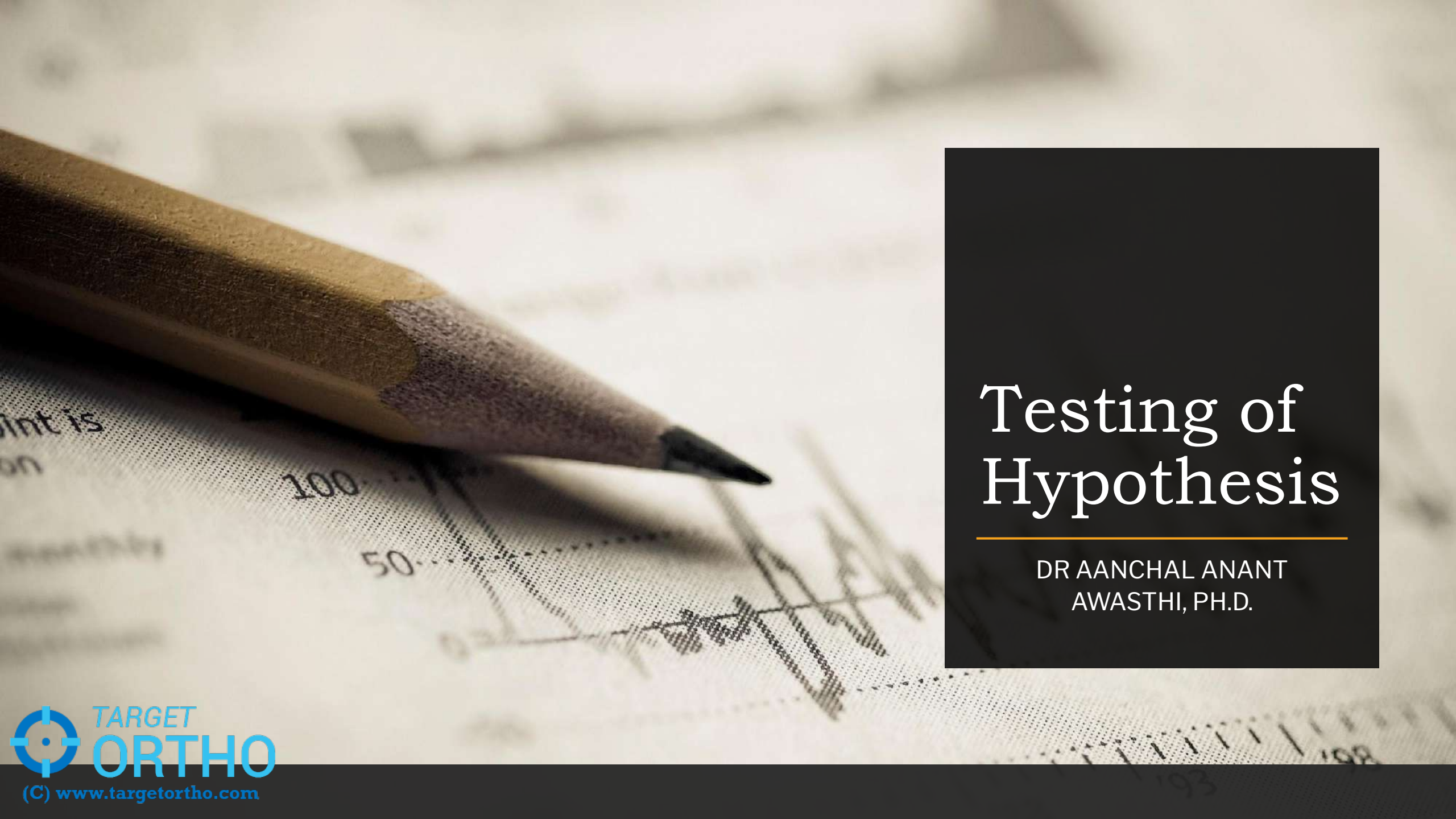
