# Chapter 9: Hypothesis Testing - One Sample

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# Introduction

- What is Hypothesis?

  Testing whether or not a claim is valid.

**Ex:** Most people get their jobs through networking.

**Ex:** The average weight of population in USA is 172 lbs.

# Introduction

- What is Hypothesis?
- Conjecture (guess) about a population parameter.
- May or may not be true.

# Big Idea

- Have a conjecture for a mean for a polulation
- Collect data from a sample
- If data is close to guess, then guess is OK
- If data is a far from guess, then guess is wrong

# Example from Confidence Intervals

- According to an internet post, a sample of 15 college heavyweight wrestlers had an average weight of 255.88 lbs with a sample standard deviation of 19.29 lbs.

- If a coach claimed that average weight of wrestlers was 280, would that be believable?˜

# Competing Hypothesis

- **Null Hypothesis**: Symbol $H_0$ is a statistical hypothesis that states that there is no difference between a parameter and a specific value.

- **Alternative Hypothesis**: Symbol $H_1$ states there is some kind of difference between parameter and specific value.

# How to Test a Hypothesis

- Start by assuming that $H_0$ is true. Then use the evidence to reach a conclusion.
  - Reject $H_0$ : I have enough evidence to prove $H_0$ is wrong.
  - Fail to Reject $H_0$: I Don't ...

# Example from Confidence intervals

- $H_0 : \mu = 280$
- $H_1 : \mu \neq 280$
- Could also have $<$ or $>$ as the inequality
- If only care about being less than or more than

# How to identify $H_0$ and $H_1$

- State the original claim symbolically
- State the opposite of the original claim as well.

Note: The original claim should be $H_0$
However, depends of where the equality is.

# Example

- The mean of fluid is at least 12 oz in a Can.

**Claim:**

**Opposite:**

# Example

- The proportion of the make CEO's is greater than 0.5

**Claim:**

**Opposite:**

# Example

- The mean weight of babies is at most 8.9 lbs.

**Claim:**

**Opposite:**

# Example

- The mean IQ score is 100

**Claim:**

**Opposite:**

# Error Types

- $H_0$ is true then the coach is correct (innocent)
- $H_1$ is true then the coach is incorrect (guilty)

# Proper Language

Courtroom decisions

- Language: Guilty or Not Guilty

Statistical Testing

- Language: Reject $H_0$ or Do not reject $H_0$

# Central Limit Theorem

- Imagine that we can use Central Limit Theorem
- Assume Null hupothesis is correct
- 95% confident that we don't have $\alpha$ error using a two tailed test ($\neq$)

# Explaination

# Central Limit Theorem

- If $\overline{X}$ is far from guess of $\mu$ then we say Null Hypothesis is not correct.
- Critical Region is size $\alpha$

# Central Limit Theorem

- Multiple numerical ways
- We compare p-value to $\alpha$
  - If p-value $< \alpha$, then reject $H_0$
  - If p-value $> \alpha$, then do not reject $H_0$

# Explaination

# Outline

- Z test (For mean when $\sigma$ is known)
- T test (For mean when $\sigma$ is unknown ... $s$ known)
- Proportion test (For proportion)

# Example 1

- A personal trainer claims that the Body Mass Index (BMI) of eighteen year old males is about 25. The CDC found that a sample of 160 eighteen year old males had an average BMI of 26.4 with a sample standard deviation of 5.75. Should the personal trainer's hypothesis be rejected at $\alpha = .01$?

# Expectations

On each statistical test, you will have to do the same things.

- State the null and alternative hypothesis
- State the test that is used
- State the p-value
- Reject $H_0$ or Do not Reject $H_0$
- State conclusion in terms of the problem

# Example 2

- In 2007, the Department of Agriculture found that the average size of farms in Isabella County was 192.6 acres. A sample of 928 farms was selected, and the mean size of the farms was 203.1 acres. The population standard deviation of all farms was 183.8 acres. Test the claim at $\alpha = .05$ that the average farm size is larger today in Isabella County than it used to be.

# Example 3

- A farmer says that female owned farms in Michigan sell about \$16,000 worth of goods per year. We can use Isabella County as a cluster sample. As a sample, Isabella county had 116 Female owned farms which averaged \$14,436 in sales. Assume that the sample standard deviation is \$8,000. Is there sufficient evidence at the $\alpha = .01$ level to conclude that the mean sales are different from the farmer's claim?

# Example 4

- A large university reports that the mean salary of newly hired professors is \$70,000. A faculty member wonders if that salary is higher than most other universities. A survey done by higher ed jobs showed that in a sample of 34 institutions, the average salary of newly hired professors was \$67,750 with a sample standard deviation of \$15,000. Can the faculty member conclude that the average salary at universities is less than the \$70,000 at their university at the $\alpha = .10$ level?

# Example 5

- A football coach says that the average number of injuries per year in collegiate football during games is roughly 18,000. The CDC did a study over 5 years and found that the average number of football injuries during competition was 19,982. Assume the population standard deviation is 400. Determine whether the average number of injuries is actually more than what the coach claims. Use $\alpha = .05$.

# Example 6

- A student claims that the Mt. Pleasant City Police issue an average of 60 drinking tickets per day of a football game. These data show the number of drinking tickets issued each day for all home football games over a period of two years. Is there enough evidence to reject the student's claim at $\alpha = .05$.

  72, 36, 68, 69, 71, 60, 83, 60, 72, 87, 48, 59, 42, 63

# Example 7

- An anchor on a news program reported that 65% of American teens say that anxiety and depression is a major problem among their peers. The PEW research center did a survey in 2018 and found that 646 out of 920 teens said that anxiety and depression is a major problem among their peers. At $\alpha = .05$, test the claim that the anchor made.

# Example 8

- The Pew Research Center did a study and found that 7.3% of the total K-12 students in the U.S. were children of unauthorized immigrants in 2014. A principal wants to find out if her school district has that percentage. She randomly selects 1000 students in her district and find out that 76 out of the 1000 students are children of unauthorized immigrants. Using $\alpha = .05$, does her district have the same percentage of unauthorized immigrants as the Pew Research Center found?

# Example 9

- In November 2017, Rasmussen Reports said that 70% of American Adults say their religious faith is at least somewhat important in their daily life. A political candidate says Michigan has the same percent. A sample is done in Michigan and 55 out of 80 people surveyed in Michigan say their religious faith is at least somewhat important. Test the candidate's claim at $\alpha = .02$.

# Standard Deviation

- Can do testing on standard deviations
- Use a $\chi^2$ test
- We skip this