With infinite love for Magus, Hero, and Gryphon.
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Preface: The Power of Methods

The purpose of this textbook is to convey the essence of epidemiologic methods so that the student develops an understanding of them in a conceptual way. Through this approach, it will become clear that the methods we use to collect data not only affect the results we find but also the public health recommendations we make. By increasing comfort with real-world design and analysis situations that face the newly minted MPH in epidemiology, students will gain a foundation in the epidemiologic methods necessary to prepare them for practice as epidemiologists. This book is intended to be used for intermediate epidemiology courses in a standard three course methods series, preceded by an introductory course and followed by advanced methods. The focus is on examples and application, structured so that the student is actively engaged in thinking about the methods to yield depth of understanding rather than simply memorization. With the many nuances of the epidemiology tool kit, sometimes its elegance can be challenging when moving from introductory to advanced coursework. The focus of this text is on concepts and application that will delve into these nuances, so that by the time the students reach the advanced coursework, they have an organic and conceptual understanding of epidemiologic methods and are prepared to absorb the more complex and quantitative material. The approach is less quantitative and more applied than other textbooks, striving to integrate into each professor’s unique pedagogical approach in their own way.

Note to Students Using This Text

As an epidemiologist, you will contribute to the welfare of populations as you work in local departments of health, health-related industries, academia, and government. But the ability to contribute to public health in these settings in a substantive way requires you go beyond the
basics and deepen your relationship with epidemiologic methods: you will need to be facile with the methods themselves as well as be able to apply them to public health situations and communicate them effectively. The studies you design, the data you collect, and the findings you interpret all will affect the public health decisions that follow from them. In the field, you will move beyond calculating a measure of association between a putative exposure and disease in the classroom and begin to develop instrumentation and studies to evaluate the associations, working hard to minimize and quantify bias from your design and creating, supervising, and ensuring quality of the data collection processes. You will go beyond a hypothetical write-up for your professor and instead disseminate your results to real communities at risk, to the media, and to the scientific community. In this book, we will focus on expanding these skills so you are ready to take the next steps in your career as an epidemiologist. We will focus on methods, methods, and more methods. Why? Because when you know and are comfortable with the nuances of epidemiologic methods going beyond the introductory level, you will be able to apply them easily and with confidence in your future coursework as well as in your eventual workplace.

As you already know, epidemiology is a tool kit that enables us to answer questions and relate exposures to outcomes. As many conditions and challenges as there are in public health—cancer, infectious diseases, environmental exposures, barriers to nutrition, chronic diseases, cardiovascular diseases, promotion of maternal-child health, global and domestic public health issues, and more—epidemiologic tools are an effective way of identifying the risk factors and, later, evaluating the ability of interventions to help prevent disease and improve health. The designs change remarkably little between topic areas. In practice, sometimes the designs we have at our disposal are not perfect; they require a detailed knowledge of the methods in order to account for real-world challenges. For example, we might be interested in characterizing how a new chemical used in dry-cleaning processes could be teratogenic (causing birth defects). We may select a case-control study as the optimal way to study this relationship. It may be optimal, but that does not mean it is perfect: we must still wrestle with design issues as we assess exposures present at the period during which the embryo was most vulnerable. We might have to deal with recall bias, incomplete medical records, or poor exposure assessment methods that introduce nonrandom error into our understanding of the relationship. Or if we decided to conduct a cohort study to explore birth defects among the offspring of exposed women, we may find that the effects are too rare and necessitate a very large and expensive sample. If that cohort has attrition, then our associations of interest may be biased.

These are the real-world problems an epidemiologist faces outside of the classroom. You already know about the study designs we have at our disposal, so we will now help you layer on increasing concepts surrounding their limitations and strengths, how to minimize and quantify challenges, maximize benefits, and characterize what you don’t or can’t know. The goal is to provide you with the methodological scaffolding on which you may overlay further in-depth content area knowledge, advanced epidemiologic study, and professional work as an epidemiologist.

Learning anything takes practice, and epidemiology is no different. Examples at the end of each chapter are available to help you apply the material. Though the approach of this book is to make the concepts easy to understand on a basic level through a reduction in jargon, it will become increasingly important to be able to use proper terminology when communicating with
others in the field. To this end, as you use this textbook, practice saying technical words and phrases aloud so that you build your comfort level in communicating ideas using terms specific to epidemiology. Read current peer-reviewed literature in your field as much as you can beyond what is required by your professors: reading studies is one of the best ways to learn not only how to do research but also how to write for the scientific community.

