

review.” Explain the terms in parentheses to someone who knows nothing about medical trials.

29. Eye cataracts are responsible for over 40% of blindness around the world. Can drinking tea regularly slow the growth of cataracts? We can't experiment on people, so we use rats as subjects. Researchers injected 14 young rats with a substance that causes cataracts. Half the rats also received tea extract; the other half got a placebo. The response variable was the growth of cataracts over the next six weeks. Yes, the tea extract did slow cataract growth.

- (a) Outline the design of this experiment.
- (b) Use Table 7.1, starting at line 108, to assign rats to treatments.

■ 30. The rats in the previous exercise were labeled 01 to 14 in order to use the table of random digits. Unknown to the researchers, the 5 rats labeled 01 to 05 have a genetic defect that favors cataracts. If we simply put rats 01 to 07 in the tea group, the experiment would be biased against tea. We can observe how random selection works to reduce bias by keeping track of how many of these 5 rats get assigned to the tea group. Carry out the random assignment of 7 rats to the tea group 20 times, keeping track of how many of rats 01 to 05 are in the tea group each time. Make a histogram of the count of rats 01 to 05 assigned to tea. What is the average number in your 20 tries?

7.6 Experiments Versus Observational Studies

◆ 31. People who eat lots of fruits and vegetables have lower rates of colon cancer than those who eat little of these foods. Fruits and vegetables are rich in antioxidants such as vitamins A, C, and E. Will taking antioxidants help prevent colon cancer? A clinical trial studied this question with 864 people who were at risk for colon cancer. The subjects were divided into four groups: daily beta-carotene, daily vitamins C and E, all three vitamins every day, and daily placebo. After four years, the researchers were surprised to find no significant difference in colon cancer among the groups.

- (a) Outline the design of the experiment. Use your judgment in choosing the group sizes.
- (b) Assign labels to the 864 subjects and use Table 7.1, starting at line 118, to choose the first five subjects for the beta-carotene group.
- (c) The study was double-blind. What does this mean?
- (d) What does “no significant difference” mean in describing the outcome of the study?
- (e) Suggest some characteristics of the kind of people who eat lots of fruits and vegetables that might explain lower rates of colon cancer. The experiment suggests that these variables, rather than the antioxidants, may be responsible for the observed benefits of fruits and vegetables.

◆ 32. The financial aid office of a university asks a sample of students about their employment and earnings. The report says that “for academic year earnings, a statistically significant difference was found between the sexes, with men earning more on the average. No significant difference was found between the earnings of black and white students.” Explain both of these conclusions, for the effects of sex and of race on average earnings, in language understandable to someone who knows no statistics.

◆ 33. Do those high center brake lights, required on all cars sold in the United States since 1986, really reduce rear-end collisions? Randomized comparative experiments with fleets of rental and business cars, done before the lights were required, showed that the third brake light reduced rear-end collisions by as much as 50%. Alas, requiring the third light in all cars led to only a 5% drop. Explain why the experiment did not realistically imitate conditions after the lights were required.

◆ 34. A psychologist studies how much people disclose about themselves to other people met at a party. He arranges for student subjects to be introduced to new people. The subjects are both female and male and both black and white. The results show that “there were no significant race effects, but self-disclosure was significantly higher among females than among males.” Explain what this means in language understandable to someone who knows no statistics. Do not use the word *significance* in your answer.

◆ 35. In the July 15, 2007 issue of *Cancer*, a study reported on 533,715 women at least 40 years old who were diagnosed with invasive breast cancer and reported to the National Cancer Data Base. The study found strong evidence that patients without health insurance were more likely to have a more advanced stage (i.e., III or IV) of cancer. Is this an experiment or observational study and how do you know?

7.7 Inference: From Sample to Population

36. An opinion poll uses random digit dialing equipment to dial 2000 randomly chosen residential telephone numbers. Of these, 631 are unlisted numbers. This isn't surprising, because 35% of all residential numbers are unlisted. For each underlined number, state whether it is a parameter or a statistic.

37. The Tennessee STAR experiment randomly assigned children to regular or small classes during their first four years of school. When these children reached high school, 40.2% of blacks from small classes took the ACT or SAT college entrance exams. Only 31.7% of blacks from regular classes took one of these exams. For each underlined number, state whether it is a parameter or a statistic.

