

An Introduction to Epidemiology

THIRD EDITION



THOMAS C. TIMMRECK, PhD

California State University, San Bernardino

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Dedication

To all of my dedicated students who have enjoyed, yet diligently struggled through, their epidemiology learning experiences, the third edition of this book is dedicated to you.

Acknowledgment

A great deal of appreciation is extended to Ellen for her diligence and support in the editing of the original manuscript of An Introduction to Epidemiology

About the Author

Thomas C. Timmreck, Ph.D. has been actively involved in the field of public health, health science, and health services since his professional career began in 1971. His work has brought him to public health departments, community health services, hospitals, nursing homes, environmental health services, and both public and private social and health agencies, Dr. Timmreck served on the full-time faculty at Texas Tech University, Idaho State University, Northern Arizona University, and was formerly a Professor of Public Health and Health Care Administration, Department of Health Science and Human Ecology at California State University San Bernardino. Dr. Timmreck also served on the adjunct faculty of the University of Redlands, University of Southern California, Chapman University, California State University Long Beach, Loretto Heights College, University of Colorado at Denver, University of Denver and Western International University in Phoenix, teaching both graduate and undergraduate courses. He has over 50 professional publications in a variety of subject areas including public health, health services, long-term care and gerontology, health education and health promotion, and behavioral health, and is the author of four nationally published books. Dr. Timmreck received his Ph.D. in health science from the University of Utah. In addition, he holds two master's degrees, one in community health and community health education from Oregon State University and one in counseling psychology and human relations and behavior from Northern Arizona University, and a Bachelor of Science degree in Health Science from the Brigham Young University. He also received a graduate certificate in gerontology from the Rocky Mountain Gerontology Center at the University of Utah. Dr. Timmreck has been a Registered Sanitarian and taught public health and epidemiology courses for over 23 years.

Preface

The field of epidemiology has come a long way since the exciting days of infectious disease investigations by famous scientists such as Louis Pasteur, Dr. Robert Koch, and Dr. John Snow. The knowledge explosion in the fields of biology and medical science has advanced at such a rapid rate that it is difficult to keep up with. Epidemiology has benefited greatly from these advances, as it has from the knowledge gained in the social and behavioral sciences. Advances in the field of statistics have aided biomedical and behavioral science research efforts by providing effective and sound analysis of research findings. However, these advances also have affected the perception of some biomedical science and epidemiology professionals as to what constitutes the field of epidemiology. Such perceptions have tended to cloud the importance of the basics of epidemiology which seem to be becoming lost to the processes of analyzing the findings of biomedical research.

Many recent books bearing the title of *epidemiology* are in fact biostatistics books, with limited information on the basics of epidemiological investigations or the study of epidemics. Biostatistics, an important branch of traditional statistics, is essential in completing the last phases of an epidemiological investigation, the analysis of the data. However, biostatistics is not epidemiology. Some epidemiology books seem to be written by biostatisticians for biostatisticians, with many of the basics left out, or at the most, quickly glossed over, in order to get to the biostatistics. Other epidemiology books are written by physicians with many advanced public health degrees and other outstanding credentials, who assume the student also has advanced levels of biomedical knowledge and background. Such books, written by advanced scientists for the other biomedical scientists, leave introductory students lost and bewildered.

This book was written and developed as an introductory epidemiology text for the student who has minimal training in the biomedical sciences and statistics. *Introduction to Epidemiology* is based on the premise of filling the role of a very basic text and that the advanced analysis of empirical research studies, using advanced statistical methods, are more akin to biostatistics than epidemiology and, therefore, are not included in this book and are left to biostatistics courses and books.

Many fine books are already available on statistics, empirical research design, and biostatistics, so these topics need not be included in an introductory epidemiology textbook. This book takes the introductory student of epidemiology up to and through descriptive statistics and stops at the threshold of inferential statistics. Thus, if the student wishes to know how to conduct advanced experimental studies and then analyze the results with T-tests, multivariate analysis, or ANOVAs, additional biostatistics and related statistical books and research resources should be sought.

Preface to the Third Edition

In this era of bioterrorism, epidemiology has become more important than ever. Through the media, the public learns more and more about disease outbreaks, mutating pathogens, new and unknown infections, and increased communicable diseases. Increasingly, public health, health science, health education and health promotion, nursing, and health administration programs are recognizing the importance of offering a course on epidemiology. Both undergraduate and graduate courses in epidemiology are being offered in the above mentioned disciplines because of heightened awareness of diseases in the populations around the world, and the need for the promotion of disease prevention.

