Applying the Concepts 9–6

Smoking and Education

You are researching the hypothesis that there is no difference in the percent of public school students who smoke and the percent of private school students who smoke. You find these results from a recent survey.

<table>
<thead>
<tr>
<th>School</th>
<th>Percent who smoke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>32.3</td>
</tr>
<tr>
<td>Private</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Based on these figures, answer the following questions.

1. What hypotheses would you use if you wanted to compare percentages of the public school students who smoke with the private school students who smoke?
2. What critical value(s) would you use?
3. What statistical test would you use to compare the two percentages?
4. What information would you need to complete the statistical test?
5. Suppose you found that 1000 individuals in each group were surveyed. Could you perform the statistical test?
6. If so, complete the test and summarize the results.

See page 519 for the answers.

Exercises 9–6

1a. Find the proportions \( \hat{p} \) and \( \hat{q} \) for each.
   a. \( n = 48, X = 34 \)
   b. \( n = 75, X = 28 \)
   c. \( n = 100, X = 50 \)
   d. \( n = 24, X = 6 \)
   e. \( n = 144, X = 12 \)

1b. Find each \( X \), given \( \hat{p} \).
   a. \( \hat{p} = 0.16, n = 100 \)
   b. \( \hat{p} = 0.08, n = 50 \)
   c. \( \hat{p} = 6\%, n = 800 \)
   d. \( \hat{p} = 52\%, n = 200 \)
   e. \( \hat{p} = 20\%, n = 150 \)

2. Find \( \bar{p} \) and \( \bar{q} \) for each.
   a. \( X_1 = 60, n_1 = 100, X_2 = 40, n_2 = 100 \)
   b. \( X_1 = 22, n_1 = 50, X_2 = 18, n_2 = 30 \)
   c. \( X_1 = 18, n_1 = 60, X_2 = 20, n_2 = 80 \)
   d. \( X_1 = 5, n_1 = 32, X_2 = 12, n_2 = 48 \)
   e. \( X_1 = 12, n_1 = 75, X_2 = 15, n_2 = 50 \)

For Exercises 3 through 14, perform these steps.
   a. State the hypotheses and identify the claim.
   b. Find the critical value(s).
   c. Compute the test value.
   d. Make the decision.
   e. Summarize the results.

Use the traditional method of hypothesis testing unless otherwise specified.

3. Smoking and Health Care A sample of 150 people from a certain industrial community showed that 80 people suffered from a lung disease. A sample of 100 people from a rural community showed that 30 suffered from the same lung disease. At \( \alpha = 0.05 \), is there a difference between the proportions of people who suffer from the disease in the two communities?

4. Undergraduate Financial Aid A study is conducted to determine if the percent of women who receive financial aid in undergraduate school is different from the percent of men who receive financial aid in undergraduate school. A random sample of undergraduates revealed these results. At \( \alpha = 0.01 \), is there significant evidence to reject the null hypothesis?

<table>
<thead>
<tr>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>250</td>
</tr>
<tr>
<td>Number receiving aid</td>
<td>200</td>
</tr>
</tbody>
</table>


5. Female Cashiers and Servers Labor statistics indicate that 77% of cashiers and servers are women. A random sample of cashiers and servers in a large metropolitan area found that 112 of 150 cashiers and 150 of 200 servers were women. At the 0.05 level of significance,
is there sufficient evidence to conclude that a difference exists between the proportion of servers and the proportion of cashiers who are women?
Source: N.Y. Times Almanac.

6. Animal Bites of Postal Workers In Cleveland, a sample of 73 mail carriers showed that 10 had been bitten by an animal during one week. In Philadelphia, in a sample of 80 mail carriers, 16 had received animal bites. Is there a significant difference in the proportions? Use $\alpha = 0.05$. Find the 95% confidence interval for the difference of the two proportions.

7. Lecture versus Computer-Assisted Instruction A survey found that 83% of the men questioned preferred computer-assisted instruction to lecture and 75% of the women preferred computer-assisted instruction to lecture. There were 100 individuals in each sample. At $\alpha = 0.05$, test the claim that there is no difference in the proportion of men and the proportion of women who favor computer-assisted instruction over lecture. Find the 95% confidence interval for the difference of the two proportions.

8. Leisure Time In a sample of 50 men, 44 said that they had less leisure time today than they had 10 years ago. In a sample of 50 women, 48 said that they had less leisure time than they had 10 years ago. At $\alpha = 0.10$ is there a difference in the proportion? Find the 90% confidence interval for the difference of the two proportions. Does the confidence interval contain 0? Give a reason why this information would be of interest to a researcher.
Source: Based on statistics from Market Directory.

9. Desire to Be Rich In a sample of 80 Americans, 55% wished that they were rich. In a sample of 90 Europeans, 45% wished that they were rich. At $\alpha = 0.01$, is there a difference in the proportions? Find the 99% confidence interval for the difference of the two proportions.

