

# Statistics

FIFTH EDITION

A TOOL FOR SOCIAL RESEARCH



JOSEPH F. HEALEY

# **Statistics:** A Tool for Social Research

Fifth Edition

Joseph F. Healey

Christopher Newport University



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# Preface

Sociology and the other social sciences are research-based disciplines. Social scientists test and refine their ideas against the highest quality evidence available. The research capabilities of the social sciences have grown enormously over the past several decades and, as the end of the twentieth century approaches, the essential “tools of the trade” for the social scientist now routinely include calculators and computers.

Statistics and research methodology are essential components in the education of the social scientist. However, learning (and teaching) these subjects can present challenges that are not present in other areas of the curriculum. Sociology and other social science majors typically begin a statistics course with a wide range of mathematical backgrounds and an equally diverse set of career goals. Students are often puzzled about how statistics relates to sociology in general and, not infrequently, there is some math anxiety to overcome.

This text was written to meet the challenge of introducing statistical analysis to social science majors while addressing the instructional challenges that are inherent in the course. The text makes minimal assumptions about the mathematical background of the students (the ability to read a simple formula is sufficient preparation for virtually all of the material in the text), and a variety of special features have been integrated into the text to assist students to successfully analyze data. The text has been written especially for sociology and social work programs but is sufficiently flexible to be used in statistics courses in political science or in any program with a social science base and an applied focus (for example, public administration, criminal justice, urban studies, and gerontology).

The text is written at a level intermediate between the more rigorous and sophisticated texts on one hand and the mere “cookbook” on the other. That is, while I have not sacrificed comprehensive coverage or statistical correctness, the theoretical and mathematical explanations of why statistics “do what they do” are kept at an elementary level, as is appropriate in a first exposure to social statistics. For example, I do not treat formal probability theory *per se*. Rather, the background necessary for an understanding of inferential statistics is introduced, informally and intuitively, in Chapters 5 and 6 while considering the concepts of the normal curve and the sampling distribution. The text makes no claim that statistics are “fun” or that the material can be mastered without considerable effort. At the same time, students are not overwhelmed with abstract proofs and mathematical theory, which at this level needlessly frustrate the learning experience.

My major goal is basic statistical literacy. The text is designed to provide a solid foundation in statistical analysis and to prepare students to be intelligent consumers of social research. More specifically, I believe that basic statistical literacy can be defined in terms of three interrelated qualities and, as a way of further describing the nature of this text, I would like to list

each of these qualities and briefly summarize how the text is designed to develop them.

**Computational Competence.** At a minimum, students should emerge from their first course in statistics with the ability to perform elementary forms of data analysis—to execute a series of calculations and arrive at the correct answer. Since students in social science statistics courses frequently do not have strong quantitative backgrounds, I have included a number of features to help students cope with computations:

- *Step-by-step computational algorithms* are provided for each statistic.
- *Extensive problem sets* are provided at the end of each chapter. For the most part, these problems use fictitious data and are designed for relative ease of computation.
- *Cumulative exercises* are included at the end of each part to provide practice in choosing statistics. These exercises present only data sets and research questions. Students must choose appropriate statistics as part of the exercise.
- *Solutions* to odd-numbered computational problems are provided so that students may check their answers.
- *SPSS for Windows*, the leading social science statistical software, is incorporated to give students access to the computational power of the computer. This feature is explained in more detail below.

**An Appreciation of Statistics.** A statistically literate person can do much more, of course, than merely calculate correct answers. Such a person understands the relevance of statistics for social research, can select an appropriate statistic for a given purpose and a given set of data, and can analyze and interpret the meaning of that statistic. This textbook begins to develop these qualities, within the constraints imposed by the introductory nature of the course, in the following ways:

- *The relevance of statistics.* Chapter 1 includes a discussion of the role of statistics in social research and stresses the usefulness of these techniques as ways of analyzing and manipulating data and answering research questions. Each example problem is framed in the context of a research problem. A question is posed and then, with the aid of a statistic, answered. The relevance of statistics for answering questions is thus stressed throughout the text. This central theme of usefulness is further reinforced by a series of boxes labeled “Applications,” each of which illustrates some specific way statistics can be used to answer questions.

