulthood
- CASE STUDY 11.3** Alzheimer's Disease
- CASE STUDY 12.1** Analyzing Forced Displacement as a Public Health Issue Using Mixed Methods
- CASE STUDY 13.1** Public Health Practice During Florida Hurricane Season
- CASE STUDY 14.2** Citizen Action for Disaster Mitigation
- CASE STUDY 15.2** Making Your Pain Go Away/Creating an Opioid Epidemic

ABBREVIATIONS AND COMMON DEFINITIONS

ABBREVIATIONS

AAA: Agricultural Adjustment Act
AACAP: American Academy of Child and Adolescent Psychiatry
ABM: agent-based model
ACA: Affordable Care Act
ACE: adverse childhood experience
ACL: Administration for Community Living
ADHD: attention deficit hyperactivity disorder
ADLs: activities of daily living
AHA: American Heart Association
AI/AN: American Indian/Alaska Native
AMA: American Medical Association
ANHB: Alaska Native Health Board
AoA: Administration of Aging
APHA: American Public Health Association
ATF: Bureau of Alcohol, Tobacco, Firearms and Explosives
ASPH: Association of Schools of Public Health
ASPPH: Association of Schools and Programs of Public Health
ASPR: Assistant Secretary for Preparedness and Response
BMI: body mass index
BNI: basic needs insecurities
BP: blood pressure
CBT: cognitive behavioral therapy
CDC: Centers for Disease Control and Prevention
CEPH: Council on Education for Public Health
CHA: community health assessment
CIA: Central Intelligence Agency
CIHR: Canadian Institutes of Health Research
CLRD: chronic lower respiratory disease
CMS: Center for Medicare and Medicaid Services
CMV: cytomegalovirus
CO₂: carbon dioxide

COP: Conference of the Parties
COPD: chronic obstructive pulmonary disease
CVD: cardiovascular disease
DALY: disability-adjusted life year
DBP: diastolic blood pressure
DCM: depression care management
DEEP: Disaster and Extreme Event Preparedness
DFA: Dementia Friendly America
DHEW: Department of Health, Education, and Welfare
DM: diabetes mellitus
EBP: Evidence-Based Practice
ED: emergency department
EMS: emergency medical services
EPA: Environmental Protection Agency
ESKD: end-stage kidney disease
EUA: emergency use authorization
EVALI: e-cigarette, or vaping, product use-associated lung injury
EVD: Ebola Virus Disease
FAS: fetal alcohol syndrome
FASD: fetal alcohol spectrum disorder
FDA: Food and Drug Administration
FEMA: Federal Emergency Management Agency
FHA: Federal Housing Administration
FoMO: fear of missing out
FPL: federal poverty level
GBD: global burden of disease (Global Burden of Diseases, Injuries, and Risk Factors Study)
GDP: gross domestic product
GIS: geographic information system
GM: General Motors
GPEI: Global Polio Eradication Initiative
GRIDS: gay-related immunodeficiency syndrome
HALE: health-adjusted life expectancy
HBM: Health Belief Model
HCV: Hepatitis C Virus
HDL: high-density lipoprotein
HHS: U.S. Department of Health and Human Services
HIA: health impact assessment
HiAP: Health in All Policies

HIPAA: Health Insurance Portability and Accountability Act

HPV: human papillomavirus

HSV: herpes simplex virus

HUD: Department of Housing and Urban Development

ICD-11: 11th Revision of the *International Statistical Classification of Diseases and Related Health Problems*

ICDS: India's Integrated Child Development Services

ICP: Inclusive Communities Project

IDMC: Internal Displacement Monitoring Centre

IDP: internally displaced person

IHD: Ischemic Heart Disease

IHS: Indian Health Service

IMR: infant mortality rate

INGOs: International Nongovernmental Organizations

IPV: intimate partner violence

IRR: Incident Rate Ratio

K2A: Knowledge to Action

LDL: low-density lipoprotein

LE: life expectancy

LGB: lesbian, gay, bisexual

LHD: local health department

LHI: Leading Health Indicator

LIA: Lead Industries Association

LMIC: low- to middle-income country

LRC: Linkage to, Retention in, Re-engagement in HIV Care

LTOT: long-term oxygen therapy

MADD: Mothers Against Drunk Driving

MBSR: Mindfulness-Based Stress Reduction

MBTA: Massachusetts Bay Transportation Authority

MedVP: medically vulnerable patient

MHS: U.S. Marine Hospital Service

MIDAS: Models of Infectious Disease Agent Study

MMWR: Morbidity and Mortality Weekly Report

MPH: Master of Public Health

MSM: men who have sex with men

NAHIC: National Adolescent and Young Adult Health Information Center

NAPA: National Alzheimer's Project Act

NCD: noncommunicable disease

NCI: National Cancer Institute

NGO: nongovernmental organization

NIH: National Institutes of Health

NIMH: National Institute of Mental Health

NPA: National Partnership for Action

NPR: National Public Radio

NSDUH: National Survey on Drug Use and Health

NSSI: nonsuicidal self-injury

ODD: oppositional defiant disorder

ODPHP: Office of Disease Prevention and Health Promotion

OEM: Office of Emergency Management

OPR: opioid pain relievers

OSHA: Occupational Safety and Health Administration

PAHO: Pan-American Health Organization

PPE: Personal Protective Equipment

PrEP: pre-exposure prophylactics

PSA: prostate specific antigen

PTSD: posttraumatic stress disorder

QALY: quality-adjusted life year

QOL: quality of life

QOLS: Quality of Life Scale

REACH: Racial and Ethnic Approaches to Community Health

RR: risk ratio *or* relative risk

RWJF: Robert Wood Johnson Foundation

SAMHSA: Substance Abuse and Mental Health Services Administration

SBP: systolic blood pressure

SDG: Sustainable Development Goal

SDI: Sociodemographic Index

SDOH: social determinants of health

SDWA: Safe Drinking Water Act

SES: socioeconomic status

SIDS: sudden infant death syndrome

SITB: self-injurious thoughts and behaviors

SNAP: Supplemental Nutrition Assistance Program

STI: sexually transmitted infections

SUL: Shelter Unit Leader

TANF: Temporary Assistance for Needy Families

TDHCA: Texas Department of Housing and Community Affairs

T1D: type 1 diabetes
T2D: type 2 diabetes
UHC: universal health coverage
UN: United Nations
UNAIDS: United Nations Programme on HIV and AIDS
UNFPA: United Nations Population Fund
UNHCR: United Nations High Commissioner for Refugees
UNICEF: United Nations International Children’s Emergency Fund
UNODC: United Nations Office on Drugs and Crime
UNRWA: United Nations Relief and Works Agency for Palestine Refugees in the Near East
USAID: U.S. Agency for International Development
USDA: United States Department of Agriculture
USDHEW: U.S. Department of Health, Education, and Welfare
USDHHS: U.S. Department of Health and Human Services
USPHS: U.S. Public Health Service
USPSTF: U.S. Preventive Services Task Force
VMT: vehicle miles traveled
VOAD: voluntary organizations active in disasters
VOC: variant of concern
WFP: World Food Programme
WHA: World Health Assembly
WHO: World Health Organization
WIC: Special Supplemental Nutrition Program for Women, Infants and Children
WISEWOMAN: Well-Integrated Screening and Evaluation for Women Across the Nation
WTO: World Trade Organization
YLD: years lived with disability
YLLs: years of life lost
YRBS: Youth Risk Behavior Survey
YRBSS: Youth Risk Behavior Surveillance System

COMMON DEFINITIONS

Age-standardized death rates: rates of death applied to a standard age distribution to allow for fair comparison

Biostatistics: the study of understanding variability in potential causes and outcomes in order to infer associations and relationships among them

Communicable disease: a disease that is passed from an infected person (a person who harbors an infectious agent, such as a bacteria or virus) to a previously noninfected person

Dose-response: an upward stairstep relationship between exposure and outcome

Efficiency: a term often used in economics to describe the maximization of the total economic output of a system

Epidemiology: the study of the distribution and determinants of disease

Incidence: the number of new cases of specific disease conditions

Life course perspective: a perspective stating that our health is produced throughout our life, through the perinatal period, infancy, and childhood (before birth through age 14); adolescence and young adulthood (ages 15–24); adulthood (ages 25–64); and older adulthood (ages 65 and older)

Meta-analysis: a type of statistical analysis that pools data from multiple smaller studies on a particular topic to build more precise estimates of association

Population health science: the study of the conditions that shape distributions of health within and across populations, and the mechanisms through which these conditions manifest as the health of individuals

Prevalence: the number of existing cases of specific disease conditions

Primary prevention: actions that keep people from becoming ill or injured in the first place

Secondary prevention: actions aimed to reduce the impact of a disease or injury in the earliest stages of occurrence

Social ecological perspective: a perspective explaining that our health is produced through a variety of levels starting from the individual and extending to an individual's family members and friends, their neighborhoods, their cities, and their countries

Tertiary prevention: actions that reduce the impact of an ongoing injury or disease once an individual has been diagnosed and treated for clinical disease

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- Instructor Test Bank
 - Multiple-Choice Questions with Answers/Rationales
- Instructor PowerPoints
- Instructor Syllabus

STUDENT RESOURCES

- Case Study Podcasts
- Podcast Transcripts

SECTION I

INTRODUCTION

THE ORIGINS OF PUBLIC HEALTH

LEARNING OBJECTIVES

- Distinguish and compare the terms *public health* and *population health*.
- Discuss the history of public health across the globe.
- Discuss the great public health achievements of the 20th century that increased life expectancy by 25 years.
- Identify the processes, approaches, or interventions used in major public health achievements.

