AP Statistics

Chapter 9 Review

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Review Chapter 9 of NTA, *then* complete the following problems.

R9.1 Stating hypotheses State the appropriate null and alternative hypotheses in each of the following cases.

(a) The average height of 18-year-old American women is 64.2 inches. You wonder whether the mean height of this year's female graduates from a large local high school (over 3000 students) differs from the national average. You measure an SRS of 48 female graduates and find that $\bar{x} = 63.1$ inches.

$H_0: \mu = 64.2$

$H_A: \mu \neq 64.2$

μ = MEAN HT OF THIS YR'S FEMALE GRADUATES FROM A LARGE H.S.

(b) Mr. Starnes believes that less than 75% of the students at his school completed their math homework last night. The math teachers inspect the homework assignments from a random sample of students at the school to help Mr. Starnes test his claim.

$H_0: p = 0.75$

$H_A: p < 0.75$

p = PROP OF STUDENTS AT SCHOOL WHO COMPLETED HW LAST NIGHT.

R9.2 Eye black Athletes performing in bright sunlight often smear black grease under their eyes to reduce glare. Does eye black work? In one experiment, 16 randomly selected student subjects took a test of sensitivity to contrast after 3 hours facing into bright sun, both with and without eye black. Here are the differences in sensitivity, with eye black minus without eye black:[34]

0.07	0.64	−0.12	−0.05	−0.18	0.14	−0.16	0.03
0.05	0.02	0.43	0.24	−0.11	0.28	0.05	0.29

We want to know whether eye black increases sensitivity on the average.

(a) State hypotheses. Be sure to define the parameter.

(b) Check conditions for carrying out a significance test.

(c) The *P*-value of the test is 0.047. Interpret this value in context.

(A) $H_0: \mu_d = 0$ $\quad \mu_d$ = WITH − W/O EYE BLACK

$H_A: \mu_d > 0$

(B) RANDOM − SRS ✓

NORMAL −

SLIGHT R-SKEW

NO O/L'S ✓

IND: 16 LESS THAN 10% OF POP.

(C) IF EYE BLACK DOES NOT INCREASE SENSITIVITY, THEN CHANCE OF FINDING SAMPLE WITH DIFF AS LARGE AS OURS IS 4.7%.

R9.3 Strong chairs? A company that manufactures classroom chairs for high school students claims that the mean breaking strength of the chairs that they make is 300 pounds. One of the chairs collapsed beneath a 220-pound student last week. You wonder whether the manufacturer is exaggerating the breaking strength of the chairs.

(a) State null and alternative hypotheses in words and symbols.

(b) Describe a Type I error and a Type II error in this situation, and give the consequences of each.

(c) Would you recommend a significance level of 0.01, 0.05, or 0.10 for this test? Justify your choice.

(d) The power of this test to detect $\mu = 294$ is 0.71. Explain what this means to someone who knows little statistics.

(e) Explain two ways that you could increase the power of the test from (d).

(A) $H_0: \mu = 300$

$H_A: \mu < 300$

μ = MEAN BREAKING STRENGTH OF COMPANY'S CLASSROOM CHAIRS

(B) I: SAYING MEAN IS LOWER THAN 300 WHEN IN FACT IT IS NOT. (SAFER CHAIR)

II: SAYING MEAN IS 300 WHEN REALLY LOWER. (UNSAFE CHAIR). (WORSE)

(C) 0.01 SAFETY.

(E) INCREASE n

INCREASE α

(D) P(GETTING IT RIGHT) = 0.71

R9.4 Flu vaccine A drug company has developed a new vaccine for preventing the flu. The company claims that fewer than 5% of adults who use its vaccine will get the flu. To test the claim, researchers give the vaccine to a random sample of 1000 adults. Of these, 43 get the flu.

(a) Do these data provide convincing evidence to support the company's claim? Perform an appropriate test to support your answer.

(b) Which kind of mistake—a Type I error or a Type II error—could you have made in (a)? Explain.

(c) From the company's point of view, would a Type I error or Type II error be more serious? Why?

$H_0: p = 0.05$

$H_A: p < 0.05$

$\hat{p} = 0.043$

$z = -1.02$

P-VALUE = 0.1539.

FAIL TO REJECT

(B) TYPE II WE FAILED TO REJECT.

(C) TYPE I $\Rightarrow$ VACCINE MORE EFFECTIVE THAN IT IS.

TEST STAT = z =

$$\frac{0.043 - 0.05}{\sqrt{\frac{(0.05)(0.95)}{1000}}} \approx -1.02$$

R9.6 Improving health A large company's medical director launches a health promotion campaign to encourage employees to exercise more and eat better foods. One measure of the effectiveness of such a program is a drop in blood pressure. The director chooses a random sample of 50 employees and compares their blood pressures from physical exams given before the campaign and again a year later. The mean change (after − before) in systolic blood pressure for these 50 employees is −6 and the standard deviation is 19.8.

