

Chapter 13: Comparing Two Population Parameters

Use the following to answer questions 2 through 4:

Some researchers have conjectured that stem-pitting disease in peach tree seedlings might be controlled with weed and soil treatment. An experiment was conducted to compare peach tree seedling growth with soil and weeds treated with one of two herbicides. In a field containing 20 seedlings, 10 were randomly selected from throughout the field and assigned to receive Herbicide A. The remaining 10 seedlings were to receive Herbicide B. Soil and weeds for each seedling were treated with the appropriate herbicide, and at the end of the study period, the height (in centimeters) was recorded for each seedling. A box plot of each data set showed no indication of non-normality. The following results were obtained:

Herbicide A: $\bar{X}_1 = 94.5$ cm $s_1 = 10$ cm

Herbicide B: $\bar{X}_2 = 109.1$ cm $s_2 = 9$ cm

$$\mu_2 \neq \mu_1$$

3. Referring to the information above, suppose we wished to determine if there tended to be a significant difference in mean height for the seedlings treated with the different herbicides. To answer this question, we decide to test the hypotheses $H_0: \mu_2 - \mu_1 = 0$, $H_a: \mu_2 - \mu_1 \neq 0$. Based on our data, the value of the two-sample t test statistic is
 A) 14.60. B) 7.80. (C) 3.43. D) 2.54. E) 1.14.
4. Referring to the information above, suppose we wished to determine if there tended to be a significant difference in mean height for the seedlings treated with the different herbicides. To answer this question, we decide to test the hypotheses $H_0: \mu_2 - \mu_1 = 0$, $H_a: \mu_2 - \mu_1 \neq 0$. The 90% confidence interval is 14.6 ± 7.80 cm. Based on this confidence interval, (6.8, 22.4)
 A) we would not reject the null hypothesis of no difference at the 0.10 level.
 (B) we would reject the null hypothesis of no difference at the 0.10 level.
 C) we would reject the null hypothesis of no difference at the 0.05 level.
 D) the P -value is less than 0.10.
 E) both C) and D) are correct.

5. Researchers compared two groups of competitive rowers: a group of skilled rowers and a group of novices. The researchers measured the angular velocity of each subject's right knee, which describes the rate at which the knee joint opens as the legs push the body back on the sliding seat. The sample size n , the sample means, and the sample standard deviations for the two groups are given below.

<u>Group</u>	<u>n</u>	<u>Mean</u>	<u>Standard Deviation</u>
Skilled	16	4.2	0.6
Novice	16	3.2	0.8

The researchers wished to test the hypotheses

H_0 : the mean knee velocities for skilled and novice rowers are the same

H_a : the mean knee velocity for skilled rowers is larger than for novice rowers

The data showed no strong outliers or strong skewness, so the researchers decided to use the two-sample t test. The value of the t test statistic is

- A) 0.0002. B) 1.0. C) 1.25. D) 2.0. **(E) 4.0.**

Use the following to answer questions 6 through 9:

A researcher wished to test the effect of the addition of extra calcium to yogurt on the "tastiness" of yogurt. A collection of 200 adult volunteers was randomly divided into two groups of 100 subjects each. Group 1 tasted yogurt containing the extra calcium. Group 2 tasted yogurt from the same batch as group 1 but without the added calcium. Both groups rated the flavor on a scale of 1 to 10, with 1 being "very unpleasant" and 10 being "very pleasant." The mean rating for group 1 was $\bar{X}_1 = 6.5$ with a standard deviation of $s_1 = 1.5$. The mean rating for group 2 was $\bar{X}_2 = 7.0$ with a standard deviation of $s_2 = 2.0$. Assume the two groups' ratings are independent. Let μ_1 and μ_2 represent the mean ratings we would observe for the entire population represented by the volunteers if all members of this population tasted, respectively, the yogurt with and without the added calcium.

7. Referring to the information above, suppose the researcher had wished to test the hypotheses $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 < \mu_2$. The P -value for the test (using the conservative value for the degrees of freedom) is
- A) larger than 0.10. D) between 0.001 and 0.01.
 B) between 0.05 and 0.10. E) below 0.001.
(C) between 0.01 and 0.05.

