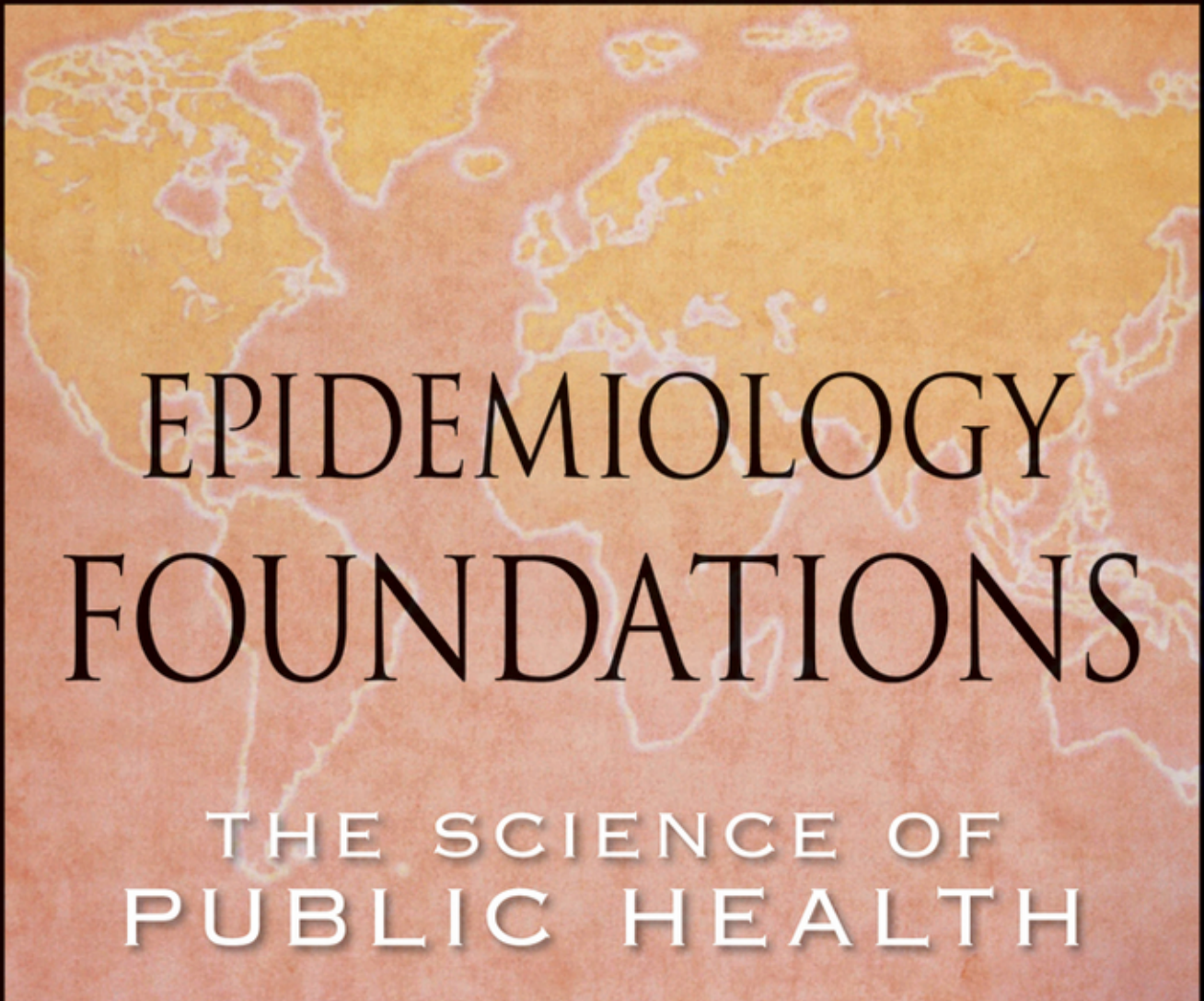




EPIDEMIOLOGY FOUNDATIONS

THE SCIENCE OF
PUBLIC HEALTH



PETER J. FOS

EPIDEMIOLOGY FOUNDATIONS

The Science of Public Health

PETER J. FOS

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*For Dylan and Madison Rose
May your futures be bright*

CONTENTS

Figures	ix
Tables	xi
Preface	xv
The Author	xix

Chapter 1: Why Epidemiology? 1

Introduction	2
Public Health and Community Medicine	2
Definition of Epidemiology	3
Population Health	9
Population Trends	10
Health Costs	15
Global Health Threats	17
Summary	17

Chapter 2: History of Epidemiology 21

Historical Perspectives	22
Uses of Epidemiology	29
Examples of Cohort Studies	30
Summary	31