OVERVIEW: PUBLIC HEALTH, POPULATION HEALTH, AND POPULATION HEALTH SCIENCE: KEY DISTINCTIONS

Humans have long recognized the need to develop systems that can create healthy populations. The roots of organized public health extend back millennia.¹ Roman aqueducts were built, in part, to accommodate the need of growing cities to have clean water that was not contaminated by urban effluent. Jump forward to the mid-19th century where modern public health as we know it emerged principally from western European countries, particularly England, France, and Germany. Spurred by industrialization and the need to create healthier cities, the first formal health departments were established. Organized public health soon became one of the most important advances in human history, leading to a period of a worldwide unprecedented increase in life span with the average life expectancy jumping from around 40 years in the mid-1800s to around 80 years in many high-income countries in the present day.

Those starting on a journey in public health build upon this legacy. This chapter aims to give the reader the foundations that can create a path for a lifetime of study or work in public health. To set those foundations, we first (a) explain core terms that underlie what we cover in this book, (b) describe the evolution of public health departments and methods of research and practice in 19th-century Europe, (c) discuss the evolution of public health practice in the United States in the 20th century, (d) outline the current organization of public health practice in the United States, including the Centers for Disease Control and Prevention (CDC) and local state and municipal health departments, (e) discuss the organization of public health globally with particular reference to the World Health Organization (WHO), and (f) describe the evolution of academic schools of public health as the academic soul of public health.

POPULATION

Public health, being about populations, requires that students actively think in terms of population health. Although population thinking is essential to public health science and practice, it is not an intuitive way of thinking. More often than not, our attention gravitates to a particular important individual: the person at the center of our “selfies.” Population thinking necessarily moves us beyond ourselves to considering more than one individual. This certainly includes other individuals with whom we are closely connected and groups of individuals of which we are a part. Extending beyond our own social networks, such thinking has us consider many other groups in which we have no obvious membership or deep connection.

So, what is a population? Two properties are necessary to describe a population.² First, a population requires more than one individual. Second, these individuals share one or more common characteristics.

Two properties are necessary to describe a population:

First, a population requires more than one individual.

Second, these individuals share one or more common characteristics.

So really, a population of interest could be as small as two persons or as encompassing as the citizenry of the entire planet. By way of example, at the expansive extreme of this continuum, while the world was suffering the ravages of World War I one century ago, pandemic influenza was circling the globe.³ The death toll from this deadly outbreak was estimated in the range of 50 to 100 million at a time when the global population was about 1.5 billion people and everyone was susceptible.

Quite often, we define a population as people in a particular place. Places have discernible geopolitical boundaries; we can talk about the population of a city, region, or country. A population may be further defined by a set of commonalities, one or more characteristics shared by members of the population. For example, we may have a population of employees in a particular workplace, or a population of people who have common hobbies or experiences. Either way, the study of public health rests on understanding the population we are concerned with so that we can improve the health of that population. Now, with a population lens in mind, we can start thinking about health.

HEALTH

What do we mean by health? The classic definition comes from the Constitution of the WHO, defining health as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.⁴ Through this definition, dating from 1948, the WHO described the enjoyment of the highest attainable standard of health as a fundamental right of every human being. Further, the WHO indicated that this is a right that should be accorded to all world citizens irrespective of race, economic or social condition, religion, or political belief. The WHO also noted that achieving health for all peoples is fundamental to the attainment of peace and security. To this day, the WHO Constitution continues to read like an enlightened call to arms more than seven decades after it was written. Importantly, this conception of health makes it clear that health is not just about the absence of disease. That means we are not interested only in giving people medicines to make them healthy after they get sick. Rather, we want to keep people healthy to begin with so that they can go about their business, living their lives. In this way of thinking, health is not an end—it is a means. It is a human right, one we should all have, so that we can choose to live our life as we wish to live it.

PUBLIC HEALTH AND POPULATION HEALTH SCIENCE

Now, with this in mind, what do we mean by public health?

There are many definitions of public health that we can lean on. The CDC Foundation notes that public health is the science of protecting and improving the health of families and communities through the promotion of healthy lifestyles, research for disease and injury prevention, and detection and control of infectious diseases.⁵

The American Public Health Association (APHA), the primary membership organization for public health professionals in the United States, considers the role of public health to be the promotion and protection of the health of people and the communities where they live, learn, work, and play.⁶

These definitions have not changed much over time. In 1920, Dr. Charles-Edward Amory Winslow, who established the Department of Public Health inside the Yale School of Medicine, described public health as the science and art of preventing disease, prolonging life, and promoting health through the organized efforts and informed choices of society, public and private organizations, communities, and individuals.⁷

The common theme in all these definitions is that public health is about collective effort, work done by groups of us, aiming to create the conditions that can keep us all healthy. This definition informs how we approach this book.

Importantly, we consider public health to be grounded in the science of population health. Population health science is the study of the conditions that shape distributions of health within and across populations, and the mechanisms through which these conditions manifest as the health of individuals.² Population health science provides us with the science and tells us what we need to know to understand what it is that causes health, so that then, in public health, we can intervene to make populations better.

Population health science provides us with the science and tells us what we need to know to understand what it is that causes health, so that then, in public health, we can intervene to make populations better.

Therefore, this book is about public health practice and population health science. Throughout this book, we aim to explore how population health is produced, and what it is that public health does, or can do, to make populations healthier.

THE HISTORY OF PUBLIC HEALTH

THE EARLY DAYS OF PUBLIC HEALTH

Human habitation on this planet did not start out with populations as we think of them today. Human societies of *Homo erectus*, dating from 1.8 million years ago, and *Homo sapiens*, dating from 200,000 years ago, employed hunting and gathering as their predominant subsistence strategies. The survival of early humans depended on mobility in search of water and sustenance. At the most basic level, a primary indicator of health was staying alive. The average life expectancy was just over 20 years. Pockets of early humans regularly died out.

Health and public health today are strongly shaped by how our primeval physiologies interact with our present-day lifestyles.

Our nomadic forebears established the baseline for what constitutes health today. Our human physiology developed and functioned optimally for this hunter-gatherer lifestyle. Health and public health today are strongly shaped by how our primeval physiologies interact with our present-day lifestyles.

The subsistence tasks of hunter-gatherer life were all-consuming. One of the initial economies that came from the clustering of humans into small bands was the development of the technology of the hunt. Even with the sporadic successful hunt, the bulk of the human diet still consisted of naturally occurring foods including fruits, berries, nuts, seeds, tubers, and primitive grains. Humans remained nomadic, propelled by the imperative to seek and find available food and fresh water sources in their environment.

The hunter-gatherer diet was rich in foods of plant origin, high in fiber, and low in fat, saturated fat, sodium, and calories. Daily, periodically strenuous physical activity was a mainstay of all subsistence activities. Hunter-gatherers needed to live close to sources of clean water, generally the same sources on which their plant-based diet depended. The constant mobility that defined hunter-gatherer life minimized the need to develop systems for sanitation. Although parasitic and communicable infectious diseases posed major threats to the health and longevity of hunter-gatherers, cardiovascular diseases and colon and lung cancers were virtually unknown.

Only in recent millennia (the most recent 7,000–8,000 years) have humans shifted toward settling in place and forming agriculture-based communities. For this to take place required the emergence of staple grains, like the fertile bread wheat, and the refinement of skills for cultivating and harvesting crops. The upside was the relative stability of the groups, now putting down roots and remaining in one locale. This was balanced against the downside that reliance on one primary grain led to widespread nutritional deficiencies and starvation following poor growing seasons. This was the epoch when populations, and by extension, population health, became meaningful.

The impetus for public health comes from humans living together in populations. As populations form and settle, two of the most basic survival concerns are ensuring a safe water supply and disposing of wastes; these remain central to public health today. The act of populating and residing in an area, and the ability to sustain that population, requires that water be brought in and wastes be shipped out or otherwise neutralized. This requires organization—collective action to promote health, or, in other words, public health. The construction of conduits for bringing water to human settlements dates back thousands of years. Excavations in the Indus Valley and the Punjab reveal primitive bathrooms, drains, and covered sewers.¹ A hemisphere away, the Incas constructed elaborate baths and sewage systems.

In the Middle Ages, as European cities grew, several outbreaks of bubonic plague, caused by *Yersinia pestis* (*Y. pestis*), illustrated the challenges occasioned by city living not accompanied by public health efforts to ensure health.⁸ *Y. pestis* resides in the intestines of fleas whose bites transmit the bacterium to rats. Rat populations thrived in the cities, harboring the disease and ensuring the survival of the bacterium. Fleas also fed on humans, who were merely incidental hosts, infecting them as they ingested a blood meal. Once an individual was infected, the bacteria replicated in the lymph nodes and spread to other tissues, producing a severe febrile illness with delirium and headache. Sixty percent of infected individuals died. Originating in Asia, bubonic plague epidemics surged throughout the entirety of Europe from the mid-1300s through the late 1700s.

