

Part 3 – Mallard Corticosterone Levels

In 2011, thirty-six Pekin ducklings were obtained to participate in a test to provide research on whether effects of exposure to OSPW differs depending on life stages. The birds were exposed as juveniles and as adults enduring two trials that lasted the duration of two years. This study provided results which showed the levels of corticosterone in females was slightly lower in the oil sands process-affected water (OSPW) than in the control water. However, this study showed the opposite for males. In the OSPW, the males had much higher levels of corticosterone than males in control water, resulting in higher levels than the females in both conditions.

The distribution of the mallard's corticosterone levels can be assumed from the boxplot. Since this boxplot is symmetrical and there are no outliers evident, this means the data meets the assumptions of normality. According to the boxplot, the median is a bit over 100 with a minimum observation of close to 0 and maximum observation around 240.

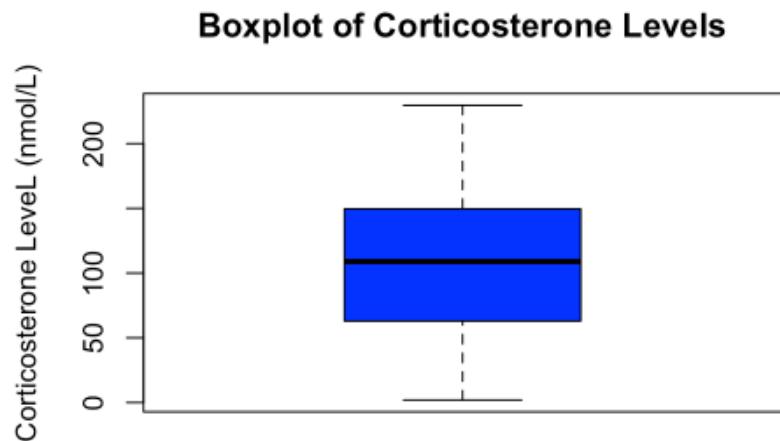


Figure 1: Boxplot of Corticosterone Levels in nmol/L

To verify these assumptions, we can also visualize the distribution through the normal quantile-quantile plot of corticosterone levels. Since this resulting plot is approximately straight, the sample data is approximately normally distributed.

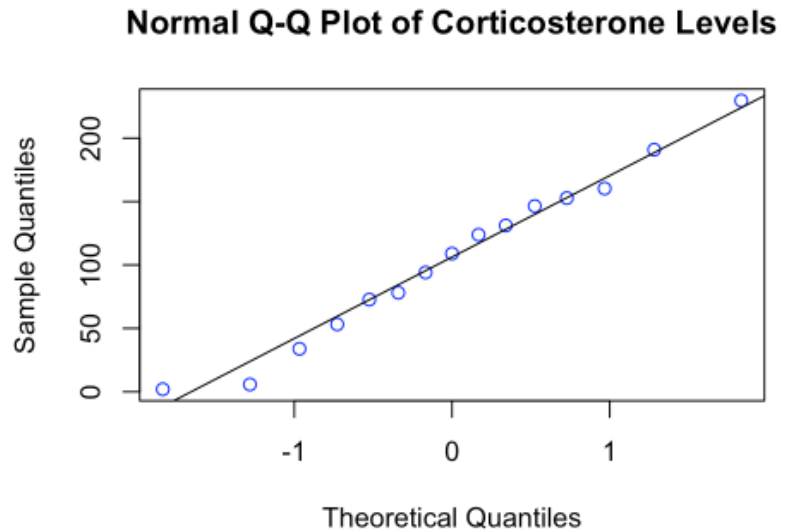


Figure 2: Normal Q-Q Plot of the Corticosterone Levels

When comparing our results to the study, the relationship shown on the Q-Q plot refers to the relationship between OSPW and corticosterone levels, which will be tested in further statistical analysis. After both tests and reflection on the study itself, it is reasonable to assume normality for the following statistical procedures.

According to our assumptions of normality, we can determine the 95% confidence interval through the R command “t.test”. From the conducted t.test, we are 95% confident that the true mean corticosterone level is in the interval (68.993, 142.160).

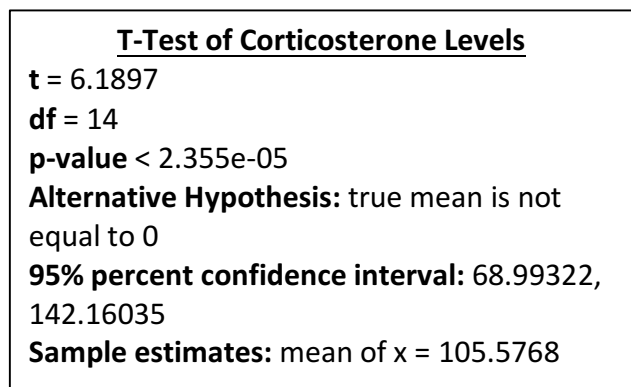


Figure 3: T-Test of the 95% confidence interval

The study shows an average corticosterone level of 72.903 nmol/L for the mallards in the control groups. Conducting a hypothesis test enables the correlation of the corticosterone levels between the mallards in the control group and OSPW to be evaluated. For this test, the null hypothesis was $H_0: \mu = 74.903$; the mallards exposed to the OSPW will have, on average, the same corticosterone levels as the mallards in the control group. The alternative hypothesis was $H_A: \mu > 74.903$; the corticosterone levels of the mallards exposed to the OSPW will be a higher average than the corticosterone levels of the mallards in the control group. This alternative hypothesis was chosen because it is critical that the effects of OSPW on the mallards is determined in order to maintain the wildlife in this affected area. To conduct this hypothesis test, the t and p values were determined in RStudio. Since the p value of 0.04 is between 0.01 and 0.05, there is moderate to strong evidence against the null hypothesis. This evidence suggests the corticosterone levels of the mallards are effected by the exposure to OSPW, therefore rejecting the null hypothesis.

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Hypothesis Test Data: Corticosterone Levels  
t <- (105.5768 - 74.903) / (66.06136/sqrt(15))  
t = 1.798315  
p <- 1 - pt(t,14)  
p = 0.04685894
```

Figure 4: RStudio Output for the Hypothesis Test

References:

Beck, E.M., Smits, J.E.G., & Cassady St. Clair, C. (2014). Health of domestic mallards (*Anas platyrhynchos domestica*) following exposure to oil sands process-affected water. *Environmental Science & Technology*, 48, 8847 - 8854.