Statistical tests
Lecture Six

Dr.Shaymaa Adil

MSc.Rana Adnan

Testing Hypotheses

Hypothesis testing and estimation are used to reach conclusions about a population by examining a sample from that population.

Hypothesis testing is widely used in medicine, dentistry, health care, biology and other fields as a means to draw conclusions about the nature of populations.

Definitions

Hypothesis: A hypothesis is a statement about one or more populations. There are research hypotheses and statistical hypotheses.

Research hypothesis: It is the assumption that motivate the research. It is usually the result of long observation by the researcher. This hypothesis led directly to the second type of hypothesis.

Statistical hypotheses: Statistical hypotheses are stated in such a way that they may be evaluated by appropriate statistical techniques. There are two statistical hypotheses involved in hypothesis testing.

Rules for testing hypotheses

1.Your expected conclusion, or what you hope to conclude as a result of the experiment should be placed in the alternative hypothesis.

2.The null hypothesis should contain an expression of equality, either =, $\leq$ or $\geq$.

3.The null hypothesis is the hypothesis that will be tested.

4.The null and alternative hypotheses are complementary. This means that the two alternatives together exhaust all possibilities of the values that the hypothesized parameter can assume.

Statistical tests

Independent samples t - tests

- Dependent variable (continuous)

Independent variable (binary)

- When to use: Compare the means of 2 independent groups.
- Assumptions: Dependent variable should be normally distributed.
- Interpretation: If the p value is less than or equal 0.05, the results are significant.

Paired samples t test

- Dependent variable (continuous)
  Independent variable (2 points in time or 2 conditions with same group)
- When to use: Compare the means of a single group at 2 points in time (pre test/post test)
  Assumptions: Paired differences should be normally distributed
- Interpretation: If the p value is less than or equal 0.05, the results are significant.

One-way ANOVA (Analysis of Variance)

- Dependent (continuous)
- Independent (categorical, at least 3 categories)
- When to use: When assessing means between 3 or more groups
- Assumptions: Normal distribution

Pearson's correlation coefficient

- • Dependent (continuous).
- • Independent (continuous).
- • When to use: When assessing the correlation between 2 or more variables.
- • Normally distributed variables.

Pearson's correlation coefficient (r)

- Interpretation Correlation coefficient
- Value -0.3 to +0.3 Weak
- -0.5 to -0.3 or 0.3 to 0.5 Moderate
- -0.9 to -0.5 or 0.5 to 0.9 Strong
- -1.0 to -0.9 or 0.9 to 1.0 Very strong •

Non parametric tests

Non-parametric Tests

Non-parametric Test	Parametric Equivalent
Mann-Whitney (Wilcoxon)	Independent samples *t* test
Wilcoxon Signed Rank	Paired samples *t* test
Kruskal-Wallis	One-way ANOVA
Friedman	Repeated measures ANOVA

CHI-SQUARE(X^2) DISTRIBUTION

The χ^2 distribution is used in categorical data analysis.

Categorical data analysis deals with data that can be organized into categories. The data are organized into a *contingency table*.

	Patient has the disease	Patient doesn't have disease
Test is positive	Correct result	False positive
Test is negative	False negative	Correct result

TESTS OF INDEPENDENCE

To test whether two criteria of classification are independent . For example socioeconomic status and area of residence of people in a city are independent.

We divide our sample according to status (low, medium and high) and the same samples is categorized according to residence (urban and rural).

Put the first criterion in columns equal in number to classification of 1st criteria (Socioeconomic status) and the 2nd in rows equal to the no. of categories of 2nd criteria (residence).

Observed versus expected frequencies

O_{ij} : The frequencies in row and column given in any contingency table are called observed frequencies that result form the cross classification according to the two classifications.

e_{ij} :Expected frequencies on the assumption of independence of two criterion are calculated by multiplying the marginal totals of any cell and then dividing by total frequency.

$\sum E = \sum O$ for each row or column.

Chi-square Test

After the calculations of expected frequency, determine calculated Chi-square :

$$\chi^2 = \sum_{i=1}^{k} \left[\frac{(o_i - e_i)^2}{e_i} \right]$$

Where summation is for all values of rows x columns = k cells.

