Teacher Resource Bank

GCE Human Biology

Students' Statistics Sheet (version 2.2)

Statistical Sheets for Students: GCE Human Biology

In scientific investigations, you would usually consider statistical analysis as part of the design of an investigation. This means that you would consider which statistical test would be appropriate when deciding what to measure or record and how many times to repeat an experiment. At A level, you are required to select an appropriate statistical test to apply to data you have already obtained. You are only expected to consider the use of tests given in the specification (and on these sheets).

Unless otherwise stated, five repeats will be considered sufficient for a statistical analysis in A2 assessments. There may be investigations where you are instructed to use as few as three repeats.

The flow chart on the next page takes you through the stages in selecting a statistical test to apply to your data.

The first step is to decide what sort of data you have.

The next step is to decide what you want to know about the data.

You should then come to an appropriate statistical analysis to use.

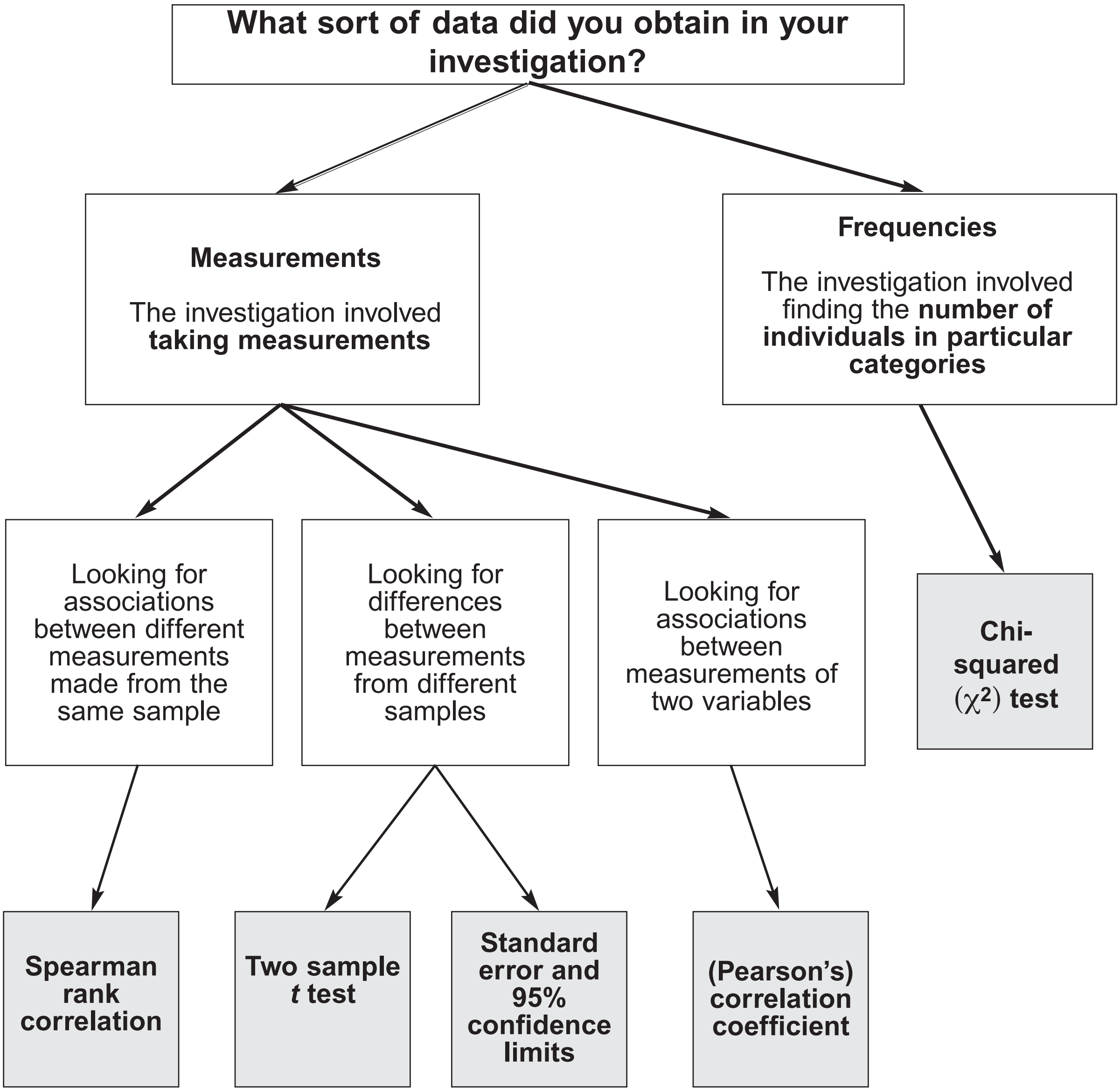
Use of calculators or computer spreadsheets

In assessments, the important skills being tested are your ability to

- identify the sort of data you have
- select an appropriate statistical test
- and decide whether or not the test statistic obtained has a value which is statistically significant.