Chapter 3: Health and Disease 35

- Definitions 36
- Distinction Between Health and Disease 37
- Disease Progression 39
- Cause and Effect 43
- Summary 49

Chapter 4: Describing Health and Disease 53

- Descriptive Epidemiology 54
- Hypotheses 55
- Descriptive Variables 56
- Examples of Use of Descriptive Information 75
- Summary 76

Chapter 5: Measuring Health and Disease 79

- Morbidity 80
- Mortality 90
- Other Measures 97
- Graphing Health and Disease Measurements 102
- Confounding 105
- Summary 108

Chapter 6: Epidemiology Study Designs: Observational and Experimental Studies 113

- Definition of Observational Studies 114
- Framework and Types of Observational Studies 114
- Descriptive Studies 115
- Analytical Studies 119
- Examples of Observational Studies 123
- Definition of Experimental Studies 124
- Framework and Types of Experimental Studies 125
- Clinical Trials 126

Bias and Validity	131
Examples of Experimental Studies	132
Summary	133

Chapter 7: Uses of Epidemiological Studies 137

Introduction	137
Observational Studies	139
Experimental Studies	152
Summary	153

Chapter 8: Epidemics 159

Definition	160
Transmission	161
Response to Epidemics	165
Surveillance	170
Reportable Diseases	171
Examples	171
Summary	174

Chapter 9: Epidemiology and Society 179

Introduction	180
Social Determinants	181
Socioeconomic Factors and Health	183
The Built Environment	185
Summary	188

Chapter 10: Screening for Disease 193

Prevention and Epidemiology	194
Screening	195
Accuracy of Screening Tests	196
Summary	207

Chapter 11: Community Public Health 211

Introduction	212
Community Health Workers	213
Community Level Planning and Evaluation	214
Examples	218
Public Health Programs	219
Public Health Agencies	224
Summary	225

Chapter 12: Epidemiology Today 229

Emergency Preparedness	230
Global Health	232
Emerging Diseases	236
Chronic Diseases	247
Summary	256

Notes 259

Index 275

FIGURES

- Figure 1.1: Cigarette smoking in the United States, 1965 to 2005 6
- Figure 1.2: Leading causes of death, United States, 1950 to 2004 7
- Figure 1.3: Projected population growth, 2010 to 2050, in the United States 11
- Figure 1.4: Projected population percentage by race, 2010 to 2050, in the United States 12
- Figure 1.5: Population growth in the United States, 2010 to 2050 12
- Figure 1.6: Projected life expectancy in years by sex, United States, 2010 to 2050 13
- Figure 1.7: Life expectancy from birth and at age 65 years by race and gender, United States, 1970 to 2005 14
- Figure 1.8: Death rates of infants and newborns, United States, 1950 to 2005 15
- Figure 1.9: Funding health care in the United States 16
- Figure 1.10: Health insurance coverage among people younger than 65 years 16
- Figure 3.1: Illness-disease matrix 37
- Figure 3.2: Causation matrix 47
- Figure 3.3: Web of causation 48
- Figure 3.4: Epidemiologic triangle 49
- Figure 3.5: Wheel of causation 49
- Figure 4.1: Point-source epidemic 72
- Figure 4.2: Propagated epidemic: estimated number of AIDS cases in adults and adolescents, United States, 1985 to 2006 72
- Figure 4.3: Seasonal disease graph 74
- Figure 4.4: Secular trend of hospitalizations associated with *Clostridium difficile* infection in Finland, 1996 to 2004 74

- Figure 5.1: Period prevalence of overweight among children and teenagers by age group and selected period, United States, 1971 to 2002 89
- Figure 5.2: Prevalence of diabetes in the United States, 2007, by age 103
- Figure 5.3: AIDS rates by race or ethnic group, United States, 2006 104
- Figure 5.4: Case-fatality rates for stroke per 100 people admitted to a hospital 104
- Figure 5.5: Infant mortality and neonatal and postneonatal deaths in the United States, 2005 105
- Figure 6.1: Framework of observational studies 115
- Figure 6.2: Cross-sectional study 117
- Figure 6.3: Prospective study 120
- Figure 6.4: Retrospective study 122
- Figure 6.5: Comparison of observational studies 125
- Figure 6.6: Experimental studies 126
- Figure 6.7: Framework for a randomized clinical trial 129
- Figure 7.1: Relationship between risk factor and disease 140
- Figure 7.2: Odds ratio calculation 145
- Figure 8.1: Common-source epidemic 164
- Figure 8.2: Propagated epidemic: Estimated number of AIDS cases in adults and adolescents, United States, 1985 to 2006 165
- Figure 8.3: Legionnaires' disease outbreak 168
- Figure 9.1: U.S. poverty rates, 1966 to 2005 182
- Figure 9.2: Prevalence rate of overweight and obesity, United States, 1960 to 2004 188
- Figure 11.1: Basic logic model of resources, program activities, public health services, and expected changes in health 215
- Figure 11.2: Logic model for program evaluation 216
- Figure 11.3: Healthy People 2010 twenty-eight focus areas 221
- Figure 11.4: Progress of objective 1–1 222
- Figure 11.5: Rural Healthy People 2010 focus areas 224
- Figure 12.1: Overweight and obesity prevalence trend, United States, 1960 to 2004 250