Two public health tools emerged from the plague years in Europe in the Middle Ages to help cope with these epidemics: quarantine and isolation. As the scourge of bubonic plague, the Black Death, was ransacking Europe, quarantine measures were imposed on ships, passengers, and their cargo that had been potentially exposed to the disease.⁸ Ships were forced to anchor off port for a period of 40 days (in Italian, *quaranta giorni*, the origin of the term “quarantine”) to ensure that the disease was not on board or had run its course. The parallel process for

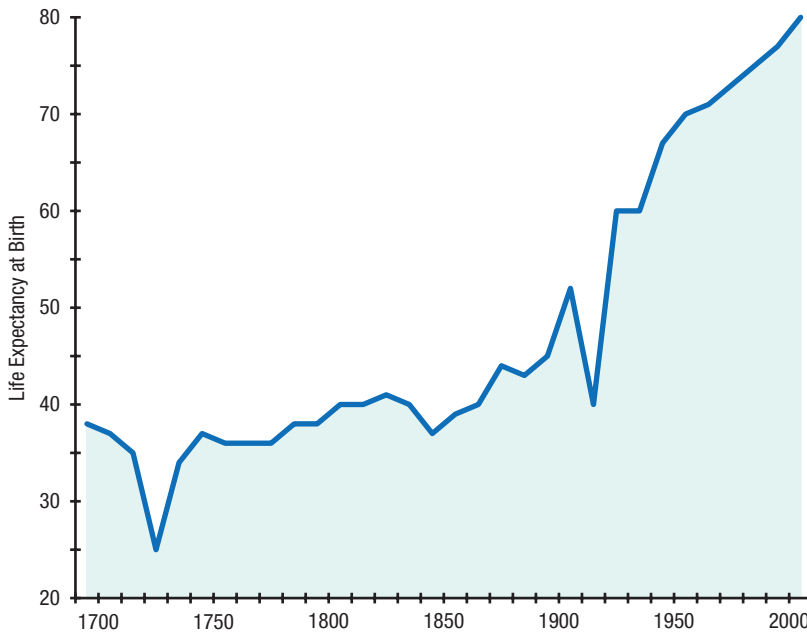


FIGURE 1.1 Life expectancy at birth in England and Wales, 1700 to 2005.

Source: Data from Roser M, Ortiz-Ospina E, Ritchie H. Life Expectancy. 2019. <https://ourworldindata.org/life-expectancy>

restricting entry and movement of possibly infected persons traveling over land was the erection of a cordon sanitaire. This was a physical barrier that could not be crossed without permission. The use of this practice continued up to the early 20th century.

Fast forward to the mid-1800s and we come to mid-19th-century London, where Edwin Chadwick advocated for improving living conditions in order to improve health. Chadwick argued, correctly, that improved health would increase productivity and reduce social costs. The tie-in to public health was his proposal to improve systems for providing clean water and removing wastes and toxic substances. In this manner, the emerging field of public health found acceptability because it aligned with the economic priorities of the government. Public health actions to improve living conditions contributed to advancing life expectancy. Average life expectancy had hovered around 35 to 40 years throughout the 1700s and the first half of the 1800s in England and Wales (**Figure 1.1**). The latter half of the 1800s saw a quantum gain of almost 10 years in life expectancy.

One of the most practical aspects of this movement was the passage of the Public Health Act of 1848.⁹ The act created and operationalized the General Board of Health in London. In turn, the General Board directed the creation of local health boards that were charged with remedying environmental threats to health in their localities. This set the model for much of what is modern public health practice to this day.

THE EVOLUTION OF PUBLIC HEALTH IN THE UNITED STATES

Several events that are relevant to public health in the United States date back to the late 1700s when Congress established the U.S. Marine Hospital Service (MHS) to deal with the health problems of sick and disabled seamen. MHS created a network of hospitals in port cities to

provide care for seamen, who were regarded as a critical asset for the new nation. MHS was the predecessor of the U.S. Public Health Service (USPHS). The city of Boston played a central role as the site of the first marine hospital, and the city created the first board of health and the first health department in the United States. None other than the legendary Bostonian, Paul Revere, was the nation's first health officer.

It was a Massachusetts legislator, Lemuel Shattuck, who developed the first system for recording vital statistics—births, deaths, and marriages—in the United States, one that became an example for emulation by other states. Shattuck's contributions were substantial. He cross-tabulated mortality data by age, sex, occupation, socioeconomic level, and location. Further, he extended the use of health data to the recording of immunizations, smoking status, and alcohol abuse. Shattuck was also the architect of a public health survey for use throughout Massachusetts that was published in the *New England Journal of Medicine*, along with a consolidated set of 50 recommendations.

The 20th century was the era when the science and practice of public health truly came into its own in the United States. Key events in the timeline include the official naming of the USPHS in 1912. The USPHS was charged with investigating a range of human diseases. Prominent concerns at that time were tuberculosis, malaria, and leprosy. Within the purview of the USPHS were such mainstays of public health as safeguarding water supplies, sanitation, and sewage disposal. National disease reporting was initiated in 1925. As one safeguard for the nation's health, legislation passed in 1938 created the Food and Drug Administration (FDA), a key public health agency, responsible for ensuring the safety of the U.S. food supply and the efficacy of drugs and medical devices, and for promoting innovations that lead to new drugs and devices that are safer, more effective, and more affordable for all.

In 1946, the Communicable Disease Center (CDC) was launched as a new program within the USPHS, with approximately 400 employees who were mostly engineers and epidemiologists with experience working on malaria control in the southern states. The program occupied a small space in Atlanta, Georgia, and the goal of the newly formed CDC was to expand its focus to all communicable diseases. Within 2 years, the CDC began a disease-surveillance program which effectively changed the practice of public health. One of its first notable accomplishments was the eradication of malaria from the United States. This set the stage for evidence-based public health practice.

Over the coming decade, the CDC expanded in size and scope. The CDC created the Epidemic Intelligence Service (EIS), comprised of trained epidemiologists, who investigated hundreds of outbreaks related to communicable diseases, and environmental and biological hazards. The CDC created and expanded systems to gather data to monitor health and established a Bureau of Health Education with curricula for educators to use across the educational continuum. In 1970, while retaining the CDC acronym, the Communicable Disease Center was renamed the Center for Disease Control. In 1981, Center (singular) was changed to Centers (plural). In 1992, the phrase “and Prevention” was appended, but the CDC acronym was left unchanged: Centers for Disease Control and Prevention (CDC). The CDC is guided by the following mission statement:

CDC works 24/7 to protect America from health, safety and security threats, both foreign and in the U.S. Whether diseases start at home or abroad, are chronic or acute, curable or preventable, human error or deliberate attack, CDC fights disease and supports communities and citizens to do the same.

*CDC increases the health security of our nation. As the nation's health protection agency, CDC saves lives and protects people from health threats. To accomplish our mission, CDC conducts critical science and provides health information that protects our nation against expensive and dangerous health threats, and responds when these arise.*¹⁰

TABLE 1.1 Three Core Functions of Public Health and 10 Essential Public Health Services

CORE FUNCTIONS		ESSENTIAL SERVICES	
1	Assessment	1	Assess and monitor population health
		2	Investigate, diagnose, and address health hazards and root causes
2	Policy development	3	Communicate effectively to inform and educate
		4	Strengthen, support, and mobilize communities and partnerships
		5	Create, champion, and implement policies, plans, and laws
		6	Utilize legal and regulatory actions
3	Assurance	7	Enable equitable access
		8	Build a diverse and skilled workforce
		9	Improve and innovate through evaluation, research, and quality improvement
		10	Build and maintain a strong organizational infrastructure for public health

Source: Adapted from Centers for Disease Control and Prevention. Public health system and the 10 essential public health services. n.d. <https://www.cdc.gov/publichealthgateway/publichealthservices/essentialhealthservices.html>

In 1988, the Institute of Medicine issued a report entitled “The Future of Public Health,” and in it, articulated three core functions of public health: assessment, policy development, and assurance.¹¹ Assessment involves collecting and analyzing data to monitor health outcomes and to identify emerging health issues that need attention. Policy development involves recommendations for interventions, programs, and policies to address health problems that have been identified. Assurance involves enforcement of policies, allocation of resources to support programs and interventions, and evaluation of how well these interventions, programs, and policies are working to promote health. In 1994, a Core Public Health Functions Steering Committee was organized with representation from the CDC and other U.S. public health agencies to develop specific functions and activities within each core function. Ten essential public health services were articulated that to this day provide a framework for nearly every public health activity (**Table 1.1**).

THE U.S. PUBLIC HEALTH SYSTEM

The public health system in the United States is organized across federal, state, municipal, and local health authorities. Other public health services are delivered by nongovernmental agencies and community programs.

THE U.S. FEDERAL PUBLIC HEALTH SYSTEM

Administratively, the U.S. federal public health system resides under the executive branch of government, principally centered within the U.S. Department of Health and Human Services (HHS). Health-related functions are also performed by the departments of Defense, Veterans Affairs, Homeland Security, and Labor, and the Social Security Administration.

The stated mission of the HHS is to enhance and protect the health and well-being of all Americans.¹² HHS seeks to achieve this mission in several ways. Not only does HHS deliver a range of health and human services, the department also actively promotes advances in public health and medical research and carries out aspects of health policy. The Office of the Secretary includes a complement of administrative officers.¹³ Among these are the Assistant Secretary of Health who oversees the office of the U.S. Surgeon General.¹⁴ After the terrorist attacks of September 11, 2001, public health preparedness became a priority public health issue and a new office was created to house the Assistant Secretary for Preparedness and Response (ASPR).¹⁵ This purview of this office was expanded in 2022, retaining the ASPR acronym while modifying the name of the entity to Administration for Strategic Preparedness and Response.