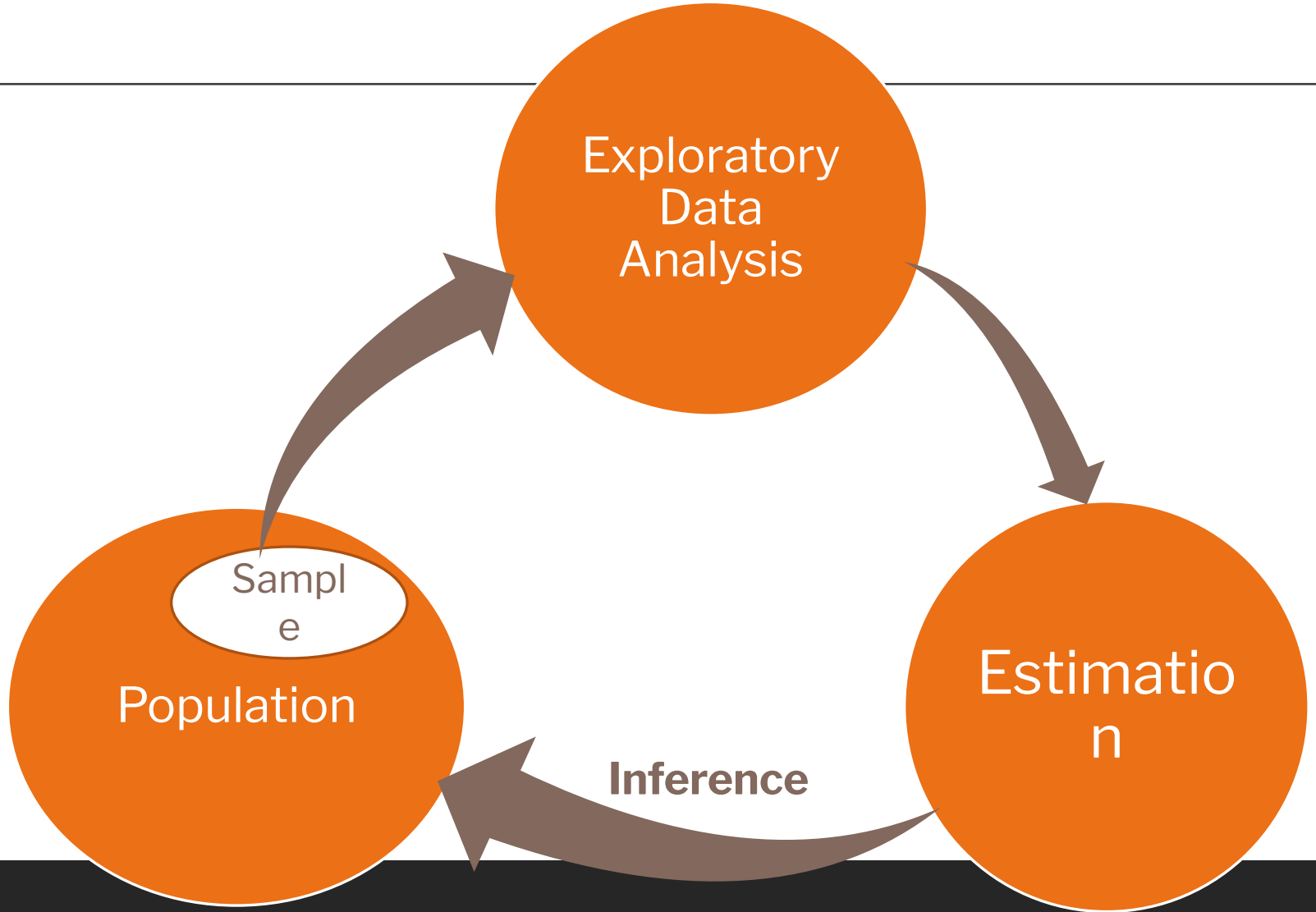


