Grade sheet for Problem Two Part 4:
Two Sample Paired T Test For Mean of the Differences in Weights on Day 1 and Day 15 for Low Exposure Test Group.

Part 4: As a result of low exposure, is there a change between the Day1 and Day 15 body weights? Justify.

Topic:
Previous studies have shown a link between pesticide exposure and thyroid disease, which can lead to increased weight gain, a symptom of thyroid disease.

Population:
Rats who are exposed to a low amount of the pesticide of interest.

Research Question:
Whether or not there is a difference in weights on day 1 and day 15 of rats who were exposed to a low level amount of this pesticide.

Methods

Description of Outcome: The weights of day 1 and day 15
Description of Predictor: Low exposure of this pesticide

Description of Data Summary:

Weights on Day 1-Low Exposure	Weights on Day 15-Low Exposure
Mean: 98.01	Mean: 126.58
Sample Size: 49	Sample Size: 49
Standard Deviation: 9.57	Standard Deviation:10.32
95% CI on Mean: 95.2622,100.7622	95% CI on Mean: 123.6145, 129.5434

Description of Data Summary for Each Variable:
110 rats were a part of a research study to test the effects of a certain pesticide on weight gain. The rats were randomly selected, and divide among two groups: rats that either receive low exposure of this pesticide or high exposure of this pesticide. The trial lasted for 15 days and the weights of the rats were recorded on day 1 and day 15.

Verification of normality:
Per the central limit theorem, if the sample size is above 30 the sample mean will follow a normal distribution.

Statement of Null Hypothesis:
The differences in body weight after a low exposure of the pesticide is centered at 0 (H_0: $\mu_d=0$)

Statement of Alternative Hypothesis:
The differences in body weight after a low exposure of the pesticide is less than 0 (H_A: $\mu_d<0$)

Statistical Method for Test:
Paired T test

Decision Rule:
Reject H_O in favor of H_A if p-value is less than alpha (p-value<α) otherwise fail to reject the null H_O

Method of Computation:
R statistical software version 2.11.1

Significance Level:
α=0.05

Results

Summary of the difference in Table 4.0

Table 4.0 Data Summary: For Day 1 and Day 15 Body Weights of Low Exposure of the Pesticide

Groups	*n*	mean	SD	95% CI
Low Exposure: Day 1 Weights	49	98.01	9.57	95.2623, 100.7622
Low Exposure: Day 15 Weights	49	126.58	10.32	123.6145, 129.5434
Difference(D1-D15)		-28.57	7.08	-30.6020 -26.5315

Normality is assumed per the CLT based on adequate sample size for each group

Assumptions:
Sample is large enough
Sample is representative of the population from which it is drawn
Subjects were randomized into each group, therefore we assume measurements of each subject is independent of one another

Test Results of Paired T-Test:
t = -28.221, df = 48, p-value < 0.001

P-value Results
Since p-value < 0.05, we reject the H_O in favor of the Alternative H_A

Description of Results:
The paired t-test p-value is less than the stated alpha level (0.05), indicating that the data provided enough evidence to reject the null hypothesis and conclude that on average, low exposure of this pesticide causes increased weight gain. We find that the mean difference for μ_d is -28.57 and the 95% CI for μ_d, (the mean difference of day 1 and day 15 of low pesticide exposure) is roughly -30.6020, -26.5315. Therefore, we can say with 95% confidence that after being exposed to low levels of this pesticide for 15 days the true mean increase of body weight is between 26.5315,30.6020

Discussion

Since the mean reduction from day 1 and day 15 was significantly different from zero, we conclude that the evidence suggests that low exposure to this pesticide causes increased weight gain.

Implication of Results

Based on the evidence, we conclude that low levels of exposure to this pesticide causes an increase in weight gain, a symptom of thyroid disease. Therefore, we encourage that all future users of this pesticide be made aware of this through proper labeling on the bottle.

R-code

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#!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!question 4!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
#As a result of low exposure, is there a change between the Day1
#and Day 15 body weights? Justify
# each observation in one sample is linked to an observation in another sample
# the mean of the differences (not the difference in means)
#paired t test is nothing more than a regular one sample mean for the mean of the difference
#null Ho: ud = uo alt. Ha ud /=uo
#paired sunjects, before and after
#assumptions: sample size is above 30, there for CLT holds, subjects are represensative, measurements are
indpendent of eachother
#!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!summary!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Q4_lo_day1<-T4_Problem2[T4_Problem2$Exposure=='low' & T4_Problem2$BWDay1,1]
Q4_lo_day15<-T4_Problem2[T4_Problem2$Exposure=='low' & T4_Problem2$BWDay15,2]

diff_day_1_low<-sqrt((-28.57--14.28)^2/48)

#Sam 85 94 9
#Tamika 94 87 -7
#Brian 78 79 2
#Mike 87 88 1
#Mean difference = (9-7+2+1)/4 = 1.25



#Var =sum[(diff-mean diff)^2] / 3
#= [(9-1.25)^2 + (-7-1.25)^2 + (2-1.25)^2 + (1-1.25)^2] / 3
#= 128.75/3
#= 42.92

SD = sqrt(Var) = sqrt(42.92) = 6.55


CI(Q4_lo_day1,ci=0.95)
#upper      mean     lower
#100.76221  98.01224  95.26228
CI(Q4_lo_day15, ci=0.95)
#upper     mean    lower
#129.5434 126.5790 123.6145

weight_diff_lo_2.data<-(Q4_lo_day1-Q4_lo_day15)

#differences in means
weight_diff_lo<-(MDay1_lo-MDay15_lo)
#> weight_diff_lo
#[1] -28.56673
t.test(weight_diff_lo_2.data)
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```
#standard deviation
#Exposure    BWDay1
#      low  9.573986
#Exposure  BWDay15
#    low 10.32063
#!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!paired t test!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
t.test(Day1_lo,Day15_lo, mu=0,alternative="less", paired=TRUE)
#Paired t-test

#data:  Day1_lo and Day15_lo
#t = -28.221, df = 48, p-value < 2.2e-16
#alternative hypothesis: true difference in means is not equal to 0
#95 percent confidence interval:
#  -30.60198 -26.53149
#sample estimates:
#  mean of the differences
#-28.56673

#p values is 0.0001, which is less than the stated alpha level. therefore we say
# indicating enough evidence to reject the null, and conclude that on average, low exposure
# does cause weight gain
```