Perhaps most well known to the general public are the CDC,¹⁶ the National Institutes of Health (NIH),¹⁷ and the FDA.¹⁸ The Center for Medicare and Medicaid Services (CMS) is rarely mentioned by name but its component programs, Medicare and Medicaid, are broadly known.¹⁹ CMS performs one of the most essential functions of HHS, administering the major federal healthcare funding programs for older adults (Medicare); and for low-income families, pregnant women, people of all ages with disabilities, and people who need long-term care (Medicaid). Another division, the Substance Abuse and Mental Health Services Administration (SAMHSA), supports substance abuse treatment and prevention programs.²⁰ The HHS is also charged with providing healthcare to American Indians/Alaska Natives residing on government lands through the Indian Health Services.²¹

STATE, MUNICIPAL, AND LOCAL HEALTH AUTHORITIES

Much of the direct delivery of public health services to individual recipients occurs at state, county, city, and municipality levels. Correspondingly, the majority of government public health professionals work in state, county, and local health departments close to their places of residence. CDC is a resource to local health officials and operations. CDC provides technical guidance, consultations, toolkits, data, and assistance connecting local health officials with others outside of specific jurisdictions who may be experiencing similar issues or who have particular expertise that might be useful.

Apart from the practicality of bringing services directly to the people, this structure aligns with the tradition, since the founding of the nation, of vesting significant governing power in the states. In the case of public health, where needs reach down to the community, the family unit, and the individual, the provision of public health programs and services is shared among state and local levels. The specific division of labor and the delegation of duties between state and local levels differ across states.

GLOBAL PUBLIC HEALTH

On an international level, the WHO is the body charged with protecting and promoting health and preventing disease on a global scale. Moreover, public health services are also delivered by national and international nongovernmental agencies and community programs around the globe.

THE WORLD HEALTH ORGANIZATION

The WHO is part of the United Nations (UN) system.²² The WHO is the organization most directly involved in global health. Many other UN agencies also participate in functions that bear directly on the health of populations. As examples, UN entities focus on women's health (UN Women),²³ HIV/AIDS (United Nations Programme on HIV and AIDS [UNAIDS]),²⁴ drug

abuse (United Nations Office on Drugs and Crime [UNODC]),²⁵ refugee health (United Nations High Commissioner for Refugees [UNHCR] and United Nations Relief and Works Agency for Palestine Refugees in the Near East [UNRWA]),^{26,27} children's health (United Nations International Children's Emergency Fund [UNICEF]),²⁸ and famine prevention/intervention through the World Food Programme (WFP),²⁹ among other entities.

Established in 1948 and headquartered in Geneva, Switzerland, the WHO has six regional offices and 150 country offices. The Pan-American Health Organization (PAHO),³⁰ based in Washington, DC, is the WHO regional office for the entire Western Hemisphere, the "Americas."

The WHO addresses health needs that may be brought forward by any of the 193 UN member states (as of 2022). The organization has 7,000 staff members worldwide, and more than 700 institutions support the WHO's work.

GLOBAL NONGOVERNMENTAL ORGANIZATIONS AND CIVIL SOCIETY

Many thousands of national and international nongovernmental organizations (NGOs) focus their activities on some aspect of public health. Name a major disease, and there will be an organization advocating for prevention and effective treatment of that medical condition. Consider cancer. Well known is the American Cancer Society.³¹ There are counterpart cancer organizations beginning with the names of dozens of other nations (e.g., Dutch Cancer Society, Saudi Cancer Society).^{32,33} Many organizations have a focus on a specific cancer. In the United States, Susan G. Komen for the Cure is well known for fundraising for breast cancer using community walks and running events to garner community participation.³⁴ The most common and major cancers (lung, breast, colorectal) have organizations; so too do little-known cancers. (The Acoustic Neuroma Association is the first listed on the alphabetical index of more than 300 cancer organizations.)³⁵

In parallel, other prominent diseases are represented by associations that seek funding for research and offer support to persons living with the disease and their family members. Diseases that are the leading causes of death in the United States are represented by such organizations as the American Heart Association,³⁶ the American Cancer Society³⁰, the American Lung Association,³⁷ the American Diabetes Association,³⁸ and the Alzheimer's Association.³⁹ The recent appearance of COVID-19 as a new entry among the leading causes of disease and death has given rise to new organizations including the Long-COVID Alliance.

There are associations for surviving family members who have lost a loved one to drunk driving (Mothers Against Drunk Driving),⁴⁰ gun violence (The Sandy Hook Promise),⁴¹ and suicide (Alliance of Hope).⁴²

There are health professional organizations for public health (APHA)⁴³ and for most every type of health and medical professional. Some professional organizations represent a broad occupational category (American Medical Association)⁴⁴ while others represent a specific specialty (American Psychiatric Association)⁴⁵ or even subspecialty (Academy of Consultation-Liaison Psychiatry).⁴⁶

By way of example, disasters, humanitarian emergencies, and public health crises bring together governmental and nongovernmental entities to assist populations in need. ReliefWeb serves as an international online hub and information resource, helping to coordinate humanitarian assistance for specific disaster events.⁴⁷ ReliefWeb lists more than 3,000 organizations that may be active in disasters. Well known among NGOs and international nongovernmental organizations (INGOs) are the American Red Cross,⁴⁸ International Federation of Red Cross and Red Crescent Societies,⁴⁹ CARE,⁵⁰ Caritas,⁵¹ and Doctors Without Borders (Médecins Sans Frontières).⁵² Large numbers of religiously affiliated NGOs also operate in this space (e.g., Catholic Charities USA, Episcopal Relief and Development, Lutheran World Relief, and Mennonite Central Committee).⁵³⁻⁵⁶

THE EVOLUTION OF ACADEMIC SCHOOLS OF PUBLIC HEALTH IN THE UNITED STATES

THE EARLY ORIGINS OF ACADEMIC PUBLIC HEALTH

Academic schools of public health date back to the time of the Great Influenza.⁵⁷ Years of planning went into the creation of health education that was distinct from the traditional medical school curriculum. In 1916, just prior to the onset of the global influenza pandemic, the Johns Hopkins University School of Hygiene and Public Health became the first school of public health, endowed by the Rockefeller Foundation. Early schools of public health were private institutions that were populated almost exclusively by professionals with medical degrees. Not surprisingly, the education focused on infectious diseases. In the early decades, the prioritized enrollment of physicians, coupled with the failure to include field training, did not succeed in producing a cadre of graduates who could assume roles as public health officers and sanitarians.

Impetus for expanding public health education was provided by the Social Security Act of 1935. The act increased funding for the USPHS and upgraded qualifications for federally funded health personnel that translated, in most states, into a requirement of at least 1 year of graduate education. This increase in public health positions created demand for public health credentials that triggered state universities to open new schools. By 1936, graduate public health training was offered in 10 institutions: Johns Hopkins, Harvard, Columbia, Michigan, University of California at Berkeley, Massachusetts Institute of Technology, Minnesota, Pennsylvania, Wayne State, and Yale. During the 1930s, there was a proliferation of 1-year graduates who received a Master of Public Health (MPH) degree with a strong emphasis on applied field training.

The expansion of public health training continued during the Second World War to prepare physicians, nurses, and sanitarians with skills to deal with tropical and parasitic diseases, sexually transmitted infections, and sanitation in the theaters of war. Training was also provided to impart industrial hygiene skills to ensure the health of workers in the domestic industries that supported the war effort. This boom in public health training was accompanied by the formation of the Association of Schools of Public Health (ASPH) in 1941 and the establishment of the Council on Education for Public Health (CEPH) of the APHA, adding rigor and standardization to public health curricula.

Some of the earliest insights from population health scholarship that informed public health were studies that elucidated the causal relationship between cigarette smoking and rising lung cancer rates, published by Doll and Hill in 1948. In the same year, the Framingham Heart Study was launched. This research continues more than 70 years later as one of the most consequential studies that connects a series of lifestyle risk factors to the onset, progression, and mortality associated with cardiovascular and other noncommunicable diseases (NCDs).

In 1953, President Eisenhower created the U.S. Department of Health, Education, and Welfare (DHEW). The year 1970 expanded the breadth of the public health agenda, marking the inception of both the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA). In 1979, reorganization of the executive branch separated health and education into separate departments. Public health functions resided within the renamed and reorganized HHS.

POST-WORLD WAR II AND ACADEMIC PUBLIC HEALTH TODAY

The focus on preparing public health practitioners through applied courses and fieldwork took a downturn after the war when university funding for public health faculty shifted toward an imperative for these professionals to compete for research grant support. Foundation support for public health education dwindled. Schools of public health found themselves at a

disadvantage when competing with medical schools for NIH funding and other research support. Community-focused field training educational programs vanished. Nationwide, enrollment in graduate public health education decreased by half by the mid-1950s.

Later that decade, an emergency infusion of federal funding partially revived public health education. In 1958, the First National Conference on Public Health Training was held. The introduction of major national social programs of the 1960s—Medicare and Medicaid—once again increased the demand for public health education, this time focusing on healthcare delivery. The 1960s and 1970s saw a revitalization of graduate public health training as schools of public health received direct funding for training along with an enhanced ability to compete for research grants.

