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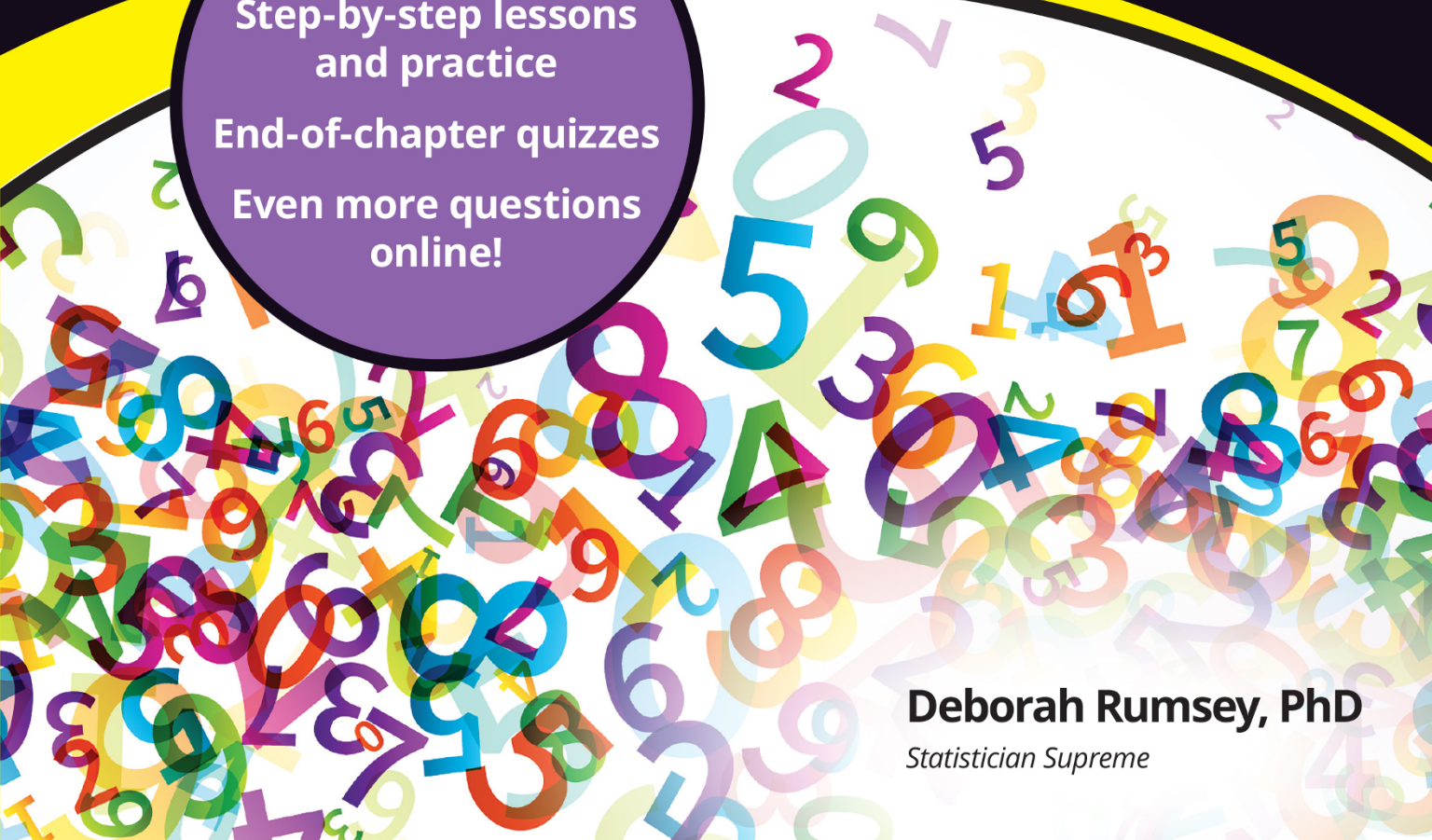

