Practical 2. Hypothesis testing: differences between two groups – Answers

Question 1: How many cases and how many variables does the dataset has?

cases	50
variables	two

Question 1.1 : Specify the type of variable and the scale of measurement for each, indicating which one is the explanatory or independent variable and which is the response or dependent variable.

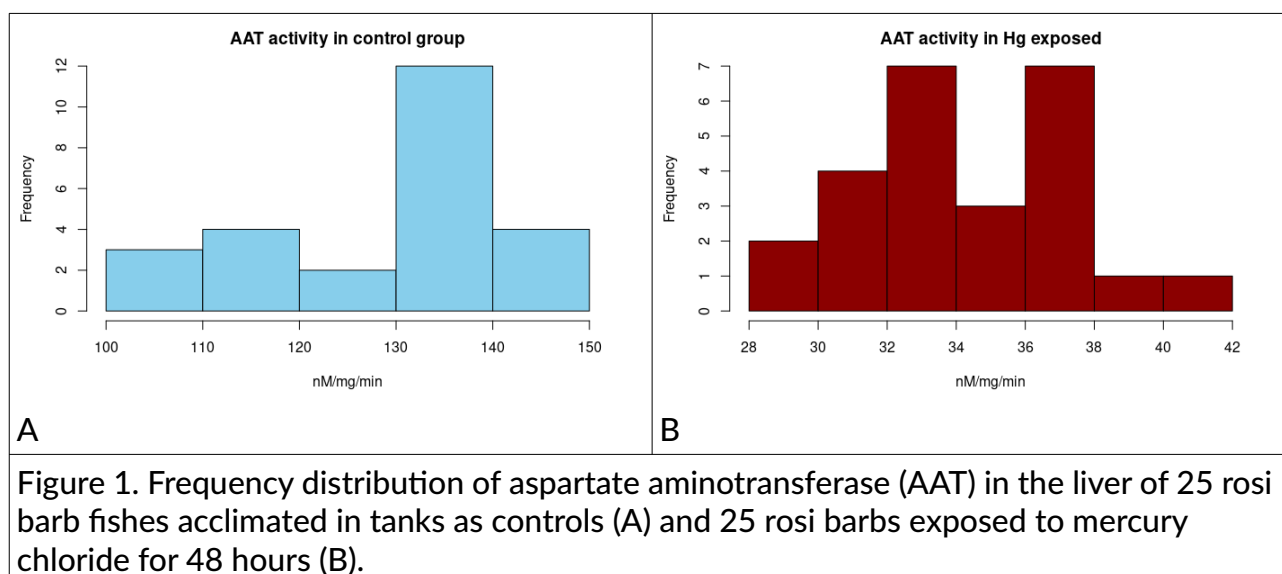| Mercury exposure	Categorical, nominal with two labels: Control or not exposed to mercury and Exposed to mercury. These are also called treatments. Independent or explanatory variable
AAT activity	Continuous, ratio scale. Response or dependent variable

Question 1.2: What are the groups you would like to compare?

The labels of the categorical explanatory variable, which is a factor and therefore, the two levels are the groups to compare: Control vs Exposed to mercury each with 25 cases.

Question 2: Write a short narrative describing the data. Remember to include the basic information that a reader needs for they to have an idea of the data obtained by the researchers.

The activity of aspartate aminotransferase enzyme in the liver of rosy barb fishes ranged in between 101.6 nM/μg/min and 149.0 nM/μg/min with an average of 128.7 ± 13.08 nM/μg/min (mean ± SD) in the control treatment, while in the fishes exposed to mercury chloride, that average was almost 4-fold lower at 34.39 ± 2.84 nM/μg/min (mean ± SD) with values within a narrower range (28.99 – 40.44 nM/μg/min; Fig.1)

Question 3: Copy and paste the histograms into your narrative and remember to reference the figure and include a caption.

Figure 1. Frequency distribution of aspartate aminotransferase (AAT) in the liver of 25 rosi barb fishes acclimated in tanks as controls (A) and 25 rosi barbs exposed to mercury chloride for 48 hours (B).

