# Practical: Comparing the means between 2 groups

In the following exercises, we will use the t‐test (paired and unpaired), and their non‐parametric alternatives, to compare the means between two groups. All exercises are done on the ***surgery dataset***. The outlier on row 21 has been adjusted to 29.41.

## Independent samples t‐test

The independent samples t‐test is used to compare the population mean of a continuous variable between two groups. That is to say, we test the null hypothesis that the mean of the continuous variable is equal in the two groups. The observations in group 1 are independent from the observations in group 2 – no individual has been measured twice.

The independent samples t‐test is a parametric test. The conditions for parametric testing (at least 10 observations and a normal distribution) have to be fulfilled in both groups.

Exercise:

Test whether the BMI before surgery (**BMIpre**) is different between males and females (variable **sex**).

1. Verify whether the conditions for parametric testing hold in both groups (males and females separately)
2. Perform an independent samples t‐test with **BMIpre** as response variable and **sex** as group.
   1. Is there a significant difference? What is the p‐value?
   2. What are the means in both groups?

Additional questions:

The independent samples t‐test comes in two flavors: the t‐test assuming equal variances in both groups, and the t‐test that does not make this assumption (the t‐test for unequal variances).

Verify the equal variances in the exercise you just made by

‐ Making a boxplot of **BMIpre** versus **sex** and check visually if the variance does not differ too much.

‐ Performing a formal statistical test for equality of variances.

Go to the help for the t‐test (?t.test) and find out which of the two t‐tests is carried out by default in R, and which additional argument you can supply to the t.test() function to modify this.

‐ Did you carry out the t‐test with equal or unequal variances before?

‐ Which of the two tests would you run after verifying the equal variances?

## Paired t‐test

Paired tests are used when two measurements are taken from the same individual (say, person). The null hypothesis states that on average, there is no difference between the first measurement and the second measurement. That is, the difference between the first and the second measurement in the population is on average zero.

Exercise:

Investigate whether the BMI has changed following the surgery. That is, test the hypothesis that the mean of **BMIpre** is equal to the mean of **BMIpost**.

1. Verify whether the condition for parametric testing holds by analysing the difference between

## BMIpre‐BMIpost.

* 1. Calculate a new variable that shows the difference **BMIpre**‐**BMIpost**:
  2. Generate a histogram and a QQ‐plot for this new variable.

1. Perform a paired t‐test on **BMIpre** and **BMIpost**
   1. Is there a significant difference between **BMIpre** and **BMIpost**? What is the p‐value?
   2. What is the mean difference between **BMIpre** and **BMIpost**?

## Nonparametric tests

In case the number of observations in (one of) the groups is small (<10), or the distribution of the numeric variable is far from normal, parametric tests like the t‐test are not valid. Non‐parametric testing, that does not rely on the normality assumptions, offers an alternative in these cases. The independent‐samples t‐test and the paired t‐test have a non‐parametric analogue, resp. the Wilcoxon two‐sample test (aka Mann‐Whitney test, aka Wilcoxon rank sum test) and the Wilcoxon paired samples test (aka Wilcoxon signed‐rank test).

Go on with the ***surgery*** dataset but make a subset containing only the persons with diabetes (*diabetes == 1)*.

Exercise:

Analyze the previous 2 research questions in this ***subDiabetes*** subset. Note that in this latter dataset, we only have 21 individuals.

* 1. Verify the assumptions for parametric testing, using the methods outlined in previous paragraphs.
  2. Carry out the Mann‐Whitney test and the Wilcoxon signed rank tests, respectively. Also enter the correct argument(s) to run the right analysis.