Activity 20-15: Nicotine Lozenge

a. The null hypothesis is that the population mean number of cigarettes smoked per day is 20. In symbols, H_0: $\mu = 20$.

The alternative hypothesis is that the population mean number of cigarettes smoked per day is not 20. In symbols, H_a: $\mu \neq 20$.

Technical conditions: The sample size is large, but the subjects were not randomly selected.

The test statistic is $t = \dfrac{22 - 20}{10.8/\sqrt{1818}} = 7.90$.

Using Table III with degrees of freedom equal to infinity, p-value $< 2 \times .0005$. Using Minitab, the p-value is .000000.

Because of the small p-value, reject H_0 at any significance level.

If this sample is representative of the general population, you have very strong statistical evidence that the population mean number of cigarettes smoked per day is not 20 (one pack).

b. The null hypothesis is that the population mean number of cigarettes smoked per day is 20. In symbols, H_0: $\mu = 20$.

The alternative hypothesis is that the population mean number of cigarettes smoked per day is not 20. In symbols, H_a: $\mu \neq 20$.

The test statistic is $t = \dfrac{22 - 20}{10.8/\sqrt{100}} = 1.85$.

You have $2 \times .025 < p$-value $< 2 \times .05$. Using Table III with 80 degrees of freedom, $.05 < p$-value $< .1$. Using Minitab, p-value $= 2 \times .0336481 = .0673$.

Barely fail to reject H_0 at the $\alpha = .05$ significance level ($.0673 > .05$)

You do not have sufficient statistical evidence (at the 5% level) to conclude that the population mean number of cigarettes smoked per day differs from 20.

You reached different conclusions in parts a and b: rejecting the null hypothesis when the sample size was very large, but failing to reject it when the sample size was only 100. This result makes sense because with larger samples there is less random sampling variability and the same sample mean will be more surprising/less likely to happen by chance alone.

Activity 20-16: Random Babies

Answers will vary by class. The following is one representative set of answers.

a. From Activity 11-1, part g, the sample size $n = 100$, the sample mean $\bar{x} = 1.090$ matches, and the sample standard deviation $s = 1.036$ matches.

b. The null hypothesis is that the population mean number of matches is equal to 1.0. In symbols, the null hypothesis is H_0: $\mu = 1.0$.

The alternative hypothesis is that the population mean number of matches is not equal to 1.0. In symbols, the null hypothesis is H_a: $\mu \neq 1.0$.

Technical conditions: The sample size is large ($n = 100$), and the samples were randomly selected, so the technical conditions necessary for this test procedure to be valid are satisfied.

Under the assumption of the null hypothesis, the CLT says the *sample mean number of matches* will be normally distributed, with center 1.0 match and standard deviation 1.036 match. So the test statistic is

$$t = \frac{1.09 - 1}{1.036/\sqrt{100}} = 0.87$$

Using Table III with 80 degrees of freedom, $2 \times .10 < p\text{-value} < 2 \times .20$, so $.20 < p\text{-value} < .40$. Using Minitab, $p\text{-value} = 2 \times .193202 = .3864$.

Do not reject H_0 because the *p*-value is not small.

You do not have any statistical evidence that the population mean number of matches differs from 1.0.

Activity 20-17: Backpack Weights

a. This is a quantitative variable.

b. The null hypothesis is that the population mean ratio of backpack weight to body weight is .10. In symbols, H_0: $\mu = .10$.

The alternative hypothesis is that the population mean ratio of backpack weight to body weight is not .10. In symbols, H_a: $\mu \neq .10$.

Technical conditions: The sample was not randomly selected, but the researchers did try to select a representative sample. The sample size is large ($n = 100 > 30$). You may consider the technical conditions have been met.

The test statistic is $t = \dfrac{.0771 - 1}{.0366/\sqrt{100}} = -6.26$.

Using Table III with 80 degrees of freedom, $p\text{-value} < 2 \times .0005 = .0010$. Using technology, $p\text{-value} \approx .0000$.

Because the *p*-value is small, reject H_0 at any reasonable significance level.

You have very strong statistical evidence that the population mean ratio is not .10.

c. The 99% confidence interval given in Activity 19-6 is (.0674, .0868). Note that .10 is not in this interval, which implies that you would reject this as a plausible value for μ at the $\alpha = .01$ significance level. This is consistent with your test results.

Activity 20-18: Looking Up to CEOs

a. The null hypothesis is that the average height for male CEOs of American companies is 69 inches. In symbols, H_0: $\mu = 69$ inches.

The alternative hypothesis is that the average height for male CEOs of American companies is more than 69 inches. In symbols, H_a: $\mu > 69$ inches.

b. A Type I error would be concluding that the average height for male CEOs is greater than 69 inches when it really isn't.

c. A Type II error would be failing to realize that the average height for male CEOs of American companies is greater than 69 inches.

Activity 20-19: Nicotine Lozenge

a. From Activity 19-11, a 99% confidence interval for μ is (21.3475, 22.6525). Thus, any value in this interval is a plausible value for μ, and any value *not* in this interval would be rejected at the $\alpha = .01$ significance level.

b. The null hypothesis is that the population mean number of cigarettes smoked per day is 22. In symbols, H_0: $\mu = 22$.

The alternative hypothesis is that the population mean number of cigarettes smoked per day is not 22. In symbols, H_a: $\mu \neq 22$.

Technical conditions: The sample size is large ($1818 > 30$), but the subjects were not randomly selected, so proceed with caution.

The test statistic is $t = \dfrac{22 - 22}{10.8/\sqrt{1818}} = 0$.

Using Table III with degrees of freedom equal to infinity, p-value $> 2 \times .2 = .4$. Using Minitab, p-value $= 2 \times .5 = 1.0$.

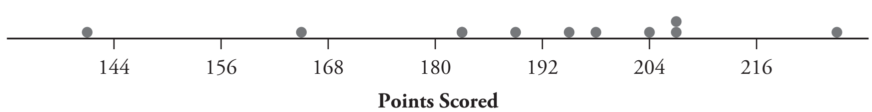
With the large p-value, do not reject H_0 at the $\alpha = .05$ significance level.

You have no statistical evidence that the population mean number of cigarettes smoked per day differs from 22.

c. Based on this p-value, 22 would be in the 95% confidence interval for μ (in fact, because it equals the sample mean, it will be at the center of the interval).

Activity 20-20: Basketball Scoring

a. The following dotplot displays the data:



Yes, it appears that these games average more than 183.2 points per game. The average points per game for these 10 games is 191, the standard deviation is 24.01 points, and the median number of points per game is 197.

b. The null hypothesis is that the mean number of points per game for the entire 1999–2000 season is 183.2. In symbols, H_0: $\mu = 183.2$.

The alternative hypothesis is that the mean number of points per game for the entire 1999–2000 season is greater than 183.2. In symbols, H_a: $\mu > 183.2$.

The test statistic is $t = \dfrac{191 - 183.2}{24.01/\sqrt{10}} = 1.03$.

Using Table III with 9 degrees of freedom, $1 < p$-value $< .2$. Using Minitab, the p-value is .164947.

c. No, you would not reject the null hypothesis at the $\alpha = .05$ level. You do not have sufficient statistical evidence to conclude that the mean number of points per game for the entire 1999–2000 season has increased beyond the mean of the previous season of 183.2 points.