However, in 1973, just as the number of graduate public health degrees awarded annually was approaching 5,000, President Nixon attempted to eliminate all federal funding for schools of public health and for research training grants. Fortunately, funding was not terminated and in 1976, the Milbank Memorial Fund published a detailed public health roadmap report, *Higher Education for Public Health*, that proposed a three-tiered structure for public health education.⁵⁸ This included the preparation of public health leaders; created specialist public health training for nurses, health educators, and environmental health professionals; and added an undergraduate training component to graduate entry-level personnel. The report defined core disciplines within public health and recommended a role for the schools as regional resources to educational institutions in the area of public health research. It also highlighted engagement of schools in local community health services and renewed emphasis on public health practice.

There are currently 68 schools of public health and 139 programs in public health that are accredited by the CEPH. These programs are distributed across 47 states and eight countries.

Today, the public health ecosystem includes schools of public health, official governmental bodies charged with promoting health, NGOs, and a range of international bodies, all aspiring to create the conditions for states of complete physical and mental well-being for as many people as possible.

WHAT ARE THE MAJOR PUBLIC HEALTH ACHIEVEMENTS OVER THE 20TH CENTURY AND MORE RECENTLY IN THE UNITED STATES?

Public health has transformed healthy life and catapulted life expectancy forward within the past 125 years. During the 20th century, life expectancy in the United States increased by 30 years. The CDC credits 25 years of this unprecedented jump in life expectancy to 10 great public health achievements during the 20th century, 1900–1999.⁵⁹ Here is the list:

Ten Great Public Health Achievements—United States, 1900–1999⁵⁸:

- Control of infectious diseases
- Decline in deaths from coronary heart disease and stroke
- Family planning
- Fluoridation of drinking water
- Healthier mothers and babies
- Motor vehicle safety
- Recognition of tobacco use as a health hazard
- Safer and healthier foods
- Safer workplaces
- Vaccination

We select a subset of these achievements for further discussion.

VACCINATION AND CONTROL OF INFECTIOUS DISEASES—TWO CLOSELY INTERRELATED ACHIEVEMENTS

Vaccination was a major contributor to the control of infectious diseases in past decades. Smallpox was declared eradicated in 1979. Smallpox, a disease that produced illness exclusively in humans, transformed the course of history over centuries. European explorers unknowingly introduced smallpox to the Americas, decimating populations of First Nations peoples who were immunologically naïve to the disease.⁶⁰ Poliomyelitis was banished from the Western Hemisphere during the 20th century. The spread of measles, diphtheria, rubella, and tetanus became well controlled through childhood vaccination.

Beyond vaccine-preventable diseases, water purification and improved sanitation—fundamental pillars of public health—successfully decreased the disease burden of major killers like typhoid and cholera. The introduction of antimicrobial therapies diminished the spread of tuberculosis and some sexually transmitted infections.

HEALTHIER MOTHERS AND BABIES, FAMILY PLANNING, AND FOOD SAFETY

The health and survival of mothers and their children benefitted from improved hygiene and better nutrition. Expanded access to healthcare, advances in medical procedures, antibiotic medications, and the introduction of prenatal and neonatal care also improved the well-being of mothers and babies. Collectively, these developments translated into a startling 90% decline in the infant mortality rate and a 99% decrease in the maternal mortality rate over the 20th century. Related to the realm of maternal and child health, the 1900s also ushered in the era of family planning. The availability of preconception counseling and contraceptive options paved the way for smaller families. Planned pregnancies and prenatal care combined to lower rates of fetal, infant, and maternal deaths.

The United States made strides to improve the safety of foods and the purity of the water supply. The introduction of safer and healthier foods had the complementary effects of decreasing food contamination and improving the nutritional content of foods. The ability to supplement vital micronutrients and to fortify foods led to the virtual elimination of nutritional deficiency diseases in childhood. As examples, in the United States, diseases such as rickets, pellagra, and goiter have vanished.

WATER FLUORIDATION

In the mid-20th century, the United States began to fluoridate the drinking water, reaching more than half the population by the end of the century. This public health action benefits people across the socioeconomic spectrum. As a result of this simple low-cost action, rates of tooth decay in children and tooth loss in adults were reduced by more than half.

SAFER WORKPLACES

During the 20th century, major reductions were achieved in rates of work-related injuries and deaths in the mining, construction, and manufacturing sectors. Toxic and disease-producing exposures to hazardous materials, poisons, dusts, fumes, and carcinogens in work settings have been monitored and significantly controlled. Worksite risk reduction occurred through combinations of regulations, installation of safety equipment, workforce training, use of personal protective equipment, attentive worker supervision, and when necessary, litigation.

MOTOR VEHICLE SAFETY

The introduction of the automobile and motorized transportation early in the 20th century re-defined mobility and simultaneously created new patterns of unintentional injury. In the United States, unintentional injury is the leading cause of death for people aged 1 to 44 years. For multiple decades prior to the opiate epidemic, motor vehicle crash deaths were the principal cause of death from unintentional injury—and now rank second, following “unintentional poisonings” (drug overdose deaths).

There are multiple pathways available for successfully mitigating motor vehicle crash trauma and death (**Figure 1.2**). These include training motorists and passengers on every-time use of seat belts, child safety seats, and motorcycle helmets. Safety technology rapidly evolved. Carmakers began to design vehicles with rigid passenger cages surrounded by deformable extremities. In a crash, the passenger compartment would remain intact while the bumpers and the motor or trunk compartments would collapse and absorb the impact. A similar mind-set went into the design of the passenger compartment, replacing metals with softer, cushioned plastics to reduce trauma during a collision.

The national highway system continuously upgrades the quality of roadways; improves highway lighting; and introduces new signals, signage, and safeguards to make motoring safer. Onboard navigation systems and smart technologies are being used to alert drivers to dangerous situations and to diminish distractions. Laws have been passed to keep drivers in their lanes and driving within specified speed limits. Significant penalties are set for risky human behaviors including driving while under the influence of substances or while texting or using other electronics. New sensor technologies increasingly allow vehicles to sense—and avoid—road hazards such as side-impact collisions and rear-end collisions when vehicles in front decelerate quickly. Sensors can detect persons or objects passing behind the vehicle and rapidly apply the brakes. The evolving technology of self-driving vehicles holds considerable future promise for decreasing collision risks.

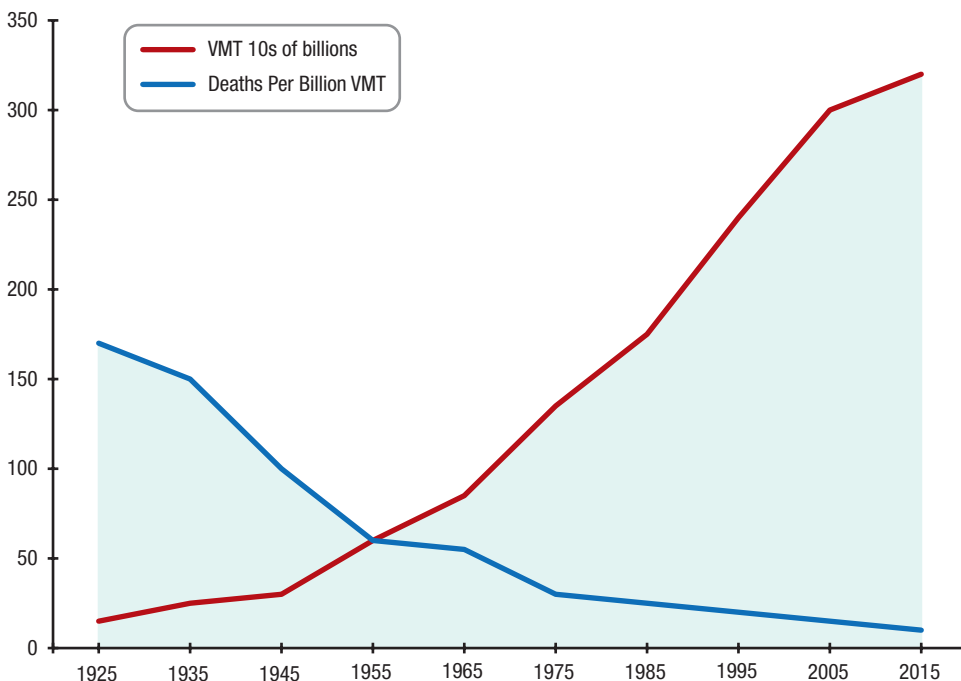


FIGURE 1.2 VMT and deaths per billion VMT, United States, 1925 to 2015. VMT, vehicle miles traveled.

Source: Data from Bratland D. US traffic deaths per VMT, VMT, per capita, and total annual deaths. 2018. https://commons.wikimedia.org/wiki/File:US_traffic_deaths_per_VMT,_VMT,_per_capita,_and_total_annual_deaths.png

DECLINE IN DEATHS FROM CORONARY HEART DISEASE AND STROKE

While rates of communicable diseases were declining, the number of cases of NCDs was increasing. Most notably, heart disease rates rose steadily during the first half of the 20th century. With the successful identification of modifiable lifestyle-related risk factors that were associated with heart disease, programs were devised for risk factor modification at both the individual and population levels. A combination of decreased saturated fat intake in the habitual diet; improved detection, treatment, and control of high blood pressure; and smoking cessation contributed to steady, long-term declines in both stroke and ischemic heart disease mortality rates beginning in the 1960s and continuing for more than 50 years. By the 2010s, heart disease death rates were only slightly higher than cancer death rates for men and actually lower than cancer death rates for women. The downward trends in heart disease and stroke present a visible contrast to the relatively unchanging cancer death rates from the late 1970s onward (**Figure 1.3**).

