

Time Out to Think

In Example 6, suppose the poll found the candidate had 55% of the vote. Should she be confident of a win?

QUICK QUIZ

Choose the best answer to each of the following questions. Explain your reasoning with one or more complete sentences.

- You conduct a poll in which you randomly select 1000 registered voters from Texas and ask if they approve of the job their governor is doing. The *population* for this study is
 - all registered voters in the state of Texas.
 - the 1000 people that you interview.
 - the governor of Texas.
- Results of the poll described in question 1 would most likely suffer from *bias* if you chose the participants from
 - all registered voters in Texas.
 - all people with a Texas driver's license.
 - people who donated money to the governor's campaign.
- When we say that a sample is *representative* of the population, we mean that
 - the results found for the sample are similar to those we would find for the entire population.
 - the sample is very large.
 - the sample was chosen in the best possible way.
- Consider an experiment designed to test whether cash incentives improve school attendance. The researcher chooses two groups of 100 high school students. She offers one group \$10 for every week of perfect attendance. She tells the other group that they are part of an experiment but does not give them any incentive. The students who do not receive an incentive represent
 - the treatment group.
 - the control group.
 - the observation group.
- The experiment described in question 4 is
 - single-blind.
 - double-blind.
 - not blind.
- The purpose of a *placebo* is
 - to prevent participants from knowing whether they belong to the treatment group or the control group.
 - to distinguish between the cases and the controls in a case-control study.
 - to determine whether diseases can be cured without any treatment.
- If we see a *placebo effect* in an experiment to test a new treatment designed to cure warts, we know that
 - the experiment was not properly double-blind.
 - the experimental groups were too small.
 - the warts of those in the control group were cured.
- An experiment is single-blind if
 - it lacks a treatment group.
 - it lacks a control group.
 - the participants do not know whether they belong to the treatment or the control group.
- Poll X predicts that Powell will receive 49% of the vote, while Poll Y predicts that he will receive 53% of the vote. Both polls have a margin of error of 3 percentage points. What can you conclude?
 - One of the two polls must have been conducted poorly.
 - The two polls are consistent with each other.
 - Powell will receive 51% of the vote.
- A survey reveals that 12% of Americans believe Elvis is still alive, with a margin of error of 4 percentage points. The confidence interval for this poll is
 - from 10% to 14%.
 - from 8% to 16%.
 - from 4% to 20%.

Exercises

REVIEW QUESTIONS

- Why do we say that the term *statistics* has two meanings? Describe both meanings.
- Define the terms *population*, *sample*, *population parameter*, and *sample statistics* as they apply to statistical studies.
- Describe the five basic steps in a statistical study, and give an example of their application.
- Why is it so important that a statistical study use a representative sample? Briefly describe four common sampling methods.

- 6. What is bias? How can it affect a statistical study? Give examples of several forms of bias.
- 7. Describe and contrast observational studies and experiments. What do we mean by the treatment group and control group in an experiment? What do we mean by the cases and controls in an observational case-control study?
- 8. What is a placebo? Describe the placebo effect and how it can make experiments difficult to interpret. How can making an experiment single-blind or double-blind help?
- 9. What is meant by the margin of error in a survey or opinion poll? How is it used to identify a confidence interval?

DOES IT MAKE SENSE?

Decide whether each of the following statements makes sense (or is clearly true) or does not make sense (or is clearly false). Explain your reasoning.

- 9. In my experimental study, I used a sample that was larger than the population.
- 10. I followed all the guidelines for sample selection carefully, yet my sample still did not reflect the characteristics of the population.
- 11. I wanted to test the effects of vitamin C on colds, so I gave the treatment group vitamin C and gave the control group vitamin D.
- 12. I don't believe the results of the experiment, because the results were based on interviews but the study was not double-blind.
- 13. The pre-election poll found that Kennedy would get 58% of the vote, with a margin of error of 4%, but he ended up losing the election.
- 14. By choosing my sample carefully, I can make a good estimate of the average height of Americans by measuring the heights of only 500 people.