TABLES

- Table 4.1: Limitation of Activity (Percentage) Caused by Chronic Conditions, United States, 2005 and 2006 57
- Table 4.2: Death Rates from All Causes by Age, United States, 2002 to 2005 58
- Table 4.3: Death Rates Caused by Diabetes Mellitus by Age, United States, 2002 to 2005 58
- Table 4.4: Current Cigarette Smoking Among Adults, Estimated Percentage, by Sex, United States, 2006 59
- Table 4.5: Rate of Vision and Hearing Problems Among People Older Than 18 Years, United States, Selected Years from 1997 to 2006, by Sex 59
- Table 4.6: Percentage of Medicaid Coverage Among People Younger Than 65 Years, United States, Selected Years from 1984 to 2006, by Sex 60
- Table 4.7: Rate of Hospital Stays in the Past Year, United States, Selected Years from 1997 to 2006, by Sex 60
- Table 4.8: Age-Adjusted Death Rates by Race, United States, 2002 to 2005 61
- Table 4.9: Rate of Emergency Room Visits in the Past Year for Persons Younger Than 18 Years, United States, Selected Years from 1997 to 2006, by Race 62
- Table 4.10: Percentage of Teenaged Childbearing, United States, 2002 to 2006, by Race 63
- Table 4.11: Percentage of People Older Than 18 Years with Vision and Hearing Problems, United States, Selected Years from 1997 to 2006, by Race 63

- Table 4.12: Age-Adjusted Death Rates Among Persons Aged 25 to 64 Years by Educational Attainment, Selected States, 2001 to 2005 64
- Table 4.13: Percentage of People Older Than 18 Years with Vision and Hearing Problems, United States, Selected Years from 1997 to 2006, by Educational Attainment 65
- Table 4.14: Estimated TB Incidence Rate for Selected Countries, 2006 66
- Table 4.15: Average Annual Age-Adjusted Death Rates, Regions of the United States, 2003 to 2005 67
- Table 4.16: Average Annual Age-Adjusted Death Rates by Selected States, 2003 to 2005 67
- Table 4.17: County-Level Estimated Diagnosed Diabetes, by Selected Counties in Mississippi, 2005 68
- Table 4.18: Average Annual Age-Adjusted Death Rates, Urban and Rural Counties, United States, 1996–1998, 1999–2001, and 2003–2005 69
- Table 5.1: AIDS Rates in the United States in 2006 by Race or Ethnic Group 81
- Table 5.2: Cumulative Reported AIDS Cases Through 2006 in the United States 82
- Table 5.3: Cumulative Reported AIDS Deaths Through 2006 in the United States 82
- Table 5.4: Crude Invasive Cancer Incidence Rates by Primary Site and Race and Ethnicity, United States, 2004 84
- Table 5.5: Incidence of Acute Hepatitis A by Selected States in the United States, 2002 to 2006 84
- Table 5.6: Incidence Rates of Actual Viral Hepatitis by Type and Year, United States, 1997 to 2006 85
- Table 5.7: Prevalence of Diabetes in the United States, 2007, by Age 87
- Table 5.8: Prevalence of Obesity in Selected States, 2007 88
- Table 5.9: Number of Deaths and Crude Death Rates for the 15 Leading Causes of Death, 2005 91
- Table 5.10: Cause-Specific Death Rates by Age for the 15 Leading Causes of Death, United States, 2005, for Selected Age Categories 92
- Table 5.11: Infant, Neonatal, and Postneonatal Mortality Rates in the United States, 2000 to 2005 94
- Table 5.12: Infant, Neonatal, and Postneonatal Mortality Rates by Race of the Mother in the United States, 2000 to 2005 95
- Table 5.13: Fetal Death Rates in the United States, 2000 to 2004 96