You can use a calculator or computer spreadsheet when calculating the test statistic but you must do this yourself.

Students' Statistics Sheet (version 2)



For use in the A2 ISA and EMPA assessment

Statistical tests and tables of critical values

Tables of critical values

A table of critical values is provided with each statistical test. If your calculated test statistic is greater than, or equal to, the critical value, then the result of your statistical test is significant. This means that your null hypothesis should be rejected.

Spearman rank correlation test

Use this test when
- you wish to find out if there is a significant association between two sets of measurements from the same sample
- and you have between 5 and 30 pairs of measurements.

Record the data as values of X and Y.

Convert these values to rank orders, 1 for largest, 2 for second largest, etc.

Now calculate the value of the Spearman rank correlation, r_s, from the equation

$$r_s = 1 - \left[\frac{6 \times \Sigma D^2}{N^3 - N}\right]$$

Where N is the number of pairs of items in the sample.
D is the difference between each pair (X-Y) of ranked measurements.

A table showing the critical values of r_s for different numbers of paired values.

Number of pairs of measurements	Critical value
5	1.00
6	0.89
7	0.79
8	0.74
9	0.68
10	0.65
12	0.59
14	0.54
16	0.51
18	0.48

Correlation coefficient (Pearson's correlation coefficient)

Use this test when
- you wish to find out if there is a significant association between two sets of measurements measured on interval or ratio scales
- the data are normally distributed.

Record the data as values of variables X and Y.

Now calculate the value of the (Pearson) correlation coefficient, r, from the equation

$$r = \frac{\Sigma XY - [(\Sigma X)(\Sigma Y)]/n}{\sqrt{\{\Sigma X^2 - [(\Sigma X)^2/n]\}\ \{\Sigma Y^2 - [(\Sigma Y)^2/n]\}}}$$

Where n is the number of values of X and Y.

A table showing the critical values of *r* for different degrees of freedom.

Degrees of freedom	Critical value	Degrees of freedom	Critical value
1	1.00	12	0.53
2	0.95	14	0.50
3	0.88	16	0.47
4	0.81	18	0.44
5	0.75	20	0.52
6	0.71	22	0.40
7	0.67	24	0.39
8	0.63	26	0.37
9	0.60	28	0.36
10	0.58	30	0.35

For most cases, the number of degrees of freedom is = $n - 2$

The *t* test

Use this test when
- you wish to find out if there is a significant difference between two means
- the data are normally distributed
- the sample size is less than 25.

t can be calculated from the formula

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(s_1{}^2/n_1) + (s_2{}^2/n_2)}}$$

Where $\bar{x}_1$ = mean of first sample
$\bar{x}_2$ = mean of second sample
s_1 = standard deviation of first sample
s_2 = standard deviation of second sample
n_1 = number of measurements in first sample
n_2 = number of measurements in second sample

A table showing the critical values of t for different degrees of freedom.

Degrees of freedom	Critical value	Degrees of freedom	Critical value
4	2.78		
5	2.57	15	2.13
6	2.48	16	2.12
7	2.37	18	2.10
8	2.31	20	2.09
9	2.26	22	2.07
10	2.23	24	2.06
11	2.20	26	2.06
12	2.18	28	2.05
13	2.16	30	2.04
14	2.15	40	2.02

The number of degrees of freedom = $(n_1 + n_2) - 2$

Standard error and 95% confidence limits

Use this when
- you wish to find out if the difference between two means is significant
- the data are normally distributed
- the sizes of the samples are at least 30. For assessment purposes, five samples are acceptable providing that this is acknowledged either at a convenient place in the statistical analysis or in the conclusions.

Standard error
Calculate the standard error of the mean, SE, for each sample from the following formula:

$$SE = \frac{SD}{\sqrt{n}}$$

Where SD = the standard deviation
n = sample size

95% confidence limits
In a normal distribution, 95% of datapoints fall within ± 2 standard deviations of the mean.

Usually, you are dealing with a sample of a larger population. In this case the 95% confidence limits for the sample mean is calculated using the following formula

95% confidence limits = $\bar{x} \pm 2 \times \frac{\mathrm{SD}}{\sqrt{n}}$ **OR** $\bar{x} \pm 2 \times \mathrm{SE}$

Turn over ▶

The chi-squared test

Use this test when
- the measurements relate to the number of individuals in particular categories
- the observed number can be compared with an expected number which is calculated from a theory, as in the case of genetics experiments.

The chi-square (χ^2) test is based on calculating the value of χ^2 from the equation

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Where O represents the observed results
E represents the results we expect.

A table showing the critical values of χ^2 for different degrees of freedom.

Degrees of freedom	Critical value
1	3.84
2	5.99
3	7.82
4	9.49
5	11.07
6	12.59
7	14.07
8	15.51
9	16.92
10	18.31

The number of degrees of freedom = number of categories – 1