3- Calculate the test-statistic

$$\chi^2 = \sum\left[\frac{(O-E)^2}{E}\right]$$

Observed

107	88
93	112

Expected

97.5	97.5
102.5	102.5

$$\chi^2 = \frac{(107-97.5)^2}{97.5} + \frac{(88-97.5)^2}{97.5} + \frac{(93-102.5)^2}{102.5} + \frac{(112-102.5)^2}{102.5}$$

$$\chi^2 = 0.93 + 0.93 + 0.88 + 0.88 = 3.62$$ → Calculated Value

Chi-square Test

Tabulated chi - sequare determine as below :

$$\chi^2_{(1-\alpha)),df}$$

df: the degrees of freedom for using the table are equal (r-1)(c-1) for α level of significance. Note that the test is always one-sided.

So df= (r-1) X (c-1)

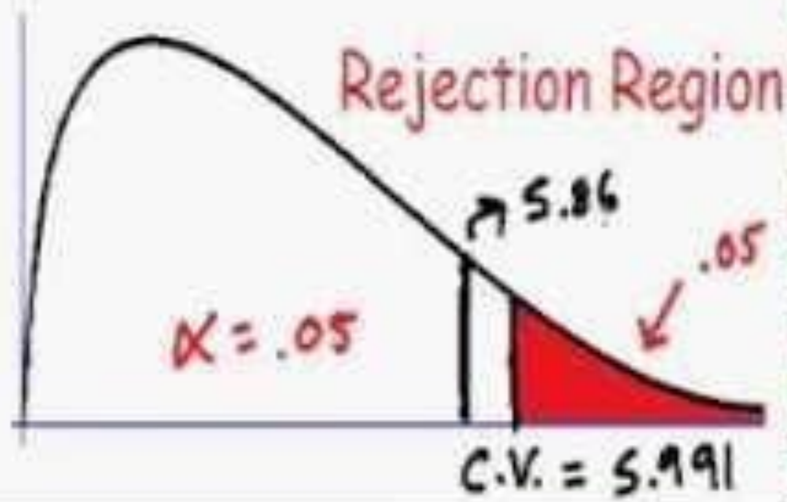
Chi-square Test

Observed				
	rep.	dem.	other	Total
male	26	13	5	44
female	20	29	7	56
	46	42	12	100

H_0: • Political party
• independent upon gender

H_1: Political party
dependent upon gender

Expected			
	rep.	dem.	other
male	20.24	18.48	5.28
female	25.76	23.52	6.72



Example

The researcher interested to determine that preconception use of folic acid and race are independent. Let $\alpha = 0.05$, The data is:

	Use	Not use	Total
White	260 a	299 b	559
Black	15 c	41 d	56
Other	7 e	14 f	21
Total	282	354	636

Solution

<u>Expected values:</u>

Cell a = 559x 282 / 636= 247.86.

Cell b= 559x 354 / 636=311.14.

Cell c = 56x 282 /636= 24.83 .

Cell d = 56x 354 /636 = 31.17.

Cell e = 21x 282 /636= 9.31 .

Cell f = 21x 354 /636= 11.69.

Solution

Hypothesis: H_0: Race and use of folic acid are independent

HA: The two variables are not independent.

df= (r-1)(c-1) = (3-1)(2-1)= 2

χ^2 tabulated = χ^2 (1- α)2 = χ^2 (0.95)2= 5.991

χ^2 Calculated:

$$\chi^2 = (260 - 247.86)^2 / 247.86 + (299 - 311.14)^2 / 311.14$$

$$+ \ldots\ldots + (14 - 11.69)^2 / 11.69 = \underline{9.091}$$

Statistical decision. We reject H0 since 9.091> 5.991.

Conclusion: we conclude that H0 is false, and that there is a relationship between race and preconception use of folic acid.

Chi-square Test

For row X column table X^2 –test is not applicable if:

1. The expected frequency of any cell is <1.
2. More than 20% of the cells has expected frequency < 5.

For 2x2 table X^2 –test is not applicable if :

The expected frequency of any cell is <5.

Yates' Continuity Correction

- Yates used for 2 X 2 tables only.
- No correction is necessary for larger tables.
- Many researchers now are against its use on the basis that it (always result in non rejection of null hypothesis.)

$$\chi^2 = \frac{n\left(|ad - bc| - 0.5n\right)^2}{(a+c)(b+d)(a+b)(c+d)} \quad \text{------------- Yate's Correction}$$

Fisher's Exact Test

This test is used if chi square test is not applicable because of small expected value.