HW #25 6 – 8, 10, 11, 13, 21

12.6 **EQUALITY FOR WOMEN?** Have efforts to promote equality for women gone far enough in the United States? A poll on this issue by the cable network MSNBC contacted 1019 adults. A newspaper article about the poll said, "Results have a margin of sampling error of plus or minus 3 percentage points."

(a) Overall, 54% of the sample (550 of 1019 people) answered "Yes." Find a 95% confidence interval for the proportion in the adult population who would say "Yes" if asked. Is the report's claim about the margin of error roughly right? (Assume that the sample is an SRS.)

- p = true proportion of adults who would say "Yes" if asked whether efforts to promote equality for women have gone far enough in the U.S.
- SRS
  1019 < 10% of adult population
  $n\hat{p} = 550 > 10$ and $n(1-\hat{p}) = 469 > 10$
- One-proportion z interval
- $$95\%\,CI = 0.54 \pm 1.96\sqrt{\frac{(0.54)(0.46)}{1019}}$$
  $$= (0.51, 0.57)$$
- We are 95% confident that the true proportion of adults who would say "Yes" if asked whether efforts to promote equality for women have gone far enough in the U.S. is between 51 and 57%.

The margin of error is about 3% as stated.

(b) The news article said that 65% of men, but only 43% of women, think that efforts to promote equality have gone far enough. Explain why we do not have enough information to give confidence intervals for men and women separately.

We weren't given sample sizes for each gender.

(c) Would a 95% confidence interval for women alone have a margin of error less than 0.03, about equal to 0.03, or greater than 0.03? Why? You see that the news article's statement about the margin of error for poll results is a bit misleading.

The margin of error for women alone would be greater than 0.03 since the sample size is smaller.

12.7 **TEENS AND THEIR TV SETS** *The New York Times* and CBS News conducted a nationwide poll of 1048 randomly selected 13- to 17-year-olds. Of these teenagers, 692 had a television in their room and 189 named Fox as their favorite television network. We will act as if the sample were an SRS.

(a) Use your calculator to give 95% confidence intervals for the proportion of all people in this age group who have a TV in their room and the proportion who would choose Fox as their favorite network. Check that we can use our methods. *(Check assumptions.)*

Check assumptions for TV in room: SRS 1048 < 10% of all 13- to 17-year olds $n\hat{p}$ = 692 > 10, $n(1-\hat{p})$ = 356 >10	Check assumptions for prefer FOX: SRS 1048 < 10% of all 13- to 17-year olds $n\hat{p}$ = 189 > 10, $n(1-\hat{p})$ = 859 >10
$95\%\ CI\ \ for\ TV\ in\ room = 0.66 \pm 1.96\sqrt{\frac{(0.66)(0.34)}{1048}}$ $= (0.631, 0.689)$	$95\%\ CI\ \ for\ \ preferring\ FOX = 0.18 \pm 1.96\sqrt{\frac{(0.18)(0.82)}{1048}}$ $= (0.157, 0.203)$

(b) The news article says, "In theory, in 19 cases out of 20, the poll 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.

In both cases, the margin of error for a 95% CI ("19 cases out of 20") was (no more than) 3%.

(c) Is there good evidence that more than half of all teenagers have a TV in their room?

- p = proportion of teenagers with TV's in their rooms
- $H_0:\ p = 0.5\ \ v\ \ H_A: p > 0.5$
- Assumptions checked above
- One-proportion z test.
- $z = \dfrac{0.66 - 0.5}{\sqrt{\dfrac{(0.5)(0.5)}{1048}}} = 10.36$
- p-value = P(Z >10.36) < 0.0002
- since the p-value is so small, we reject H_0, and conclude that more than half of teenagers have TVs in their rooms.

(Additionally, the interval from (a) does not include 0.50 or less)

12.8 **WE WANT TO BE RICH** In a recent year, 73% of first-year college students responding to a national survey identified "being very well-off financially" as an important personal goal. A state university finds that 132 of an SRS of 200 of its first-year students say that this goal is important.

(a) Give a 95% confidence interval for the proportion of all first-year students at the university who would identify being well-off as an important goal.

