

Epidemiology 101

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Long Beach, California

Series Editor: Richard Riegelman



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Composition: Auburn Associates, Inc.
Cover Design: Kristin E. Parker
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Printing and Binding: Malloy, Inc.
Cover Printing: John Pow Company

Library of Congress Cataloging-in-Publication Data

Friis, Robert H.
Epidemiology 101 / Robert H. Friis.
p. ; cm.
Includes bibliographical references and index.
ISBN-13: 978-0-7637-5443-3 (pbk.)
ISBN-10: 0-7637-5443-9 (pbk.)
ISBN-10: (invalid) 0-7637-5443-3 (pbk.) 1. Epidemiology. I. Title. II. Title: Epidemiology one hundred and one.
III. Title: Epidemiology one hundred one.
[DNLM: 1. Epidemiology. 2. Epidemiologic Methods. WA 105 F9118e 2009]
RA651.F687 2009
614.4—dc22

2008041624

6048

Printed in the United States of America

13 12 11 10 09 10 9 8 7 6 5 4 3 2 1

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ABOUT THE EDITOR:

Richard Riegelman, MD, MPH, PhD, is professor of Epidemiology-Biostatistics, Medicine, and Health Policy and founding dean at The George Washington University School of Public Health and Health Services in Washington, D.C.

Prologue

Robert Friis's *Epidemiology 101* introduces you to the world of epidemiology—the basic science of public health—and shows you the many ways that epidemiology affects all of our lives. *Epidemiology 101* clearly conveys the key concepts with a minimum of mathematics. It presents epidemiology as a scientific way of thinking applicable to a wide range of fields from basic and clinical sciences to public policy.

Epidemiology 101 builds upon Robert Friis's many years of teaching and writing about epidemiology and environmental health, bringing alive the excitement of these fields. You will come away from *Epidemiology 101* with an enduring understanding that you can use and build upon in a wide range of careers for many years to come.

In 2006, a Consensus Conference on Undergraduate Public Health Education attended by arts and sciences, public health, and clinical health professions educators recommended that all undergraduates have access to a curriculum such as *Epidemiology 101* as part of their general education. Epidemiology was also recommended as a core component of an undergraduate public health curriculum.¹

Epidemiology 101 follows the basic curriculum framework recommended by the Consensus Conference. In addition, an “epidemiology laboratory” was suggested for institutions that require a laboratory as part of science courses. *Epidemiology 101* fulfills that goal by providing references to exercises from the Young Epidemiology Scholars (YES) program developed by the Robert Wood Johnson Foundation.

Robert Friis's book *Essentials of Environmental Health* was the first book to be published as part of our *Essential Public Health* book series. It set a high standard for the series that is now rapidly expanding to provide introductory textbooks that cover the full spectrum of public health. In *Epidemiology 101*, Dr. Friis has done it again. Here, you will find the work of a true educator, a real pro. Take a look and see for yourself.

Richard Riegelman MD, MPH, PhD
Series Editor—Essential Public Health

1. The Educated Citizen and Public Health: Report of the Consensus Conference on Undergraduate Public Health Education, Council of Colleges of Arts and Sciences, Williamsburg VA, 2007. Available at: <http://www.ccas.net/i4a/pages/index.cfm?pageid=3351>.

Acknowledgments

The concept for *Epidemiology 101* originated with Dr. Richard Riegelman, professor and founding dean of the School of Public Health and Health Services, at The George Washington University. I would like to thank Dr. Riegelman for his encouragement and support. This work is part of the *Essential Public Health* series, which offers a comprehensive curriculum in public health. This is the fourth textbook that I have completed. Each project begins with enthusiasm, anxiety, and an ocean of blank pages. From the author's perspective, the input of colleagues and students was essential in completing the work. My colleagues and students were extremely helpful in providing comments. I wish to thank the following students from California State University, Long Beach: Sarah Long, Paula Griego, and Che Wankie. Students aided with literature searches, reviewed written text materials, and provided feedback. I also acknowledge the helpful comments and other contributions of Ibtisam Khoury-Sirhan, Claire Garrido-Ortega, Dr. Javier Lopez-Zetina, and Dr. Veronica Acosta-Deprez of California State University, Long Beach. These professional colleagues reviewed chapters that were relevant to their areas of expertise. Mike Brown, publisher for Jones & Bartlett, provided continuing encouragement and motivation for completion of the project; Jones & Bartlett staff offered much helpful expertise. Finally, my wife, Carol Friis, was involved extensively with this project; for example, she critiqued the manuscript, typed final versions of the document, provided detailed editorial comments, verified the accuracy of the references, and helped with many other aspects of the book. Without her support and assistance, completion of the text would not have been possible.

R. H. F.

About the Author

Robert H. Friis, PhD, is Professor and Chair of the Department of Health Science at California State University, Long Beach (CSULB), and Director of the CSULB-Veterans Affairs Medical Center, Long Beach, Joint Studies Institute. He is a past president of the Southern California Public Health Association and member of the governing council. He serves or has served on the advisory boards of several health-related organizations, including the California Health Interview Survey. Previously, he was an Associate Clinical Professor in the Department of Medicine, Department of Neurology, and School of Social Ecology, University of California, Irvine, from which he has retired. He is an epidemiologist by training and profession.