Almost all end-of-chapter problems are labeled by the social science discipline or subdiscipline from which they are drawn. The following are

used as labels: [SOC] for sociology, [SW] for social work, [PS] for political science, [CJ] for criminal justice, [PA] for public administration, and [GER] for gerontology. By identifying problems with specific disciplines, students can more easily see the relevance of statistics to their own academic interests. (Not incidentally, they will also see that the disciplines have a large subject matter in common.)

- *Selecting appropriate statistics.* A series of flowcharts are included to help students select appropriate statistics. These flowcharts have two components. Decision points are represented by diamonds and information by rectangles. The selection process is represented in general terms on the inside front cover and at the beginning of each part. Chapters begin with detailed flowcharts that lead students to specific formulas or sections of the chapter based on a consideration of the purpose of the analysis, the format of the data, and the level of measurement criterion.
- *Interpreting statistics.* After selecting and computing a statistic, students still face difficulties in understanding what the statistic means. The ability to interpret statistics can be developed only by exposure and experience. To provide exposure, I have been careful, in the example problems, always to express the meaning of the statistic in terms of the original research question. To provide experience, the end-of-chapter problems almost always call for an interpretation of the statistic calculated. To provide examples, many of the Answers to Odd-Numbered Computational Problems in the back of the text are expressed in words as well as numbers. In particular, the answers to the cumulative exercises include discussions on the process of selecting statistics.

**The Ability to Read the Professional Social Science Literature.** The statistically literate person can comprehend and critically appreciate research reports written by others. The development of this quality is a particular problem at the introductory level because of the marked disparity between the concise language of the professional researcher and the rather wordy vocabulary of the classroom. To help bridge this gap, I have included a series of boxes labeled “Reading Statistics” beginning in Chapter 1. In each box, I briefly describe the reporting style typically used for the statistic in question and try to alert students about what to expect when they approach the professional literature. These inserts include excerpts from the research literature and illustrate how statistics are actually applied and interpreted by social scientists.

**Additional Features.** A number of other features make the text more meaningful for students and more useful for instructors:

- *Readability.* The writing style is informal and accessible to students without ignoring the traditional vocabulary of statistics. Problems and ex-

amples have been written to maximize student interest and to focus on issues of concern and significance. For the more difficult material (such as hypothesis testing), students are first walked through an example problem before being confronted by formal terminology and concepts. Each chapter ends with a summary of major points and formulas and a glossary of important concepts. A glossary of symbols inside the back cover can be used for quick reference.

- *Organization and coverage.* The text is divided into four parts, with most of the coverage devoted to univariate descriptive statistics, inferential statistics, and bivariate measures of association. The distinction between description and inference is introduced in the first chapter and maintained throughout the text. In selecting statistics for inclusion, I have tried to strike a balance between the essential concepts with which students must be familiar and the amount of material students can reasonably be expected to learn in their first (and perhaps only) statistics course, while bearing in mind that different instructors will naturally wish to stress different aspects of the subject. Thus, the text covers a full gamut of the usual statistics, with each chapter broken into subsections so that instructors may choose the particular statistics they wish to include.
- *Review of mathematical skills.* Appendix H provides a comprehensive review of all of the mathematical skills that will be used in this text. Students who are inexperienced or out of practice with mathematics may want to study this section early in the course and/or refer to it as needed. A self-test is included in Appendix H so students may check their level of preparation for the course.
- *Computer applications.* To help students take advantage of the power of the computer, this text integrates SPSS, the most widely used statistical software in the social sciences. Appendix F is an introduction to statistical packages in general and SPSS in particular. There are demonstrations at the end of each chapter that explain how to use SPSS to produce the statistics presented in the chapter. Student exercises analyzing data with SPSS are also included.
- *Realistic, up-to-date data.* The database for computer applications is the General Social Survey. This database will give students the opportunity to practice their statistical skills on “real-life” survey data. The database is described in Appendix G, and instructors may request a data diskette from the publisher.
- *Instructor’s Manual.* The Instructor’s Manual includes learning objectives, chapter summaries, a test item file of multiple-choice questions, answers to even-numbered computational problems, and step-by-step solutions to selected problems. In addition, the Instructor’s Manual includes cumula-

tive exercises (with answers) similar to those in the text but with different variables or scores. These may be used for testing purposes.