BASIC SKILLS & CONCEPTS

15–20: Population and Sample. For the following studies, describe the population, sample, population parameters, and sample statistics.

- 15. In order to gauge public opinion on how to handle Iran's growing nuclear program, the Pew Research Center surveyed 1001 Americans by telephone.
- 16. Astronomers typically determine the distance to a galaxy (a huge collection of billions of stars) by measuring the distances to just a few stars within it and taking the mean (average) of these distance measurements.
- 17. An AP/CBS telephone poll of 998 randomly selected Americans revealed that 6 in 10 people believe there has been progress in finding a cure for cancer in the last 30 years.
- 18. A Gallup poll of 1051 American adults shows that 32% of Americans say they have been spending less in recent months and 27% say they are saving more now and intend to make this their new, normal pattern in the years ahead.
- 19. In a USA Today/Gallup poll of 1027 Americans surveyed by cell phones and land lines, 62% of those who responded said that there should be an investigation of anti-terror tactics used during the Bush administration.

- 20. The Higher Education Research Institute conducts an annual study of attitudes of incoming college students by surveying approximately 241,000 first-year students at 340 colleges and universities. There are approximately 1.4 million first-year college students in this country.

21–26: Steps in a Study. Describe how you would apply the five basic steps of a statistical study to the following issues.

- 21. You want to determine the average number of hours per week that ninth-graders spend on cell phones.
- 22. A supermarket manager wants to determine whether the variety of products in her store meets customers' needs.
- 23. You want to know the percentage of male college students in America who play chess at least once per week.
- 24. You want to know the typical percentage of the bill that is left as a tip in restaurants.
- 25. You want to know the average time to failure of batteries in a particular model of laptop computer.
- 26. You want to know the percentage of high school students who are vegetarians.
- 27. Representative Sample? You want to determine the average percentage of classes skipped by first-year students at a small college during a particular semester. Determine, with an explanation, which of the following samples are likely to be representative and which are not likely to be representative.
 - 100 first-year students who belong to a sorority or fraternity
 - 100 first-year students who play a varsity sport
 - The first 100 first-year students whom you meet at the student union
 - 100 first-year students taking honors humanities courses
- 28. Representative Sample? You want to determine the typical dietary habits of students at a college. Which of the following would make the best sample, and why? Also explain why each of the other choices would *not* make a good sample for this study.
 - Students in a single dormitory
 - Students majoring in public health
 - Students who participate in intercollegiate sports
 - Students enrolled in a required mathematics class

29–34: Identify the Sampling Method. Identify the sampling method (simple random sampling, systematic sampling, convenience sampling, or stratified sampling) in the following studies.

- 29. An IRS (Internal Revenue Service) auditor randomly selects for audits 30 taxpayers in each of the filing status categories: single, head of household, married filing jointly, and married filing separately.
- 30. People magazine chooses its "25 most beautiful women" by looking at responses from readers who voluntarily mail in a survey printed in the magazine.
- 31. A study of the use of antidepressants selects 50 participants between the ages of 20 and 29, 50 participants between the ages of 30 and 39, and 50 participants between the ages of 40 and 49.

