STATISTICS

A Tool for Social Research

TENTH
EDITION

JOSEPH F. HEALEY

STATISTICS

A Tool for Social Research

Tenth Edition

Joseph F. Healey

Christopher Newport University

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FREQUENTLY USED FORMULAS

CHAPTER 2

Proportion

$$p = \frac{f}{N}$$

Percentage

$$\% = \left(\frac{f}{N}\right) \times 100$$

CHAPTER 3

Mean

$$\overline{X} = \frac{\Sigma(X_i)}{N}$$

CHAPTER 4

Standard deviation

$$s = \sqrt{\frac{\Sigma(X_i - \overline{X})^2}{N}}$$

CHAPTER 5

Z scores

$$Z = \frac{X_i - \overline{X}}{s}$$

CHAPTER 7

Confidence interval for a sample mean

$$\text{c.i.} = \overline{X} \pm Z\left(\frac{s}{\sqrt{N-1}}\right)$$

Confidence interval for a sample proportion

$$\text{c.i.} = P_s \pm Z\sqrt{\frac{P_u(1-P_u)}{N}}$$

CHAPTER 8

Means

$$Z(\text{obtained}) = \frac{\overline{X} - \mu}{s/\sqrt{N-1}}$$

Proportions

$$Z(\text{obtained}) = \frac{P_s - P_u}{\sqrt{P_u(1-P_u)/N}}$$

CHAPTER 9

Means

$$Z(\text{obtained}) = \frac{(\overline{X}_1 - \overline{X}_2)}{\sigma_{\overline{x}-\overline{x}}}$$

Standard deviation of the sampling distribution for sample means

$$\sigma_{\overline{x}-\overline{x}} = \sqrt{\frac{s_1^2}{N_1 - 1} + \frac{s_2^2}{N_2 - 1}}$$

Pooled estimate of population proportion

$$P_u = \frac{N_1 P_{s1} + N_2 P_{s2}}{N_1 + N_2}$$

Standard deviation of the sampling distribution for sample proportions

$$\sigma_{p-p} = \sqrt{P_u(1-P_u)}\sqrt{(N_1 + N_2)/N_1 N_2}$$

Proportions

$$Z(\text{obtained}) = \frac{(P_{s1} - P_{s2})}{\sigma_{p-p}}$$

CHAPTER 10

Total sum of squares

$$\text{SST} = \Sigma X_i - N\overline{X}^2$$

Sum of squares between

$$\text{SSB} = \Sigma N_k(\overline{X}_k - \overline{X})^2$$

Sum of squares within

$$\text{SSW} = \text{SST} - \text{SSB}$$

Degrees of freedom for SSW

$$\text{dfw} = N - k$$

Degrees of freedom for SSB

$$\text{dfb} = k - 1$$

Mean square within

$$\text{MSW} = \frac{\text{SSW}}{\text{dfw}}$$

Mean square between

$$\text{MSB} = \frac{\text{SSB}}{\text{dfb}}$$

F ratio

$$F = \frac{\text{MSB}}{\text{MSW}}$$

CHAPTER 11

Chi square

$$\chi^2(\text{obtained}) = \sum \frac{(f_o - f_e)^2}{f_e}$$

CHAPTER 12

Phi

$$\phi = \sqrt{\frac{\chi^2}{N}}$$

Cramer's *V*

$$V = \sqrt{\frac{\chi^2}{(N)(\text{Minimum of } r-1, c-1)}}$$

Lambda

$$\lambda = \frac{E_1 - E_2}{E_1}$$

Gamma

$$G = \frac{N_s - N_d}{N_s + N_d}$$

Spearman's rho

$$r_s = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

CHAPTER 13

Least-squares regression line

$$Y = a + bX$$

Slope

$$b = \frac{\Sigma(X - \overline{X})(Y - \overline{Y})}{\Sigma(X - \overline{X})^2}$$

