Chapter 1: Introduction to Statistics

Section 1-1: Statistical and Critical Thinking

1. The respondents are a voluntary response sample or a self-selected sample. Because those with strong interests in the topic are more likely to respond, it is very possible that their responses do not reflect the opinions or behavior of the general population.

2. a. The sample consists of the 1046 adults who were surveyed. The population consists of all adults.
    b. When asked, respondents might be inclined to avoid the shame of the unhealthy habit of not washing their hands, so the reported rate of 70% might well be much higher than it is in reality. It is generally better to observe or measure human behavior than to ask subjects about it.

3. Statistical significance is indicated when methods of statistics are used to reach a conclusion that a treatment is effective, but common sense might suggest that the treatment does not make enough of a difference to justify its use or to be practical. Yes, it is possible for a study to have statistical significance, but not practical significance.

4. No. Correlation does not imply causation. The example illustrates a correlation that is clearly not the result of any interaction or cause effect relationship between deaths in swimming pools and power generated from nuclear power plants.

5. Yes, there does appear to be a potential to create a bias.

6. No, there does not appear to be a potential to create a bias.

7. No, there does not appear to be a potential to create a bias.

8. Yes, there does appear to be a potential to create a bias.

9. The sample is a voluntary response sample and has strong potential to be flawed.

10. The samples are voluntary response samples and have potential for being flawed, but this approach might be necessary due to ethical considerations involved in randomly selecting subjects and somehow imposing treatments on them.

11. The sampling method appears to be sound.

12. The sampling method appears to be sound.

13. With only a 1% chance of getting such results with a program that has no effect, the program appears to have statistical significance. Also, because the average loss of 22 pounds does seem substantial, the program appears to also have practical significance.

14. Because there is a 0.3% chance of getting such results by chance, the increase in scores does appear to have statistical significance. The typical increase of 5 points suggests that the course does have practical significance. The course does appear to be successful.

15. Because there is a 19% chance of getting that many girls by chance, the method appears to lack statistical significance. The result of 1020 girls in 2000 births (51% girls) is above the approximately 50% rate expected by chance, but it does not appear to be high enough to have practical significance. Not many couples would bother with a procedure that raises the likelihood of a girl from 50% to 51%.

16. Because there is a 25% chance of getting such results with a program that has no effect, the program does not appear to have statistical significance. Because the average increase is only 3 IQ points, the program does not appear to have practical significance.

17. Yes. Each column of 8 AM and 12 AM temperatures is recorded from the same subject, so each pair is matched.

18. No. The source is from university researchers who do not appear to gain from distorting the data.

19. The data can be used to address the issue of whether there is a correlation between body temperatures at 8 AM and at 12 AM. Also, the data can be used to determine whether there are differences between body temperatures at 8 AM and at 12 AM.

20. Because the differences could easily occur by chance (with a 64% chance), the differences do not appear to have statistical significance.

21. No. The white blood cell counts measure a different quantity than the red blood cell counts, so their differences are meaningless.

22. The issue that can be addressed is whether there is a correlation, or association, between white blood cell counts and red blood cell counts.

23. No. The National Center for Health Statistics has no reason to collect or present the data in a way that is biased.

24. No. Correlation does not imply causation, so a statistical correlation between white blood cell counts and red blood cell counts should not be used to conclude that higher white blood cell counts are the cause of higher red blood cell counts.

25. It is questionable that the sponsor is the Idaho Potato Commission and the favorite vegetable is potatoes.

26. The sample is a voluntary response sample, so there is a good chance that the results do not reflect the larger population of people who have a water preference.

27. The correlation, or association, between two variables does not mean that one of the variables is the cause of the other. Correlation does not imply causation. Clearly, sour cream consumption is not directly related in any way to motorcycle fatalities.

28. The sponsor of the poll is an electronic cigarette maker, so the sponsor does have an interest in the poll results. The source is questionable.

29. a. 700 adults
    b. 55%

30. a. 253.31 subjects
    b. No. Because the result is a count of people among the 347 who were surveyed, the result must be a whole number.
    c. 253 subjects
    d. 32%

31. a. 559.2 respondents
    b. No. Because the result is a count of respondents among the 1165 engaged or married women who were surveyed, the result must be a whole number.
    c. 559 respondents
    d. 8%

32. a. 293.17 women
    b. No. Because the result is a count of women among the 1543 who were surveyed, the result must be a whole number.
    c. 293 women
    d. 15%
    e. Interpretations of a "typical" week and what it means to "kick back and relax" might vary considerably by different survey respondents. The survey might be improved by asking about behavior within "the past seven days" instead of a "typical" week. Instead of "kick back and relax," respondents might be surveyed about specific behavior, such as reading, taking a nap, watching television, listening to music, or going for a walk.