8. Referring to the information above, which of the following would lead us to believe that the t procedures were not safe to use here?
- A) The sample medians and means for the two groups were slightly different.
 - B) The distributions of the data were moderately skewed.
 - C) The data are integers between 1 and 10 and so cannot be normal.
 - ☒ D) Only the most severe departures from normality would lead us to believe the t procedures were not safe to use.
 - E) The standard deviations from both samples were very different from each other.
9. Referring to the information above, if we had used the more accurate software approximation to the degrees of freedom, we would have used which of the following as the number of degrees of freedom for the t procedures?
- A) 199. B) 198. C) 190. ☒ D) 183. E) 99.

Round down \rightarrow calc
 $df = 1836$
 \uparrow use 183

Use the following to answer questions 10 through 13:

A sports writer wished to see if a football filled with helium travels farther, on average, than a football filled with air. To test this, the writer used 18 adult male volunteers. These volunteers were randomly divided into two groups of nine subjects each. Group 1 kicked a football filled with helium to the recommended pressure. Group 2 kicked a football filled with air to the recommended pressure. The mean yardage for group 1 was $\bar{X}_1 = 30$ yards with a standard deviation of $s_1 = 8$ yards. The mean yardage for group 2 was $\bar{X}_2 = 26$ yards with a standard deviation of $s_2 = 6$ yards. Assume the two groups of kicks are independent. Let μ_1 and μ_2 represent the mean yardage we would observe for the entire population represented by the volunteers if all members of this population kicked, respectively, a helium- and an air-filled football.

11. Referring to the information above, suppose the researcher had wished to test the hypotheses $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 > \mu_2$. The P -value for the test (using the conservative value for the degrees of freedom) is
- ☒ A) larger than 0.10.
 - B) between 0.05 and 0.10.
 - C) between 0.01 and 0.05.
 - D) between 0.001 and 0.01.
 - E) below 0.001.
12. Referring to the information above, to which of the following would it have been most important that the subjects be blind during the experiment?
- A) The identity of the sports writer.
 - B) Whether or not the balls were of regulation size and weight.
 - C) The method they were to use in kicking the ball.
 - ☒ D) Whether the ball they were kicking was filled with helium or air.
 - E) The direction in which they were to kick the ball.

Blind meaning not knowing what Ball filled with

13. Referring to the information above, if we had used the more accurate software approximation to the degrees of freedom, we would have used which of the following as the number of degrees of freedom for the t procedures?
- A) 16. (B) 14. C) 12. D) 9. E) 8.

Use the following to answer questions 21 and 22:

In a large Midwestern university (with the class of entering freshmen being on the order of 6000 or more students), an SRS of 100 entering freshmen in 1993 found that 20 finished in the bottom third of their high school class. Admission standards at the university were tightened in 1995. In 1997, an SRS of 100 entering freshmen found that 10 finished in the bottom third of their high school class. Let p_1 be the proportion of all entering freshmen in 1993 who graduated in the bottom third of their high school class, and let p_2 be the proportion of all entering freshmen in 1997 who graduated in the bottom third of their high school class.

22. Referring to the information above, is there evidence that the proportion of freshmen who graduated in the bottom third of their high school class in 1997 has been reduced as a result of the tougher admission standards adopted in 1995, compared to the proportion in 1993? To determine this, you test the hypotheses $H_0: p_1 = p_2$, $H_a: p_1 > p_2$. The P -value of your test is
- A) greater than 0.10. D) between 0.001 and 0.01.
 B) between 0.05 and 0.10. E) below 0.001.
 (C) between 0.01 and 0.05.

Use the following to answer questions 30 and 31:

A sociologist is studying the effect of having children within the first three years of marriage on the divorce rate. From city marriage records, she selects a random sample of 400 couples that were married between 1985 and 1990 for the first time, with both members of the couple being between the ages of 20 and 25. Of the 400 couples, 220 had at least one child within the first three years of marriage. Of the couples that had children, 83 were divorced within five years, while of the couples that didn't have children, only 52 were divorced within three years. Suppose p_1 is the proportion of couples married in this time frame that had a child within the first three years and were divorced within five years and p_2 is the proportion of couples married in this time frame that did not have a child within the first two years and were divorced within five years.

