Two Independent Samples

• Do males and females at I.S.U. spend the same amount of time, on average, at the Lied Recreation Athletic Center?

1. Female 2. Male

Populations

Samples

Inference

random selection

Time (minutes)

1. Females 2. Males

63, 32, 86, 53, 49 52, 75, 74, 68, 93
73, 39, 56, 45, 67 77, 41, 87, 72, 53
49, 51, 65, 54, 56 84, 65, 66, 69, 62
### Time (minutes)

<table>
<thead>
<tr>
<th></th>
<th>Sex=F</th>
<th>Sex=M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>55.87</td>
<td>69.20</td>
</tr>
<tr>
<td>Std Dev</td>
<td>13.527</td>
<td>13.790</td>
</tr>
<tr>
<td>n</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

### Description

- This sample of I.S.U. females spends, on average, 13.33 minutes less time at the Lied Recreation Athletic Center than this sample of I.S.U. males.

### Confidence Interval: $\mu_1 - \mu_2$

$$(\bar{y}_1 - \bar{y}_2) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

- $t^*$ from Table T,
- $df = \text{nasty formula}$
Finding t* 
- Use Table T. 
- Confidence Level in last row. 
- df = 27.99 or 28. 

Table T

<table>
<thead>
<tr>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
</tr>
<tr>
<td>90%</td>
</tr>
<tr>
<td>95%</td>
</tr>
<tr>
<td>98%</td>
</tr>
<tr>
<td>99%</td>
</tr>
<tr>
<td>df</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>28</td>
</tr>
</tbody>
</table>

\[
\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = \sqrt{\frac{(13.527)^2}{15} + \frac{(13.792)^2}{15}}
\]

\[
= \sqrt{24.88} = 4.988
\]
Confidence Interval: $\mu_1 - \mu_2$

\[
(\bar{y}_1 - \bar{y}_2) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}
\]

\[
(55.87 - 69.2) \pm 2.048(4.988)
\]

\[= -13.33 \pm 10.22
\]

\[= -23.55 \text{ to } -3.11
\]

**Interpretation**

• We are 95% confident that I.S.U. females spend, on average, from 3.11 to 23.55 minutes less time at the Lied Recreation Athletic Center than I.S.U. males do.

**Inference**

• The confidence interval is making a generalization to ALL students (males and females) at I.S.U. who use the Lead Recreation Athletic Center
Test of Hypothesis: $\mu_1 - \mu_2$

- Step 1: Hypotheses.

$H_0 : \mu_1 = \mu_2$ or $H_0 : \mu_1 - \mu_2 = 0$

$H_A : \mu_1 \neq \mu_2$ or $H_A : \mu_1 - \mu_2 \neq 0$

- Step 2: Conditions.
  - Quantitative response for two groups.
  - Independent random samples.
  - Approximately normal distribution for both groups.

- Step 3: Test Statistic.

$$t = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$
Time (minutes)

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\[
\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = \sqrt{\frac{(13.527)^2}{15} + \frac{(13.790)^2}{15}}
= \sqrt{24.88} = 4.988
\]

Test of Hypothesis: \( \mu_1 - \mu_2 \)

- Step 3: Test Statistic.

\[
t = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{(55.87 - 69.20)}{4.988}
= -2.672
\]
Table T

<table>
<thead>
<tr>
<th>df</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>...</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.313</td>
<td>1.701</td>
<td>2.048</td>
<td>2.467</td>
<td>2.672</td>
<td>2.763</td>
</tr>
</tbody>
</table>

Test of Hypothesis: $\mu_1 - \mu_2$

- Step 4: Probability value
  - The P-value is between $2(0.005) = 0.010$ and $2(0.010) = 0.020$.

Test of Hypothesis: $\mu_1 - \mu_2$

- Step 5: Results.
  - Reject the null hypothesis because the P-value is smaller than $\alpha = 0.05$
  - The difference in mean times is not zero.
Conclusion in Context

• Therefore, on average, females and males at I.S.U. spend different amounts of time at the Lied Recreation Athletic Center.

Comment

• This conclusion agrees with the results of the confidence interval.
• Zero is not contained in the 95% confidence interval (–23.55 mins to –3.11 mins), therefore the difference in population mean times is not zero.

JMP

• Data in two columns.
  –Response variable:
    • Numeric – Continuous
  –Explanatory variable:
    • Character – Nominal
Analyze – Fit Y by X

• Y, Response: Time
• X, Factor: Sex

Click on OK
– Means and Std Dev
– t Test