33. Because a reduction of 100% would eliminate all of the size, it is not possible to reduce the size by 100% or more.

34. In an editorial criticizing the statement, the *New York Times* correctly interpreted the 100% improvement to mean that no baggage is being lost, which was not true.

35. Because a reduction of 100% would eliminate all plaque, it is not possible to reduce it by more than 100%.

36. If one subgroup receives a 4% raise and another subgroup receives a 4% raise, the combined group will receive a 4% raise, not an 8% raise. The percentages should not be added in this case.

37. The wording of the question is biased and tends to encourage negative responses. The sample size of 20 is too small. Survey respondents are self-selected instead of being randomly selected by the newspaper. If 20 readers respond, the percentages should be multiples of 5, so 87% and 13% are not possible results.

38. All percentages of success should be multiples of 5. The given percentages cannot be correct.

Section 1-2: Types of Data

1. The population consists of all adults in the United States, and the sample is the 2276 adults who were surveyed. Because the value of 33% refers to the sample, it is a statistic.

2. a. quantitative   c. categorical
    b. categorical   d. quantitative

3. Only part (a) describes discrete data.

4. a. The sample is the 1020 adults who were surveyed. The population is all adults in the United States.
    b. statistic
    c. ratio
    d. discrete

5. statistic   17. discrete

6. statistic   18. continuous

7. parameter   19. continuous

8. parameter   20. discrete

9. statistic   21. ordinal

10. statistic   22. nominal

11. parameter   23. nominal

12. parameter   24. ratio

13. continuous   25. interval

14. continuous   26. ordinal

15. discrete   27. ordinal

16. discrete   28. interval

29. The numbers are not counts or measures of anything. They are at the nominal level of measurement, and it makes no sense to compute the average (mean) of them.

30. The digits are not counts or measures of anything. They are at the nominal level of measurement and it makes no sense to calculate their average (mean).

31. The temperatures are at the interval level of measurement. Because there is no natural starting point with $0°\text{F}$ representing "no heat," ratios such as "twice" make no sense, so it is wrong to say that it is twice as warm at the author's home as it is in Auckland, New Zealand.

32. The ranks are at the ordinal level of measurement. Differences between the universities cannot be determined, so there is no way to know whether the difference between Princeton and Harvard is the same as the difference between Yale and Columbia.

33. a. Continuous, because the number of possible values is infinite and not countable.
    b. Discrete, because the number of possible values is finite.
    c. Discrete, because the number of possible values is finite.
    d. Discrete, because the number of possible values is infinite and countable.

Section 1-3: Collecting Sample Data

1. The study is an experiment because subjects were given treatments.

2. The subjects in the study did not know whether they were taking a placebo or the paracetamol medication, and those who administered the pills also did not know.

3. The group sample sizes of 547, 550, and 546 are all large so that the researchers could see the effects of the paracetamol treatment.

4. The sample appears to be a convenience sample. Given that the subjects were randomly assigned to the three different treatment groups, it appears that the results of the study are good because they are not likely to be distorted from bias, but we should investigate the sample groups to ensure that they are not fundamentally different from the population.

5. The sample appears to be a convenience sample. By e-mailing the survey to a readily available group of Internet users, it was easy to obtain results. Although there is a real potential for getting a sample group that is not representative of the population, indications of which ear is used for cell phone calls and which hand is dominant do not appear to be factors that would be distorted much by a sample bias.

6. The study is an observational study because the subjects were not given any treatment.

7. With 717 responses, the response rate is 14%, which does appear to be quite low. In general, a very low response rate creates a serious potential for getting a biased sample that consists of those with a special interest in the topic.

8. Answers vary, but the following are good possibilities.
    a. Obtain a printed copy of the class roster, assign consecutive numbers (integers), then use a computer to randomly generate six of those numbers.
    b. Select every third student leaving class until six students are chosen.
    c. Randomly select three males and three females.
    d. Randomly select a row, and then select the students in that row. (Use only the first six to meet the requirement of a sample of size six.)

9. systematic

10. convenience

11. random

12. stratified

13. cluster

14. random

15. stratified

16. systematic

17. random

18. cluster

19. convenience

20. systematic

21. Observational study. The sample is a convenience sample consisting of subjects who decided themselves to respond. Such voluntary response samples have a high chance of not being representative of the larger population, so the sample may well be biased. The question was posted in an electronic edition of a newspaper, so the sample is biased from the beginning.