Testing of Hypothesis

DR AANCHAL ANANT AWASTHI, PH.D.

Figure 1: Annotated Diagram for Statistical Inference

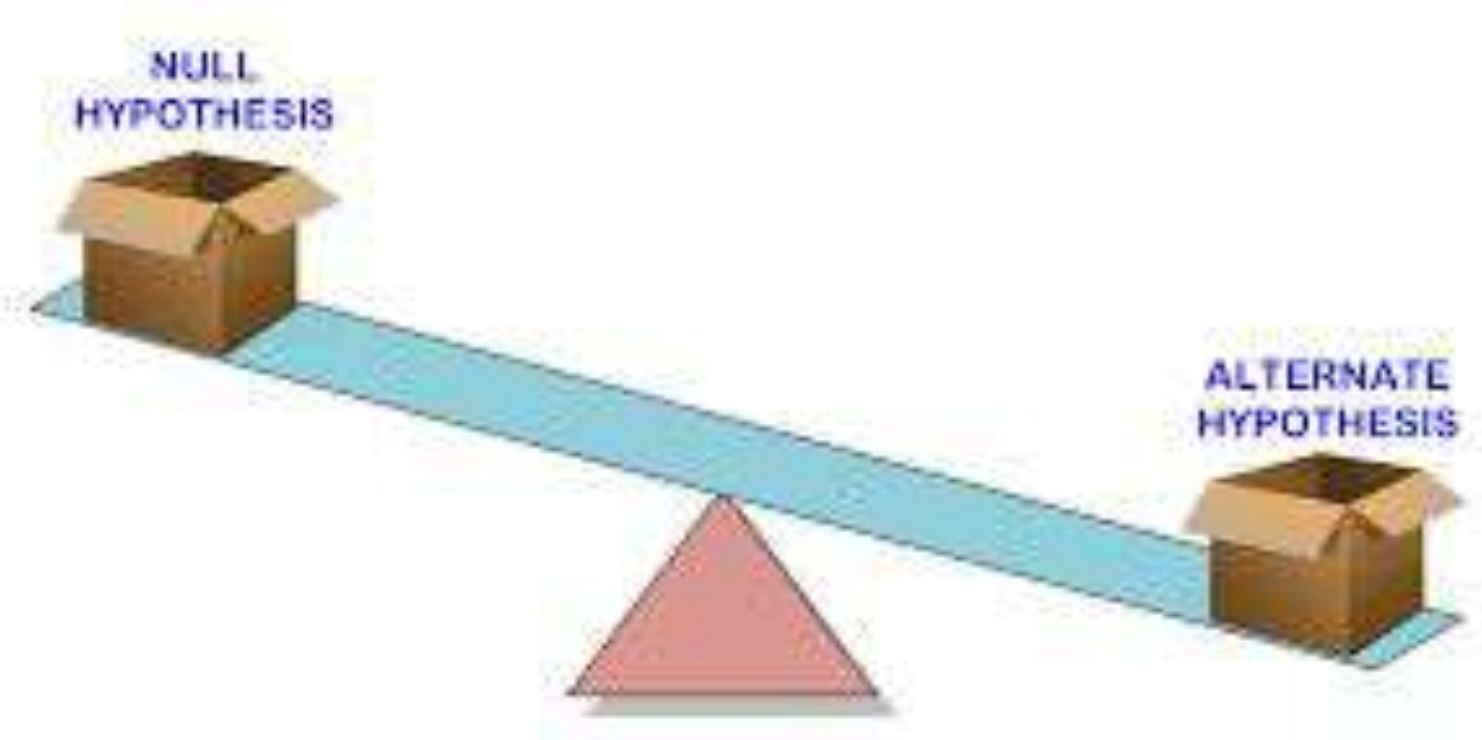


Hypothesis testing

Starting the research, a research question is formulated using the null hypothesis is that always assumes that any effect observed in the intervention (or exposed) group versus the control group is merely a product of chance.

Fundamentals : Hypothesis

Null & Alternate Hypothesis



Null vs Alternate Hypothesis

- Null Hypothesis (H_0) states the Assumption to be tested.

  E.g. Average SBP of participants = 120 mmhg

  (H_0: μ = 120 mmhg)

- Alternative Hypothesis (H_1 or H_a)is the opposite of the null hypothesis

  E.g. SBP of participants ≠ 120 mmhg

  (H_1: μ ≠ 120 mmhg)

Null vs Alternate Hypothesis

Null Hypothesis (H_0)

There is no correlation between height of father and height of son

Mathematically,

(H_0: r = 0)

Alternative Hypothesis (H_1 or H_a)

There is a correlation between height of father and height of son

Mathematically,

(H_1: r ≠ 0)

Test Statistic

- **TEST STATISTIC** is a value calculated from a sample to decide whether to accept or reject the null (H_0) and varies between tests.