Question 4: Write the logical hypothesis and its null equivalent (logical null hypothesis) in an IF-THEN statement.

Logical Hypothesis	**If** mercury affects the activity of the enzyme AAT in freshwater fishes, **then** we would expect the activity of AAT in the liver of rosi barbs **to be different** between fishes that are exposed to mercury and those that are not.
Logical Null Hypothesis	**If** mercury affects the activity of the enzyme AAT in freshwater fishes, **then** we would expect the activity of AAT in the liver of rosi barbs **not to be different** between fishes that are exposed to mercury and those that are not.

Question 4.1: Write the null statistical hypothesis

$$Ho : \mu \text{ control} = \mu \text{ Hg-exposed}$$
$$Hi: \mu \text{ control} \neq \mu \text{ Hg-exposed}$$

Question 4.2: Is the data from both groups normally distributed? Write your results in narrative form. Remember to include the value of the test statistic and the p-value.

The Shapiro-Wilks test indicated the AAT activity for both, the control (W = 0.92818, p-value = 0.07889) and Hg-exposed treatments (W = 0.97692, p-value = 0.818) was normally distributed (Fig. 2)
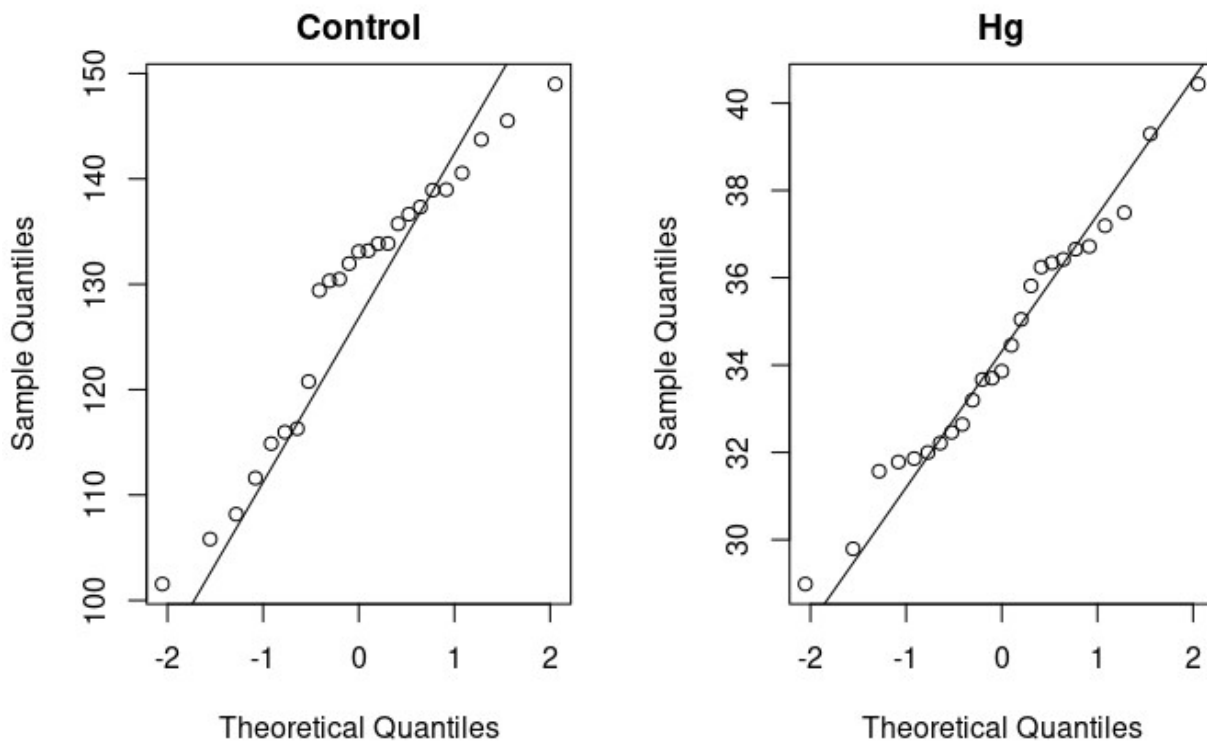
Figure 2. Quantile-Quantile (Q-Q) plot for the activity of aspartate aminotransferase (AAT) in the liver of 25 rosi barb fishes acclimated in tanks as controls (A) and 25 rosi barbs exposed to mercury chloride for 48 hours (B).