10. Seat Belt Use In a sample of 200 men, 130 said they used seat belts. In a sample of 300 women, 63 said they used seat belts. Test the claim that men are more safety conscious than women, at $\alpha = 0.01$. Use the $P$-value method.

11. Dog Ownership A survey found that in a sample of 75 families, 26 owned dogs. A survey done 15 years ago found that in a sample of 60 families, 26 owned dogs. At $\alpha = 0.05$ has the proportion of dog owners changed over the 15-year period? Find the 95% confidence interval of the true difference in the proportions. Does the confidence interval contain 0? Why would this fact be important to a researcher?
Source: Based on statistics from the American Veterinary Medical Association.

12. Visiting Disney World and Disneyland A recent study showed that in a sample of 100 people, 30% had visited Disneyland. In another sample of 100 people, 24% had visited Disney World. Are the proportions of people who visited each park different? Use $\alpha = 0.02$ and the $P$-value method.

13. Survey on Inevitability of War A sample of 200 teenagers shows that 50 believe that war is inevitable, and a sample of 300 people over age 60 shows that 93 believe war is inevitable. Is the proportion of teenagers who believe war is inevitable different from the proportion of people over age 60 who do? Use $\alpha = 0.01$. Find the 99% confidence interval for the difference of the two proportions.

14. Student Cars In a sample of 50 high school seniors, 8 had their own cars. In a sample of 75 college freshmen, 20 had their own cars. At $\alpha = 0.05$, can it be concluded that a higher proportion of college freshmen have their own cars? Use the $P$-value method.

15. Partisan Support of Salary Increase Bill Find the 99% confidence interval for the difference in the population proportions for the data of a study in which 60% of the 150 Republicans surveyed favored the bill for a salary increase and 60% of the 200 Democrats surveyed favored the bill for a salary increase.

16. Percentage of Female Workers The Miami County commissioners feel that a higher percentage of women work there than in neighboring Greene County. To test this, they randomly select 1000 women in each county and find that in Miami, 622 women work and in Greene, 594 work. Using $\alpha = 0.05$, do you think the Miami County commissioners are correct?

17. Credit Card Use In a sample of 100 store customers, 43 used a MasterCard. In another sample of 100, 58 used a Visa card. At $\alpha = 0.05$, is there a difference in the proportion of people who use each type of credit card?

18. Death Penalty Find the 95% confidence interval for the true difference in proportions for the data of a study in which 40% of the 200 males surveyed opposed the death penalty and 56% of the 100 females surveyed opposed the death penalty.

19. College Education The percentages of adults 25 years of age and older who have completed 4 or more years of college are 23.6% for females and 27.8% for males. A random sample of women and men who were 25 years old or older was surveyed with these results. Estimate the true difference in proportions with 95% confidence, and compare your interval with the Almanac statistics.

<table>
<thead>
<tr>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>100</td>
<td>115</td>
</tr>
</tbody>
</table>

Source: N.Y. Times Almanac.
Appendix H  Selected Answers

7. $H_0: \mu_D \leq 0$ and $H_1: \mu_D > 0$ (claim); C.V. = 2.571; d.f. = 5; $t = 2.24$; do not reject. There is not enough evidence to support the claim that the errors have been reduced.

9. $H_0: \mu_D = 0$ and $H_1: \mu_D \neq 0$ (claim); d.f. = 7; $t = 0.978$; 0.20 < $P$-value < 0.50 (0.361). Do not reject since $P$-value > 0.01. There is not enough evidence to support the claim that there is a difference in the pulse rates. $-3.23 < \mu_D < 5.73$

11. Using the previous problem $\bar{D} = -1.5625$, whereas the mean of the before values is 95.375 and the mean of the after values is 96.9375; hence, $\bar{D} = 95.375 - 96.9375 = -1.5625$.

Exercises 9–6

1a. $p_1 = 0.333$, $\bar{p}_1 = 0.3; \bar{p} = 0.44; q = 0.56; H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.196; $z = 3.64$; reject. There is enough evidence to support the claim that there is a significant difference in the proportions.

1b. $p_1 = 0.747; \bar{p}_2 = 0.75; \bar{p} = 0.749; q = 0.251$; $H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.196; $z = -0.07$; do not reject. There is not enough evidence to support the claim that the proportions are not equal.

