Biostatistics for nursing students

Your BEST GUIDE

Done by your colleague:

Ihdaa Bani Khalaf

References:

- Textbooks.
- Doctor's slides.
- Records.
- Past years questions.

Calma Study

Lecture #:

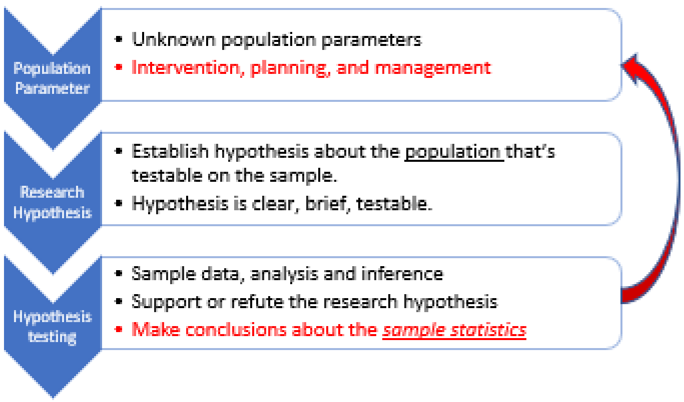
المحاضرة الأخيرة

سكند

Hypothesis Testing

- Hypothesis testing is a technique to help determine whether a hypothesis is true (e.g. treatment or procedure has an effect in a population), or simply if a relationship exists between two or more variables.
- The general goal of a hypothesis test is to rule out chance (sampling error) as a plausible explanation for the results from a research study.

➢ What's the Purpose of Hypothesis Testing?



➢ Research Hypothesis

- Research or alternative hypothesis (H_1)
- Is what the researcher believes to be a true reflection on the general population.
- A true explanation for a population phenomenon (there is a difference, relationship…etc.).
- Can **not** be statistically tested

✓ Examples:

- There is a difference in growth rate between pediatric patients who received chemotherapy and those who did not receive chemotherapy
- The mean systolic blood pressure in our sample is different from the population mean

➢ Directional and Non-Directional Research Hypothesis

➔ Directional research hypothesis

- Predicts a relationship between variables and the direction of the relationship
  - ✓ Example: People who smoke are more likely to develop lung cancer than those who do not smoke.
- Tested with one-tailed statistical tests

➔ Non-Directional research hypothesis

- Predicts a relationship between variables (without direction)
- Does not predict direction of the relationship
  - ✓ Example: There is a relationship between serotonin levels and Sudden Infant Death Syndrome (SIDS).
- Tested with two-tailed statistical tests

- **Null Hypothesis**
    - Null hypothesis (H_0) is the opposite of the research hypothesis.
    - This means that the alternative hypothesis about a certain phenomena is <u>not</u> correct, and that there is <u>no</u> real difference, relationship…etc.
    - **Can be statistically tested**.

✓ <u>Examples</u>:

- There is **no difference** in growth rate between pediatric patients who received chemotherapy and those who did not receive chemotherapy
- The mean systolic blood pressure in our sample is **indifferent** from the population mean

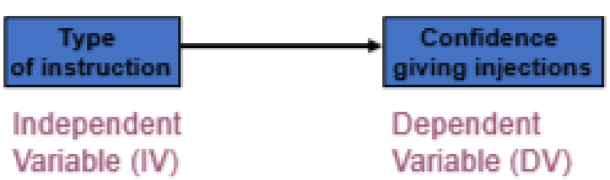
- **Null Hypothesis vs Research Hypothesis**

Null hypothesis H_0	Research Hypothesis H_1
There is no relationship or difference	There is a relationship or difference
Refers to the population	Refers to the examined sample
Research aims to reject the null	Research aims to accept the alternative

- **How to Establish a Good Hypothesis?**
    - Clear and declarative statement. Not a question.
    - Show a relationship between variables
    - Reflect a body of literature or a theory
    - Be direct, explicit, and to the point
    - Be testable and measurable

✓ **Example (Guided by Self-Efficacy Theory)**

- A researcher aims to test the impact of type of instruction (viewing videos vs practice the technique on a mannequin or a person) on confidence in giving injections among nursing students.
- Question: form research and null hypotheses



- **Research hypothesis (H_a)**
    - → **Non-Directional**
        - There IS a difference in the level of confidence between nursing students who learn injection technique by viewing videos and those who learn by practicing on a person or mannequin
    - → **Directional**
        - Nursing students who learn injection technique by viewing videos are <u>*less*</u> confident than those who learn by practicing on a person or mannequin
        - Nursing students who learn injection technique by viewing videos are <u>*more*</u> confident than those who learn by practicing on a person or mannequin

- **Null hypothesis (H_o)**
    - There is NO difference in level of confidence between nursing students who learn injection technique by viewing videos and nursing students who practice their technique on a mannequin or person.