Question 4.3: Are the variances homogeneous? Write your results in narrative form. Remember to include the value of the test statistic, degrees of freedom and the p-value.

The variances of AAT activity in the control and Hg-exposed treatments were not homogeneous (Levene's test, F=16.361; df=48;p-value=0.0002). Therefore, data were transformed using logarithm base 10 and homogeneity of variances checked again (F=0.406; df=48;p-value=0.526).

Question 4.4: Do you failed to accept or to reject your Null Hypothesis? Write the results of your t-test in a narrative form and remember to include the value of the test statistic, degrees of freedom and p-value.

I failed to accept Ho.

The t-test showed the activity of AAT in the liver of rosi barbs differed significantly between fishes that were exposed to mercury chloride for 48 hours and those kept as controls (t=49.138; df=45.38; p-value=$2.2*10^{-16}$;Fig. 3)
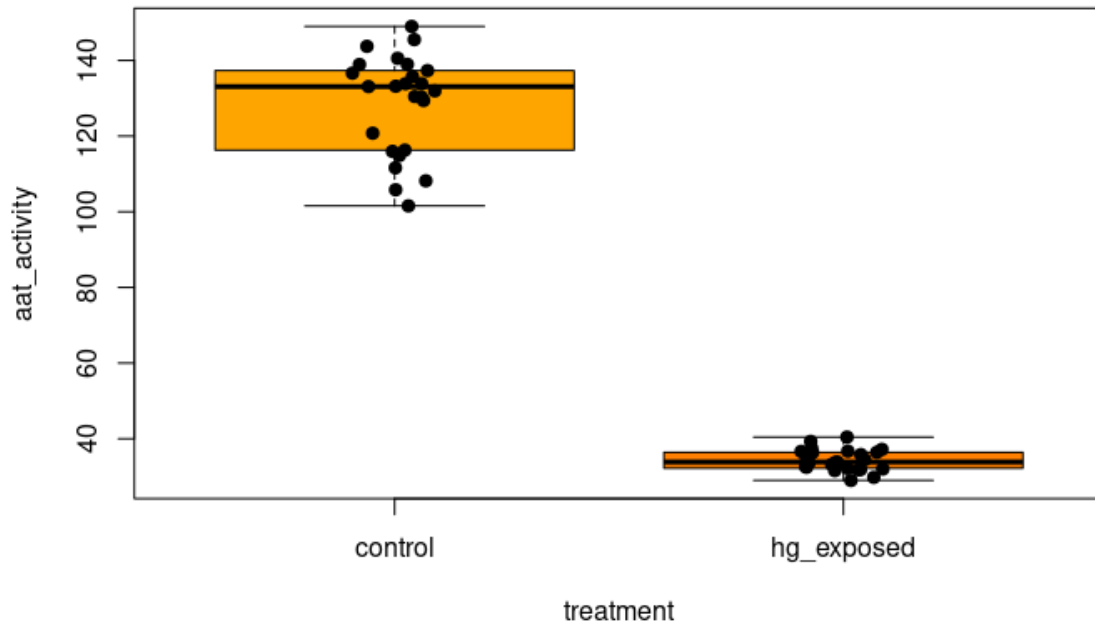
Figure 3. Activity of aspartate aminotransferase (AAT) in the liver of 25 rosi barb fishes acclimated in tanks as controls (A) and 25 rosi barb exposed to mercury chloride for 48 hours (B).

Question 4.5: What argument(s) would you change in the t.test function and how if you would like to perform a t-test for paired samples?

I would set the argument paired = TRUE

Question 4.6: What argument(s) would you change in the t.test function and how if you would like to test a null hypothesis like this one:

Ho μ control > μ Hg-exposed

I would set the argument alternative= "greater"