(a) Do these data provide convincing evidence of an average decrease in blood pressure among all of the company's employees during this year? Carry out a test at the $\alpha = 0.05$ significance level.

(b) Can we conclude that the health campaign caused a decrease in blood pressure? Why or why not?

(A)

$H_0: \mu_d = 0$ $\quad$ μ_d = ACT ~~DIFF~~ MEAN DIFF (AFTER - BEFORE)

$H_a: \mu_d < 0$

NORMAL $n > 30$ (CLT) ✓

RANDOM ✓ SRS

IND: > 50 (100) EMPLOYEES ✓

$\bar{x} = -6$ $\quad S_x = 19.8$ $\quad$ DF = 50 − 1 = 49

$t = -2.143$ $\quad$ P-VALUE 0.0186

REJECT H_0 $\quad$ BP REDUCED.

TEST STAT:

$$t = \frac{-6 - 0}{19.8/\sqrt{50}} = -2.143$$

(B) NO – OBS STUDY W/NO COMPARISON GROUP.

R9.8 Radon detectors Radon is a colorless, odorless gas that is naturally released by rocks and soils and may concentrate in tightly closed houses. Because radon is slightly radioactive, there is some concern that it may be a health hazard. Radon detectors are sold to homeowners worried about this risk, but the detectors may be inaccurate. University researchers placed a random sample of 11 detectors in a chamber where they were exposed to 105 picocuries per liter of radon over 3 days. A graph of the radon readings from the 11 detectors shows no strong skewness or outliers. The Minitab output below shows the results of a one-sample t interval.

Is there significant evidence at the 10% level that the mean reading μ differs from the true value 105? Give appropriate evidence to support your answer.

Session

One-Sample T: Radon

Variable	N	Mean	StDev	SE Mean	90% CI
Radon	11	104.82	9.54	2.88	(99.61, 110.03)

$H_0: \mu = 105$ $\quad$ $\alpha = 0.01$

$H_A: \mu \neq 105$

RANDOM ✓

NORMAL – GRAPH SHOWED NO STRONG SKEW. OR O/LS ✓

IND: 11 IS LESS THAN 10% ✓

CONDS MET. ✓

90% CI (99.61, 110.03)

CONTAINS 105 ∴ WE DO NOT REJECT H_0. WE DO NOT HAVE ENOUGH EVIDENCE TO CONCLUDE THAT THE RADON DETECTORS ARE INACCURATE

R9.9 Better barley Does drying barley seeds in a kiln increase the yield of barley? A famous experiment by William S. Gosset (who discovered the t distributions) investigated this question. Eleven pairs of adjacent plots were marked out in a large field. For each pair, regular barley seeds were planted in one plot and kiln-dried seeds were planted in the other. The following table displays the data on yield (lb/acre).[35]

Plot	Regular	Kiln
1	1903	2009
2	1935	1915
3	1910	2011
4	2496	2463
5	2108	2180
6	1961	1925
7	2060	2122
8	1444	1482
9	1612	1542
10	1316	1443
11	1511	1535

(a) How can the Random condition be satisfied in this study?

(b) Perform an appropriate test to help answer the research question. Assume that the Random condition is met. What conclusion would you draw?

(A) BY RANDOMLY ALLOCATING WHICH PLOT GOT REGULAR + WHICH PLOT GOT KILN.

(B) $H_0: \mu_d = 0$

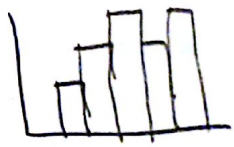
$H_A: \mu_d < 0$

μ_d = ACTUAL MEAN DIFF (REGULAR − KILN)

$\alpha = 0.05$

RANDOM ✓ RANDOM EXP.

NORMAL CHECK GRAPH



NO STRONG SKEWNESS OR O/L'S ✓

INDEPENDENT ✓ CLEARLY MORE THAN 110 PLOTS

$$\text{TEST STAT} = \frac{-33.7 - 0}{\frac{66.2}{\sqrt{11}}} \approx -1.688$$

$\bar{X} = -33.7 \quad S_x = 66.2$

$t = -1.688 \quad df = 11 - 1 = 10$

P-VALUE (TECH) 0.0612

$P > 0.05$ WE FAIL TO REJECT H_0

WE DO NOT HAVE ENOUGH EVIDENCE TO CONCLUDE KILN-DRIED BARLEY SEEDS PRODUCE A LARGER YIELD.