- Type 1 & Type 2 errors
    - <u>Type 1 error</u>: reject the null when the null is true
        - P (Type I error) = α level (level of significance)
        - Confidence = 1- α
        - Usually 0.05 in health research (can be other values as well)
    - <u>Type 2 error</u>: accept the null when the null is false
        - P (Type II error): β level
        - Power = 1 – β
        - Usually 0.2 in health research (can be other values as well)
        - As sample size increases, Type II error decreases
        - As Type I error increases, Type II error decreases

	H_0 True	H_0 False
Accept H_0	**OK** 1-α = .95 = 95% probability of accepting H_0 when it is true	**Type II error** β = .20 = 20% probability of accepting H_0 when it is false. We conclude there IS NOT a difference [or relationship] when there IS one
Reject H_0	**Type I error** α = .05 = 5% probability of rejecting H_0 when it is true. We conclude there IS difference [or relationship] when there IS NOT one	**OK** 1-β = .80 = 80% probability of rejecting H_0 when it is false

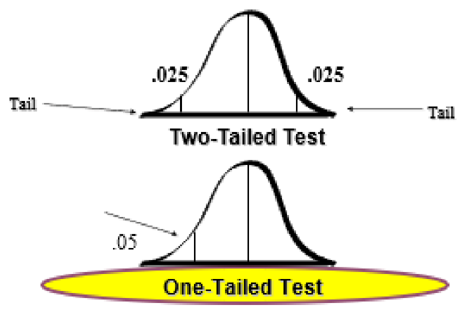
- **Six Steps of Hypothesis Testing**
    1. Set your hypothesis.
    2. Set level of significance associated with the hypothesis.
    3. Compute the appropriate test statistics (t-test, F-test, Chi-square, etc.).
    4. Set the critical value needed to reject the null hypothesis (from Tables).
    5. Compare the test statistics value with the critical value of rejection.
    6. Decide whether to reject the null hypothesis and confidence statement.

- Step 1
    - Set your hypothesis
    - Set both H_1 & H_0
        - Research Hypothesis:
            - If two-tailed, $H_1: \mu_1 \neq \mu_2$
            - If one-tailed, $H_1: \mu_1 > \mu_2, \mu_1 < \mu_2$

- Null Hypothesis
  - $H_0 : \mu_1 = \mu_2$

➔ **Step 2**

- Set level of significance associated with the hypothesis (e.g., $\alpha = 0.05$)



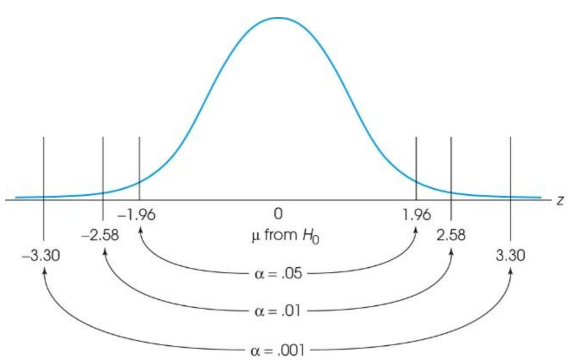
➔ **Step 3**

- Compute the appropriate test statistic
  1. Determine which test statistic you should use based on the research question (Z-test, t-test, F-test, Chi-square, etc.)
  2. Determine the comparison measurement (i.e. mean, variance)
  3. Do the statistical test to define where the obtained value is located on the standardized curve
- We will focus on the Z distribution, so we will use the following formula to calculate Z_{test} (when $n \geq 30$):
- Used to <u>determine probability that a given sample is representative of the known population</u>
- H_0 : the two means represent the same population (hypothesized population mean = known population mean)
- You can use the Z test only when μ is known

$$Z = \frac{\overline{X} - \mu_0}{s/\sqrt{n}}$$

➔ **Step 4**

- Set the critical value needed to reject the null hypothesis (from Tables).
- Based on the chosen table, look for the cut off value based on the level of significance you determined in step 2.
- You might need the Z table to get the $Z_{critical}$

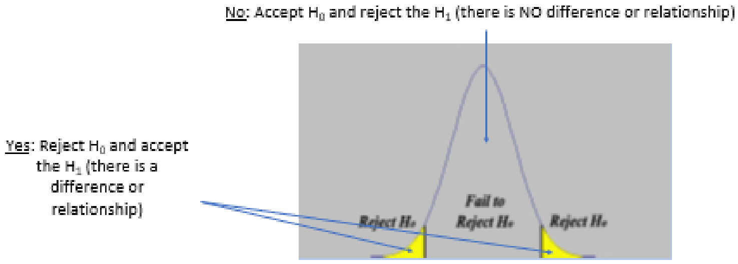


➔ **Step 5**

- Compare the test statistics value (Z_{test}) with the critical value ($Z_{critical}$) of rejection (from steps 3 & 4).
  - is the $|Z_{test}| > |Z_{critical}|$? (in case of two-sided test)

➔ Step 6

- Decide whether to reject or accept the null hypothesis



✓ Example 1

- The National Center for Health Statistics reports that the average systolic blood pressure for adults is 122 mmHg. A researcher wants to determine if the systolic blood pressure of patients in a new health program differs from the national average.
- The researcher collects a sample of 100 patients participating in the program and finds a mean systolic blood pressure of 119.5 mmHg with a standard deviation of 12.5 mmHg. Is the mean systolic blood pressure of the sample different from that of the population?