- p = true proportion of all first-year students at this university who identify being well-off as an important goal
- SRS
  200 < 10% of first-year students at this university
  $n\hat{p} = 132 > 10$ and $n(1-\hat{p}) = 68 > 10$
- One-proportion z interval
- $95\%\ CI = 0.66 \pm 1.96\sqrt{\dfrac{(0.66)(0.34)}{200}}$
  $= (0.594, 0.726)$
- We are 95% confident that the true proportion of all first-year students at this university who identify being well-off as an important goal is between 59.4 and 72.6%.

(b) Is there good evidence that the proportion of all first-year students at this university who think being very well-off is important differs from the national value.

Yes; the 95% confidence interval for this university contains only values that are less than 0.73, so it is likely that for this particular population, p differs from 0.73 (specifically, is less than 0.73).

12.10 **STARTING A NIGHT CLUB** A college student organization wants to start a nightclub for students under the age of 21. To assess support for this proposal, they will select an SRS of students and ask each respondent if he or she would patronize this type of establishment. They expect that about 70% of the student body would respond favorably. What sample size is required to obtain a 90% confidence interval with an approximate margin of error of 0.04. Suppose that 50% of the sample responds favorably. Calculate the margin of error of the 90% confidence interval.

Solving for *n:* $1.645\sqrt{\dfrac{(0.7)(0.3)}{n}} = 0.04$ we find $n \geq 356$

If $p = 0.5$, then the true margin of error = $1.645\sqrt{\dfrac{(0.5)(0.5)}{356}} = 0.0436$

12.11 **SCHOOL VOUCHERS** A national opinion poll found that 44% of all American adults agree that parents should be given vouchers good for education at any public or private school of their choice. The result was based on a small sample. How large an SRS is required to obtain a margin of error of 0.03 (that is, ±3%) in a 95% confidence interval?

(a) Answer this question using the previous poll's result as the guessed value p^*.

Solving for *n:* $1.96\sqrt{\frac{(0.44)(0.56)}{n}} = 0.03$ we find $n \geq 1052$

(b) Do the problem again using the conservative guess $p^* = 0.05$. By how much do the two sample sizes differ.

Solving for *n:* $1.96\sqrt{\frac{(0.5)(0.5)}{n}} = 0.03$ we find $n \geq 1068$

An additional 16 people are needed.

12.13 **DRUNKEN CYCLISTS** In the United States approximately 900 people die in bicycle accidents each year. One study examined the records of 1711 bicyclists aged 15 or older who were fatally injured in bicycle accidents between 1987 and 1991 and were tested for alcohol. Of these, 542 tested positive for alcohol (blood alcohol concentration of 0.01% or higher).

(a) Find a 95% confidence interval for *p*.

- *p* = true proportion of all cyclists involved in fatal accidents who had alcohol in their systems
- SRS – we do NOT know that the examined records come from as SRS, so we proceed with caution.
  1711 is probably not < 10% of all bicyclists fatally injured between 1987 and 1991, so again proceed with caution
  $n\hat{p} = 542 > 10$ and $n(1-\hat{p}) = 1169 > 10$
- One-proportion *z* interval
- $95\%\ CI = \frac{542}{1711} \pm 1.96\sqrt{\frac{\frac{542}{1711}\cdot\frac{1169}{1711}}{1711}}$
  $= (0.295, 0.339)$
- If our assumptions had been satisfied we would be 95% confident that the true proportion of all cyclists involved in fatal accidents who had alcohol in their systems is between 29.5 and 33.9%.

(b) Can you conclude from your statistical analysis of this study that alcohol causes fatal bicycle accidents? Explain.

No: We do not know; for example, what percentage of cyclists who were not involved in fatal accidents had alcohol in their systems.

12.21 **COLLEGE FOOD** Tonya, Frank, and Sarah are investigating student attitudes toward college food for an assignment in their introductory statistics class. Based on comments overheard from other students, they believe that fewer than 1 in 3 students like college food. To test this hypothesis, each selects an SRS of students who regularly eat in the cafeteria, and asks them if they like college food. Fourteen in Tonya's SRS of 50 replied, "Yes," while 98 in Frank's sample of 350, and 140 in Sarah's sample of 500 said they like college food. Use your calculator to perform a test of significance on all three results and fill in a table like this:

X	n	$\hat{p}$	z	P-value
14	50	0.28	-0.752	0.2261
98	350	0.28	-1.998	0.0233
140	500	0.28	-2.378	0.0088

Describe your findings in a short narrative.