The structure of this textbook will take you on a journey from research question to dissemination of results to special topics the epidemiologist encounters in the field. We will begin with basics in research design and question articulation and conceptualization, then move to descriptive methods and study design to implementation, quantitative and qualitative assessment of threats to internal and external validity, analysis of the study data, and synthesis of this journey through critical evaluation of the literature and program evaluation with a look at the problems epidemiologists face in the world of public health in outbreak investigations, program evaluation, and surveillance.

As with learning in all fields, this book is just a starting point. As you enjoy this course, seek out extra exercises in your favorite area of focus, read up-to-date scientific journals to your interest, and sign up for the publicly available listserves and publications. The more you read and practice, the more you will understand about how to use these important methodological tools. Volunteer, keep apprised of the public health news, and become involved in public health settings in your city, state, county, or country. Globally, there is a shortage of public health personnel, in a world filled with emerging, reemerging, known, and as-yet-unknown health conditions. Take your interest and passion beyond the classroom and translate it into action as you improve the health of global populations now and into the future.

Note to Course Directors Using This Text

Our epidemiologic tools offer powerful approaches to messy health problems. After years of teaching, I began to notice that MPH students often would emerge from methods courses with memorization of formulae but not with a visceral understanding of the concepts they represent or how they can be applied to the unique problems we encounter in the real world of epidemiologic practice. They would sometimes lack joy in the material, and their perception of what we could do methodologically would be reduced to the sense of the field as number crunching; the elegance of our designs and methods was often overlooked. This book is designed to impart a conceptual understanding of epidemiologic methods, building on a first semester of coursework. It is intentionally developed differently from other intermediate-level texts: it is quantitatively simpler than the books I greatly admire, such as Szklo’s *Epidemiology: Beyond the Basics* and Rothman, Greenland, and Lash’s *Modern Epidemiology*. Where those books are perfect for an advanced MPH or doctoral student, this text is designed for the intermediate student. Written in first-person narrative, it focuses on examples first as a way to apply and develop further the concepts taught in introductory methods, followed by formulae and application emerging out of the application rather than the reverse. This provides layered learning, which grafts application to theory, ideal for the student moving into the real world of public health. It is designed to be easy to read and exciting, preparing the reader to enter the next level of advanced methods with confidence.
This book is designed so that students will read and absorb the conceptual (practically formula-free) text on their own and then come to class prepared to build on their foundational understanding with your lectures, supplemental papers, and exercises. This focus on the conceptual will enable them to come to class facile with the topics covered in each chapter; they won't need you to sift through and reiterate the content in the textbook, thus freeing you to present the material with examples from papers and exercises based on your own expertise. It also allows you to bring in your own specialty in research so that the course is punctuated by your real-life work and examples to echo what is in the text. With each semester so short (and quarters shorter still), this will ideally cut down on time spent going over the textbook concepts and allow your class time to be used for thoughtful exploration and building on foundations instead.

I am hopeful that students will emerge from your course with a real-world sense of how our methodological tool kit can be used in the field, armed to understand the messy public health problems we work with, and ready to improve the health of individuals and populations. Hopefully this book will be sufficiently enjoyable to read that students are excited by our methods and stimulated to look things up at the library, read the literature, learn more about the examples provided, and appreciate the nuance that is an odds ratio, for example, not just vaguely recall that it is easier to remember than a relative risk. Hopefully they will understand the notion of a confidence interval so that when they are reading the papers you assign they don't just scan the column for “p < 0.05” but ponder the CI for what it means about the study and not whether it is “significant” before moving on.

We each teach epidemiologic methods differently. Hopefully this book will leave you with a canvas to teach your course your way to students prepared by a deeper concept of the tools we use. I am hopeful that the students who use this book will be prepared for their next level epidemiology courses, ready not only with formulae but with nuanced understandings of bias and the effect of design and how to think through an analysis plan and critically evaluate a paper. I want them to smile when dealing with a case-control study design problem and delight in identifying where bias was introduced.

I am eager to make this a new approach worth using in the years to come. Please send me your comments and feedback about how it will or will not work for you, and I will improve the book to support your teaching experience and needs. If there are pedagogical tools that would help you as ancillary support to this text, let me know and I will strive to provide them as well.
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