Deborah Rumsey, PhD

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Statistics All-in-One For Dummies®

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Introduction

You get hit with an incredible amount of statistical information on a daily basis. You know what I'm talking about: charts, graphs, tables, and headlines that talk about the results of the latest poll, survey, experiment, or other scientific study. The purpose of this book is to develop and sharpen your skills in sorting through, analyzing, and evaluating all that info, and to do so in a clear, fun, and pain-free way with tons of opportunities to practice. You also gain the ability to decipher and make important decisions about statistical results (for example, the results of the latest medical studies), while being ever aware of the ways that people can mislead you with statistics. And you see how to do it right when it's your turn to design the study, collect the data, crunch the numbers, and/or draw the conclusions.

This book is also designed to help those of you who are looking to get a solid foundation in introductory statistics or those taking a statistics class and wanting some backup. You'll gain a working knowledge of the big ideas of statistics and gather a boatload of tools and tricks of the trade that'll help you get ahead of the curve, especially for taking exams.

This book is chock-full of real examples from real sources that are relevant to your everyday life — from the latest medical breakthroughs, crime studies, and population trends to the latest U.S. government reports. I even address a survey on the worst cars of the millennium! By reading this book, you'll understand how to collect, display, and analyze data correctly and effectively, and you'll be ready to critically examine and make informed decisions about the latest polls, surveys, experiments, and reports that bombard you every day. You will even find out how to use crickets to gauge temperature!

You will also get to climb inside the minds of statisticians to see what's worth taking seriously and what isn't to be taken so seriously. After all, with the right skills and knowledge, you don't have to be a professional statistician to understand introductory statistics. You can be a data guru in your own right.

About This Book

This book departs from traditional statistics texts, references, supplemental books, and study guides in the following ways:

- It includes practical and intuitive explanations of statistical concepts, ideas, techniques, formulas, and calculations found in an introductory statistics course.
- It shows you clear and concise step-by-step procedures that explain how you can intuitively work through statistics problems.
- It features interesting real-world examples relating to your everyday life and workplace.

- It contains plenty of excellent practice problems crafted in a straightforward manner to lead you down the path of success.
- It offers not only answers, but also clear, complete explanations of the answers. Explanations help you know exactly how to approach a problem, what information you need to solve it, and common problems you need to avoid.
- It includes tips, strategies, and warnings based on my vast experience with students of all backgrounds and learning styles.
- It gives you upfront and honest answers to your questions like, "What does this really mean?" and "When and how will I ever use this?"

As you work your way through the lessons and problems in this book, you should be aware of four conventions that I've used.

- **Dual use of the word *statistics:*** In some situations, I refer to statistics as a subject of study or as a field of research, so the word is a singular noun. For example, "Statistics is really quite an interesting subject." In other situations, I refer to statistics as the plural of *statistic,* in a numerical sense. For example, "The most commonly used statistics are the mean and the standard deviation."
- **Use of the word *data:*** You're probably unaware of the debate raging among statisticians about whether the word *data* should be singular ("data is ") or plural ("data are "). It got so bad that one group of statisticians had to develop two versions of a statistics T-shirt: "Messy Data Happens" and "Messy Data Happen." I go with the plural version of the word *data* in this book.
- **Use of the term *standard deviation:*** When I use the term *standard deviation,* I mean *s,* the sample standard deviation. (When I refer to the population standard deviation, I let you know.)
- **Use of *italics:*** I use *italics* to let you know a new statistical term is appearing on the scene. Look for a definition accompanying its first appearance.

Foolish Assumptions

I don't assume that you've had any previous experience with statistics, other than the fact that you're a member of the general public who gets bombarded every day with statistics in the form of numbers, percents, charts, graphs, "statistically significant" results, "scientific" studies, polls, surveys, experiments, and so on.

