

# Chi – square Test

**M.Prasad Naidu**  
**MSc Medical Biochemistry, Ph.D.,**

# Introduction

- Chi-square test offers an alternate method of testing the significance of difference between two proportions.
- Chi-square test involves the calculation of chi-square.
- Chi-square is derived from the greek letter 'chi' ( $\chi$ ).
- 'Chi' is pronounced as 'Kye'.
- Chi-square was developed by Karl Pearson.

- Chi-square test is a non-parametric test.
- It follows a specific distribution known as Chi-square distribution.

### Calculation of Chi-square value

- The three essential requirements for Chi-square test are:
- A random sample
- Qualitative data
- Lowest expected frequency not less than 5

● The calculation of Chi-square value is as follows:

- Make the contingency tables
- Note the frequencies observed (O) in each class of one event, row-wise and the number in each group of the other event, column-wise.
- Determine the expected number (E) in each group of the sample or the cell of table on the assumption of null hypothesis.

- The hypothesis that there was no difference between the effect of the two frequencies, and then proceed to test the hypothesis in quantitative terms is called the Null hypothesis.
- Find the difference between the observed and the expected frequencies in each cell ( $O - E$ ).
- Calculate the Chi-square values by the formula
- Sum up the Chi-square values of all the cells to get the total Chi-square value.

## (2) APPLYING THE $\chi^2$ TEST

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

Vaccine	Attacked	Not Attacked
A	$O = 22$ $E = \frac{18.36}{+ 3.64}$	$O = 68$ $E = \frac{71.55}{3.55}$
B	$O = 14$ $E = \frac{17.54}{- 3.54}$	$O = 72$ $E = \frac{68.37}{+ 3.63}$

## (2) APPLYING THE $\chi^2$ TEST

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

$$\chi^2 = \frac{(3.64)^2}{18.36} + \frac{(3.55)^2}{71.55} + \frac{(3.54)^2}{17.54} + \frac{(3.63)^2}{68.37}$$

$$= 0.72 + 0.17 + 0.71 + 0.19$$

$$= 1.79$$

(3) FINDING THE DEGREE OF FREEDOM

- Calculate the degrees of freedom which are related to the number of categories in both the events.
- The formula adopted in case of contingency table is

$$\text{Degrees of freedom (d.f.)} = (c - 1) (r - 1)$$

Where  $c$  is the number of columns and  $r$  is the number of rows

# Applications of Chi-square

- Chi-square test is most commonly used when data are in frequencies such as the number of responses in two or more categories.
- Chi-square test is very useful in research.
- The important applications of Chi-square in medical statistics are :
  - Test of proportion
  - Test of association
  - Test of goodness of fit

## - Test of proportion

- It is an alternate test to find the significance of difference in two or more than two proportions.
- Chi-square test is applied to find significance in the same type of data with two more advantages,
  - to compare the values of two binomial samples even if they are small.
  - to compare the frequencies of two multinomial samples.

## - Test of association

- Test of association is the most important application of Chi-square test in statistical methods.
- Test of association between two events in binomial or multinomial samples is measured.
- Chi-square test measures the probability of association between two discrete attributes.

## - Test of Goodness of fit

- Chi-square test is also applied as a test of “goodness of ‘ fit”.
- Chi-square test is used to determine if actual numbers are similar to the expected or theoretical numbers – goodness of fit to a theory.

## Restrictions (limitations) in application of Chi-square test

- The Chi-square test is applied in a four fold table will not give a reliable result with one degree of freedom if the expected value in any cell is less than 5.
- The Chi-square test does not measure the strength of association.
- The statistical finding of relationship, does not indicate the cause and effect.



Thank You