- The test statistic compares differences between the samples or between observed and expected values when the null hypothesis is true.

Type I, Type II Error, Level of Significance & Power of the test

Statistical Decision	Actual Situation	
	H_0 True	H_0 False
Reject H_0	Type 1 Error(α) (False positive)	Correct Decision Power (1-β)
Do not reject H_0	Correct Decision Confidence (1-α)	Type II Error(β) (False Negative)

Level of Significance

SIGNIFICANCE LEVEL

The probability of rejecting the null hypothesis when it is true, (also known as a type 1 error). This is decided by the individual but is normally set at 5% (0.05) which means that there is a 1 in 20 chance of rejecting the null hypothesis when it is true.

Hypothesis Testing: Quiz

The court case
Hypothesis testing can be thought of as a court case

Members of a jury have to decide whether a person is guilty or innocent based on evidence presented to them.

Null: ???
Alternative: ???

Hypothesis Testing: Quiz

The court case

- Hypothesis testing can be thought of as a court case

- Members of a jury have to decide whether a person is guilty or innocent based on evidence presented to them.

Null: The person is innocent
Alternative: ???

Hypothesis Testing

The court case

- Hypothesis testing can be thought of as a court case

- Members of a jury have to decide whether a person is guilty or innocent based on evidence presented to them.

Null: The person is innocent
Alternative: The person is not innocent

Hypothesis Testing

The court case

Type1 error (α): Reject Null hypothesis when it is true

We found person guilty when the person was innocent

Type 2 error (β): Accept null hypothesis when it is false

Person is guilty actually, but court proves him innocent

Confidence level (1-α): Accept null hypothesis when it is true

Peron is actually innocent, and court also proves him innocent

Hypothesis Testing

The court case

Power of the test (1- β) rejecting null hypothesis when it is false

When person is actually guilty, and court also proves him guilty

Level significance (Probability of type 1 error)

Probability that we found person guilty when the person was innocent

Example 2: Understanding Concept

Null Hypothesis: effect of Drug A= effect of Drug B

Alternate Hypothesis: effect of Drug A ≠ effect of Drug B

Example 2: Understanding Concept

Null Hypothesis: effect of Drug A= effect of Drug B

Alternate Hypothesis: effect of Drug A ≠ effect of Drug B

Type I error: Reject Null hypothesis when it is true

We found that effect of Drug A is not equal to effect of Drug B , But actually both are equally effective

Type II error- Accept null hypothesis when it is false

We fond no difference in both the treatments while actually effect of Drug A is not equal to effect of Drug B

Example 2: Understanding Concept

Confidence level (1-α): accept null hypothesis when it is true

Correctly accepting the null hypothesis of no difference between two treatments

Power of the test (1- β) : rejecting null hypothesis when it is false

Correctly rejecting the null hypothesis of no difference between two treatments

Level significance: Probability of type 1 error

Probability that we found Drug A ≠ Drug B , But actually it is

Example 3: Understanding Concept

Null Hypothesis: There is no correlation between ice cream sales and temperature of the day

Alternate Hypothesis: There is a correlation between ice cream sales and temperature of the day

P-value

It determines how likely it is that the observed effect in the sample is due to chance

It’s the probability of obtaining the study results by chance if the null hypothesis is true

Smallest alpha, the observed sample would reject the null hypothesis

A significant result is when the p-value is less than the chosen level of significance (usually 0.05).

P-value

A p value of 0.02, indicates that there is only 2% chance of getting observed difference by chance

Statistical vs Clinical Significance

Statistical vs Clinical Significance

A Pharmaceutical company claims that their new drug for genital herpes decreases the persistence of an outbreak from 5.5 to 5.3 days. This difference is significant at the 95% confidence interval. This result is:

Clinically significant but not statistically significant

Not clinically significant but statistically significant

Neither clinically nor statistically significant

Both clinically and statistically significant

Statistical vs Clinical Significance

A Pharmaceutical company claims that their new drug for genital herpes decreases the persistence of an outbreak from 5.5 to 5.3 days. This difference is significant at the 95% confidence interval. This result is:

Clinically significant but not statistically significant

Not clinically significant but statistically significant

Neither clinically nor statistically significant

Both clinically and statistically significant

Statistical vs Clinical Significance

A Pharmaceutical company claims that their new drug for reducing SBP decreases the blood pressure from 160mmhg to 155mmhg. This difference is significant at the 95% confidence interval. This result is:

Clinically significant but not statistically significant

Not clinically significant but statistically significant

Neither clinically nor statistically significant

Both clinically and statistically significant

Confidence Interval (C.I.)