What I do assume is that you can do some of the basic mathematical operations and understand some of the basic notation used in algebra, such as the variables x and y, summation signs (Σ), taking the square root, squaring a number, and so on. If you need to brush up on your algebra skills, check out *U Can Algebra I For Dummies* by Mary Jane Sterling (Wiley).

I don't want to mislead you: You do encounter formulas in this book, because statistics does involve a bit of number crunching. But don't let that worry you. I take you slowly and carefully

through each step of any calculations you need to do, explaining things both with notation and without. I also provide practice questions for you to work so you can become familiar and comfortable with the calculations and make them your own.

Icons Used in This Book

You'll see the following five icons throughout the book:

EXAMPLE

Each example is a stat question based on the discussion and explanation, followed by a solution. Work through these examples, and then refer to them to help you solve the practice problems that follow them as well as the quiz questions at the end of the chapter.

REMEMBER

This icon points out important information that you need to focus on. Make sure you understand this information fully before moving on. You can skim through these icons when reading a chapter to make sure you remember the highlights.

TIP

Tips are hints that can help speed you along when answering a question. See whether you find them useful when working on practice problems.

WARNING

This icon flags common mistakes that students make if they're not careful. Take note and proceed with caution!

YOUR TURN

When you see this icon, it's time to put on your thinking cap and work out a few practice problems on your own. The answers and detailed solutions are available so you can feel confident about your progress.

Beyond the Book

In addition to the material in the print or e-book you're reading right now, this book also comes with a handy online Cheat Sheet. Use it when you need a quick refresher on a formula or the next step in conducting a hypothesis test. To get this Cheat Sheet, simply go to `www.dummies.com` and type **Statistics All in One For Dummies Cheat Sheet** in the Search box.

You'll also have access to online quizzes related to each chapter, beginning with Unit 2, Chapter 4. These quizzes provide a whole new set of problems for practice and confidence-building. To access the quizzes, follow these simple steps:

1. **Register your book or ebook at Dummies.com to get your PIN. Go to `www.dummies.com/go/getaccess`.**
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Now you're ready to go! You can come back to the practice material as often as you want — simply log on with the username and password you created during your initial login. No need to enter the access code a second time.

Your registration is good for one year from the day you activate your PIN.

Where to Go from Here

This book is written in such a way that you can start anywhere and still be able to understand what's going on. So you can take a peek at the table of contents or the index, look up the information that interests you, and flip to the page listed. However, if you have a specific topic in mind and are eager to dive into it, here are some directions:

- To work on interpreting graphs, charts, means or medians, and the like, head to Unit 2.
- To find info on the normal, *Z*-, *t*-, or binomial distributions or the Central Limit Theorem, see Unit 3.
- To focus on confidence intervals and hypothesis tests of all shapes and sizes, flip to Unit 4.
- To delve into surveys, experiments, regression, and two-way tables, see Unit 5.

Or if you aren't sure where you want to start, start with Chapter 1 for the big picture and then plow your way through the rest of the book. Ready, set, go!

1 Getting Started with Statistics

In This Unit . . .

CHAPTER 1: **The Statistics of Everyday Life**

Statistics and the Media: More Questions than Answers?
Using Statistics at Work

CHAPTER 2: **Taking Control: So Many Numbers, So Little Time**

Detecting Errors, Exaggerations, and Just Plain Lies
Feeling the Impact of Misleading Statistics

CHAPTER 3: **Tools of the Trade**

Thriving in a Statistical World
Statistics: More than Just Numbers
Designing Appropriate Studies
Collecting Quality Data
Grabbing Some Basic Statistical Jargon
Drawing Credible Conclusions
Becoming a Sleuth, Not a Skeptic

IN THIS CHAPTER

- Raising questions about statistics you see in everyday life
- Encountering statistics in the workplace

Chapter 1
The Statistics of Everyday Life

Today's society is completely taken over by numbers. Numbers are everywhere you look, from billboards showing the on-time statistics for a particular airline, to sports shows discussing the Las Vegas odds for upcoming football games. The evening news is filled with stories focusing on crime rates, the expected life span of junk-food junkies, and the president's approval rating. On a normal day, you can run into 5, 10, or even 20 different statistics (with many more on election night). Just by reading a Sunday newspaper all the way through, you come across literally hundreds of statistics in reports, advertisements, and articles covering everything from soup (how much does an average person consume per year?) to nuts (almonds are known to have positive health effects — what about other types of nuts?).