Table 5.14:	PMR for Deaths in Infants Due to the Five Leading Causes of Death in the United States, 2004	97
Table 5.15:	Five-Year Cancer Survival Rates for Selected Cancers by Race, 1987–1989 Through 1996–2003	98
Table 5.16:	Estimated Vaccination Coverage (Percentage) Among Children Ages 19 to 35 Months, by Vaccine and Dosage, 2000 to 2004	99
Table 5.17:	Estimated Fertility Rates in Selected Countries, 2008	100
Table 5.18:	Self-Assessed Health Status, Poor or Fair, by Age, Sex, and Race in the United States, 2002 to 2006	101
Table 5.19:	Potential Years of Life Lost (PYLL) Before Age 75, United States, 2005	102
Table 5.20:	Age-Adjusted Invasive Cancer Incidence Rates by Primary Site and Race and Ethnicity in the United States, 2004	107
Table 5.21:	Crude and Age-Adjusted Death Rates for Alcohol-Induced Causes, by Race, United States, 1999 to 2005	108
Table 7.1:	Relative Risk 2×2 Contingency Table	141
Table 7.2:	Relative Risk Calculation	142
Table 7.3:	Relative Risk Calculation Example 1	143
Table 7.4:	Relative Risk Calculation Example 2	144
Table 7.5:	Odds Ratio 2×2 Contingency Table	146
Table 7.6:	Calculation of Odds Ratio	147
Table 7.7:	Odds Ratio Example 1	147
Table 7.8:	Odds Ratio Example 2	148
Table 7.9:	Odds Ratio Example 3	149
Table 7.10:	Attributable Risk Table	150
Table 7.11:	Attributable Risk Calculation	150
Table 7.12:	Attributable Risk Calculation Example 1	151
Table 7.13:	Lung Cancer and Alcohol Use	154
Table 7.14:	Smoking Status Stratification for Lung Cancer	155
Table 8.1:	Nationally Notifiable Diseases, 2009	172
Table 8.2:	Diseases Under Surveillance by the World Health Organization, 2009	173
Table 8.3:	West Nile Virus Cases, Selected States, 2008	175
Table 10.1:	2×2 Contingency Table	197
Table 10.2:	Sensitivity: True-Positive Ratio	198
Table 10.3:	Specificity: True-Negative Ratio	199
Table 10.4:	False-Positive (FP) Ratio	199
Table 10.5:	False-Negative (FN) Ratio	200
Table 10.6:	Validity Calculation Example	200

Table 10.7:	Validity Calculation Example: Sensitivity	201
Table 10.8:	Validity Calculation Example: Specificity	201
Table 10.9:	Validity Calculation Example: FN Ratio	202
Table 10.10:	Validity Calculation Example: FP Ratio	202
Table 10.11:	Predictive Value of a Positive Test Result (PV+)	203
Table 10.12:	Predictive Value of a Negative Test Result (PV-)	203
Table 10.13:	Validity Calculation Example: PV+	204
Table 10.14:	Validity Calculation Example: PV-	204
Table 10.15:	Reliability Index	206
Table 10.16:	Reliability Index Example	207
Table 10.17:	ECG Results	208
Table 11.1:	Diabetes Focus Area	223
Table 12.1:	Global Summary of AIDS Epidemic, December 2007	233
Table 12.2:	Estimated Number of People Receiving Antiretroviral Therapy, by Region, December 2003 to December 2007	233
Table 12.3:	Cumulative Number of Confirmed Human Cases of Avian Influenza A (H5N1), 2003 to 2008	235
Table 12.4:	Cumulative Number of Confirmed Human Deaths from Avian Influenza A (H5N1), 2003 to 2008	235
Table 12.5:	West Nile Virus Activity, United States, 2008	237
Table 12.6:	Emerging Infectious Diseases	238
Table 12.7:	Obesity Prevalence Rates, United States, 2007	249
Table 12.8:	Lifetime Asthma Population Estimates by Age, United States, 2006	253
Table 12.9:	Current Asthma Estimates by Age, United States, 2006	254
Table 12.10:	Current Asthma Prevalence Rates by Age, Sex, and Race, United States, 2006	254
Table 12.11:	Age-Specific Prevalence Rate of Diagnosed Diabetes per 100 Population by Sex and Race or Ethnicity, 2005	255
Table 12.12:	Number of Persons with Diagnosed Diabetes, in Millions, United States, 1990 to 2005	255
Table 12.13:	Crude and Age-Adjusted Prevalence Rates of Diagnosed Diabetes per 100 Population, United States, 1990 to 2005	256

PREFACE

Epidemiology? Many people have heard the term, but few really understand what it is, what it does, and how it influences our daily lives. This book is intended to inform students and practitioners about the vital role of epidemiology in enhancing the health of individuals and communities, to understand how to read and interpret epidemiological studies to become more enlightened citizens, and to understand the global effects of epidemiological studies.

The motivation for this book has developed over the years from the influence of several factors. I have taught epidemiology to graduate students for more than twenty years and have written other textbooks aimed at illustrating the relevance and benefit of epidemiology for specialized uses in health care administration and population health management. Through my years of teaching and writing, I have seen the positive response from students and practitioners to the myriad applications of epidemiology to their respective fields and everyday life. With this in mind, it makes sense to expose young scholars to epidemiology earlier in their intellectual journey. The more people who understand and appreciate the uses of epidemiology, the better chance its application will improve the public's health and well-being.