RECOGNITION OF TOBACCO USE AS A HEALTH HAZARD

The widespread adoption of the cigarette smoking habit was a 20th-century phenomenon. Shrewd marketing coupled with the addictive properties of nicotine led to a surge in smoking rates, first for men and later for women throughout the first half of the 1900s (**Figure 1.4**). Although by the late 20th century, cigarette smoking was described as the chief preventable cause of death in the United States, public recognition that tobacco posed a grave health hazard was slow to develop. One of the reasons is the 20-year time lag between rising smoking rates and rising deaths from smoking-related diseases. This is due, in part, to the fact that it takes a matter of decades, on average, for a regular smoking habit to produce fatal cancer, respiratory disease, or cardiovascular disease.

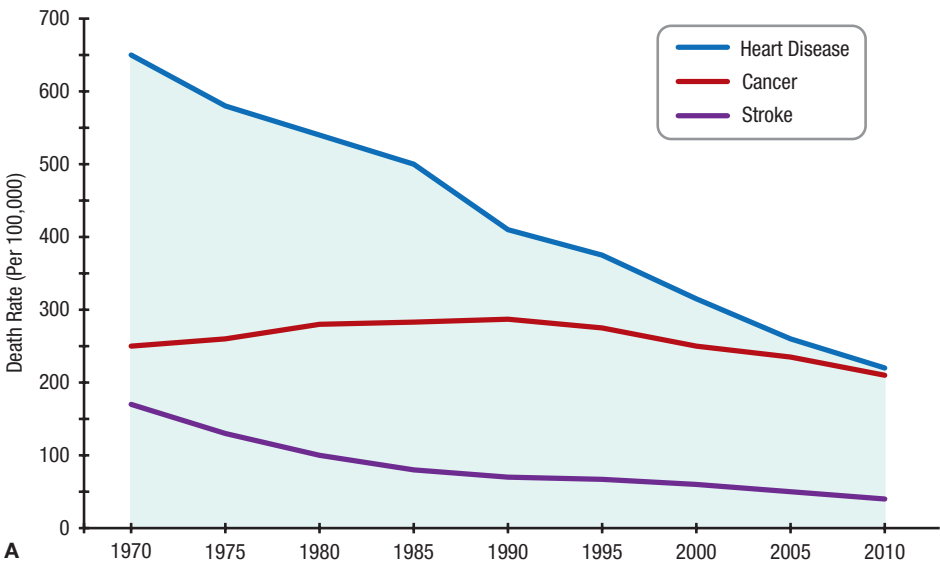


FIGURE 1.3 Trends in heart disease, cancer, and stroke deaths per 100,000 for (A) males and (B) females, United States, 1970 to 2010.

Source: Data from Ma J, Ward EM, Siegel RL, Jemal A. Temporal trends in mortality in the United States, 1969–2013. Original Investigation. *JAMA*. 2015;314(16):1731–1739. doi:10.1001/jama.2015.12319

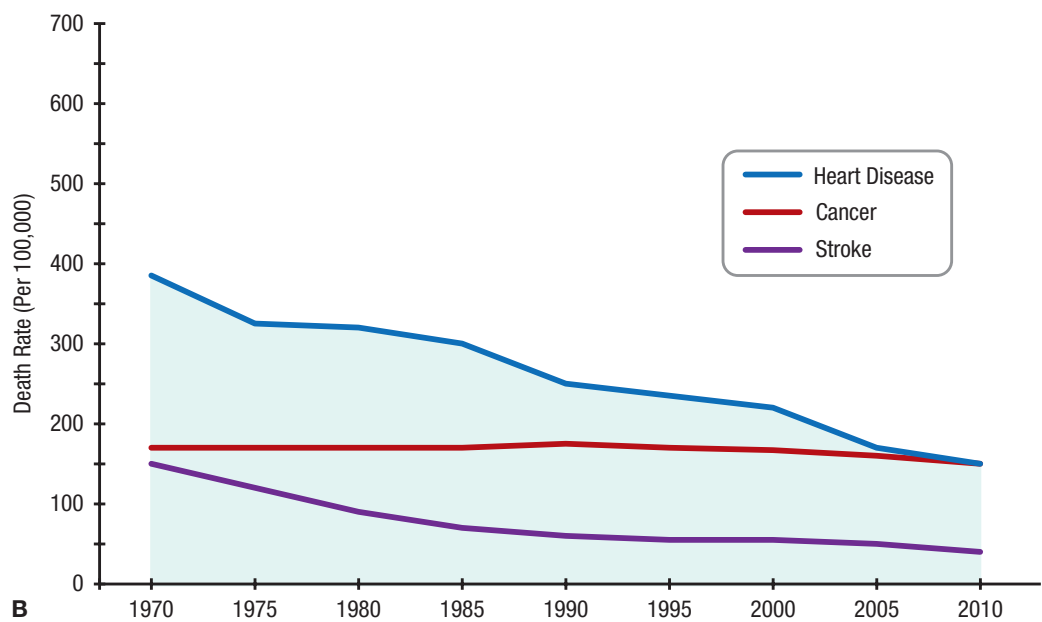


FIGURE 1.3 (continued)

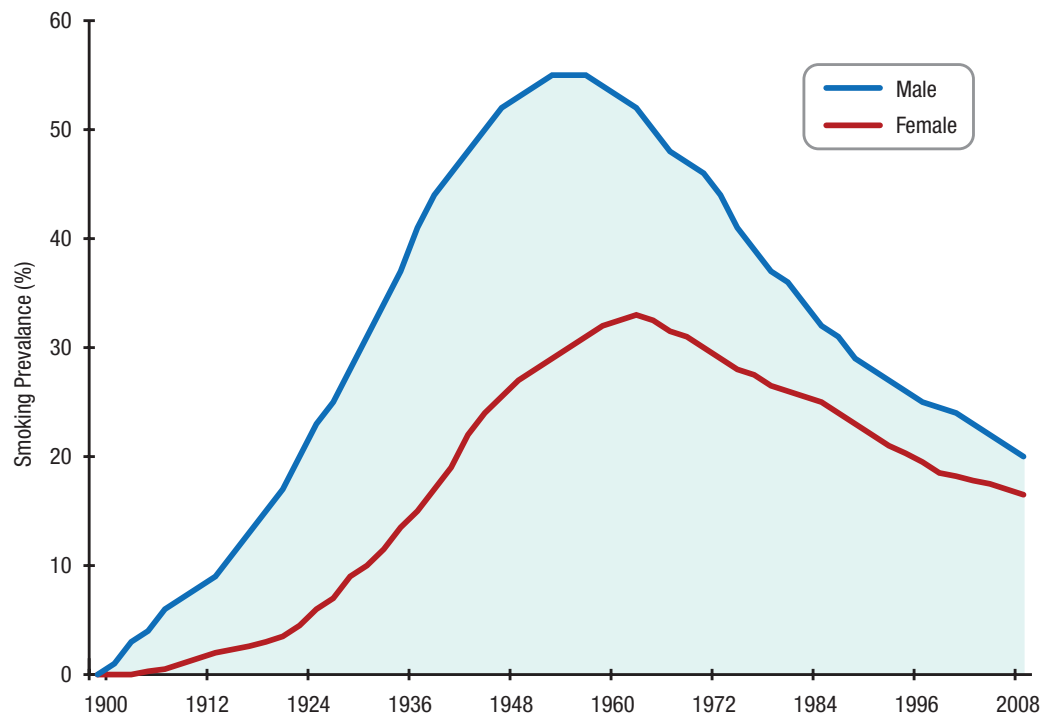


FIGURE 1.4 Cigarette smoking prevalence for males and females, United States, 1900 to 2010.

Following the release of the landmark 1964 Surgeon General's Report on the health risks of smoking, there was an abrupt drop in numbers of smokers, followed by a long-term downward trend in tobacco use.⁶¹

PUBLIC HEALTH ACHIEVEMENTS CONTINUING INTO THE 21ST CENTURY

Taken together, these public health achievements throughout the 1900s continue to produce favorable trends that have extended into the 21st century. The CDC presented an updated list of major public health achievements for the first decade of the 2000s.⁶² Seven are direct offshoots of the original list for the 20th century:

- cardiovascular disease prevention
- maternal and infant health
- motor vehicle safety
- occupational safety
- prevention and control of infectious diseases
- tobacco control
- vaccine-preventable diseases

Three new achievements were introduced into the roster:

- cancer prevention
- childhood lead poisoning prevention
- improved public health preparedness and response

The new additions include public health preparedness that became a priority following the September 11, 2001, terrorist attacks. The other two new achievements are in the areas of prevention of cancer and childhood lead poisoning.

The interconnection and coordination among academic, public health, governmental, and nongovernmental entities will be a recurring theme as we explore the science and practice of population health.

Now we explore the concept of population health thinking using a case study example that describes how early misperceptions about risk behaviors for the transmission of HIV/AIDS—and the populations affected—had detrimental effects on disease control and proved to be highly stigmatizing for men who have sex with men (MSM).