Y intercept

$$a = \overline{Y} - b\overline{X}$$

Pearson's *r*

$$r = \frac{\Sigma(X - \overline{X})(Y - \overline{Y})}{\sqrt{[\Sigma(X - \overline{X})^2][\Sigma(Y - \overline{Y})^2]}}$$

CHAPTER 15

Partial correlation coefficient

$$r_{yx.z} = \frac{r_{yx} - (r_{yz})(r_{xz})}{\sqrt{1 - r_{yz}^2}\sqrt{1 - r_{xz}^2}}$$

Least-squares multiple regression line

$$Y = a + b_1X_1 + b_2X_2$$

Partial slope for X_1

$$b_1 = \left(\frac{s_y}{s_1}\right)\left(\frac{r_{y1} - r_{y2}r_{12}}{1 - r_{12}^2}\right)$$

Partial slope for X_2

$$b_2 = \left(\frac{s_y}{s_2}\right)\left(\frac{r_{y2} - r_{y1}r_{12}}{1 - r_{12}^2}\right)$$

Y intercept

$$a = \overline{Y} - b_1\overline{X}_1 - b_2\overline{X}_2$$

Beta-weight for X_1

$$b_1^* = b_1\left(\frac{s_1}{s_y}\right)$$

Beta-weight for X_2

$$b_2^* = b_2\left(\frac{s_2}{s_y}\right)$$

Standardized least-squares regression line

$$Z_y = b_1^*Z_1 + b_2^*Z_2$$

Coefficient of multiple determination

$$R^2 = r_{y1}^2 + r_{y2.1}^2(1 - r_{y1}^2)$$

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Preface

Statistics are part of the everyday language of sociology and other social sciences (including political science, social work, public administration, criminal justice, urban studies, and gerontology). These disciplines are research-based and routinely use statistics to express knowledge and to discuss theory and research. To join the conversations being conducted in these disciplines, you must be literate in the vocabulary of research, data analysis, and scientific thinking. Knowledge of statistics will enable you to understand the professional research literature, conduct quantitative research yourself, contribute to the growing body of social science knowledge, and reach your full potential as a social scientist.

Although essential, learning (and teaching) statistics can be a challenge. Students in social science statistics courses typically have a wide range of mathematical backgrounds and an equally diverse set of career goals. They are often puzzled about the relevance of statistics for them, and, not infrequently, there is some math anxiety to deal with. This text introduces statistical analysis for the social sciences while addressing these realities.

The text makes minimal assumptions about mathematical background (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 help students analyze data successfully. The text has been written especially for sociology and social work programs but is sufficiently flexible to be used in any program with a social science base.

The text is written at an intermediate level and its goal is to show the relevance and value of statistics for the social sciences. I emphasize interpretation and understanding statistics in the context of social science research, but I have not sacrificed comprehensive coverage or statistical correctness. Mathematical explanations 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 in the text.[1] 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 does not 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, formula derivations, or mathematical theory, which can needlessly frustrate the learning experience at this level.

[1] A presentation of probability is available at the Web site for this text for those who are interested.

Goal of the Text

The goal of this text is to develop basic statistical literacy. The statistically literate person understands and appreciates the role of statistics in the research process, is competent to perform basic calculations, and can read and appreciate the professional research literature in his or her field as well as any research reports he or she may encounter in everyday life. This goal has not changed since the first edition of this text. However, in recognition of the fact that "mere computation" has become less of a challenge in this high-tech age, this edition continues to increase the stress on interpretation and computer applications while deemphasizing computation. This will be apparent in several ways. For example, the feature called "Interpreting Statistics" has been updated. These noncomputational sections are included in about half of the chapters and present detailed examples of "what to say after the statistics have been calculated." They use real data and real research situations to illustrate the process of developing understanding, and they exemplify how statistics can be used to answer important questions. The issues addressed in these sections include recent changes in the American family, the gender gap in income, and the correlates of street crime.