38. The College Alcohol Study interviewed an SRS of 14,941 college students about their drinking habits. Suppose that half of all college students “drink to get drunk” at least once in a while. That is, $p = 0.5$.

- What are the mean and standard deviation of the proportion \hat{p} of the sample who drink to get drunk?
- In what range of values do the proportions \hat{p} from 95% of all samples fall?
- In what range of values do the proportions \hat{p} from 99.7% of all samples fall?

39. Harley-Davidson motorcycles make up 14% of all the motorcycles registered in the United States. You plan to interview an SRS of 500 motorcycle owners.



(Peter Turnley/Corbis)

- What is the approximate distribution of the proportion of your sample who own Harleys?
- In 95% of all samples like this one, the proportion of the sample who own Harleys will fall between _____ and _____. What are the missing numbers?

40. Exercise 38 asks what values the sample proportion \hat{p} is likely to take when the population proportion is $p = 0.5$ and the sample size is $n = 14,941$. What range covers the middle 95% of values of \hat{p} when $p = 0.5$ and $n = 1000$? When $n = 4000$? When $n = 16,000$? What general fact about the behavior of \hat{p} do your results illustrate?

■ 41. You can use a table of random digits to *simulate* sampling from a population. Suppose that 60% of the population bought a lottery ticket in the last 12 months. We will simulate the behavior of random samples of size 40 from this population.

- Let each digit in the table stand for one person in this population. Digits 0 to 5 stand for people who bought a lottery ticket, and 6 to 9 stand for people who did not. Why does looking at one digit from Table 7.1 simulate drawing one person at random from a population with 60% “yes”?
- Each row in Table 7.1 contains 40 digits. So the first 10 rows represent the results of 10 samples. How many digits between 0 and 5 does the top row contain? What is the percent of “yes” responses in this sample? How many of your 10 samples overestimated the

population truth 60%? How many underestimated it? You could program a computer to continue this process, say 1000 times, to produce a pattern like that in Figure 7.4.

7.8 Confidence Intervals

42. In a random sample of students who took the SAT Reasoning college entrance examination twice, it was found that 427 of the respondents had paid for coaching courses and that the remaining 2733 had not. Give a 95% confidence interval for the proportion of coaching among students who retake the SAT.

43. A Gallup poll asked each of 1785 randomly selected adults whether she happened to attend a house of worship in the previous seven days. Of the respondents, 750 said “yes.” Give a 95% confidence interval for the proportion of all adults who claim that they attended a house of worship during the week preceding the poll. (The proportion who actually attended may be lower—some people say “yes” if they often attend, even if they didn’t attend that particular week.)

44. *The New York Times* and CBS News conducted a nationwide survey of 1048 randomly selected 13- to 17-year-olds. Of these teenagers, 692 had a television in their room.

- Give a 95% confidence interval for the proportion of all teens who have a TV set in their room.
- The news article says, “In theory, in 19 cases out of 20, the survey results will differ by no more than three percentage points in either direction from what would have been obtained by seeking out all American teenagers.” Explain how your results agree with this statement.

◆ 45. A telephone survey of 880 randomly selected drivers asked, “Recalling the last 10 traffic lights you drove through, how many of them were red when you entered the intersections?” Of the 880 respondents, 171 admitted that at least one light had been red.

- Give a 95% confidence interval for the proportion of all drivers who ran one or more of the last 10 red lights they met.
- A practical problem with this survey is that people may not give truthful answers. What is the likely direction of the bias: Do you think more or fewer than 171 of the 880 respondents really ran a red light? Why?

◆ 46. The Harris poll asked a sample of 1009 adults which causes of death they thought would become more common in the future. Topping the list was gun violence: 70% of the sample thought deaths from guns would increase.

- How many of the 1009 people interviewed thought deaths from gun violence would increase?
- Harris says that the margin of error for this poll is plus or minus 3 percentage points. Explain to someone

who knows no statistics what “margin of error plus or minus 3 percentage points” means.

(c) Give a 95% confidence interval for this survey. Does your margin of error agree with the 3 percentage points announced by Harris?