Although Tonya, Frank, and Sarah all recorded the same sample proportion, $\hat{p} = 0.28$, the p-values were all quite different. Conclude: For a given sample proportion, the larger the sample size, the smaller the p-value.

HW #26   22, 23, 25 – 27, 29

12.22 **IN-LINE SKATERS** A study of injuries to in-line skaters used data from the National Electronic Injury Surveillance System, which collects data from a random sample of hospital emergency rooms. In the six-month study period, 206 people came to the sample hospitals with injuries from in-line skating. We can think of these people as an SRS of all people injured while skating. Researchers were able to interview 161 of these people. Wrist injuries (mostly fractures) were the most common.

(a) The interviews found that 53 people were wearing wrist guards and 6 of these had wrist injuries. Of the 108 who did not wear wrist guards, 45 had wrist injuries. What are the two sample proportions of wrist injuries?

$$\hat{p}_1 = \frac{6}{53} = 0.1132 \quad \textit{and} \;\; \hat{p}_2 = \frac{45}{108} = 0.4167$$

(b) Give a 95% confidence interval for the difference between the two population proportions of wrist injuries. State carefully what populations your inference compares. We would like to draw conclusions about all in-line skaters, but we have data only for injured skaters.

- p_1 = true proportion of all people who went to the ER with wrist injuries who were wearing wrist guards, p_2 = true proportion of all people who went to the ER with wrist injuries who were NOT wearing wrist guards

- SRSs, given
  independent samples
  53 < 10% of people wearing wrist guards who came to the ER with skating injuries, 108 < 10% of people NOT wearing wrist guards who came to the ER with skating injuries
  $n_1\hat{p}_1 = 6 > 5,\ n_1(1-\hat{p}_1) = 47 > 5,\ n_2\hat{p}_2 = 45 > 5,\ n_2(1-\hat{p}_2) = 63 > 5$

- Two-proportion *z* interval

- $$95\%\, CI = (0.1132 - 0.4167) \pm 1.96\sqrt{\frac{(0.1132)(0.8868)}{53} + \frac{(0.4167)(0.5833)}{108}}$$
  $$= (-0.430, -0.177)$$

- We are 95% confident that the true proportion of skaters with wrist injuries is lower by 43 to 18% for skaters who are wearing wrist guards.

  As the problem notes, this interval should at least apply to the two groups about whom we have information: skaters (with and without wrist guards) with severe enough injuries to go to the emergency room.

(c) What was the percent of nonresponse among the original sample of 206 injured skaters? Explain why nonresponse may bias your conclusions.

45/206 = 0.218 did not respond. If those who did not respond were different in some way from those who did, then not having them represented in our sample makes our conclusions suspect.

12.23 **LYME DISEASE** Lyme disease is spread in the northeastern United States by infected ticks. The ticks were infected mainly by feeding on mice, so more mice result in more infected ticks. The mouse population in turn rises and falls with the abundance of acorns, their favored food. Experimenters studied two similar forest areas in a year when the acorn crop failed. They added hundreds of thousands of acorns to one area to imitate an abundant acorn crop, while leaving the other area untouched. The next spring, 54 of the 72 mice trapped in the first area were in breeding condition, versus 10 of the 17 mice trapped in the second area. Give a 90% confidence interval for the difference between the proportion of mice ready to breed in good acorn years and bad acorn years.

- p_1 = true proportion of mice ready to breed in a good acorn year, p_2 = true proportion of mice ready to breed in a bad acorn year

- SRSs, assumed
  independent samples
  72 < 10% of mice in good year, 17 < 10% of mice in bad years
  $n_1\hat{p}_1 = 54 > 5,\ n_1(1-\hat{p}_1) = 18 > 5,\ n_2\hat{p}_2 = 10 > 5,\ n_2(1-\hat{p}_2) = 7 > 5$

- Two-proportion z interval

- $$90\%\ CI = (0.75 - 0.5882) \pm 1.645\sqrt{\frac{(0.75)(0.25)}{72} + \frac{(0.5882)(0.4118)}{17}}$$
  $$= (-0.0518, 0.3753)$$

- We are 90% confident that the true proportion of mice who are ready to breed in good acorn years is between -5% and 38% greater than the proportion of mice are ready to breed in bad acorn years.