- *Study Guide.* The Study Guide, written by Rebecca Davis, University of Maryland–College Park, contains additional examples to illuminate basic principles, review problems with detailed answers, SPSS work, and multiple-choice questions and answers that complement but do not duplicate the test item file.

### CHANGES IN THIS EDITION

Two changes are designed to further enhance computational competence:

- *Statistical techniques and end-of-chapter problems are explicitly linked.* After a technique is introduced, students are directed to specific problems for practice and review. The “how-to-do-it” aspects of calculation are reinforced immediately and clearly.
- *End-of-chapter problems are organized progressively.* Simpler problems with small data sets are presented first. Often, explicit instructions or hints accompany the first several problems in a set. The problems gradually become more challenging and require more decision making by the student (e.g., choosing the most appropriate statistic for a certain situation). Thus, each problem set develops problem-solving abilities gradually and progressively.
- To strengthen the link with the professional literature, the “Reading Statistics” boxes have been updated and increased in both number and variety.
- The database has been updated to the 1996 version of the General Social Survey (GSS), and the statistics package is the latest available version of *SPSS for Windows*. The original GSS sample includes almost 3000 respondents and hundreds of variables. Since some students may use the Student Version of *SPSS for Windows*, which limits the size of the database, I have reduced the number of variables to less than 50. Also, the number of cases has been reduced to less than 1500 by selecting a 50% random sample from the original database.
- The number of end-of-chapter problems has been increased. For the most part, the new problems feature small data sets and ease of computation.
- In response to suggestions from reviewers and instructors, the introduction to bivariate tables has been moved from Chapter 2 to Chapters 12 and 13.
- Also in response to suggestions from reviewers and instructors, the chapter on Analysis of Variance (formerly Chapter 12) has been moved so that



it immediately follows Chapter 9. This tightens the connection between the  $t$  test for means in Chapter 9 and ANOVA (now Chapter 10).

The text has been thoroughly reviewed for clarity and readability. As with previous editions, my goal is to provide a comprehensive, flexible, and student-oriented text that will provide a challenging first exposure to social statistics.

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# Acknowledgments

This text has been in development, in one form or another, for more than fifteen years. An enormous number of people have made contributions, both great and small, to this project and, at the risk of inadvertently omitting someone, I am bound to at least attempt to acknowledge my many debts.

This edition reflects the thoughtful guidance of both Eve Howard of Wadsworth, and Denise Simon. I thank them for their many contributions. Much of whatever integrity and quality this book has is a direct result of the contributions of colleagues who reviewed the manuscript during the various stages of writing. I have been consistently impressed by their sensitivity to the needs of the students, and I would like to thank Nelta Edwards, Arizona State University; Barry L. Johnson, Brigham Young University; David Jorgenson, Southwest Texas State University; Joseph J. Sudano, Jr., Kent State University; Keith Warren, University of Texas at Austin; and Jiping Zuo, St. Cloud State University. Whatever failings are contained in the text are, of course, my responsibility and are probably the results of my occasional decisions not to follow the advice of my colleagues.

I would like to thank the instructors who made statistics understandable to me (Professors Satoshi Ito, Noelle Herzog, and Ed Erikson) and all of my colleagues at Christopher Newport University for their support and encouragement (especially Professors F. Samuel Bauer, Robert Durel, James Forte, Ruth Kernodle, Timothy Marshall, Cheryl Mathews, Lea Pellet, Virginia Purtle, and William Winter). I would be very remiss if I did not acknowledge the constant support and excellent assistance of Jessica Ledbetter and Brigid Halpin. I also need to thank all of my students for their patience and thoughtful feedback. Also, I am grateful to the Literary Executor of the late Sir Ronald A. Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Longman Group Ltd., London, for permission to reprint Appendixes B, C, and D, from their book *Statistical Tables for Biological, Agricultural and Medical Research* (6th edition, 1974).

Finally, I want to acknowledge the support of my family and rededicate this work to them. I have the extreme good fortune to be a member of an extended family that is remarkable in many ways and has recently increased in size. Although I cannot list everyone, I would like to especially thank the older generation (my mother, Alice T. Healey), the next generation (my sons Kevin and Christopher, my daughter-in-law Jennifer), the new members (Patricia, Christopher, Katherine, and Jennifer Schroen), and the youngest generation (Benjamin John Healey).

J. F. H.

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<b>Appendix B Distribution of <math>t</math></b>		<b>484</b>