A Very Small Introduction to Research Methods Statistical Error and P-Value (Day 5)

Prepared for the Brilliant Mowhia students

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Learning Outcomes

By the end of this session, the participant will be able to:

- Employ the PICO approach for searching a topic
- Employ Boolean operators to narrow down a search in PubMed
- Use "truncation", "quotation", and "parentheses" to aid in literature search in PubMed
- Use the "advanced" search option in PubMed
- Employ filters to refine literature search
- Retrieve articles from the Saudi Digital Library

Challenge Time

- My puzzle for you... until you solve it
- What color are swans?
- White swans vs black swans





•Don't look for the "yes" answer. Needed to ask questions that are wrong so that you can learn the truth

In the scientific method... why disprove the null?

- You plan things to be disproved.
- If you think that something is true, you should try your best to disprove it.
- Only, and only when you cannot disprove it that it is the truth

The Scientific Method

- 1. Observation or asking a question
- 2. Background research
- 3. Make a hypothesis
- 4. Design and conduct an experiment(s)
- 5. Analyze the results
- 6. Produce an appropriate inference/conclusion
- 7. (share the knowledge)

Types of hypotheses

- Null Hypothesis: There is no association between the variables. (stated to be rejected)
- **Alternative Hypothesis:** There is an association

- One sided (one tailed): The association is directional
- Two sided (two-tailed): only states that there is an association

Statistical Error

Type I

- False Positive
- Rejection of the null
- Erroneous acceptance of the alternative hypothesis

Type II False Negative Failure to reject the null hypothesis Erroneous rejection of the alternative hypothesis

Statistical Significance

- The probability of committing a type I error (false positive) is known as the alpha (α) value
- Small value that gives an upper limit of the chance of incorrectly rejecting the null hypothesis
- ~0.01- 0.05

The probability of committing a type II error (false negative) is known as the beta **(β)** value

Failure to reject the null when it is actually incorrect

~0.05 -0.20

Depends on the situation

- Studying the efficacy of biopsies to diagnose OVCA
- **α**= 0.05
- 5 out of every 100
 women will be
 subjected to a
 dangerous and
 invasive technique for
 nothing

Using CA125 as a biomarker to detect early stage OVCA **β**= 0.20 20 out of every 100 women with OVCA will be misdiagnosed/under diagnosed

Jury Decision

- Innocence: ------
- Guilt: -----
- Beyond reasonable doubt: ---
- Acquit an innocent person or convict a criminal: ------
- Convict an innocent person:
- Acquit a criminal: ------

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Null
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Alternative

Significance (α)

Correct inference Type I error *(false pos) Type II error (false neg)*

POWER

- The quantity of $1-\beta$ is power
- The probability of correctly rejecting the null hypothesis **when it is false** and accepting the alternative
- A power of 0.90 means that the samples will fall under the predicted outcome by the alternative hypothesis 90% of the time.

P-Value

• The chance (%age) of null is true

- The null hypothesis is rejected in favor of its alternative **only** if the *P* value is smaller than α (significance)
- In other words, the results cannot be explained by the alternative hypothesis alone, but it could NOT be explained by chance as well.
- The smaller the *P*-value the better.

POWER

- The quantity of 1- β is power
- The probability of correctly rejecting the "FALSE" null hypothesis and accepting the alternative
- likelihood to detect an <u>effect</u> when there is an actual and true effect to be detected
- A power of 0.90 means that the samples will fall under the predicted outcome by the alternative hypothesis 90% of the time.

P Value

- The null hypothesis is rejected in favor of its alternative **only** if the *P* value is smaller than α (significance)
- In other words, the results cannot be explained by the alternative hypothesis alone, but it could NOT be explained by chance as well.
- The smaller the *P* value the better.

In other words

P value is the probability that the null hypothesis is true when backed up by evidence