CASE STUDY 1.1: POPULATION HEALTH THINKING (HIV/AIDS)

POPULATION HEALTH

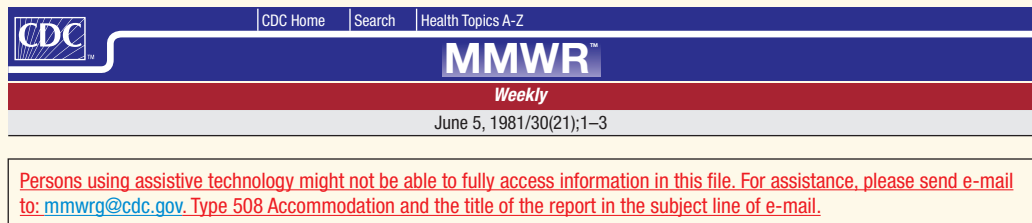
Population health, as a concept of health, signifies the health outcomes of a group of individuals, including the distribution of such outcomes within the group.⁶³ Population health science, in turn, is the study of the conditions that shape distributions of health within and across populations, and of the mechanisms through which these conditions manifest as the health of individuals.⁶⁴ Population health science provides the quantitative scaffolding for public health and the allied field of preventive medicine.

(continued)

POPULATION HEALTH THINKING

One of the most important skills in public health is being able to think in terms of populations. This skill, if applied effectively, can be life-changing and life-saving. This skill is critical to be able to differentiate the relationship between individual and population health.⁶⁵ Here is an illustration of why it is important to develop this facility using the example of what was once an emerging infectious disease outbreak that expanded to global pandemic proportions. The initial cases were reported as a case series report of a mysterious and perplexing illness with an unusual presentation.

In the early 1980s, information based on several early cases of a new disease led to major misconceptions about the true population dynamics of the outbreak. These misconceptions continue to this day as the disease has grown into a pandemic. We begin a case report of an individual who was among the first to be diagnosed.



Epidemiologic Notes and Reports

***Pneumocystis* Pneumonia — Los Angeles**

In the period October 1980–May 1981, 5 young men, all active homosexuals, were treated for biopsy-confirmed *Pneumocystis carinii* pneumonia at 3 different hospitals in Los Angeles, California. Two of the patients died. All 5 patients had laboratory-confirmed previous or current cytomegalovirus (CMV) infection and candidal mucosal infection. Case reports of these patients follow.

Patient 1: A previously healthy 33-year-old man developed *P. carinii* pneumonia and oral mucosal candidiasis in March 1981 after a 2-month history of fever associated with elevated liver enzymes, leukopenia, and CMV viremia. The serum complement-fixation CMV titer in October 1980 was 256; in May 1981 it was 32.* The patient's condition deteriorated despite courses of treatment with trimethoprim-sulfamethoxazole (TMP/SMX), pentamidine, and acyclovir. He died May 3, and postmortem examination showed residual *P. carinii* and CMV pneumonia, but no evidence of neoplasia.

Patient 2: A previously healthy 30-year-old man developed *P. carinii* pneumonia in April 1981 after a 5-month history of fever each day and of elevated liver-function tests, CMV viremia, and documented seroconversion to CMV, i.e., an acute-phase titer of 16 and a convalescent-phase titer of 28* in anticomplement immunofluorescence tests. Other features of his illness included leukopenia and mucosal candidiasis. His pneumonia responded to a course of intravenous TMP/SMX, but, as of the latest reports, he continues to have a fever each day.

Patient 3: A 30-year-old man was well until January 1981 when he developed esophageal and oral candidiasis that responded to Amphotericin B treatment. He was hospitalized in February 1981 for *P. carinii* pneumonia that responded to TMP/SMX. His esophageal candidiasis recurred after the pneumonia was diagnosed, and he was again given Amphotericin B. The CMV complement-fixation titer in March 1981 was 8. Material from an esophageal biopsy was positive for CMV.

Patient 4: A 29-year-old man developed *P. carinii* pneumonia in February 1981. He had had Hodgkins disease 3 years earlier, but had been successfully treated with radiation therapy alone. He did not improve after being given intravenous TMP/SMX and corticosteroids and died in March. Postmortem examination showed no evidence of Hodgkins disease, but *P. carinii* and CMV were found in lung tissue.

Patient 5: A previously healthy 36-year-old man with clinically diagnosed CMV infection in September 1980 was seen in April 1981 because of a 4-month history of fever, dyspnea, and cough. On admission he was found to have *P. carinii* pneumonia, oral candidiasis, and CMV retinitis. A complement-fixation CMV titer in April 1981 was 128. The patient has been treated with 2 short courses of TMP/SMX that have been limited because of a sulfa-induced neutropenia. He is being treated for candidiasis with topical nystatin.

(continued)

The following case report of a single patient was published in the *Morbidity and Mortality Weekly Report (MMWR)*.⁶⁶

Patient: A previously healthy 33-year-old man developed Pneumocystis carinii pneumonia and oral mucosal candidiasis in March after a 2-month history of fever associated with elevated liver enzymes, leukopenia, and CMV viremia. The serum complement-fixation CMV titer in October was 256; in May it was 32. The patient's condition deteriorated despite courses of treatment with trimethoprim-sulfamethoxazole (TMP/SMX), pentamidine, and acyclovir. He died May 3, and postmortem examination showed residual P. carinii and CMV pneumonia, but no evidence of neoplasia.

Actually, this description of a novel patient presentation was the first listed among a total of five similar reports that were compiled into a case series published on June 5, 1981, describing a medical curiosity.

Here is what was known:

- All five case patients were previously healthy young adult men, ages 29 to 36 years.
- All five cases were patients of one Los Angeles internist.
- All cases were white.
- All cases were male.
- All cases were gay (MSM).
- All reported having multiple sexual partners.
- All cases had multiple, simultaneous, diverse opportunistic diseases (parasitic, fungal, viral):
 - All cases had biopsy-confirmed *P. carinii* pneumonia—a parasitic disease.
 - All cases had oral mucosal candidiasis (“oral thrush”)—a fungal infection.
 - All cases had laboratory-confirmed cytomegalovirus infection of the brain—a viral disease.
- All died.

Despite the similarities:

- The five patients did not know each other.
- These patients did not have any known sexual contacts in common.

Based on a small number of individual cases, what were some hunches at the time that were circulated rampantly?

Certainly, the commonalities among the cases would lead to speculation that this was

- a white, gay male disease;
- a disease that ransacks the immune system;
- a disease that allows multiple types of infections to spread simultaneously and unchecked; and
- a disease that kills.

Indeed, the spectre of a white, gay male disease was all over the news. The illness was variously described as “the gay plague,” or gay cancer, or even as gay-related immunodeficiency syndrome (GRIDS).⁶⁷

(continued)

Within the first year, it became known that this yet-unnamed disease could also be transmitted through contaminated blood and blood products, setting off an alarm worldwide. This was likely to be a viral disease and there was potential for anyone to become infected. Within the early months, Miami, Florida, became an epicenter for multiple modes of transmission. It was in Miami that the first case was diagnosed in a person with hemophilia. Some of the first cases in Haitian nationals and injection drug users were also first identified in southern Florida. Internally, some investigators referred to this strange ailment with the shorthand mnemonic, “4H disease.” While clever, this was in fact an extremely stigmatizing and pejorative expression that signified four population subgroups thought to be at higher risk for the disease: homosexuals, hemophiliacs, Haitians, and heroin-users.⁶⁸

It took 13 months following the publication of the case series for this disease to be officially named:

Acquired immunodeficiency syndrome: AIDS. Four more years would elapse before the virus was isolated and given a consensus name, human immunodeficiency virus: HIV. Sometimes, both names are combined and the disease is referred to as HIV/AIDS.

The early consensus conceptualization that this was a white, gay male disease was highly stigmatizing and discriminatory. It was also wrong. Seen through the lens of population health thinking on a global scale, HIV/AIDS is a pandemic that affects men and women of all races and has multiple modes of sexual and drug-use-associated transmission.

On a global scale, by the numbers:

- HIV/AIDS is currently more prevalent in non-Whites than Whites.
- Heterosexual contact—not male-to-male sex—is the primary mode of HIV/AIDS virus transmission.
- There are slightly more women than men living with HIV/AIDS. Among HIV/AIDS cases worldwide, 52% are women.⁶⁹

Therefore, numerically, HIV/AIDS cases globally are

- not predominantly white,
- not primarily gay, and
- not primarily male.

The initial speculations, based on a few individual cases, suggesting that this strange disease—that would later be named HIV/AIDS—could be described as a white, gay male disease, were inaccurate on all counts.

Failing to apply a population health lens has real-world, life-and-death consequences.

In the case of HIV/AIDS, these were the consequences:

- discrimination and stigma against gay men and other persons living with HIV
- delays in funding and providing care
- disease cases that could have been prevented by timely action
- death due to discrimination, delays, and preventable disease transmission

Consider population health thinking to be an essential skill.

SUMMARY

Public health focuses on the health of populations. Public health has been relevant since the time when early humans transitioned to living as populations in communal settings. Public health issues that immediately came to prominence were providing the population with clean water and adequate nutrition while disposing of wastes. Existential challenges were posed by population encounters with common communicable diseases that caused high rates of infant and early childhood mortality, punctuated by periodic plagues that swept broad geographic regions and decimated communities.