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32. Every 100th computer chip that is produced is given a reliability test.
33. A computer randomly selects 400 names from a list of all registered voters. Those selected are surveyed to predict who will win the election for mayor.
34. A taste test for chips and salsa is conducted at the entrance to a supermarket.
- 35–40: **Type of Study.** Determine whether the following studies are observational studies or experiments. If the study is an experiment, identify the control and treatment groups, and discuss whether single- or double-blinding is necessary. If the study is observational, state whether it is a case-control study, and if so, identify the cases and controls.
35. A study at the University of Southern California separated 108 volunteers into groups, based on psychological tests designed to determine how often they lied and cheated. Those with a tendency to lie had different brain structures than those who did not lie (*British Journal of Psychiatry*).
36. A National Cancer Institute study of 716 melanoma patients and 1014 cancer-free patients matched by age, sex, and race found that those having a single large mole had twice the risk of melanoma. Having 10 or more moles was associated with a 12 times greater risk of melanoma (*Journal of the American Medical Association*).
37. In a study done at Boston University, researchers took snapshots of 4000 white adults every four years for 30 years and determined that 9 of 10 men and 7 of 10 women will eventually become overweight (*Annals of Internal Medicine*).
38. A breast cancer study began by asking 25,624 women questions about how they spent their leisure time. The health of these women was tracked over the next 15 years. Those women who said they exercised regularly were found to have lower incidence of breast cancer (*New England Journal of Medicine*).
39. A double-blind drug versus placebo study of 103 patients suffering from tinnitus (the perception of ringing in the ears) demonstrated the effectiveness of ginkgo biloba extract. The ginkgo treatment improved the condition of all the tinnitus patients (*Annals of Otolaryngology, Rhinology, and Laryngology*).
40. Using a survey of 35,000 Americans, the Pew Forum on Religion and Public Life determined that between 47 and 59 percent of adults switch their religious affiliation at least once in their lives.
- 41–46: **What Type of Study?** What type of statistical study is most likely to lead to an answer to the following questions?
41. Is magnet therapy a more effective way to treat headaches than aspirin or doing nothing at all?
42. Which of eight airlines has the lowest percentage of delayed flights?
43. Which National Football League team has the linemen with the greatest average weight?
44. Which of the leading brands of insect repellent provides the best protection from mosquitoes?
45. Does taking a multivitamin a day reduce the incidence of strokes?
46. Are the Sunday horoscopes in a local newspaper more accurate than the weekday horoscopes?
- 47–50: **Margin of Error.** The following summaries of statistical studies give a sample statistic and a margin of error. Find the confidence interval and answer any additional questions.
47. A poll is conducted the day before an election for state senator. There are only two candidates running. The poll shows that 53% of the voters surveyed favor the Republican candidate, with a margin of error of ± 2.5 percentage points. Should the Republican plan a victory party? Why or why not?
48. In an NBC News/*Wall Street Journal* poll of 500 adults nationwide, 53% of those surveyed answered yes to the question, "Do you favor a law to ban the sale of assault weapons and semiautomatic rifles?" The margin of error was ± 4.4 percentage points. Would you claim that a majority of American support such a law?
49. A national survey by the Pew Research Center for the People and the Press of 1521 respondents reached on land lines and cell phones found that the percentage of adults who favor legalized abortion has dropped from 54% a year ago to 46%. The study claimed that the error attributable to sampling is ± 3 percentage points. Would you claim that a majority of American oppose legalized abortion?
50. In a survey of 1002 people, 701 (which is 70%) said that they voted in the most recent presidential election (based on data from ICR Research Group). The margin of error for the survey was ± 3 percentage points. However, actual voting records show that only 61% of all eligible voters actually did vote. Does this necessarily imply that people lied when they answered the survey?

FURTHER APPLICATIONS

51–54: **Experimental Results.** Consider the following results of experiments designed to measure the efficacy of a new drug. The new drug was given to participants in the treatment group, while a placebo was given to those in the control group. Discuss whether there is evidence that the treatment is effective.

51. 70% of those in the treatment group showed improvement; 30% of those in the placebo group showed improvement.
52. 45% of those in the treatment group showed improvement; 45% of those in the placebo group showed improvement.
53. 90% of those in the treatment group showed improvement; 50% of those in the placebo group showed improvement.
54. 25% of those in the treatment group showed improvement; 50% of those in the placebo group showed improvement.

55–60: **Real Studies.** Consider the following statistical studies.

- Identify the population and the population parameter of interest.
 - Describe the sample and sample statistic for the study.
 - Identify the type of study.
 - Discuss what additional facts you would like to know before you believed the study or acted on the results of the study.
55. A study done at the Center for AIDS and STD at the University of Washington tracked the survival rates of 17,517 asymptomatic