ESSENTIALS OF
Epidemiology
IN PUBLIC HEALTH

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# Contents

Preface ........................................... vii  
Acknowledgments .............................. xi  

**Chapter 1  The Approach and Evolution of Epidemiology  .......... 1**  
Introduction ................................... 1  
Definition and Goals of Public Health ........ 2  
Sources of Scientific Knowledge in Public Health 3  
Definition and Objectives of Epidemiology .... 5  
Historical Development of Epidemiology ...... 8  
Modern Epidemiology .......................... 27  
Summary ........................................ 29  
References ...................................... 30  
Chapter Questions .............................. 31  

**Chapter 2  Measures of Disease Frequency  .................. 33**  
Introduction ................................... 33  
Definition of a Population .................... 34  
Definitions of Health and Disease .......... 36  
Changes in Disease Definitions ............. 37  
Measuring Disease Occurrence .............. 39  
Types of Calculations: Ratios, Proportions, and Rates .... 40  
Measures of Disease Frequency ............. 41  
Commonly Used Measures of Disease Frequency in Public Health .......... 51  
Summary ........................................ 52  
References ...................................... 53  
Chapter Questions .............................. 54  

**Chapter 3  Comparing Disease Frequencies  ............ 57**  
Introduction ................................... 57  
Data Organization .............................. 58  
Measures of Comparison ..................... 61  
Direct Standardization ...................... 69  
Summary ........................................ 72  
References ...................................... 73  
Chapter Questions .............................. 73  

**Chapter 4  Sources of Public Health Data ............. 77**  
Introduction ................................... 77  
Census of the U.S. Population ............... 78  
Vital Statistics ................................. 79  
National Survey of Family Growth .......... 84  
National Health Interview Survey .......... 84  
National Health and Nutrition Examination Survey ......................... 85  
Behavioral Risk Factor Surveillance System .... 85  
National Health Care Surveys ............... 86  
National Notifiable Diseases Surveillance System ......................... 87  
Surveillance of HIV Infection ............... 87  
Reproductive Health Statistics ............. 88  
National Immunization Survey .............. 89  
Survey of Occupational Injuries and Illnesses ......................... 89  
National Survey on Drug Use and Health ......................... 90
# Contents

Air Quality System .................................. 90  
Surveillance, Epidemiology and  
End Results Program ................................. 91  
Birth Defects Surveillance  
and Research Programs ............................... 91  
**Health, United States** ............................. 92  
**Demographic Yearbook** ........................... 92  
**World Health Statistics** .......................... 92  
Cancer Incidence on Five Continents ............... 93  
Other Resources ................................... 93  
Summary ............................................ 94  
References .......................................... 96  
Chapter Questions ................................... 97  

## Chapter 5  Descriptive Epidemiology .... 99

Introduction ....................................... 99  
Person ............................................. 100  
Place .............................................. 102  
Time ............................................... 104  
Disease Clusters and Epidemics ................. 105  
Ebola Outbreak and Its Investigation ........... 110  
Uses of Descriptive Epidemiology .............. 116  
Generating Hypotheses About  
Causal Relationships ............................... 116  
Public Health Planning and  
Evaluation ......................................... 117  
Example: Patterns of Mortality  
in the United States According to Age .......... 118  
Overall Pattern of Mortality ..................... 121  
Examples: Three Important Causes  
of Morbidity in the United States ............... 129  
Summary ........................................... 144  
References ........................................ 145  
Chapter Questions ................................ 150  

## Chapter 6  Overview of Epidemiological  
Study Designs ............................ 153

Introduction ....................................... 153  
Overview of Experimental Studies ............... 156  
Overview of Cohort Studies ....................... 159  
Overview of Case–Control Studies .......... 163  
When Is It Desirable to Use a  
Particular Study Design? ......................... 168  
Other Types of Studies ............................ 170  
Summary ........................................... 177  
References ........................................ 178  
Chapter Questions ................................ 179  

## Chapter 7  Experimental Studies ...... 181

Introduction ....................................... 181  
Overview of Experimental Studies ............ 182  
Types of Experimental Studies ................. 185  
Study Population ................................. 190  
Sample Size ...................................... 191  
Consent Process .................................. 192  
Treatment Assignment ............................ 192  
Use of the Placebo and Masking ............... 196  
Maintenance and Assessment  
of Compliance ...................................... 197  
Ascertaining the Outcomes ...................... 200  
Data Analysis .................................... 202  
Generalizability .................................. 205  
Special Issues in Experimental Studies ....... 205  
Summary ........................................... 207  
References ........................................ 207  
Chapter Questions ................................ 209  