Also, in recognition of the fact that modern technology has rendered hand calculation increasingly obsolete, the end-of-chapter problems feature smaller, easier-to-handle data sets, although some more challenging problems are also included. A new section, called "Using SPSS," has been added to most chapters to demonstrate how to use a computerized statistical package to produce statistics. The end-of-chapter problems now include SPSS-based exercises, and research projects using SPSS are included at the end of almost all chapters. To accommodate the increased use of SPSS, several new data sets have been added to the text and the General Social Survey data set has been updated to 2012.

A further goal of this text is to provide examples of everyday applications of statistics. Boxed features entitled "Statistics in Everyday Life" appear in each chapter and highlight the relevance of statistics in the real world.

This edition continues to focus on the development of basic statistical literacy, the three aspects of which provide a framework for discussing the additional features of this text.

1. **An Appreciation of Statistics.** A statistically literate person understands the relevance of statistics for social research, can analyze and interpret the meaning of a statistical test, and can select an appropriate statistic for a given purpose and a given set of data. This textbook develops these skills, within the constraints imposed by the introductory nature of the course, in several ways.
   - *The relevance of statistics.* Chapter 1 includes a discussion of the role of statistics in social research and stresses their usefulness as ways of analyzing and manipulating data and answering research questions. Throughout the text, each example problem is framed in the context of a research situation. A question is posed and then, with the aid of a statistic, answered. This central theme of usefulness is further reinforced by a series of "Applying Statistics" boxes, each of which illustrates some specific way statistics can be used to answer questions, and by the "Using Statistics" feature that opens every chapter.

End-of-chapter problems are labeled by the social science discipline from which they are drawn: SOC for sociology, SW for social work, PS for political science, CJ for criminal justice, PA for public administration, and GER for gerontology. Identifying problems with specific disciplines allows students to 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.)

- *Interpreting statistics.* For most students, interpretation—saying what statistics mean—is a big challenge. The ability to interpret statistics can be developed only by exposure and experience. To provide exposure, I have been careful, in the example problems, to express the meaning of the statistic in terms of the original research question. To provide experience, the end-of-chapter problems 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. The "Interpreting Statistics" sections provide additional, detailed examples of how to express the meaning of statistics.
- *Using statistics: Ideas for research projects.* Appendix E offers ideas for independent data-analysis projects for students. The projects require students to use SPSS to analyze a data set. They can be assigned at intervals throughout the semester or at the end of the course. Each project provides an opportunity for students to practice and apply their statistical skills and, above all, to exercise their ability to understand and interpret the statistics they produce.

2. **Computational Competence.** Students should emerge from their first course in statistics with the ability to perform elementary forms of data analysis. While computers have made computation less of an issue today, computation is inseparable from statistics, so I have included a number of features to help students cope with these mathematical challenges.
   - *"One Step at a Time"* boxes for each statistic break down computation into individual steps for maximum clarity and ease.
   - *Extensive problem sets* are provided at the end of each chapter. For the most part, these problems use fictitious data and are designed for ease of computation.
   - *Cumulative exercises* are included after each of Parts I–IV to provide practice in choosing, computing, and analyzing 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* gives students access to the computational power of the computer. This is explained in more detail later.
3. **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 skill is a particular problem

at the introductory level because (1) the vocabulary of professional researchers is so much more concise than the language of the textbook, and (2) the statistics featured in the literature are more advanced than those covered at the introductory level. To help bridge this gap, I have included, beginning in Chapter 1, a series of boxes labeled "Reading Statistics." In each such 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 have been updated in this edition and most include excerpts from the research literature that 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 and clarity.* The writing style is informal and accessible to students without ignoring the traditional vocabulary of statistics. Problems and examples 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 list of frequently used formulas inside the front cover and 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, all the 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.
- *Learning objectives.* Learning objectives are stated at the beginning of each chapter. These are intended to serve as "study guides" and to help students identify and focus on the most important material.
- *Review of mathematical skills.* A comprehensive review of all of the mathematical skills that will be used in this text is included as a Prologue. Students who are inexperienced or out of practice with mathematics can study this review early in the course and/or refer to it as needed. A self-test is included so that students can check their level of preparation for the course.

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