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# Essentials of Epidemiology in Public Health

## Second Edition

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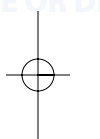
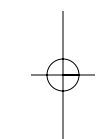
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# Essentials of Epidemiology in Public Health

## Second Edition

**Ann Aschengrau, ScD**  
Boston University School of Public Health  
Department of Epidemiology

**George R. Seage III, ScD**  
Harvard School of Public Health  
Department of Epidemiology



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Jones and Bartlett Publishers  
Canada  
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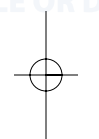
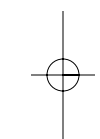
*We dedicate this book to our parents,  
Carol and Mendel Aschengrau, in memoriam,  
and Lorraine and George R. Seage Jr.*

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## New To This Edition

- Completely updated with new examples, the latest references, and public health statistics.
- 100 new review questions.
- New chapter on ethical issues in human research.
- Updated and streamlined discussion of certain epidemiologic methods, including bias.

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## Preface

What is epidemiology and how does it contribute to the health of our society? Most people don't know the answers to these questions. This is somewhat paradoxical because epidemiology, one of the basic sciences of public health, affects the daily life of nearly everyone. It impacts both the way that we make personal decisions 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 level to the societal level.

Recent years have also witnessed an important evolution in the theory and methods of epidemiologic research. For example, epidemiologists have considerably changed their views about the appropriate way to conceptualize and design the case-control study. We used to think that the case-control study was a backwards and inferior design, but we now realize that it is a valid and efficient design in many settings. In fact, our current conceptualization of the major epidemiologic study designs reveals many more similarities among them than previously thought.

Epidemiologists' thinking about causality has also changed. Where once we used Sir Austin Bradford Hill's guideposts as an uncompromising checklist for "proving" causation, we now acknowledge that Hill's causal guidelines have many exceptions and uncertainties, and that causal relationships can never be proven. Epidemiologists have also begun to use some newer conceptual models of causation, such as the sufficient/component cause model and the counterfactual causal model, as a way to bridge the gap between theories of causation and the practice of epidemiology.

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 too arcane for beginning

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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 two decades we have successfully taught the 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 the epidemiologic 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 epidemiologic literature and those who will be practicing epidemiologists. The first five chapters cover basic epidemiologic 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 epidemiologic study design. Chapter 6 provides an overview of study designs—including experimental, cohort, case-control, and 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 epidemiologic 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 epidemiologic study critiques.

Chapter 15 covers the epidemiologic 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 epidemiologic literature on diseases of public health importance are used throughout the book. In addition, over 100 new study questions were added to the second 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 of Epidemiology and Director of the Master of Science Degree Program in Epidemiology. For the past 20 years she has taught introductory epidemiology to master's level students. Her research has focused on the environmental determinants of disease, including childhood lead poisoning, cancer, disorders of reproduction and child development, and neurological abnormalities.

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. For seven years he directed the U.S. HIV Prevention Trials Network. He is currently Associate Professor of Epidemiology at the Harvard School of Public Health and Director of the Interdisciplinary Concentration in Infectious Disease Epidemiology. For the past 16 years he has taught courses in HIV epidemiology to master's and doctoral students. His research has focused on the biological and behavioral determinants of HIV transmission; ethical and feasibility issues in HIV vaccine and prevention trials; the consequences of pediatric HIV infection and its treatment; and surveillance, cost and, clinical outcomes of HIV infection.

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