22. Experiment. The sample subjects consist of male physicians only. It would have been better to include females. Also, it would be better to include male and females who are not physicians.

23. Experiment. This experiment would create an *extremely* dangerous and illegal situation that has a real potential to result in injury or death. It's difficult enough to drive in New York City while being completely sober.

24. Observational study. The sample of four males and four females is too small.

25. Experiment. The biased sample created by using drivers from New York City cannot be fixed by using a larger sample. The larger sample will still be a biased sample that is not representative of drivers in the United States.

26. Experiment. Calling the subjects and asking them to report their weights has a high risk of getting results that do not reflect the actual weights. It would have been much better to somehow measure the weights instead of asking the subjects to report them.

27. Observational study. Respondents who have been convicted of felonies are not likely to respond honestly to the second question. The survey will suffer from a "social desirability bias" because subjects will tend to respond in ways that will be viewed favorably by those conducting the survey.

28. Observational study. The number of responses is very small, and the response rate of only 1.52% is far too small. With such a low response rate, there is a real possibility that the sample of respondents is biased and consists only of those with special interests in the survey topic.

29. prospective study

30. retrospective study

31. cross-sectional study

32. prospective study

33. matched pairs design

34. randomized block design

35. completely randomized design

36. matched pairs design

37. a. Not a simple random sample, but it is a random sample.
    b. Simple random sample and also a random sample.
    c. Not a simple random sample and not a random sample.

Quick Quiz

1. No. The numbers do not measure or count anything.
2. nominal
3. continuous
4. quantitative data
5. ratio
6. statistic
7. no
8. observational study
9. The subjects did not know whether they were getting aspirin or the placebo.
10. simple random sample

Review Exercises

1. The survey sponsor has the potential to gain from the results, which raises doubts about the objectivity of the results.
2. a. The sample is a voluntary response sample, so the results are questionable.
    b. statistic
    c. observational study
3. Randomized: Subjects were assigned to the different groups through a process of random selection, whereby they had the same chance of belonging to each group. Double-blind: The subjects did not know which of the three groups they were in, and the people who evaluated results did not know either.
4. No. Correlation does not imply causality.
5. Only part (c) is a simple random sample.
6. Yes. The two questions give the false impression that they are addressing very different issues. Most people would be in favor of defending marriage, so the first question is likely to receive a substantial number of "yes" responses. The second question better describes the issue and subjects are much more likely to have varied responses.
7. a. discrete
    b. ratio
    c. The mailed responses would be a voluntary response sample, so those with strong opinions or greater interest in the topics are more likely to respond. It is very possible that the results do not reflect the true opinions of the population of all full-time college students.
    d. stratified
    e. cluster
8. a. If they have no fat at all, they have 100% less than any other amount with fat, so the 125% figure cannot be correct.
    b. 686
    c. 28%
9. a. interval data; systematic sample
    b. nominal data; stratified sample
    c. ordinal data; convenience sample
10. Because there is a 15% chance of getting the results by chance, those results could easily occur by chance so the method does not appear to have statistical significance. The result of 236 girls in 450 births is a rate of 52.4%, so it is above the 50% rate expected by chance, but it does not appear to be high enough to have practical significance. The procedure does not appear to have either statistical significance or practical significance.

Cumulative Review Exercises

1. The mean is $\dfrac{3600+1700+4000+3900+3100+3800+2200+3000}{8} = 3162.5$ grams. The weights all end with 00, suggesting that all of the weights are rounded to the hundreds place, so that the last two digits are always 00.

2. $0.5^6 = 0.015625$

3. $\dfrac{272-176}{6} = 16,$ which is an unusually high value.

4. $\dfrac{98.2-98.6}{\dfrac{0.62}{\sqrt{106}}} = -6.64$

5. $\dfrac{1.96^2 \cdot 0.25}{0.03^2} = 1067$

6. $\dfrac{4000-1700}{4} = 575$ grams

7. $\dfrac{(3600-3162.5)^2}{7} = 27,343.75$ grams^2

8. $\sqrt{\dfrac{(98.4-98.6)^2+(98.6-98.6)^2+(98.8-98.6)^2}{3-1}} = \sqrt{0.04} = 0.20$

9. $0.4^8 = 0.00065536$

10. $9^{11} = 31,381,059,609$ (or about $31,381,060,000$)

11. $6^{14} = 78,364,164,096$ (or about $78,364,164,000$)

12. $0.3^{12} = 0.000000531441$