✓ Example 1 (answer)

➔ **Step 1 - Set your hypothesis**:

- Null hypothesis (H0): The mean systolic blood pressure of the health program patients is equal to the national average, $\overline{x} = \mu$, or $\overline{x} = 122$.
- Alternative hypothesis (H1): The mean systolic blood pressure of the health program patients is not equal to the national average, $\overline{x} \neq \mu$, or $\overline{x} \neq 122$.

➔ **Step 2 - Set level of significance associated with the hypothesis**:

- $\alpha = .05$

➔ **Step 3 - Compute the appropriate test statistics:**

- $Z_{test} = \frac{\overline{x} - \mu}{S \sqrt{n}} = \frac{119.5 - 122}{12.5 / \sqrt{100}} = \frac{-2.5}{12.5/10} = = \frac{-2.5}{1.25} = -2$

➔ **Step 4 - Set the critical value**:

- Based on $\alpha = .05$, using the Z table, the $Z_{critical} = -1.96$ or 1.96

➔ **Step 5 - Compare the test statistics value with the critical value**:

- The calculated $|Z_{test}| > |Z_{critical}|$ ($|-2| > |-1.96|$)

➔ **Step 6 - Decide whether to reject the null hypothesis and confidence statement**:

- The calculated Z-score of-2 falls outside the range of-1.96 to +1.96. Therefore, we reject the null hypothesis and conclude that the mean systolic blood pressure of the patients in the health program is significantly different from the national average of 122 mmHg for the population.

✓ Example 2

- The National Center for Health Statistics reports that the average systolic blood pressure for adults is 122 mmHg. A researcher wants to determine if the systolic blood pressure of patients in a new health program differs from the national average.
- The researcher collects a sample of 49 patients participating in the program and finds a mean systolic blood pressure of 119.5 mmHg with a standard deviation of 12.5 mmHg. Is the mean systolic blood pressure of the sample different from that of the population?

✓ Example 2 (answer)

➔ **Step 1- Set your hypothesis**:

- Null hypothesis (H0): The mean systolic blood pressure of the health program patients is equal to the national average, $\overline{x} = \mu$, or $\overline{x}$ =122.
- Alternative hypothesis (H1): The mean systolic blood pressure of the health program patients is not equal to the national average, $\overline{x} \neq \mu$, or $\overline{x} \neq 122$.

➔ **Step 2- Set level of significance associated with the hypothesis**:

- $\alpha = .05$

➔ **Step 3- Compute the appropriate test statistics:**

- $Z_{test} = \frac{\overline{x} - \mu}{S\sqrt{n}} = \frac{119.5 - 122}{12.5 / \sqrt{49}} = \frac{-2.5}{12.5/7} = = \frac{-2.5}{1.8} = -1.4$

➔ **Step 4- Set the critical value**:

- Based on $\alpha = .05$, using the Z table, the $Z_{critical}$ =-1.96 or 1.96

➔ **Step 5- Compare the test statistics value with the critical value**:

- The calculated $|Z_{test}| < |Z_{critical}|$ ($|-1.4| < |-1.96|$)

➔ **Step 6- Decide whether to reject or accept the null hypothesis and confidence statement**:

- The calculated Z-score of-1.4 falls inside the range of-1.96 to +1.96. Therefore, we accept the null hypothesis and conclude that the mean systolic blood pressure of the patients in the health program is not significantly different from the national average of 122 mmHg for the population.
- Compare this to Example 1; the conclusion is different because of different sample size

✓ Example 3

- The National Center for Health Statistics (NCHS) reports that for adult participants, the mean total cholesterol is 203.
- A sample of participants (n=3310) from the Framingham Heart Study, have a mean total cholesterol of 200.3 with a standard deviation of 36.8.
- Are cholesterol levels in participants from the Framingham study significantly different from the mean total cholesterol of the national population?

✓ Example 3 (answer)

1. $H_0: \overline{x} = 203$ | $H_1: \overline{x} \neq 203$ This is a 2-Tailed test
2. $\alpha = 0.05$
3. $$Z = \frac{\overline{X} - \mu_0}{s/\sqrt{n}} = \frac{200.3 - 203}{36.8/\sqrt{3310}} = -4.22$$
4. Reject H_0 if $z \geq 1.96$ or if $z \leq -1.96$
5. is-4.22 <-1.96 ?
6. Since-4.22 <-1.96, we Reject H_0. There is a statistically significant evidence at $\alpha = 0.05$ to show that the mean total cholesterol in participants of the Framingham Heart Study is different than national mean (The chance that the sample and the population means are different due to chance only is less than 5%).