## Chapter 8  Cohort Studies .......... 211

Introduction ....................................... 211  
Cohort Study Definitions and Overview ....... 212  
Types of Populations Studied .................... 213  
Characterization of Exposure .................... 215  
Follow-Up and Outcome  
Assessment ....................................... 215  
Timing of Cohort Studies ......................... 216  
Issues in the Selection of Cohort  
Study Populations ................................ 218  
Sources of Information ........................... 224  
Analysis of Cohort Studies ...................... 229  
Special Types of Cohort Studies ............... 231
# Chapter 14: Critical Review of Epidemiological Studies

## Introduction

Guide to Answering the Critique Questions

Sample Critiques of Epidemiological Studies

Summary

References

# Chapter 15: The Epidemiological Approach to Causation

## Introduction

Definitions of a Cause

Characteristics of a Cause

Risk Factors Versus Causes

Historical Development of Disease Causation Theories

Hill’s Guidelines for Assessing Causation

Use of Hill’s Guidelines by Epidemiologists

Sufficient-Component Cause Model

Why Mainstream Scientists Believe That HIV Is the Cause of HIV/AIDS

Summary

References

Chapter Questions

# Chapter 16: Screening in Public Health Practice

## Introduction

Natural History of Disease

Definition of Primary, Secondary, and Tertiary Prevention

Appropriate Diseases for Screening

Characteristics of a Screening Test

Lead Time

Predictive Value: A Measure of Screening Program Feasibility

Evaluating a Screening Program

Bias

Selecting an Outcome

Study Designs to Evaluate Screening Programs

Examples of the Effect of Screening on Public Health

Summary

References

Chapter Questions

# Chapter 17: Ethics in Research Involving Human Participants

## Introduction

Historical Perspective

International Ethical and Research Practice Guidelines

The U.S. Regulatory Framework for Human Subjects Research

Limitations Posed by Ethical Requirements

Contemporary Examples

The Informed Consent Process

Summary

References

Chapter Questions

# Chapter 18: Answers to Chapter Questions (Chapters 1–17)

Glossary

Index
What is epidemiology, and how does it contribute to the health of our society? Most people don’t know the answer to this question. This is somewhat paradoxical because epidemiology, one of the basic sciences of public health, affects nearly everyone. It affects both the personal decisions we make about our lives and the ways in which governments, public health agencies, and medical organizations make policy decisions that affect how we live.

In recent years, the field of epidemiology has expanded tremendously in size, scope, and influence. The number of epidemiologists has grown rapidly along with the number of epidemiology training programs in schools of public health and medicine. Many subspecialties have arisen to study public health questions, from the molecular to the societal level.

Recent years have also witnessed an important evolution in the theory and methods of epidemiological research and analysis, causal inference, and the role of statistics (especially P values) in research.

Unfortunately, few of these changes have been taught in introductory epidemiology courses, particularly those for master’s-level students. We believe this has occurred mainly because instructors have mistakenly assumed the new concepts were too difficult or arcane for beginning students. As a consequence, many generations of public health students have received a dated education.

Our desire to change this practice was the main impetus for writing this book. For nearly three decades we have successfully taught both traditional and new concepts to our graduate students at Boston University and Harvard University. Not only have our students successfully mastered the material, but they have also found that the new ideas enhanced their understanding of epidemiology and its application.

In addition to providing an up-to-date education, we have taught our students the necessary skills to become knowledgeable consumers of epidemiological literature. Gaining competence in the critical evaluation of this literature is particularly important for public health practitioners because they often need to reconcile confusing and contradictory results.

This textbook reflects our educational philosophy of combining theory and practice in our teaching. It is intended for public health students who will be consumers of epidemiological literature and those who will be practicing epidemiologists. The first five chapters cover basic epidemiological concepts and data sources. Chapter 1 describes the approach and evolution of epidemiology, including the definition, goals, and historical development of epidemiology and public health. Chapters 2 and 3 describe how epidemiologists measure and compare disease occurrence in populations. Chapter 4 characterizes the major sources of health data on the U.S. population and describes how to interpret these data appropriately. Chapter 5 describes how epidemiologists analyze disease patterns to understand the health status of a population, formulate and test hypotheses of disease causation, and carry out and evaluate health programs.

The next four chapters of the textbook focus on epidemiological study design.
Chapter 6 provides an overview of study designs—including experimental, cohort, case–control, cross-sectional, and ecological studies—and describes the factors that determine when a particular design is indicated. Each of the three following chapters provides a detailed description of the three main analytic designs: experimental, cohort, and case–control studies.

The next five chapters cover the tools students need to interpret the results of epidemiological studies. Chapter 10 describes bias, including how it influences study results and the ways in which it can be avoided. Chapter 11 explains the concept of confounding, methods for assessing its presence, and methods for controlling its effects. Chapter 12 covers random error, including hypothesis testing, P-value and confidence interval estimation and interpretation, and sample size and power calculations. We believe this chapter provides a balanced view of the appropriate role of statistics in epidemiology. Chapter 13 covers the concept of effect measure modification, an often neglected topic in introductory texts. It explains the difference between confounding and effect measure modification and describes the methods for evaluating effect measure modification. Chapter 14 pulls together the information from Chapters 10 through 13 by providing a framework for evaluating the literature as well as three examples of epidemiological study critiques.