Another motivation for writing this book is the attention that epidemiology and public health education is receiving from national organizations. National public agencies have been warning that there is a crisis in the shortage of trained and qualified public health workers, especially epidemiologists.¹ There is a movement, which is gaining momentum, to expand the public health education downward from graduate programs to undergraduates, especially into community colleges.² This call to action must be met with innovative curricula and instructional resource materials.

Organization

Chapters One and Two lay the foundation to the course by discussing both the historical perspective and future trends of epidemiology. Chapter One, “Why Epidemiology?” introduces the reasons why epidemiology is an important foundation to public health. The chapter presents the role that epidemiology plays in public health. Current and future characteristics of the United States population and of global health threats are presented with an epidemiological perspective. Chapter Two, “History of Epidemiology,” continues to provide background information by presenting a historical perspective of the development of epidemiology as the basic science of public health. Past contributors and their influence on the science of epidemiology are discussed.

Chapters Three, Four, and Five discuss health and disease and how they are measured. Chapter Three, “Health and Disease,” begins the core discussion of epidemiological principles, along with the foundations of health and disease. The notion of disease causation is discussed and stressed throughout the text. Chapter Four, “Describing Health and Disease,” discusses descriptive epidemiology and its uses as an information source and as a precursor to further study and investigation. Emphasis is placed on descriptive variables that are used to explain differences in health and disease in populations. Chapter Five, “Measuring Health and Disease,” introduces morbidity and mortality measures. How these measures assist in interpreting disease information is discussed.

Chapters Six and Seven discuss epidemiological studies and how they are used. Chapter Six, “Epidemiological Study Designs: Observational and Experimental Studies,” presents study designs used to test hypotheses that result from descriptive information. Observation and experimental designs are introduced. Chapter Seven, “Uses of Epidemiological Studies,” covers the evaluation of cause-and-effect relationships between causal factors and diseases. Hypothesis testing and quantification of risk with epidemiological study designs are discussed.

Chapters Eight through Twelve discuss epidemiology from a social and community perspective and global diseases and epidemics. Chapter Eight, “Epidemics,” begins the section of the text that focuses on the use of epidemiological principles in everyday life. This chapter discusses epidemics and how they begin and spread. Modes of transmission of infectious agents are described as well as how public health agencies respond to epidemics. Disease surveillance methods, including reportable disease reporting, are presented. Chapter Nine, “Epidemiology and Society,” introduces one of the newer epidemiological disciplines. The influence of society and the neighborhoods in which people live

on their health is the crux of social epidemiology. Chapter Ten, “Screening for Disease,” brings epidemiology to a personal level. Accuracy and precision of screening tests and the evaluation of their results are discussed. Chapter Eleven, “Community Public Health,” covers the link connecting epidemiology to improvements in daily life. Public health program planning, implementation, and evaluation are presented. The role of epidemiology in community public health is described through examples of public health programs. Chapter Twelve, “Epidemiology Today,” discusses current health and disease concerns, and the pending future impact of current health problems is portrayed from the epidemiological perspective.

Features

Each chapter is supplemented with exercises to aid in understanding the epidemiological principles. These chapter exercises consist of research assignments and problem solving. Most of these exercises are open-ended to challenge the reader to be creative and innovative. In addition, each chapter has a set of multiple-choice, true-or-false, and short-answer review questions. These chapter review questions are intended to provide immediate feedback.

Audience

I anticipate that the primary users of this textbook will be students in high school, community and junior colleges, and four-year colleges and universities. This book can serve as a first resource for students new to epidemiology. One objective is to engage young people in hopes that they will embrace epidemiology as a discipline in which they will continue their study and future work. My hope is that after reading and using this book, students will understand and appreciate the relevance and impact that epidemiology, as the basic science of public health, has on improving health and wellness.

Acknowledgments

This book is a product of more than thirty years of work and study of health and disease. My personal journey has been uncharted at times but thankfully has carried me in a positive and growing direction. I have had many mentors and supporters along the way. Their support has made this journey up to this

point one characterized by more ups than downs. Included among my supporters are my students; they have been my true motivation and inspiration. I thank each and every one of you. Finally, I must thank and acknowledge my family. They have allowed me to pursue my career and intellectual pursuits with no complaints, despite the hardships they may have confronted. They have always been my greatest supporters. I must thank my colleagues who have helped me often during my journey, as well as with this book. David J. Fine first convinced me to write books for students. He has been there for me often and is a source of inspiration and encouragement. Peggy Honoré was my student many years ago and now is my friend and colleague. Her encouragement has been invaluable. Miguel Zuniga, also a former student, is now my friend and collaborator in many of my accomplishments. He is a source of technical knowledge and has kept me on task throughout the writing of this book.

