# Student's 't' Test


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# Introduction

- There are various types of problems for which the test of significance are used for drawing conclusion.
- Different types of problems need different tests but the basis for all tests ( Test of Significance) and steps involved in the procedure are the same.
- Generally, there are 4 types of tests for various problems which are

1. Z test
2. t test
3. Chi square test
4. F test

# Introduction

**Problems:-** The common types of problem in test of significance are –

1. Comparison of sample mean with the population mean.
2. Comparison of two sample means.
3. Comparison of sample proportion with the population proportion.
4. Comparison of two sample proportions.

**Procedure:-** The steps involved in the procedure of test of significance are-

- Finding the problem and the question to be answered.
- Stating the null hypothesis.

# Introduction

- Determining the correct sampling distribution and calculating the standard error of statistics used.

- Calculation of the critical ratio. Generally it is given by

$$\frac{Difference\ btween\ the\ statistics}{Standard\ Error}$$

- Comparing the critical ratio and table value of the statistics at the the pre-determined significance level.
- Making decision.
- Making inference.

# Student's 't' test

- Z test is used for large samples where standard deviation of large sample is considered as population standard deviation. For small samples, "t" test is used.
- To test the significance of difference of means of two small samples, W.S. Gosset ,1908 (Pen name Student) applied a statistical tool called "t" test. Hence, it is also called Student's 't' test. Later on A Fisher developed "t" test and applied in various ways.
- In student's "t" test we make a choice between two observation.
  - To accept null hypothesis (no difference between two means)
  - To reject null hypothesis (difference between means of two samples is statistically significant)

# Determination of significance

**Degree of freedom (df)**

This is the number of observations in which subject is free to go.

In unpaired 't' test → $df = N_1+N_2-2$

Paired 't' test → $df = N-1$

**Kinds of 't' test**

i. Unpaired 't' test
ii. Paired 't' test

**Criteria for applying 't' test**

i. Random samples
ii. Quantitative data
iii. Variables normally distributed
iv. Sample size less than 30

# Unpaired ‘t’ test

This test is applied to unpaired data of independent observations made on individuals of two different or separate groups or samples drawn from two populations.

Steps:

- State the question to be answered
- State the null hypothesis
- Find the difference of means of two samples by the formula

$$(\overline{X_1} - \overline{X_2})$$

# Unpaired ‘t’ test

- Calculate SE of difference between the two means

$$\boldsymbol{SE = \sigma \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Not use $\sqrt{\frac{S_1^{\,2}}{n_1} + \frac{S_2^{\,2}}{n_2}}$

$\boldsymbol{\sigma}$ = Standard Deviation

Where combined $\sigma = \sqrt{\frac{\sum(x_1 - \overline{x_1})^2 + \sum(x_2 - \overline{x_2})^2}{N_1 + N_2 - 2}}$

# Unpaired ‘t’ test

- Calculate or find the ‘t’ value

$$t = \frac{Difference\ between\ the\ means\ of\ two\ samples}{SE}$$

$$t = \frac{|\overline{x_1} - \overline{x_2}|}{SE}$$

# Unpaired ‘t’ test

- Determine df by $N_1+N_2-2$.
- Compare the calculated ‘t’ with the table value of “t” at 0.05 or 0.01 level of significance.
- Make decision.
- State the inference.

# Example of Unpaired 't' test

Ex. 13 children (all male) were given mother's milk while the second group of 12 children (all female) of same age group were given dairy milk. After one year, the gain in wt. ( in kg) was noted which are as follow.

Growth of 13 boys ($X_1$ ) kept on mother's milk :

5, 3 , 4, 3, 2, 6, 3, 2, 3, 6, 7, 5 & 3 kg.

Growth of 12 boys ( $X_2$ ) kept on dairy milk :

1, 3, 2, 4, 2, 1, 3, 4, 3, 2, 2, 3 kg.

Is there any difference between the findings or Is there any influence of mother's milk?

Null hypothesis: **There is no any influence of mother's milk .**

Here : $\sigma$ = 1.367, SE = 1.367 × 0.4, Calculated t= 2.739, df= N-2= 25-2 = 23

Table value: 2.81 at 0.01 level, 2.07 at 0:05 level.

Decision: The calculated value of t (2.739) is greater than the table value (2.07 at 0.05 level of significance). Hence null hypothesis is rejected ( $p < 0.05$)

**Influence: Mother's milk has slight better influence on the growth of children in positive direction.**

# Paired ‘t’ test

- It is applied to paired data of independent observations from one sample only when each individual gives a pair of observations.
- Used in biological, agriculture, veterinary and medical science such as:
  1. To study the role of a factor.
  2. To compare the effect of two factors.
  3. To compare results of two different techniques. Ex. The Sahli’s and Tallquist method for determination of hemoglobin
  4. To compare observations made at two different sites in the body.
  5. To study the comparative accuracy of two different instruments. Ex. Two types of sphygmomanometer.

Pairing is a good idea.

# Steps for paired ‘t’ test

- Find the question to be answered
- State the null hypothesis
- Find the difference in each set of observations i.e. difference of means = $X_1$-$X_2$ = x
- Find out the SE= $\frac{SD}{\sqrt{N}}$ SD =Standard Deviation of x
- Determine ‘t’ by the formula = $\frac{|\bar{x}-0|}{SE} = \frac{\bar{x}}{SE}$

Where $\bar{x}$ = mean of $X_1$-$X_2$ (i.e. x)

- df =N-1
- Comparison of calculated with the table value
- Decision
- Inference

# Example of paired 't' test

Ex. 12 pre school children were given supplement of multipurpose food for a period of four months. Their skin fold thickness (mm) was measured before the commencement of the program and also at the end. The value obtained are given. Skin thickness ( At the beginning $X_2$: At the end $X_1$ → 6:8, 8:8, 8:10, 6:7, 5:6, 9:10, 6:9, 7:8, 6:5, 6:7, 4:4, 8:6. Test , is there any change in their skin fold thickness.

Null Hypothesis: There is no any change in skin fold thickness after implementation of multipurpose food.

Here $\overline{(X_1 - X_2)}$ i.e., $\bar{x}$ =0.75, SD =1.357, SE=0.3917

$$t = \frac{|\bar{x}-0|}{SE} = \frac{0.75}{0.3917} = 1.91 \qquad df = 12-1 = 11$$

The table value at 5% level of significance is 2.201 whereas it is 3.106 at 1% level of significance.

Decision: The table value of t (i.e. 1.91) is less than the table of t (i.e. 2.201 at 5% level of significance). **Hence null hypothesis is accepted.**

Inference: **There is no any evidence to say that there is any influence on ski fold thickness due to multipurpose food.**

# Suggested Readings


- Zar JH (2007). Biostatistical Analysis. 4th Edition. Pearons's Publication. New Delhi.
- Mahajan BK (1999) .Methods in Biostatistics. Jaypee Brothers, New Delhi.
- Sunder Rao PSS and Richard J ( 2001). An Introduction To Biostatistics. Prentice Hall of India Private Limited. New Delhi.
- Prasad S (2007). Elements of Biostatistics. Rastogi Publications, Meerut.

# Thanks