As a health department epidemiologist, he led investigations into environmental health problems such as chemical spills and air pollution. He has taught courses on epidemiology, environmental health, and statistics at universities in New York City and southern California. In addition to previous employment in a local health department, he has conducted research and published and presented numerous papers related to tobacco use, mental health, chronic disease, disability, minority health, and psychosocial epidemiology. Dr. Friis has been principal investigator or coinvestigator on grants and contracts from the University of California's Tobacco-Related Disease Research Program, the National Institutes of Health, and other agencies. This funding has supported investigations into topics such as geriatric health, depression in Hispanic populations, and nursing home infections. His research interests have led him to conduct research in Mexico City and European countries. He has been a visiting professor at the Center for Nutrition and Toxicology, Karolinska Institute, Stockholm, Sweden; the Max Planck Institute, Munich, Germany; and Dresden Technical University, also in Germany. In 2008, he was a visiting professor at the Medizinische Fakultät Carl Gustav Carus of the Dresden Technical University. He reviews articles for scientific journals, including *International Migration Review*, *Social Science and Medicine*, and *Public Health*. Dr. Friis is a member of the Society for Epidemiologic Research and the American Public Health Association. Among his awards were a postdoctoral fellowship for study at the Institute for Social Research, University of Michigan, and the Achievement Award for Scholarly and Creative Activity from California State University, Long Beach. His biography is listed in *Who's Who in America*.

He is author/coauthor of the following books with Jones & Bartlett:

- *Epidemiology for Public Health Practice*, with Thomas A. Sellers (editions one through four), published by Jones and Bartlett Publishers
- *Essentials of Environmental Health*, published by Jones and Bartlett Publishers

Preface

I wrote *Epidemiology 101* in response to a call to increase the epidemiologic content of undergraduate programs. A growing movement advocates for incorporating epidemiology into undergraduate curricula as a liberal arts subject. Consequently, students in undergraduate liberal arts programs, as well as those with limited public health or mathematical backgrounds, are the target audience for *Epidemiology 101*. No extant epidemiologic textbook is tailored exactly for this audience.

Epidemiology is suited ideally as a topic for liberal arts because habits of mind such as problem analysis, deductive and inductive reasoning, and creating generalizations are key features of epidemiology. The discipline provides reinforcement of basic skills acquired in the natural sciences, mathematics and statistics, and the social sciences. Thus, a course in epidemiology might be taken in order to fulfill a distribution requirement in one of the basic or applied sciences. Furthermore, knowledge of epidemiology equips citizens with informed opinions regarding crucial health issues that appear daily in the media.

In addition to covering basic epidemiologic concepts, the text will demonstrate how these concepts can be applied to problems encountered in everyday life, e.g., hazards posed by the food supply, risks associated with lifestyle choices, and dangers associated with youth violence. One of the features of *Epidemiology 101* is its emphasis on socially related determinants of health. This text is one in the series *Essential Public Health* published by Jones and Bartlett and edited by Richard Riegelman.

Introduction

This textbook has been created for students who would like to study epidemiology in order to fulfill a requirement for a science course. Increasingly, curriculum designers recognize that as a discipline, epidemiology embodies many useful critical thinking skills, which include gathering facts, forming hypotheses, and drawing conclusions. These processes are the hallmark of the scientific method and embody modes of thinking that benefit well-educated citizens even if they do not intend to become public health professionals.¹ In this respect, epidemiology resembles a liberal art.²

Epidemiology may be approached from a nontechnical point of view that students from a variety of backgrounds can appreciate. Examples of epidemiologic investigations into such problems as bird flu and studies of lifestyle and chronic disease are inherently appealing. Although epidemiology has strong quantitative roots, this text emphasizes the nonquantitative aspects of the discipline by creating a linkage with traditional liberal arts concepts, including social justice and health disparities. A background in mathematics and statistics is not required in order to use the book. The text incorporates numerous case studies, text boxes, vignettes, exhibits, photographs, figures, and illustrations to gain the interest of readers.

Epidemiology has evolved into a discipline that has applications in many fields. Once thought of as being confined to the investigation of infectious disease outbreaks, epidemiologic methods are used increasingly in such diverse health-related areas as traditional clinical medicine, healthcare administration, nursing, dentistry, and occupational medicine. In addition, the applications of epidemiologic methods are expanding to manufacturing processes, law, and control of international terrorism. *Epidemiology 101* will provide examples of these applications.

The content of this book follows the outline of the curriculum titled Epidemiology 101, recommended by the Consensus Conference on Undergraduate Public Health Education, November 7–8, 2006, Boston, Massachusetts. Web address: http://www.aptrweb.org/resources/pdfs/Curriculum_Guide_Version3.pdf.

In some instances, for didactic purposes, the arrangement of the topics departs somewhat from the order presented in the conference's *Working Group Reports*. However, the content of this textbook is similar to the content shown in the curriculum suggested for Epidemiology 101.

This text contains a total of ten chapters, which begin with coverage of basic principles and then increase in complexity. Chapters 9 and 10 illustrate current applications of epidemiology. Examples chosen are recent and command the attention of students. Selected chapters are keyed to exercises from the College Board's Young Epidemiology Scholars (YES) Program. These exercises may be found on the Web at <http://www.collegeboard.com/yes/> (accessed July 8, 2008). The course content can be covered during an academic quarter or a semester.

A full set of supportive learning materials, e.g., PowerPoint slides, flashcards, and a test bank, is available online at <http://www.jhpub.com/essentialpublichealth> for students and instructors to access. Each chapter concludes with study questions for additional reinforcement. Students should be encouraged to use the flashcards and other supportive

materials that are available on the Web site for this textbook. The interest level of students can be increased by using group exercises, lectures from public health experts, and field visits. The Robert Wood Johnson Foundation's YES exercises can be implemented as a laboratory component of an epidemiology course.

REFERENCES

1. Weed DL. Epidemiology, the humanities, and public health. *Am J Public Health*. 1995;87:914–918.
2. Fraser DW. Epidemiology as a liberal art. *N Engl J Med*. 1987;316:309–314.