Sandra Kiselica edited this book, and her help and recommendations have been invaluable. Her expertise can be seen throughout in the sections that read easiest.

Peter J. Fos

THE AUTHOR

Peter J. Fos is provost and professor of health sciences at the University of Texas at Tyler. He is an internationally known decision scientist and epidemiologist. He earned his doctorate in health care decision analysis from Tulane University Graduate School and his master of public health degree from Tulane University Health Sciences Center, following a career in clinical dentistry. He has spent more than twenty-five years at academic institutions, where he is active in curriculum development in application of epidemiology to management, the practice of managerial epidemiology, clinical effectiveness, public-health practice, health-outcomes research, and terrorism-preparedness planning. He served, briefly, as chief science officer of the Mississippi State Department of Health. He maintains adjunct faculty positions at the University of Southern Mississippi College of Health and the University of Alabama in Birmingham School of Health-Related Professions, and is a visiting scholar at the Medical University of South Carolina, College of Health Professions.

WHY EPIDEMIOLOGY?



Introduction	2
Public Health and Community Medicine	2
Definition of Epidemiology	3
Population Health	9
Population Trends	10
Health Costs	15
Global Health Threats	17
Summary	17

LEARNING OBJECTIVES

On completing this chapter, you will be able to

Define epidemiology

Discuss the concept of populations and population health

Describe population trends and characteristics

Describe global health threats

Discuss the relationship and distinction between public health and medicine

Introduction

Epidemiology is, for most, a word that seems to be from another language. It is certainly not a word we use in everyday conversation. But epidemiology is a science that affects all of us every day of our lives. We shop for food each day with little regard to or worry about whether what we purchase and eat is unsafe. For many of us, smallpox, polio, plague, diphtheria, yellow fever, and cholera are diseases that either we have never heard of or we do not give much thought or attention to. Human immunodeficiency virus (HIV) infection and acquired immunodeficiency syndrome (AIDS) are diseases that are well known, but they are becoming less of a daily concern. New, so-called emerging diseases such as bird flu are now garnering a great deal of our attention.

Public Health and Community Medicine

Before continuing the discussion on “why epidemiology,” the concept of public health must be explained further. *Public health* is the science and practice of protecting and improving the health of a community. This can be done with preventive medicine, health education, the control of communicable diseases, the use of sanitary measures, and the monitoring of environmental conditions. Public health is concerned with the health of the community as a whole. In other words, public health and community health are synonymous.

Public health is focused on three areas: assessment and monitoring of health and disease, development of public health policies that assist in addressing health problems, and allowing for access to public health care services. These

public health care services include disease prevention, health education, and health promotion. Often public health services are considered to be the same as medical care services because of the assumed similarities. The distinction is that public health services are focused on populations, not individuals. It is true that populations are made up of individuals, so public health acknowledges the importance of the welfare of individuals, but the focus of services is on larger populations. Public health services are centered on diagnosing and monitoring health issues and providing health education and health promotion services to communities.

An example of this communitywide perspective of public health is considered an accomplishment. Public health is concerned with immunization for preventable disease, such as smallpox, poliomyelitis, measles, rubella, tetanus, diphtheria, and *Haemophilus influenzae* type b. Since immunization programs (also referred to as vaccination programs) were established, smallpox has been eradicated, poliomyelitis has been eliminated in the United States, and the other diseases are now under control. Other infectious diseases (cholera, tuberculosis, and sexually transmitted diseases) also are under control, in part due to the efforts of public health agencies and programs.

Is public health the same as medicine? Despite the fact that medical and public health services both seek to improve health, they are not the same. Two easy-to-remember differences are (1) public health services are directed at populations, and medical services are focused on the individual; and (2) public health services are mostly concerned with the prevention of disease whereas medical services are concerned with the diagnosis and treatment of disease. Public health and medicine are different, but they have the same objective of improving health and eliminating disease.

Definition of Epidemiology

Epidemiology is a word with Greek origins: from the Greek prefix *epi*, meaning “on, upon, or befall”; the Greek root *dem*, meaning “the people”; and the Greek suffix *logos*, meaning “the study of.” In other words, epidemiology studies that which befalls on people, which is disease. The word epidemiology was first used in the 1700s to describe the science and methods used to study epidemics. In the twentieth century, with the decline of infectious diseases, epidemiology expanded to study more than epidemics. This decline in infectious diseases can be attributed to improvements in nutrition, sanitation, and general living conditions that in part resulted from public health interventions. Of course, these

public health interventions were established using information provided by epidemiology.

