

## 1 Criteria for an Experimental Study

- Must manipulate the explanatory variable
- Must have random sampling
- Must control the experiment environment

## 2 Criteria for Population Inferences

- We can make population inferences on the population studied if we can obtain a random sample of participants from the study

## 3 Criteria for Causal Inferences

- We can make causal inferences if the original study groups were obtained through random sample

## 4 T-Test Procedure

Process for performing a hypothesis test using the t-distribution:

1. State the null and alternative hypotheses:
  - $H_0$ : There is no effect or difference between the population means.
  - $H_a$ : There is an effect or difference between the population means.
2. Determine the significance level ( $\alpha$ ):
  - Common levels: 0.05, 0.01.
3. Calculate the t-statistic:
  - $t = (\text{sample mean} - \text{population mean}) / (\text{standard deviation of the sample} / \sqrt{\text{sample size}})$
4. Determine the degrees of freedom (df):
  - $df = \text{sample size} - 1$ .
5. Look up the critical value in a t-table:
  - Use df and  $\alpha$  to find the critical value.
6. Make a decision:
  - If  $t$  is greater than the critical value, reject  $H_0$ .
  - If  $t$  is less than the critical value, fail to reject  $H_0$ .
7. Draw a conclusion:
  - Based on the decision, either reject or fail to reject  $H_0$ , and state conclusion in terms of problem being studied.

## 5 Appendix A - Questions and Answers

### 5.1 Chapter 1

**Question 1.** *In Orangetown in 2014, middle-aged people between the ages of 40-50 years old joined two different groups, an exercise group and a group that watched movies together. The participants had made their own decision about which group to join. In 2019, researchers selected random samples from each of these two groups to investigate any possible effects of activity group (exercise group versus movie group) on their mental and physical health. They took records of their systolic blood pressure (SBP) readings (in mm Hg), their Body Mass Index (BMI), that is body weight/(height)<sup>2</sup> (in kg/cm<sup>2</sup>), and their feelings of wellbeing (on a scale of 1-5).*

- a Identify the study units*
- b What is/are the explanatory variable(s) or factor(s)? State the type of data scale used (e.g., categorical, ordinal, etc.) for recording each explanatory variable.*
- c What is/are the response variable(s)? State the type of data scale used (e.g., categorical, ordinal, etc.) for recording each response variable.*
- d Give details of where the study was conducted.*
- e Give details of regarding temporal aspects of the study.*
- f Is this an observational or experimental study? Very briefly explain your answer.*
- g Based on this study, will it be possible to make population inferences? Briefly explain your answer.*
- h Based on this study, will it be possible to make causal inferences? Briefly explain your answer.*

**Answer 1.**

- a The study units are the atomic entities being studied, so in this case it is the middle-aged people between ages 40-50 in both the movie group and the exercise group.
- b The explanatory variable is the categorical value of the group that the individual was a part of. This is a categorical variable with two categories.
- c The response variables for the data are:
  - **SBP** - continuous, quantitative
  - **BMI** - continuous, quantitative
  - **Wellbeing** - ordinal, 5 categories
- d The study was conducted in Orangetown.
- e The study was started in 2014 and data collection was performed in 2019.
- f This is an observational study since the researchers **did not**:
  - Manipulate the explanatory variable
  - Control the environment variables
  - There was no random assignment to groups (the participants decided themselves)
- g Since the researchers took a random sample from the two groups, we can make population inferences for the two groups specifically.
- h We cannot make causal inferences based on this study since there was no random assignment to these groups.

$$\hat{a}_1 = \hat{a}_1$$

**Question 3.** An experiment was conducted to explore the effects of two teaching styles for Alberta students in grade 12 mathematics. The individuals in the experiment were a random sample of grade 12 math students from a particular high school in southern Alberta. The students were randomly assigned to the two treatment groups, each group taught by the same teacher. After a three-week course, all students took an identical standardized exam. The response was the students score on the exam. Can we make population inferences? Can we make causal inferences?

## 5.2 Chapter 2

## 5.3 Chapter 3