The 20th century was remarkable based on public health achievements that collectively accounted for a more than 25-year surge in average life expectancy. Particularly notable was the successful conquest of infectious diseases, coupled with the development and widespread distribution of vaccines; these advances had the effect of markedly decreasing childhood disease and death, and dramatically increasing life expectancy.

Two mass-produced and effectively marketed human inventions, the tobacco cigarette and the automobile, introduced entirely new patterns of illness and injury. Fortunately, public health interventions have been instrumental in diminishing the population burdens of smoking-attributable diseases and motor vehicle accidents.

Lifestyles changed markedly (and continue to do so), propelling NCDs, notably cardiovascular diseases and cancers, to the forefront. The recognition of disease risk factors led to public health interventions that have successfully decreased the population impact of disability and early death from lifestyle-related diseases. Nevertheless, in the early 21st century, the escalating prominence of NCDs poses an ongoing challenge, and some disease trends such as obesity are visibly worsening. However, the unanticipated and globe-changing appearance of the COVID-19 pandemic thrust communicable diseases back into the forefront as leading causes of disease and death worldwide.

Public health, powered by population health science, continues to make strides toward achieving disease prevention and health promotion. Concurrently, humans continue to demonstrate their capacity to both generate health threats (climate change is the most obvious and compelling at this moment) and create innovative solutions. Health-enhancing endeavors are aided by the structure of the public health system, ranging from municipal health departments to state, federal, and global governmental institutions and nongovernmental programs and policies.

End-of-Chapter Resources



Access additional case study podcasts

DISCUSSION QUESTIONS

1. Considering the list of the top 10 public health achievements for the 20th century, and again for 2001 to 2010, make your predictions for the top 10 achievements that will be on the list for 2011 to 2022 and future decades.
2. With each new era, populations encounter—and sometimes create—major threats to population health. Discuss the likely population health implications of current trends in climate change.

3. As some learners contemplate a future career in public health itself, or in public health-informed professions, discuss your preferences for working in public health at the municipal, state, federal, and international levels.

A robust set of instructor resources designed to supplement this text is available. Qualifying instructors may request access by emailing textbook@springerpub.com.

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27. UNRWA. United Nations Relief and Works Agency for Palestine refugees. <https://www.unrwa.org>
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2

UNDERSTANDING THE GLOBAL BURDEN OF DISEASE AND DISABILITY

LEARNING OBJECTIVES

- **Define disease and disability.**
- **Introduce the Global Burden of Disease and disability-adjusted life years (DALYs).**
- **Distinguish and give examples of communicable and noncommunicable diseases.**
- **Identify the leading causes of death and disability in the United States and globally.**

OVERVIEW: WHAT IS DISEASE AND DISABILITY?

As introduced in Chapter 1, “The Origins of Public Health,” health is a state of physical and mental well-being that is much more than the absence of disease. In contrast, disease is a deviation from normal structure or function characterized by specific signs that may be directly observable or detectable using available screening measures. Illness usually describes a set of symptoms such as pain, distress, or fatigue that often accompanies disease. The causes of disease are many and varied and may include harmful exposures, infection, or degeneration. Health professionals and their healthcare systems are engaged in disease detection, control, and treatment. While the optimal outcome would be to effectively manage illness and cure disease, the reality is that disease compromises the health of many, leading to disability and untimely mortality.

This chapter aims to provide the student with an understanding of the Global Burden of Disease by exploring population patterns of disease and disability. We (a) contrast the concepts of health and disease; (b) introduce the Global Burden of Disease; (c) discuss disability and the universal measure of DALYs; (d) present current data on leading causes of death and disability in the United States and worldwide; (e) distinguish and compare death and disability for communicable diseases, noncommunicable diseases, and injuries; and (f) describe the relationship of mortality to life expectancy.

CONTRASTING HEALTH AND DISEASE

WHAT DOES IT MEAN TO BE HEALTHY?

Chapter 1 introduced the World Health Organization (WHO) definition of health as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.¹ Health encompasses multiple dimensions of physical and mental well-being. Individual and population health are influenced by many factors. Health-promoting behaviors include engaging in physical activity, eating nutritious foods, getting enough sleep, managing stress, successfully completing important tasks at work and at home, engaging in mutually supportive social relationships, practicing good hygiene, and getting preventive care. These behaviors are supported by having an environment that is conducive to health, including having access to neighborhood parks and opportunities for recreation, working in safe workplaces, and benefiting from policies and laws that protect and produce health.

WHAT IS DISEASE AND HOW DO WE CLASSIFY DISEASE?

Disease signals that something is amiss and the body is not fully healthy. This creates an opportunity for a disorder to be detected, diagnosed, named, and classified. International systems have been developed for systematic disease categorization. In 2018, the WHO released its landmark 11th Revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD-11).² The WHO aims for ICD-11 to map the human condition from birth to death: any injury or disease we encounter in life—and anything we might die of—is coded.³ Diseases are listed numerically with numbers pertaining to larger disease categories such as neoplasms (cancers), diseases of the circulatory system, diseases of the respiratory system, and mental/behavioral/neurodevelopmental disorders.

Each new edition of the ICD codes is years in the making because defining diseases and disorders is a complex process and classifications change over time. A disorder is a disturbance or disruption of normal functioning, even if there may not be a sufficient burden of symptoms to diagnose a specific disease. Disorders that are classified as diseases change with each new ICD edition as diagnostic capabilities improve, understanding of the disease process advances, and the social and economic implications of the disorder are elucidated.

COMMUNICABLE AND NONCOMMUNICABLE DISEASES AND INJURIES

When considering global disease patterns and burdens, diagnosed diseases and disorders are sorted into three large buckets: communicable diseases, noncommunicable diseases (NCDs), and injuries. Communicable diseases, also known as infectious or transmissible diseases, are diseases that are transmitted from an infected person, a person who harbors an infectious agent (such as a bacteria or virus), to a previously noninfected person. The movement of the infectious agent is necessary for causing new infection that may progress to a diagnosable disease.

In contrast, at the most literal level, an NCD, also known as a nontransmissible disease, is defined in the negative—by what it is not. An NCD is not a communicable disease. An NCD is not caused by a contagious or communicable infectious agent. The term “NCD” is now preferred to the less specific, but still popular, term “chronic disease.” As we see in later chapters, the term “noncommunicable” is not precisely accurate because these diseases are transmitted between people through social interactions as well. Since the mid-1900s, NCDs have greatly exceeded communicable diseases as the primary causes of death worldwide, even as COVID-19 suddenly emerged on the scene. Among NCDs, diseases of the heart and cancers are especially prominent causes of death and disability worldwide.

Injuries and violence comprise the third major category for classification of diseases. Globally, motor vehicle crashes, leading to injury and death, are the best known example, but this diverse and expansive category also includes drug overdoses (unintentional poisonings), suicide, homicide, and armed conflict.

THE GLOBAL BURDEN OF DISEASE

Understanding the global landscape of disease and disability takes a global scientific enterprise. To tackle the extraordinary complexity of quantifying worldwide patterns, the Institute for Health Metrics and Evaluation at the University of Washington launched the ongoing and continuous Global Burden of Diseases, Injuries, and Risk Factors Study (GBD). The GBD is generally considered to be the gold standard for measuring disease burden worldwide. The GBD engages thousands of researchers distributed across more than 145 countries to examine trends in health indicators.⁴

The GBD is premised on the idea that all world citizens deserve to live a long life in full health. Two different phenomena impede the achievement of this desirable goal. First, some people die early, prematurely, from certain diseases. Second, some people continue to live on, even to advanced years of life, but their quality of life and their life experience are constrained by disability. They are living, but not in “full health.”

Part of the impetus for creating the GBD was the realization that favorable trends in mortality patterns could be offset by unfavorable trends in disability. This was precisely the situation before there was COVID-19. Mortality rates were generally decreasing worldwide, and correspondingly, life expectancies were increasing. This favorable trend had continued for decades and was not anticipated to abate. Nevertheless, rates of disability and various forms of impairment were steadily rising. These well-documented increasing rates of disability were partially explained by the fact that as people lived longer, their chances for acquiring a disabling condition increased.

GBD researchers cleverly developed a measure for examining mortality and disability simultaneously. The primary metric used in the GBD, the DALY, compares hundreds of diseases and types of injuries in terms of risks for dying early and/or living with decreased capacity and quality of life due to disability. For each health condition, the GBD quantifies both years of life lost (YLLs) and years lived with disability (YLDs) and adds them together to estimate DALYs. Premature death is measured as YLLs. Living with diminished health and functionality is quantified as YLDs. Summing these together for each health condition, $\text{DALYs} = \text{YLLs} + \text{YLDs}$.

DALYs: disability-adjusted life years

One DALY equals one lost year of healthy life.

For each disease or medical condition, DALYs are made up of two components:

- 1. Dying early—premature death—is measured as YLLs.**
- 2. Living with decreased capacity and quality of life due to disability is measured as YLDs.**

These two pieces are added together to get DALYs:

$$\text{DALYs} = \text{YLLs} + \text{YLDs}$$

One DALY equals one lost year of healthy life. Of course, dying early is counted as a complete loss of potential life. However, living with disability can range from partial to near total in terms of impact on living healthfully. YLDs are expressed as fractions. For example, an individual with mild chronic lower respiratory disease may be initially estimated to be living at 50% capacity—0.5 DALY for the year. Later, as disease and disability progress, the final year of life might be estimated at 0.75 DALY or higher.