3. $\bar{p}_1 = 0.83; \bar{p}_2 = 0.75; \bar{p} = 0.79; q = 0.21; H_0: p_1 = p_2$ (claim) and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.196; $z = 1.39$; do not reject. There is not enough evidence to reject the claim that the proportions are equal. $-0.032 < p_1 - p_2 < 0.192$

5. $\bar{p}_1 = 0.55; \bar{p}_2 = 0.54; \bar{p} = 0.549; q = 0.451; H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.258; $z = 1.302$; do not reject. There is not enough evidence to support the claim that the proportions are different. $-0.097 < p_1 - p_2 < 0.297$

7. $\bar{p}_1 = 0.347; \bar{p}_2 = 0.433; \bar{p} = 0.385; q = 0.615; H_0: p_1 = p_2$ and $H_1: p_1 
eq p_2$ (claim); C.V. = 0.196; $z = -1.03$; do not reject. There is not enough evidence to say that the proportion of dog owners has changed (0.252 < $p_1 - p_2 < 0.079$). Yes, the confidence interval contains 0. This is another way to conclude that there is no difference in the proportions.

9. $\bar{p}_1 = 0.25; \bar{p}_2 = 0.31; \bar{p} = 0.286; q = 0.714; H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.258; $z = -1.45$; do not reject. There is not enough evidence to support the claim that the proportions are different. $-0.165 < p_1 - p_2 < 0.045$

11. $\bar{p}_1 = 0.15; \bar{p}_2 = 0.05; \bar{p} = 0.104; q = 0.896; H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.196; $z = -2.12$; reject. There is enough evidence to support the claim that the proportions are different.

15. $\bar{p} = 0.43; \bar{p}_1 = 0.58; \bar{p} = 0.505; q = 0.495; H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.196; $z = -2.12$; reject. There is enough evidence to support the claim that the proportions are different.

17. $\bar{p}_1 = 0.43; \bar{p}_2 = 0.58; \bar{p} = 0.505; q = 0.495; H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.196; $z = -2.12$; reject. There is enough evidence to support the claim that the proportions are different.

19. $-0.0631 < p_1 - p_2 < 0.0667$. It does agree with the Almanac statistics stating a difference of $-0.042$ since $-0.042$ is contained in the interval.

Review Exercises

1. $H_0: \mu_1 \leq \mu_2$ and $H_1: \mu_1 > \mu_2$ (claim); C.V. = 2.23; $z = 0.59$; do not reject. There is not enough evidence to support the claim that single drivers do more pleasure driving than married drivers.

3. $H_0: \sigma_1 = \sigma_2$ and $H_1: \sigma_1 \neq \sigma_2$ (claim); C.V. = 2.77; $\alpha = 0.10$; d.f.N. = 23; d.f.D. = 10; $F = 10.365$; reject. There is enough evidence to support the claim that there is a difference in the standard deviations.

5. $H_0: \sigma_1 \leq \sigma_2$ and $H_1: \sigma_1 > \sigma_2$ (claim); $\alpha = 0.05$; d.f.N. = 9; d.f.D. = 9; $F = 5.06$. The $P$-value for the $F$ test is 0.01 < $P$-value < 0.025 (0.012); reject since $P$-value < 0.05. There is enough evidence to support the claim that the variance of the number of speeding tickets issued on Route 19 is greater than the variance of the number of speeding tickets issued on Route 22.

7. $H_0: \sigma_1 \leq \sigma_2$ and $H_1: \sigma_1 > \sigma_2$ (claim); C.V. = 1.47; $\alpha = 0.10$; d.f.N. = 64; d.f.D. = 41; $F = 2.32$; reject. There is enough evidence to support the claim that the variation in the number of days factory workers miss per year due to illness is greater than the variation in the number of days hospital workers miss per year.

9. $H_0: \sigma_1 = \sigma_2$; C.V. = 1.98; $F = 1.11$; do not reject. $H_0: \mu_1 = \mu_2$ and $H_1: \mu_1 > \mu_2$ (claim); C.V. = 1.82; $t = 1.31$; reject. There is enough evidence to support the claim that it is warmer in Birmingham.

11. $H_0: \sigma_1 = \sigma_2$; $F = 1.12$; do not reject since $p > 0.10$; $H_0: \mu_1 = \mu_2$ and $H_1: \mu_1 \neq \mu_2$ (claim); d.f. = 7; $t = -0.828$; do not reject. Since $p < 0.10$, there is not enough evidence to support the claim that the means are different. A cafeteria manager would want to know the results to make a decision on which beverage to serve.

13. $H_0: \mu_D \geq 0$ and $H_1: \mu_D < 0$ (claim); C.V. = 1.895; d.f. = 7; $t = -2.73$; reject. There is enough evidence to support the claim that the music has increased productivity.

15. $\bar{p}_1 = 0.15; \bar{p}_2 = 0.05; \bar{p} = 0.104; q = 0.896; H_0: p_1 = p_2$ and $H_1: p_1 \neq p_2$ (claim); C.V. = 0.196; $z = 2.41$; reject. There is enough evidence to support the claim that the proportion has changed. 0.023 < $p_1 - p_2 < 0.177$. The confidence level does not contain 0; hence, the null hypothesis is rejected.

Chapter Quiz

1. True 2. False
3. True 4. False
5. d 6. a
7. c 8. b