In this chapter we discuss the statistics that often appear in your life and work, and talk about how statistics are presented to the general public. After reading this chapter, you'll realize just how often the media hits you with numbers and how important it is to be able to unravel the meaning of those numbers. Like it or not, statistics are a big part of your life. So, if you can't beat 'em, join 'em. And if you don't want to join 'em, at least try to understand 'em.

Statistics and the Media: More Questions than Answers?

Open a newspaper and start looking for examples of articles and stories involving numbers. It doesn't take long before those numbers begin to pile up. Readers are inundated with results of studies, announcements of breakthroughs, statistical reports, forecasts, projections, charts, graphs, and summaries. The extent to which statistics occur in the media is mind-boggling. You may not even be aware of how many times you're hit with numbers nowadays.

This section looks at just a few examples from one Sunday paper's worth of news that I read the other day. When you see how frequently statistics are reported in the news without providing all the information you need, you may find yourself getting nervous, wondering what you can and can't believe anymore. Relax! That's what this book is for — to help you sort out the good information from the bad (the chapters in Unit 2 give you a great start on that).

Probing popcorn problems

The first article I came across that dealt with numbers was "Popcorn plant faces health probe," with the subheading: "Sick workers say flavoring chemicals caused lung problems." The article describes how the Centers for Disease Control (CDC) expressed concern about a possible link between exposure to chemicals in microwave popcorn flavorings and some cases of fixed obstructive lung disease. Eight people from one popcorn factory alone contracted this lung disease, and four of them were awaiting lung transplants.

According to the article, similar cases were reported at other popcorn factories. Now, you may be wondering, what about the folks who eat microwave popcorn? According to the article, the CDC found "no reason to believe that people who eat microwave popcorn have anything to fear." (Stay tuned.) The next step is to evaluate employees in more depth, including conducting surveys to determine health and possible exposures to the flavoring chemicals, checks of lung capacity, and detailed air samples. The question here is: How many cases of this lung disease constitute a real pattern, compared to mere chance or a statistical anomaly? (You find out more about this in Chapter 15.)

Venturing into viruses

A second article discussed a recent cyber attack: A wormlike virus made its way through the Internet, slowing down web browsing and email delivery around the world. How many computers were affected? The experts quoted in the article said that 39,000 computers were infected, and they in turn affected hundreds of thousands of other systems.

Questions: How did the experts get that number? Did they check each computer out there to see whether it was affected? The fact that the article was written less than 24 hours after the attack suggests the number is a guess. Then why say 39,000 and not 40,000 — to make it seem less like a guess? To find out more on how to guesstimate with confidence (and how to evaluate someone else's numbers), see Chapter 14.

Comprehending crashes

Next in the paper was an alert about the soaring number of motorcycle fatalities. Experts said that the *fatality rate* — the number of fatalities per 100,000 registered vehicles — for motorcyclists has been steadily increasing, as reported by the National Highway Traffic Safety Administration (NHTSA). In the article, many possible causes for the increased motorcycle death rate were discussed, including age, gender, size of engine, whether the driver had a license, alcohol use, and state helmet laws (or lack thereof). The report was very comprehensive, showing various tables and graphs with the following titles:

- Motorcyclists killed and injured, and fatality and injury rates by year, per number of registered vehicles, and per millions of vehicle miles traveled
- Motorcycle rider fatalities by state, helmet use, and blood alcohol content
- Occupant fatality rates by vehicle type (motorcycles, passenger cars, light trucks), per 10,000 registered vehicles and per 100 million vehicle miles traveled
- Motorcyclist fatalities by age group
- Motorcyclist fatalities by engine size (displacement)
- Previous driving records of drivers involved in fatal traffic crashes by type of vehicle (including previous crashes, DUI convictions, speeding convictions, and license suspensions and revocations)