Given this new need for *epidemiology*, it has been defined as the study of the distribution and determinants of health-related states or events in specified populations and the application of this study to control health problems.¹ This means that epidemiology is used to identify the diseases in a population and to understand why these diseases exist. Another often-used definition is that epidemiology is the study of the distribution and determinants of health-related states and events in *defined* populations and the application of this study to the control of health problems.²

The Greek root of epidemiology and the two definitions have a common theme, namely, the people. The people are considered as a group, which is referred to as a *population*. This population-centered nature of epidemiology leads to one of the differences between public health services and medical services. Populations are groups of people who share some common characteristics. These characteristics are personal (age, sex, race, health behaviors), geographical (live in the same neighborhood, city, region, country, continent), and time. Populations may be large groups of people (population of the United States) or small groups (people in a neighborhood or in a factory).

Epidemiology is the study of factors affecting the health and illness of populations. It serves as the foundation of interventions made in the interest of public health and preventive medicine. It is considered a cornerstone method of public health research and is highly regarded in medicine for identifying risk factors for disease and determining the best treatment approaches to clinical practice. Epidemiology is considered by many to be a critical branch of public health. In fact, it is often referred to as the basic science of public health.

Epidemiology provides a framework of methods and principles from which information can be reviewed and analyzed in a way that public health problems can be identified and addressed. The epidemiological methods allow for disease definition as well as classification, identification, and planning for disease control measures. Epidemiology also provides the way to understand the relationship between the presence of factors that cause disease, called *causal factors*, and the development of disease (for example, smoking and heart disease).

Epidemiologists are the people who work every day using epidemiological principles and methods to make our lives better. Epidemiologists identify, measure, count, and control diseases, injuries, and causes of death. They also look for connections between disease and genetic, environmental, and behavioral factors. Once these connections are established, epidemiologists plan and develop interventions to prevent disease and promote health. This process of identifying

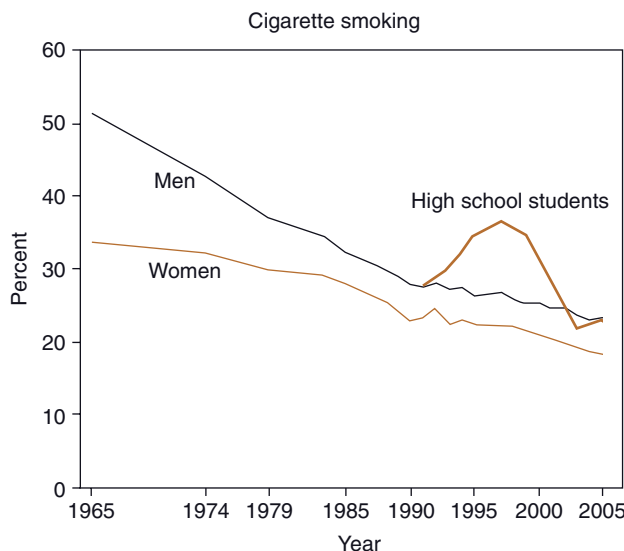
connections and developing interventions is how epidemiology touches our lives in a positive way every day.



Let's discuss some specific examples of how epidemiology has affected public health. In general terms, most of the significant improvements in the health of the people in the United States can be traced to accomplishments of public health.

An example of how public health policy improved the health and well-being of large groups of people happened in the United States in 1955. At that time, results of field tests of the polio vaccine were announced indicating that an inactivated poliovirus could produce immunity. Within days of this announcement, a national vaccination program was implemented. Today, polio has been eradicated from the United States.

Another accomplishment of public health initiatives with long-term beneficial effects is the identification of the relationship between cigarette smoking and

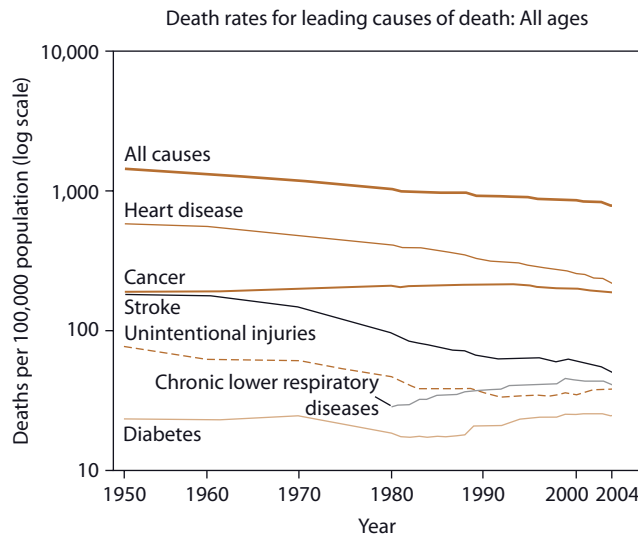
FIGURE 1.1: Cigarette smoking in the United States, 1965 to 2005

Source: CDC/NCHS, *Health, United States, 2009*, Figure 6. Data from the National Health Interview Survey and the Youth Risk Behavior Survey.

lung cancer and heart disease. Public health and epidemiological reports were instrumental in alerting people to the hazards of cigarette smoking, which led to the warning on cigarette packages from the U.S. Surgeon General. Public health, using epidemiological information as support, has worked hard in the past few decades to decrease the number of smokers in the United States. Figure 1.1 shows the results of this effort.