This text is as fundamental and user friendly as its previous editions, and remains unchanged in its basic approach, including "case files," "news files," key terms at the end of the chapters, and study questions, some of which engage students in the use of a computer. This is a comprehensive textbook on basic epidemiology meant for undergraduate and graduate courses in epidemiology or for the entry-level practitioner. Colleagues, professors who teach the course, and students alike have firmly supported the necessity of a solid separate course and book on the fundamentals, keeping it basic epidemiology without turning to inferential statistics and biostatistics. Thus, *An Introduction to Epidemiology* remains unchanged in its basic approach, retaining the elements that have made past editions so successful.

Foreword

Epidemiology is a fun and challenging subject to study as well as an interesting field to pursue as a career. Most solid undergraduate degree programs and graduate programs in community health and public health, environmental health, occupational health and industrial hygiene, health education and health promotion, health services administration, and other health-related degree programs areas require a basic introductory course in epidemiology and that is one reason this book was written. *Introduction to Epidemiology* also can be valuable as a handbook for practicing epidemiologists. Thus, it is hoped that this book will be a useful and practical handbook for introductory epidemiology courses, as well as epidemiologists working in the field. They may be specialists in international projects in developing countries, or industrial hygienists within major industrial plants, or infectious disease nurses in hospitals and medical centers, chronic disease epidemiologists in government agencies, behavioral scientists conducting behavioral health epidemiological investigations, or staff epidemiologists in local public health departments.

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1

Foundations of Epidemiology

CHAPTER OBJECTIVES

This chapter on foundations and basic concepts of epidemiology

- presents basic concepts, constructs, and principles foundational to epidemiology;
- defines epidemiology, epidemiologist, and related terms;
- presents the purposes, goals, scope, and uses of epidemiology;
- presents some basic concepts, constructs, and principles foundational to the role of the epidemiologist;
- presents the epidemiology triangle;
- reviews types and classifications of epidemics;
- presents an advanced epidemiology triangle for chronic diseases and behavioral disorders;
- presents the concepts and principles of case as used in epidemiology;
- presents the three levels of prevention used in public health and epidemiology;
- presents key terms and study questions for review of chapter concepts.

INTRODUCTION

What is epidemiology? What does epidemiology mean, and how is it defined? By turning to basic medical terminology to learn the meaning of this term, first we discover that the prefix

epi- means "on, upon, befall,"

as in the medical term epidermis, which means "upon the body (skin)." The root

demo means "people, population, man,"

as in the word *demographics*, which is the study of the statistics of populations. The suffix

-ology means "the study of."

In true medical terminology fashion, one reads the suffix first, then the prefix and the root. Thus, the term epidemiology, if taken literally, means "that which befalls man." ¹

EPIDEMIOLOGY DEFINED

Some public health professionals view epidemiology as a science. Others view epidemiology as a method rather than a pure science, as it is not a clearly defined field. This book assumes that epidemiology is a scientific methodology. Epidemiology is an investigative method used to detect the cause or source of diseases, disorders, syndromes, conditions, or perils that cause pain, injury, illness, disability, or death in human populations or groups. An epidemiologist is often considered a "detective of diseases and epidemics."

Epidemiology has been defined in several ways. One definition is the study of the nature, cause, control, and determinants of the frequency and distribution of disease, disability, and death in human populations. Epidemiology also involves characterizing the distribution of health status, diseases, or other health problems in terms of age, sex, race, geography, religion, education, occupation, behaviors, time, place, person, etc. This characterization is done in order to explain the distribution of a disease or health-related problems in terms of the causal factors. Epidemiology is useful in assessing and explaining the impact of public health control measures, prevention programs, clinical intervention, and health services on diseases or other factors that impact the health status of a population. The epidemiology of a disease can include the description of its presence in a population and the factors controlling the particular disease's presence or absence.^{2,3}

Concerned with the types and extent of injuries, conditions, or illnesses that beset groups or populations, epidemiology also deals with risk factors that impact, influence, provoke, and affect the distribution of diseases, defects, disabilities, and death.^{3,4} As a scientific method, epidemiology is used to study patterns of occurrence influencing the factors listed above. The epidemiologist has the task of determining if there has been an increase or a decrease in these factors over various time periods—days, weeks, months, years. The task also includes determining if one certain location or geographical area has an increase or decrease more than other locations or areas. A third concern is the characteristics of the people involved and if