12.25 **THE GOLD COAST** A historian examining British colonial records for the Gold Coast in Africa suspects that the death rate was higher among African miners than among European miners. In the year 1936, there were 223 deaths among 33,809 African miners and 7 deaths among 1541 European miners on the Gold Coast.

Consider this year as a sample from the pre-war era in Africa. Is there good evidence that the proportion of African miners who died was higher than the proportion of European miners who died?

- p_A = true proportion of African miners who died in 1936 on the Gold Coast, p_E = true proportion of European miners who died in 1936 on the Gold Coast

- $H_0: p_A = p_E$
  $H_A: p_A > p_E$

- SRSs, assumed
  independent samples
  33,809 < 10% of African miners, 1541 < 10% of European miners
  $n_A \hat{p}_A = 223 > 5,\ n_A(1-\hat{p}_A) = 33586 > 5,\ n_E \hat{p}_E = 7 > 5,\ n_E(1-\hat{p}_E) = 1534 > 5$

- Two-proportion *z* test

- $$\hat{p} = \frac{223+7}{33809+1541} = 0.006506$$
  $$z = \frac{0.006596 - 0.004543}{\sqrt{(0.006506)(0.993494)\left(\frac{1}{33809}+\frac{1}{1541}\right)}} = 0.9805$$

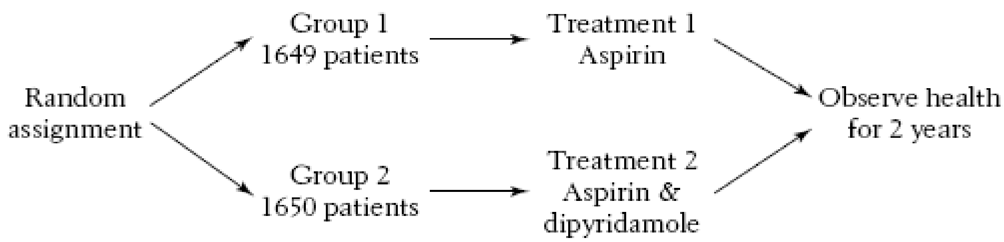
- *p*-value = P(Z > .9805) = 0.1635

- The *p*-value is large, so we fail to reject H_0, we could easily see a result like this by chance alone. We do not have evidence to conclude that the death rates for African and European miners are different.

12.26 **PREVENTING STROKES** Aspirin prevents blood from clotting and so helps prevent strokes. The Second European Stroke Prevention Study asked whether adding another anticlotting drug named diprydamole would be more effective for patients who had already had a stroke. Here are the data on strokes and deaths during the two years of the study:

	Number of patients	Number of strokes	Number of deaths
Aspirin alone	1649	206	182
Aspirin + dipyridamole	1650	157	185

(a) The study was a randomized comparative experiment. Outline the design of the study.



(b) Use your calculator to determine if there is a significant difference in the proportion of strokes in the two groups.

- p_1 = true proportion of strokes among patients who used aspirin alone,
  p_2 = true proportion of strokes among patients who used aspirin + dipyridamole
- $H_0: p_1 = p_2 \qquad H_A: p_1 \neq p_2$
- SRSs, assumed
  independent samples
  1649 < 10% of patients using aspirin alone, 1650 < 10% of patients using aspirin + dipyridamol
  pooling we have $\hat{p} = \dfrac{206+157}{1649+1650} = 0.11$
  $n_1\hat{p} = 1649(.11) = 181.4 > 5, \; n_1\hat{q} = 1649(.89) = 1467.6 > 5$
  $n_2\hat{p} = 1650(.11) = 181.5 > 5, \; n_2\hat{q} = 1650(.89) = 1467.5 > 5$
- Two-proportion *z* test
- $z = \dfrac{\hat{p}_1 - \hat{p}_2 - (p_1 - p_2)}{\sqrt{\hat{p}\hat{q}\left(\dfrac{1}{n_1} + \dfrac{1}{n_2}\right)}} = \dfrac{0.125 - 0.095 - (0)}{\sqrt{(.11)(.89)\left(\dfrac{1}{1649} + \dfrac{1}{1650}\right)}} = 2.73$
- *p*-value = 2 P(z > 2.73) = 0.0064
- The *p*-value is small, so we reject H_0. We have strong evidence to conclude that the proportions for stroke rates are different.