Chapter 15 covers the epidemiological approach to causation, including the historical development of causation theories, Hill’s guidelines for assessing causation, and the sufficient-component cause model of causation. Chapter 16 explains screening in public health practice, including the natural history of disease, characteristics of diseases appropriate for screening, important features of a screening test, and methods for evaluating a screening program. Finally, Chapter 17 describes the development and application of guidelines to ensure the ethical conduct of studies involving humans. Up-to-date examples and data from the epidemiological literature on diseases of public health importance are used throughout the book. In addition, nearly 50 new study questions were added to the fourth edition.

Our educational background and research interests are also reflected in the textbook’s outlook and examples. Ann Aschengrau received her doctorate in epidemiology from the Harvard School of Public Health in 1987 and joined the Department of Epidemiology at the Boston University School of Public Health shortly thereafter. She is currently Professor, Associate Chair for Education, and Co-Director of the Master of Science Degree Program in Epidemiology. For the past 30 years, she has taught introductory epidemiology to master’s-level students. Her research has focused on the environmental determinants of disease, including cancer, disorders of reproduction and child development, and substance use.

George R. Seage III received his doctorate in epidemiology from the Boston University School of Public Health in 1992. For more than a decade, he served as the AIDS epidemiologist for the city of Boston and as a faculty member at the Boston University School of Public Health. He is currently Professor of Epidemiology at the Harvard T.H. Chan School of Public Health and Director of the Harvard Chan Program in the Epidemiology of Infectious Diseases. For over 30 years, he has taught courses in HIV epidemiology to master’s and doctoral students. His research focuses on the biological and behavioral determinants of adult and pediatric HIV transmission, natural history, and treatment.

Drs. Aschengrau and Seage are happy to connect with instructors and students via email (aaschen@bu.edu and gseage@hsph.harvard.edu). Also check out Dr. Aschengrau’s Twitter feed @AnnfromBoston.
New to This Edition

- Completely updated with new examples and the latest references and public health statistics
- New section on process of investigating infectious disease outbreaks
- New section on the Ebola outbreaks and their investigation in Africa
- Introduction of the latest epidemiological terms and methods
- New figures depicting epidemiological concepts
- Expanded ancillary materials, including improved PowerPoint slides, an enlarged glossary, and new in-class exercises and test questions
- Over 50 new review questions
Acknowledgments

Our ideas about the principles and practice of epidemiology have been greatly influenced by teachers, colleagues, and students. We feel privileged to have been inspired and nurtured by many outstanding teachers and mentors, including Richard Monson, George (Sandy) Lamb, Steve Schoenbaum, Arnold Epstein, Ken Rothman, the late Brian MacMahon, Julie Buring, Fran Cook, Ted Colton, Bob Glynn, Adrienne Cupples, George Hutchison, and the late Alan Morrison. We are pleased to help spread the knowledge they have given us to the next generation of epidemiologists.

We are also indebted to the many colleagues who contributed to the numerous editions of this book in various ways, including clarifying our thinking about epidemiology and biostatistics, providing ideas about how to teach epidemiology, reviewing and commenting on drafts and revisions of the text, pilot testing drafts in their classes, and dispensing many doses of encouragement during the time it took to write all four editions of this book. Among these individuals are Bob Horsburgh, Herb Kayne, Dan Brooks, Wayne LaMorte, Michael Shwartz, Dave Ozonoff, Tricia Cogan, Meir Stampfer, Lorelei Mucci, Murray Mittleman, Fran Cook, Charlie Poole, Tom Fleming, Megan Murray, Marc Lipsitch, Sam Bozeman, Anne Coletti, Michael Gross, Sarah Putney, Sarah Rogers, Kimberly Shea, Kunjal Patel, and Kelly Diringer Getz. We are particularly grateful to Krystal Cantos for her many contributions to this edition, particularly the new sections on disease outbreaks, and Molly Pretorius Holme for contributing the chapter on ethics in human research. Ted Colton also deserves a special acknowledgment for originally recommending us to the publisher.

We thank our students for graciously reading drafts and earlier editions of this text in their epidemiology courses and for contributing many valuable suggestions for improvement. We hope that this book will serve as a useful reference as they embark on productive careers in public health. We also recognize Abt Associates, Inc., for providing George Seage with a development and dissemination grant to write the chapter on screening in public health practice. We are very grateful to the staff of Jones & Bartlett Learning for guiding the publication process so competently and quickly. Finally, we thank our son Gregory, an actor, for his patience and for providing many interesting and fun diversions along the way. Break a leg!