This article was very informative and provided a wealth of detailed information regarding motorcycle fatalities and injuries in the U.S. However, the onslaught of so many tables, graphs, rates, numbers, and conclusions can be overwhelming and confusing and lead you to miss the big picture. With a little practice, and help from Unit 2, you'll be better able to sort out graphs, tables, and charts and all the statistics that go along with them. For example, some important statistical issues come up when you see rates versus counts (such as death rates versus number of deaths). As I address in Chapter 2, counts can give you misleading information if they're used when rates would be more appropriate.

Mulling malpractice

Further along in the newspaper was a report about a recent medical malpractice insurance study: Malpractice cases affect people in terms of the fees doctors charge and the ability to get the healthcare they need. The article indicates that one in five Georgia doctors have stopped doing risky procedures (such as delivering babies) because of the ever-increasing malpractice insurance rates in the state. This is described as a "national epidemic" and a "health crisis" around the country. Some brief details of the study are included, and the article states that of the 2,200 Georgia doctors surveyed, 2,800 of them — which they say represent about 18 percent of those sampled — were expected to stop providing high-risk procedures.

Wait a minute! That can't be right. Out of 2,200 doctors, 2,800 don't perform the procedures, and that is supposed to represent 18 percent? That's impossible! You can't have a bigger number on the top of a fraction, and still have the fraction be under 100 percent, right? This is one

of many examples of errors in media reporting of statistics. So what's the real percentage? There's no way to tell from the article. Chapter 4 nails down the particulars of calculating these kinds of statistics so you can know what to look for and immediately tell when something's not right.

Belaboring the loss of land

In the same Sunday paper was an article about the extent of land development and speculation across the United States. Knowing how many homes are likely to be built in your neck of the woods is an important issue to get a handle on. Statistics are given regarding the number of acres of farmland being lost to development each year. To further illustrate how much land is being lost, the area is also listed in terms of football fields. In this particular example, experts said that the mid-Ohio area is losing 150,000 acres per year, which is 234 square miles, or 115,385 football fields (including end zones). How do people come up with these numbers, and how accurate are they? And does it help to visualize land loss in terms of the corresponding number of football fields? I discuss the accuracy of data collected in more detail in Chapter 17.

Scrutinizing schools

The next topic in the paper was school proficiency — specifically, whether extra school sessions help students perform better. The article stated that 81.3 percent of students in this particular district who attended extra sessions passed the writing proficiency test, whereas only 71.7 percent of those who didn't participate in the extra school sessions passed it. But is this enough of a difference to account for the $386,000 price tag per year? And what's happening in these sessions to cause an improvement? Are students in these sessions spending more time just preparing for those exams rather than learning more about writing in general? And here's the big question: Were the participants in the extra sessions student volunteers who may be more motivated than the average student to try to improve their test scores? The article didn't say.

Studies like this appear all the time, and the only way to know what to believe is to understand what questions to ask and to be able to critique the quality of the study. That's all part of statistics! The good news is, with a few clarifying questions, you can quickly critique statistical studies and their results. Chapter 18 helps you do just that.

Scanning sports

The sports section is probably the most numerically jam-packed section of the newspaper. Beginning with game scores, the win/loss percentages for each team, and the relative standing for each team, the specialized statistics reported in the sports world are so deep that they require wading boots to get through. For example, basketball statistics are broken down by team, by quarter, and by player. For each player, you get minutes played, field goals, free throws, rebounds, assists, personal fouls, turnovers, blocks, steals, and total points.

Who needs to know this stuff, besides the players' mothers? Apparently, many fans do. Statistics are something that sports fans can never get enough of and players often can't stand to hear about. Stats are the substance of water-cooler debates and the fuel for armchair quarterbacks around the world.