(c) Is there a significant difference in death rates for the two groups?

- p_1 = true proportion of deaths among patients who used aspirin alone, p_2 = true proportion of deathhs among patients who used aspirin + dipyridamole
- $H_0: p_1 = p_2 \qquad H_A: p_1 \neq p_2$
- Assumptions are satisfied analogous to above
- z = -0.16
- *p*-value = 2P(z < -0.16) = 0.8728
- The *p*-value is very large, so we fail to reject H_0. We have no evidence that the proportions for death rates are different.

12.27 **ACCESS TO COMPUTERS** A sample survey by Nielsen Media Research looked at computer access and use of the Internet. Whites were significantly more likely than blacks to own a home computer, but the black-white difference in computer access at work was not significant. The study team then looked separately at the households with at least \$40,000 income. The sample contained 1916 white and 131 black households in this class. Here are the sample counts for these households.

	Blacks	Whites
Own home computer	86	1173
Computer access at work	100	1132

Do higher-income blacks and whites differ significantly at the 5% level in the proportion who own home computers? Do they differ significantly in the proportion who have computer access at work?

- p_b = true proportion of blacks with \$40,000 income with home computer,
  p_w = true proportion of whites with \$40,000 income with home computer
- $H_0: p_b = p_w$
  $H_A: p_b \neq p_w$
- SRSs, assumed
  independent samples
  131 < 10% of blacks with \$40,000 income,
  1916 < 10% of whites with \$40,000 income

pooling

$$\hat{p} = \frac{86+1173}{131+1916} = 0.615$$

$$n_b\hat{p} = 131(.615) = 80.5 > 5,\ n_b\hat{q} = 131(.385) = 50.5 >$$

$$n_w\hat{p} = 1916(.615) = 1178 > 5,\ n_w\hat{q} = 1916(.385) = 73$$

- Two-proportion *z* test
- $$z = \frac{0.6565 - 0.6122}{\sqrt{(0.615)(0.385)\left(\frac{1}{131} + \frac{1}{1916}\right)}} = 1.01$$
- $p\text{-}value = 2P(z > 1.01) = 0.3124$
- The *p*-value is large, so we fail to reject H_0. We do not have evidence to conclude there is a difference in the proportions of higher-income blacks and whites who have home computers

- p_b = true proportion of blacks with \$40,000 income with computer access at work,
  p_w = true proportion of whites with \$40,000 income with computer access at work
- $H_0: p_b = p_w$
  $H_A: p_b \neq p_w$
- SRSs, assumed
  independent samples
  131 < 10% of blacks with \$40,000 income,
  1916 < 10% of whites with \$40,000 income

pooling

$$\hat{p} = \frac{100+1132}{131+1916} = 0.602$$

$$n_b\hat{p} = 131(.602) = 79 > 5,\ n_b\hat{q} = 131(.398) = 52 > 5$$

$$n_w\hat{p} = 1916(.602) = 1153 > 5,\ n_w\hat{q} = 1916(.398) = 763$$

- Two-proportion *z* test
- $$z = \frac{0.7634 - 0.5908}{\sqrt{(0.6019)(0.3981)\left(\frac{1}{131} + \frac{1}{1916}\right)}} = 3.90$$
- *p*-value < 0.0004
- The *p*-value is small, so we reject H_0. We hav strong evidence to conclude that there is a difference in the proportions of higher-income blacks and whites who have computer access a work. (Specifically, higher-income blacks hav more access at work.)

12.29 **TREATING AIDS** The drug AZT was the first drug that seemed effective in delaying the onset of AIDS. Evidence for AZT's effectiveness came from a large randomized comparative experiment. The subjects were 1300 volunteers who were infected with HIV, the virus that causes AIDS, but did not yet have AIDS. The study assigned 435 of the subjects at random to take 500 milligrams of AZT each day, and another 435 to take a placebo. (The others were assigned to a third treatment, a higher dose of AZT. We will compare only two groups.) At the end of the study, 38 of the placebo subjects and 17 of the AZT subjects had developed AIDS. We want to test the claim that taking AZT lowers the proportion of infected people who will develop AIDS in a given period of time.