Figure 1.1 shows that the percentage of people who smoke has drastically decreased since 1965. This reduction has been most significant in men. In 1965 more than 50 percent of men in the United States were smokers. By 2005 the percentage dropped to less than 30 percent. Perhaps the best news is the decrease in the percentage of pregnant smokers. Smoking during pregnancy has been associated with infants with low birth weight and other associated health problems. Smoking among high school students is still a concern, but tobacco cessation efforts have targeted this group for the past few years.

It is interesting to note the decline in heart disease, which in part is due to smoking cessation programs. Figure 1.2 shows the leading causes of death from 1965 to 2006. Overall cancer rates have not changed since 1965, but lung cancer

FIGURE 1.2: Leading causes of death, United States, 1950 to 2004

Source: CDC/NCHS, *Health, United States, 2009*, Figure 18. Data from the National Vital Statistics System.

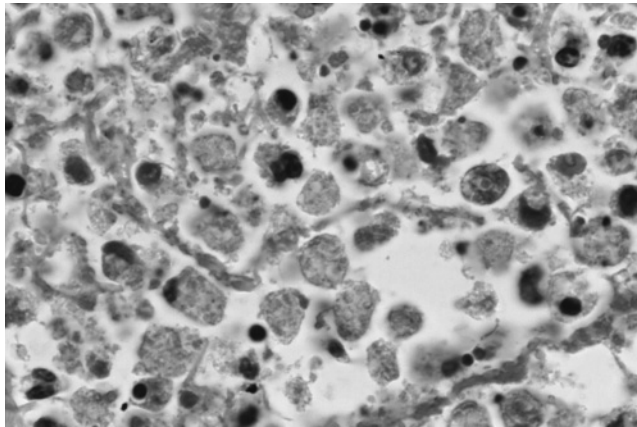
deaths have declined. Deaths due to stroke have decreased dramatically, which can be attributed to tobacco cessation programs. Also, because of public health awareness and legislation, unintentional motor vehicle injuries have decreased due to mandatory seat belt usage and protective restraints.

Other accomplishments of public health include global eradication of smallpox and establishing the relationship between Reye's syndrome and aspirin. The eradication of smallpox may be one of the greatest accomplishments of medicine and public health. Smallpox is a serious, contagious, and often fatal infectious disease. In the past, it killed almost 30 percent of infected people, and it left scars on the skin of those who survived. No vaccine or treatment existed until the end of the eighteenth century, when Edward Jenner introduced the smallpox vaccination. The last case of smallpox in the United States was in 1949, and the last naturally occurring case in the world was in Somalia in 1977.³

Reye's syndrome is a disease that affects all organs of the body but is particularly damaging to the liver and brain. The exact cause of Reye's syndrome is unknown, but it has been shown to be associated with aspirin usage. Cases are most often seen in January–March each year. An epidemic of flu or

chickenpox is commonly followed by an increase in the number of cases of Reye's syndrome.⁴

Epidemiology had a major role in the investigation of smallpox and Reye's syndrome. In fact, epidemiology is responsible for discovering the cause, and for developing control measures for other diseases such as Legionnaire's disease. Legionnaire's disease acquired its name in July 1976 when an outbreak of pneumonia occurred among people attending a convention of the American Legion in Philadelphia. On January 18, 1977, the causative agent was identified as a previously unknown bacterium, subsequently named *Legionella pneumophila*. An estimated 8,000 to 18,000 people get legionellosis in the United States each year. Some people can be infected with the *Legionella* bacterium and have only mild symptoms or no illness at all. When outbreaks do occur, they are usually in the summer and early autumn, though cases may occur at any time of the year.⁵



Another well-known accomplishment of epidemiology and public health is the work with AIDS. AIDS is the final stage of HIV infection. HIV attacks the body's immune system. Our bodies' immune system fights infections. HIV finds and destroys a white blood cell (called a T-cell) that is important for the immune system to fight infections. For someone who has HIV infection, it can take years before they have AIDS. AIDS is a disease in which a person has enough of a weakened immune system that the body has trouble fighting off infection. It was through the use of epidemiological methods that the HIV infection and AIDS were identified, along with the factors that were associated with a person's sus-