A CI, calculated from a given set of sample data, gives an estimated range of values which is likely to include an unknown population parameter.

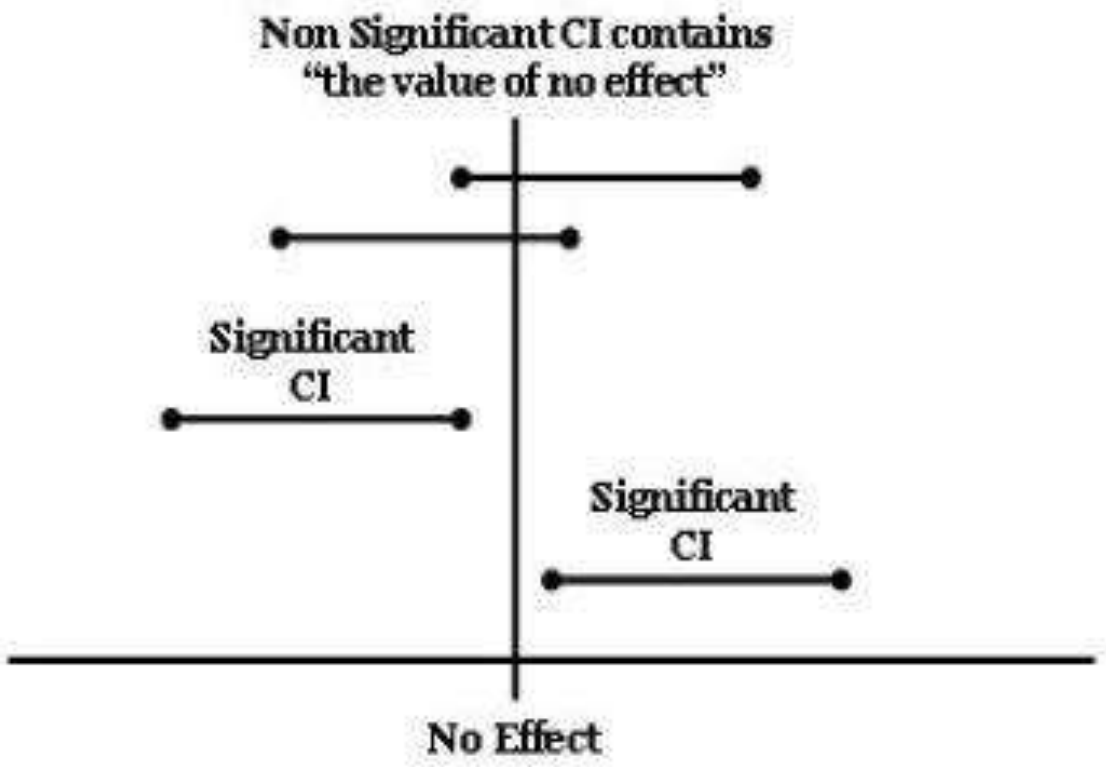
The CI is expressed as 2 numbers, known as the **confidence limits** with a range in between.

This range, with a certain level of confidence, carries the true but unknown value of the measured variable in the population.

95% Confidence Interval

The 95% CI is defined as "a range of values for a variable of interest constructed so that this range has a 95% probability of including the true value of the variable

Concept of Confidence Interval



95% Confidence Interval

Although having the same level of certainty in ruling out chance as the p-value (5%), the confidence limits here gave us extra information than the p-value.

This information is the lowest and largest effects that are likely to occur for the studied variable.

Quiz

The sensitivity of this diagnostic modality is 71.59%, while specificity is 61.63%.

The 95% CI for the sensitivity is 64.89 to 78.29%

95% CI for the specificity is 54.40 to 68.86%

Interpret the findings.

The width of the confidence interval

As a general rule,

“The narrower is the CI the better it is.”