◆ 47. Consider the margin of error formula

$$2\sqrt{\hat{p}(1 - \hat{p})/n}.$$

(a) For a fixed value of n , what value of \hat{p} causes this formula to be the largest value it can be?

(b) Using the answer to part (a), what is a simplified (and slightly more conservative) formula for the margin of error?

◆ 48. A news article reports that in a recent Gallup poll, 78% of the sample of 1108 adults said they believe there is a heaven. Only 60% said they believe there is a hell. The news article ends, “The poll’s margin of sampling error was plus or minus four percentage points.” Can we be certain that between 56% and 64% of all adults believe there is a hell? Explain your answer.

◆ 49. A survey of Internet users found that males outnumbered females by nearly 2 to 1. This was a surprise, because earlier surveys had put the ratio of men to women closer to 9 to 1. Later in the article we find that surveys were sent to 13,000 organizations and that 1468 of these responded. The survey report claims that “the margin of error is 2.8 percent, with 95 percent confidence.”

(a) What was the *response rate* for this survey? (The response rate is the percent of the planned sample that responded.)

(b) Do you think that the small margin of error is a good measure of the accuracy of the survey’s results? Explain your answer.

50. A recent Gallup poll found that 68% of adult Americans favor teaching creationism along with evolution in public schools. The Gallup press release says:

For results based on samples of this size, one can say with 95 percent confidence that the maximum error attributable to sampling and other random effects is plus or minus 3 percentage points.

Give one example of a source of error in the poll result that is *not* included in this margin of error.

■ 51. The Internal Revenue Service plans to examine an SRS of individual income tax returns from each state that were filed electronically. One variable of interest is the proportion of returns that were filed by a tax practitioner rather than by an individual taxpayer. The total number of e-filed tax returns in a state varies from 4.9 million in California to 97,000 in Vermont.

(a) Will the margin of error for estimating the proportion change from state to state if an SRS of 1000 e-filed returns is selected in each state? Explain your answer.

(b) Will the margin of error change from state to state if an SRS of 1% of all e-filed returns is selected in each state? Explain your answer.

■ 52. Exercise 46 describes a Harris poll that interviewed 1009 people. Suppose you want a margin of error half as large as the one you found in that exercise. How many people must you plan to interview?

■ 53. Though opinion polls usually make 95% confidence statements, some sample surveys use other confidence levels. The monthly unemployment rate, for example, is based on the Current Population Survey of about 60,000 households. The margin of error in the unemployment rate is announced as about $\pm 0.15\%$ with 90% confidence. Is the margin of error for 90% confidence larger or smaller than the margin of error for 95% confidence? Why? (*Hint*: Look at Figure 7.7 again.)

Chapter Review

54. The proportion of one’s body that is fat is a key indicator of fitness. The many ways to estimate this have different margins of error (given in percentage points):

method	calipers pinch	bioelectrical impedance	body mass index calculator	hydrostatic weighing (dunk test)
margin of error	± 3	± 4	± 10	± 1

(a) Which of these tests is the least accurate?

(b) If the pinch test says you have 21% body fat, what is the 95% confidence interval for this estimate?

55. Many medical trials randomly assign patients to either an active treatment or a placebo. These trials are always double-blind. Sometimes the patients can tell whether or not they are getting the active treatment. This defeats the purpose of blinding. Reports of medical research usually ignore this problem. Investigators looked at a random sample of 97 articles reporting on placebo-controlled randomized trials in the top five general medical journals. Only 7 of the 97 discussed the success of blinding. Give a 95% confidence interval for the proportion of all such articles that discuss the success of blinding. [Dean Fergusson et al., Turning a blind eye: The success of blinding reported in a random sample of randomised, placebo-controlled trials, *British Medical Journal*, 328 (2004): 432–436.]

56. Tomeka wants to ask a sample of students at her college, “Do you think that Social Security will still be paying benefits when you retire?” She obtains the college email addresses of the 2654 students.

(a) How would you label the addresses in order to choose a simple random sample of 100 students?

(b) Use Table 7.1, starting at line 103, to choose the first three labels in the sample.

(c) Tomeka sends her question by email to the 100 addresses in her sample. Although she has chosen an