

# MODERN EPIDEMIOLOGY

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LITTLE, BROWN AND COMPANY

*Boston/Toronto*

To N. A. D.

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*Tenth Printing*

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Library of Congress Catalog Card No. 85-82480

ISBN 0-316-75776-4

Printed in the United States of America

RRD VA

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## PREFACE

The tenets of epidemiology, like those of every other science, have become established piecemeal. Some are more useful than others, and some exist in mutual conflict. In this book my aim has been to weave the diverse threads of epidemiologic concepts and research methods into a single fabric. I have tried to reconcile conflicting ideas and unify the conceptual foundation, omitting needless partitions. In particular, I have labored to tie the statistical topics of epidemiologic analysis—which have a way of generating their own special goals, momentum, and lingo—to the basic goals of epidemiologic research. I have also ventured to reconcile epidemiologic principles with the broader goals and methods of scientific inquiry, as I understand them. In sewing the final cloth, I have been mindful that I cannot succeed fully, but rather must fail in my attempts to varying degrees. Intent readers will surely find holes in the fabric and an incorrect stitch here and there. Some of these irregularities undoubtedly reflect inadequate understanding or communication on my part. Some mark conceptual areas, such as confounding and interaction between causes, where development is progressing rapidly. I hope that such problems are few, and small enough not to impair the overall usefulness of the work.

Throughout this book I have strived to make the material accessible to a novice to the field. Whenever possible the descriptions are verbal rather than mathematical, despite the quantitative objectives of research. The first eight chapters deal with fundamental issues of epidemiologic conceptualization, measurement, and study design, and should be comprehensible even to those who lack previous training in epidemiology or statistics; the second eight chapters address the somewhat more technical issues of epidemiologic data analysis, but even these topics are presented with step by step explanations and simplicity as a central objective.

Chapters 1 through 5 form an introductory unit on basic epidemiologic concepts and tools. Chapter 1 places epidemiology in its historical perspective. Chapter 2 ventures into the philosophic foundation for epidemiology, providing a model for causal action that serves as a platform for understanding etiology and its quantitative description. Chapters 3 through 5 continue with the fundamental measures of epidemiology (incidence, prevalence, and risk) and the measures derived from them to quantify causal actions.

Chapters 6 through 8 form a second unit that deals with epidemiologic studies. The basic types of studies are presented in Chapter 6, where I have pursued steadfastly the objective of a unified approach, stressing the theoretical connections among study types. Chapters 7 and 8 explore the issues of study design without resorting to mathematical notation. They emphasize the sources of error in effect estimates as well as the quantitative nature of most aspects of study design.

Chapters 9 through 16 deal with data analysis. In this section some reliance on mathematical formulations has been unavoidable, and I have assumed a basic knowledge of the relevant statistical distributions. Never-

theless, the fundamental statistical principles are introduced and explained in Chapters 9 and 10 using as little notation as possible. Chapter 11 introduces the basic analytic formulations for crude data, which are extended in Chapters 12 and 13 for stratified and matched data. Chapters 11 through 13 cover the routine analytic tasks that an epidemiologist faces; consequently, these are the most technical chapters in the book. Various approaches are described in detail, so that these chapters can be used as a reference for researchers, as well as an instructional guide to the fundamental analytic methods.

The final three chapters turn to more advanced analytic topics, but the emphasis is not so much on formulas as on analytic strategies. Thus, Chapter 14 on multivariate analysis is probably the least technical description of multivariate analysis in any textbook; it provides practical guidance on choosing, constructing, and interpreting multivariate models. Chapters 15 and 16 deal with the advanced topics of interaction and “dose-response” evaluation, but the emphasis once again is on the principles and pitfalls of such analyses, rather than on the technical aspects of the requisite calculations. I could not avoid formulas entirely and still provide an adequate discussion of these topics, but the formulas presented illustrate approaches of conceptual simplicity amenable to a pencil-and-paper solution.

In my efforts to tie together epidemiologic concepts for all these topics, I have encountered some fossilized divisions that I consider no longer useful. For example, a rift has separated the traditional area of infectious disease epidemiology from the more recent and growing area of “chronic” disease epidemiology. I have never been persuaded of any rationale for this distinction. The terms “infectious” and “chronic” are neither mutually exclusive nor collectively exhaustive alternatives. Many diseases are both infectious and chronic; some, such as fatal traumatic injury, are neither. “Chronic” has sometimes been taken to mean a long induction period, rather than a long period of manifestation, but this redefinition still fails to make a meaningful distinction between two conceptually different types of epidemiology. Although some specialized methods have been developed solely to study the spread of infectious illness, whatever distinctions exist between traditional and modern areas of epidemiology are certainly less important than the broad base of concepts that are shared. This book does not deal with models for epidemic spread, but focuses on the general epidemiologic concepts that apply to all diseases, infectious or not, chronic or not, and to causes that have short or long induction periods.

Another distinction that has been used to categorize epidemiologic work is its classification into descriptive and analytic epidemiology. My view is that this demarcation is also best forgotten. It has been used in reference both to specific study variables (so-called “descriptive” variables being distinguished from putative causes) and to entire studies, but in neither context does it hold as a sensible classification scheme. No quali-

tative distinction, other than a completely arbitrary one, distinguishes “descriptive” variables from more fundamental risk factors. Any disease determinant can be specified in terms of more proximal determinants or previously unsuspected confounding factors. The division of epidemiologic research into descriptive and analytic compartments has given rise to the illusion that there are different sets of research principles that apply to descriptive and analytic studies. This notion devolves from a mechanical view of scientific research, and diverges from prevailing doctrines of scientific philosophy. For example, the view that “descriptive data” from “exploratory studies” generate hypotheses, whereas the data from “analytic studies” are used to test hypotheses, does not cohere with a broader understanding of science. Hypotheses are not generated by data; they are proposed by scientists. The process by which scientists use their imagination to create hypotheses has no formal methodology and is certainly not prescriptive. Any study, whether considered exploratory or not, can serve to refute a hypothesis. It is not useful to regard some studies merely as “hypothesis generating” and others as “hypothesis testing,” because the inexorable advance of scientific knowledge cannot be constrained by such rigidities.

I believe that epidemiology is much more coherent than these traditional divisions would suggest. Even the stark contrast between follow-up studies and case-control studies has been softened as understanding of the basic principles of epidemiology has progressed. In writing this book, my greatest hope is to convey to the reader the conviction that epidemiologic principles can be understood as an integrated substrate of logical ideas, rather than as a jumble of isolated and sometimes conflicting postulates.

K. J. R.