

Hypothesis Testing

Adejumo Ridwan Suleiman

**What is a Statistical
Hypothesis?**

What is Hypothesis?

Statement about an expected relationship between one or more independent variables and a dependent variable

Types of Hypothesis

- **Research Hypothesis:** Statement that motivates the research
- **Statistical Hypothesis:** Statements that can be evaluated by statistical techniques.

What is Statistical Hypothesis?

- Statement or fact not yet tested
- Characteristics of a population not yet verified
- For example, smokers are at risk of developing lung cancer

Null and Alternative Hypothesis

Null Hypothesis ()

- Statement forming basis of investigation
- Statement of **no difference, no association, no effect or statement of equality.**
- Example:
 - : The average weight of patients in the clinic is not equal to 60kg
 H_0
 - : Smokers have no risk of getting lung cancer
 H_0
- This hypothesis is either **rejected or not rejected**

Alternative Hypothesis ()

- Complement or alternative of H_0
- Statement of **inequality**
- Investigators will accept if H_0 is rejected
- Example:
 - : The average weight of patients in the clinic is more than 60kg
 - : Smokers have a higher risk of getting lung cancer

Steps in Hypothesis Testing

1. State the null hypothesis (H_0)
2. State the alternative hypothesis (H_1)
3. State the level of significance (α)
4. Choose the appropriate test statistic
5. Evaluate the test statistic
6. Decision making

Errors in Hypothesis Testing

Type I Error

- Rejecting a true null hypothesis
- Probability of committing a **Type I error** is denoted by
- Incorrectly concluding that a difference exists, when actually ^{α} there is no difference
- A false positive decision

Type II Error

- Accepting a false null hypothesis
- Probability of committing a **Type II error** is denoted by β
- Incorrectly concluding that no difference exists, when actually there is a difference
- A false negative decision

Errors Complement

Confidence level ()

$$1 - \alpha$$

- Tests the ability to accept the null hypothesis when it is actually true

Power of a test ()

$$1 - \beta$$

- Power of a test
- Tests the ability to reject a null hypothesis when it is false

Level of significance

- Maximum probability of committing a **Type I error**
- Mostly **0.05**
- Denoted by
 α

P-value

P-value

- Measure of the amount of evidence we have against the **null hypothesis**
- The smaller the **p-value** the more the evidence against H_0 and vice versa

P-value Interpretation

- If $\alpha = 0.05$ and $p\text{-value} < 0.03$, this implies statistical significance.
- This means that the probability of getting an observed effect if truly there was no effect is 3%.
- In other words, there is a 3% probability that an observed effect is likely by chance.

Decision Making

$\text{p-value} < \alpha$
Difference is unlikely due to
chance

$\text{p-value} \geq \alpha$
Difference might be due to
chance

Choice of Test Statistic

- Test Statistic tests for a statistical hypothesis
- Depends:
 - Study objective
 - Study design
 - Variable type
 - Sample size and sampling method
 - Sampling distribution

Selecting appropriate Test Statistic

- Relationship between two qualitative variables
 - **Z-test** or **chi-square test** (for difference in proportion)
 - **Chi-square test** (for association/independence)
- Relationship between one qualitative and one quantitative variable
 - two groups - **t-test**
 - more than two groups - **F-test**
- Relationship between two quantitative variables
 - Correlation analysis
 - Linear regression analysis

Types of parametric tests

Parametric

Assumes measurements are **normally distributed**

Non-parametric

- Assumes measurements are not **normally distributed**
- Small sample size, nominal or ordinal data
- Weaker than parametric tests