(a) State hypotheses, and check that you can safely use the *z* procedure.

- p_1 = true proportion of HIV infected patients who develop AIDS while taking AZT, p_2 = true proportion of HIV infected patients who develop AIDS while taking a placebo
- $H_0 : p_1 = p_2$
  $H_A : p_1 < p_2$
- SRSs, assumed
  independent samples
  435 < 10% of HIV infected patients taking AZT, 435 < 10% of of HIV infected patients taking a placebo
  pooling
  $$\hat{p} = \frac{38+17}{435+435} = 0.0632$$
  $$n_1\hat{p} = 435(0.0632) = 27.5 > 5,$$
  $$n_1\hat{q} = 435(0.9368) = 407.5 > 5$$
  $$same\ for\ \ n_2\hat{p}\ \ and\ \ n_2\hat{q}$$

(b) How significant is the evidence that AZT is effective?

$\hat{p}$ = 0.0632,

$$z = \frac{\hat{p}_1 - \hat{p}_2 - (p_1 - p_2)}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{0.087 - 0.039 - (0)}{\sqrt{(.0632)(.9368)\left(\frac{1}{435} + \frac{1}{435}\right)}} = 2.926$$

$$p = P(z > 2.926) = 0.0017$$

The difference is statistically significant. With such a small *p*-value we reject H_0 and conclude that the proportions are different.

(c) The experiment was double-blind. Explain what this means.

Neither the subjects nor the researchers who had contact with them knew which subjects were getting which drug—if anyone had known, they might have confounded the outcome by letting their expectations or biases affect the results.

HW #27   35, 37, 39, 41

12.35 **POLICE RADAR AND SPEEDING** Do drivers reduce excessive speed when they encounter police radar? Researchers studied the behavior of drivers on a rural interstate highway in Maryland where the speed limit was 55 miles per hour. They measured speed with an electronic device hidden in the pavement and, to eliminate large trucks, considered only vehicles less than 20 feet long. During some time periods, police radar was set up at the measurement location. Here are some of the data:

	Number of vehicles	Number over 65 mph
No radar	12,931	5,690
Radar	3,285	1,051

(a) Give a 95% confidence interval for the proportion of vehicles going faster than 65 miles per hour when no radar is present.

- p = true proportion of vehicles going faster than 65 miles per hour when no radar is present.
- SRS – assumed
  12931 < 10% of all motorists
  $n\hat{p} = 5690 > 10$ and $n(1-\hat{p}) = 7241 > 10$
- One-proportion z interval
- $$95\%\ CI = 0.44 \pm 1.96\sqrt{\frac{(0.44)(0.56)}{12,931}}$$
  $$= (0.432, 0.449)$$
- We are 95% confident that the true proportion of vehicles going faster than 65 miles per hour when no radar is present is between 43.2 and 44.9%.

(b) Give a 95% confidence interval for the effect of radar, as measured by the difference in proportions of vehicles going faster than 65 miles per hour with and without radar.

- p_1 = true proportion of vehicles going faster than 65 miles per hour when no radar is present,
  p_2 = true proportion of vehicles going faster than 65 miles per hour when radar is present.
- SRSs, assumed
  independent samples ??
  12,931 < 10% of all motorists in no radar zones
  3285 < 10% of all motorists in radar zones
  $n_1\hat{p}_1 = 5690 > 5,\ n_1(1-\hat{p}_1) = 7241 > 5,\ n_2\hat{p}_2 = 1051 > 5,\ n_2(1-\hat{p}_2) = 2234 > 5$
- Two-proportion z interval
- $$95\%\ CI = (0.44 - 0.32) \pm 1.96\sqrt{\frac{(0.44)(0.56)}{12,931} + \frac{(0.32)(0.68)}{3285}}$$
  $$= (0.102, 0.138)$$
- We are 95% confident that the 10.2 to 13.8% of drivers are more apt to speed when no radar is present, then when radar is present.

(c) The researchers chose a rural highway so that cars would be separated rather than in clusters where some cars might slow because they see other cars slowing. Explain why such clusters might make inference invalid.

In a cluster of cars, where one driver's behavior might affect the others, we do not have independence—one of the important properties of a random sample.