30. Referring to the information above, the estimate of $p_1 - p_2$ is
- A) 0.0775. (B) 0.0884. C) 0.3100. D) 0.3375. E) 0.3773.

$$\frac{83}{220} - \frac{52}{180}$$

31. Referring to the information above, the sociologist had hypothesized that having children early would increase the divorce rate. She tested the one-sided alternative and obtained a P -value of 0.0314. The correct conclusion is that
- A) if you want to decrease your chances of getting divorced, it is best to wait several years before having children.
 - B) having more children increases the risk of divorce during the first 5 years of marriage.
 - C) if you want to decrease your chances of getting divorced, it is best not to marry when you are closer to 30 years old.
 - D) it is best not to have children.
 - E) there is evidence of an association between divorce rate and having children early in a marriage.

1. Popular wisdom is that eating presweetened cereal tends to increase the number of dental caries (cavities) in children. A sample of children was (with parental consent) entered into a study and followed for several years. Each child was classified as a sweetened-cereal lover or a nonsweetened cereal lover. At the end of the study, the amount of tooth damage was measured. Here are the summary data:

Group	n	Mean	Std. Dev
Sugar bombed	10	6.41	5.0
No sugar	15	5.20	15.0

An approximate 95% confidence interval for the difference in the mean tooth damage is

(a) $(6.41 - 5.20) \pm 2.26 \sqrt{\frac{5}{10} + \frac{15}{15}}$

(b) $(6.41 - 5.20) \pm 2.26 \sqrt{\frac{25}{10} + \frac{225}{15}}$

(c) $(6.41 - 5.20) \pm 1.96 \sqrt{\frac{25}{10} + \frac{225}{15}}$

(d) $(6.41 - 5.20) \pm 2.26 \sqrt{\frac{25}{100} + \frac{225}{225}}$

(e) $(6.41 - 5.20) \pm 1.96 \sqrt{\frac{25}{100} + \frac{225}{225}}$

6. A study was conducted to estimate the effectiveness of doing assignments in an introductory statistics course. Students in one section, taught by Instructor A, received no assignments. Students in another section, taught by Instructor B, received assignments. The final grade of each student was recorded. A 95% confidence interval for the difference in the mean grades (Section A – Section B) was computed to be -3.5 ± 1.8 . This means that

- (a) there is evidence that doing assignments improves the average grade since the difference in the population means is less than zero.
- (b) there is little evidence that doing assignments improves the average grade since the 95% confidence interval does not cover 0.
- (c) there is evidence that doing assignments improves the average grade since the 95% confidence interval does not cover 0.
- (d) there is evidence that doing assignments does not improve the average grade since the 95% confidence interval does not cover 0.
- (e) there is little evidence that doing assignments does not improve the average grade since the 95% confidence interval does cover 0.

An SRS of size 100 is taken from a population having proportion 0.8 of successes. An independent SRS of size 400 is taken from a population having proportion 0.5 of successes.

18. Referring to the information above, the sampling distribution for the difference in the sample proportions, $\hat{p}_1 - \hat{p}_2$, has mean

A) equal to the smaller of 0.8 and 0.5.
B) 0.56.
C) 0.3.
D) 0.15.
E) The mean cannot be determined without knowing the sample results.

19. Referring to the information above, the sampling distribution for the difference in the sample proportions, $\hat{p}_1 - \hat{p}_2$, has standard deviation

A) 1.3. B) 0.40. C) 0.047. D) 0.055. E) 0.002.

20. An SRS of 100 of a certain popular model car in 1993 found that 20 had a certain minor defect in the brakes. An SRS of 400 of this model car in 1994 found that 50 had the minor defect in the brakes. Let p_1 and p_2 be the proportion of all cars of this model in 1993 and 1994, respectively, that actually contain the defect. A 90% confidence interval for $p_1 - p_2$ is 0.075 ± 0.071 .

Suppose the sample of 1993 cars consisted of only 10 cars, of which two had the minor brake defect. Suppose also the sample of 1994 cars consisted of only 40 cars, of which five had the minor brake defect. A 90% confidence interval for $p_1 - p_2$ is now

A) the same as that for the original sample of 100 and 400 cars.
B) much wider than that for the original sample of 100 and 400 cars.
C) the same as 99% for the original sample of 100 and 400 cars.
D) unsafe to compute, since it is unsafe to use the normal distribution to approximate the sampling distribution of $\hat{p}_1 - \hat{p}_2$.
E) much narrower than that for the original sample of 100 and 400 cars.

