Example: PAIRED T-TEST

It is thought that the glycaemic index (GI) of food is an indicator of how sustaining or satisfying it is and may influence appetite.

A sample of children were provided with a breakfast of low GI foods on one day and high GI foods on another. The two breakfasts contained the same quantities of carbohydrate, fat and protein. On each day a buffet lunch was provided and the number of calories eaten at lunchtime were recorded.

On the first day the children ate a low GI breakfast and on the second day a high GI breakfast. The objective is to determine whether the kind of breakfast eaten has an effect on mean calorie intake.

The table below summarises the data for children in the sample. This shows that for the children in the experiment, mean calorie intake at lunchtime was higher after the high GI breakfast. A hypothesis test is needed to determine whether these results mean that we can predict that there would be differences in mean calorie intake for other children who ate low and high GI breakfasts.

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
kcal after low gi breakfast	607.9697	33	182.82445	31.82565
kcal after high gi breakfast	771.6061	33	222.10779	38.66400

The hypotheses to test are:

Null hypothesis (H_0): Mean calorie intake is the same following low or high GI breakfast

Alternative: (H_1): Mean calorie intake depends on whether a low or high GI breakfast was eaten

A paired t-test is appropriate because:

(1) two related samples are being compared. The samples are related because the same group of children tested both breakfasts

(2) the dependent variable, that is, the calorie intake, is a continuous variable

The next table shows the result of the paired t-test – this allows us to draw conclusions about the population of children from which the sample was drawn. The key outputs are the test statistic, the degrees of freedom and the P-value.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	kcal after low gi breakfast - kcal after high gi breakfast	-163.636	186.40762	32.44940	-229.734	-97.53910	-5.043	32	.000

SPSS calculates the P-value from the test statistic and the degrees of freedom and reports it to 3 decimal places. The actual value of P is 0.0000175. This is so small that when reported to three decimal places, it is shown as 0.000 which we report as $P < 0.001$. Because the P-value is less than 0.05, we have statistically significant evidence that mean calorie intake at lunchtime depends on whether a child's breakfast had a low or high GI.
Although our conclusion is based wholly on the P-value, the convention is to report the value of t and the df as well.

The hypothesis test allows you to say:
The kind of food eaten at breakfast has a statistically significant effect on mean calorie consumption ($t= -5.043$, $df= 32$, $P < 0.001$).

The confidence interval allows you to say:
We are 95% confident that eating a low GI breakfast reduces children's mean calorie consumption at lunchtime by between 98 and 230 kcal (to the nearest whole number).

Assumptions underlying the test
The paired t-test is based on the assumption that if you calculate the difference in calorie intake following low and high GI breakfasts for each child, the results are Normally distributed. If there are major problems then the results of the test can be unreliable. This can be checked by plotting the differences between intakes following low and high GI breakfasts on a P-P plot. This is a graph that is specially designed to detect departures from the Normal distribution (which appear as deviations from the 45 degree line). If the data does not support the Normality assumption, then the problem can be solved either by using an alternative test, such as the Wilcoxon test or by transforming the data.