Example: The width of the confidence Interval

First study reported the average age of menopause to be 49.5 (95% CI, 41-59) years

Second study reported the average age to be 50.5 (95% CI, 48-53) years

Which study seems more promising?

Example: The width of the confidence Interval

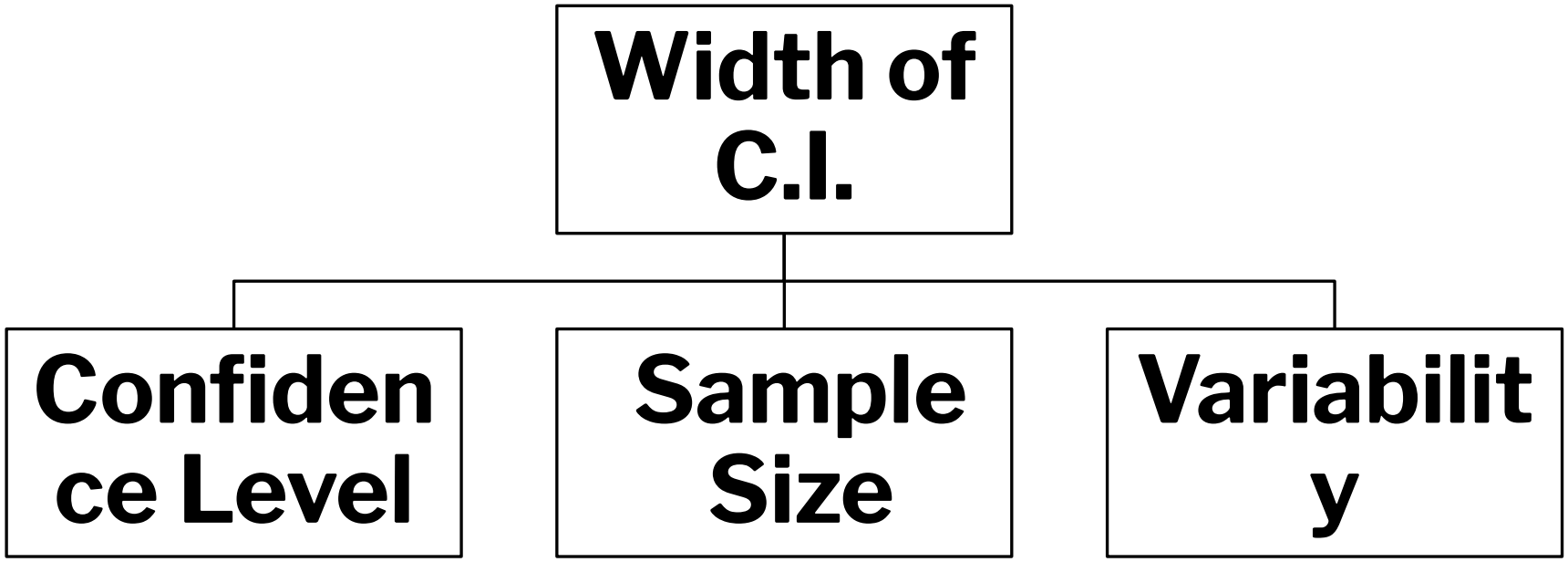
First study reported the average age of menopause to be 49.5 (95% CI, 41-59) years

Second study reported the average age to be 50.5 (95% CI, 48-53) years

Which study seems more promising?

Second Study

Factors affecting the width of the CI



Confidence Level & the width of the CI

The **width of the CI varies directly with the confidence level**.

A 99% CI would be wider than the corresponding 95% CI from the same sample.

This stands to reason, since a larger probability of containing the true population value would lie with the wider interval.

Sample Size & the width of the CI

A larger sample size expectedly will lead to a better estimate of the population parameter and this is reflected in a narrower CI.

The width of the CI is thus inversely related to the sample size.

In fact, required sample size calculation for some statistical procedures is based on the acceptable width of the CI.

Sample Size & the width of the CI

Variability in a random sample directly influences the width of the CI.

A larger spread implies that it is more difficult to reliably estimate population value without large amounts of data.

Thus as the **variability in the data (often expressed as the SD) increases, the CI also widens**.

Lets Connect!

draanchalawasthi@gmail.com

https://www.youtube.com/c/sscrindia

+91 750.625.0403