12.37 **SMALL-BUSINESS FAILURES, I** A study of the survival of small businesses chose an SRS from the telephone directory's Yellow Pages listings of food-and-drink businesses in 12 counties in central Indiana. For various reasons, they study got no response from 45% of the businesses chosen. Interviews were completed with 148 businesses. Three years later, 22 of these businesses had failed.

(a) Give a 95% confidence interval for the percent of all small businesses in this class that fail within three years.

- *p* = true proportion of small businesses in this class that fail within three years
- SRS – assumed
  148 < 10% of small food-and-drink businesses
  $n\hat{p} = 22 > 10$ and $n(1-\hat{p}) = 126 > 10$
- One-proportion *z* interval
- $95\%\, CI = 0.1486 \pm 1.96\sqrt{\frac{(0.1486)(0.8514)}{148}}$
  $= (0.0913, 0.2059)$
- We are 95% confident that the true proportion of small businesses in this class that fail within three years is between 9.1 and 20.6%.

(b) Based on the results of this study, how large a sample would you need to reduce the margin of error to 0.04?

Solving for *n:* $1.96\sqrt{\frac{(0.1486)(0.8514)}{n}} = 0.04$ we find $n \geq 304$

(We should not use $p^* = 0.5$ here since we have evidence that the true value of *p* is not in the range 0.3 to 0.7.)

(c) The authors hope that their findings describe the population of all small businesses. What about the study makes this unlikely? What population do you think the study findings describe?

Aside from the 45% nonresponse rate, the sample comes from a limited area in Indiana, focuses on only one kind of business, and leaves out any businesses not in the Yellow Pages (there might be a few of these; perhaps they are more likely to fail). It is more realistic to believe that this describes businesses that match the above profile; it might generalize to food-and-drink establishments elsewhere, but probably not to hardware stores and other types of business.

12.39 **SIGNIFICANT DOES NOT MEAN IMPORTANT** Never forget that even small effects can be statistically significant if the samples are large. To illustrate this fact, return to the study of 148 small businesses from the preceding exercise. Of these, 106 were headed by men and 42 were headed by women. During a three-year period, 15 of the men's businesses and 7 of the women's businesses failed.

(a) Find the proportions of failures for businesses headed by women and businesses headed by men. These sample proportions are quite close to each other. Test the hypothesis that the sample proportions of women's and men's businesses fail. (Use the two-sided alternative.) The test is very far from being significant.

$\hat{p}_m = 0.1415, \quad \hat{p}_w = 0.1667; \quad p = 0.6981$

(b) Now suppose that the same sample proportions came from a sample 30 times as large. That is, 210 out of 1260 businesses headed by women and 450 out of 3180 businesses headed by men fail. Verify that the proportions of failures are exactly the same as in (a). Repeat the *z* test for the new data, and show that it is now significant at the $\alpha = 0.05$ level.

$z = 2.12$, $p = 0.0336$

(c) It is wise to use a confidence interval to estimate the size of an effect, rather than just giving a *P*-value. Give 95% confidence intervals for the difference between the proportions of women's and men's businesses that fail for the settings of both (a) and (b). What is the effect of larger samples on the confidence interval?

From (a) (-0.1056, 0.1559)
From (b) (0.001278, 0.049036) The larger samples make the margin of error (and thus the length of the confidence interval) smaller

12.41 **MEN VERSUS WOMEN** The National Assessment of Educational Progress (NAEP) Young Adult Literacy Assessment Survey interviewed a random sample of 1917 people 21 to 25 years old. The sample contained 840 men, of whom 775 were fully employed. There were 1077 women, and 680 of them were fully employed.

(a) Use your calculator to find a 99% confidence interval to describe the difference between the proportions of young men and young women who are fully employed. Is the difference statistically significant at the 1% significance level?

99 % CI is 0.2465 to 0.3359—since 0 is not in this interval, we would reject H_0: $p_1 = p_2$ at the 1% level (in fact, P is practically 0).

(b) The mean and standard deviation of scores on the NAEP's test of quantitative skills were $\overline{x}_1 = 272.40 \; and \; s_1 = 59.2$ for the men in the sample. For the women, the results were $\overline{x}_2 = 274.73 \; and \; s_2 = 59.2$. Is the difference between the mean scores for men and women significant at the 1% level? No: $t = -0.8658$, which gives a *p*-value close to 0.4, not significant.