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Independent Samples t-test

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Discipline of Public Health Medicine
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UKZN INSPIRING GREATNESS

Statistical tests for continuous data

Number of groups	Dependent / Independent	Statistical test
One	N/A	One- Sample t-test
Two	Dependent	Paired samples t-test
Two	**Independent**	**Independent samples t-test**
Three	Independent	One-way Analysis of Variance

Assume normal distribution

Steps in Hypothesis Testing

- ✓ Establish H_0 and H_a
- ✓ Set the significance level α (usually 0.05)
- ✓ Choose the appropriate statistical test
- ✓ Calculate the appropriate test statistic
- ✓ Read the relevant critical value from a stats table
- ✓ Compare the calculated statistics and the critical value.

Steps in Hypothesis Testing (cont)

- Make a decision regarding $H_{0:}$ If the calculated value is greater that the critical value, we reject H_0. If not we fail to reject the $H_{0.}$
- When the null hypothesis is rejected, the outcome is said to be "statistically significant"; when the null hypothesis is not rejected then the outcome is said be "not statistically significant."
- Draw a conclusion regarding your original research hypothesis based on your decision above.

Learning outcomes

- When to use independent samples t-test
- Assumptions
- Null and alternative hypotheses
- Calculate relevant statistics
- Interpret results

When to use Independent samples t-test

Appropriate for comparing means between **two unrelated** groups.

Example:

Assess cholesterol level of women who are on a contraceptive pill and those who are not on a contraceptive pill.

Assumptions

1. Comparing two unrelated groups

2. Dependent variable is normally distributed

3. Equal variances

Assumptions

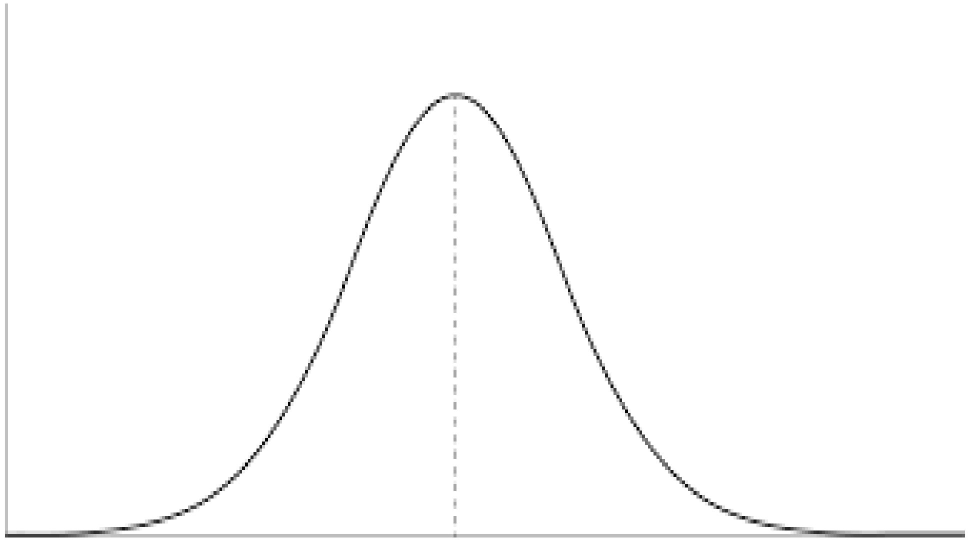
Two unrelated groups also known as independent groups or unpaired groups.

A person cannot be in both groups.

For example: smokers vs non-smokers
males vs females
discharged vs demised

Assumptions

- Normal distribution of a dependent variable



mean = median = mode

Assumptions

Testing for normality

Shapiro-Wilks test and Kolmogorov-Smirnov test

(significant p-values imply that the data is NOT normally distributed)

Assumptions

If data are not normally distributed

- ***Transform data***

- Use a non-parametric equivalent test
Mann-Whitney U test also known as **Wilcoxon ranksum test**

(not for HMA exercises)

Assumptions

Equal variances

- The **Levene's test** is used to test for equality of variances
- SPSS performs the test automatically

(not expected to perform this test for HMA exercises)

Null hypothesis

- Null hypothesis is a hypothesis of no difference, no association or no effect

Null hypothesis: the population means of the two groups are equal

$$H_0: \mu_1 = \mu_2$$

Alternative hypothesis

- Alternative hypothesis is a hypothesis of difference, association or effect

Alternative hypothesis : the population means of the two groups are not equal

$$H_a : \mu_1 \neq \mu_2$$

Relevant statistics

- t-test

$$t_{n_1+n_2-2} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}}$$

Relevant Statistics

pooled variance

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

Example 1

- A researcher wants to find out whether exercise or low-calorie diet reduces cholesterol level.
- She conducts a study and recruit 40 inactive males.
- Randomly assigned 20 into a low-calorie diet and 20 into an exercise program.

Statistical Tests - Example

✓Establish H_0 and H_a

H_0: $\mu_{diet} = \mu_{exercise}$

H_a: $\mu_{diet} \neq \mu_{exercise}$

✓Set the significance level α (usually 0.05)

Statistical Tests - Examples

✓ Choose the appropriate statistical test

Type of variable analyzed(cholesterol) – continuous
Distribution of cholesterol – normal
Number of groups – two
Independent or dependent - independent

Appropriate test statistic: Two independent samples ttest

Statistical Tests - Examples

- Calculate the appropriate test statistic

$$t_{n_1+n_2-2} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}}$$

Relevant Statistics

pooled variance

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

Descriptive Statistics

	mean	standard deviation
Diet	6,14	0,51
Exercise	5,79	0,38

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

$s_1 = 0{,}51$ $s_2 = 0{,}38$

$$s_p^2 = \frac{(20 - 1)(0{,}51)^2 + (20 - 1)(0{,}38)^2}{20 + 20 - 2}$$

$$s_p^2 = \frac{19 * 0,2601 + 19 * 0,1444}{38}$$

$$= \frac{4,9419 + 2,7436}{38}$$

$$= \frac{7,6855}{38} = 0,202$$

$$t_{n_1+n_2-2} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}}$$

$$t_{38;0,05} = \frac{6,14 - 5,79}{\sqrt{\frac{0,202}{20} + \frac{0,202}{20}}}$$

$$t = \frac{0,35}{\sqrt{0,0101 + 0,0101}}$$

$$t = \frac{0,35}{\sqrt{0,0202}}$$

$$t = \frac{0,35}{0,142} = 2,46$$

- Check the critical value associated with the test statistics in the table

Read critical value of t from the stats tables for t-statistics.

TABLE 3—Percentage Points of Student's t Distribution

Degrees of Freedom	Level of Significance for a One-Tailed Test								
	.25	.20	.15	.10	.05	.025	.01	.005	.0005
(n-1)	Level of Significance for a Two-Tailed Test								
	.50	.40	.30	.20	.10	.05	.02	.01	.001
1	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619
2	.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598
3	.765	.978	1.250	1.638	2.353	3.182	4.541	5.841	12.924
4	.741	.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610
5	.727	.920	1.156	1.476	2.015	2.571	3.365	4.032	6.869
6	.718	.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959
7	.711	.896	1.119	1.415	1.895	2.365	2.998	3.499	5.408
8	.706	.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041
9	.703	.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781
10	.700	.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11	.697	.876	1.088	1.363	1.796	2.201	2.718	3.106	4.437
12	.695	.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13	.694	.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221
14	.692	.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140
15	.691	.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16	.690	.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015
17	.689	.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965
18	.688	.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922
19	.688	.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20	.687	.860	1.064	1.325	1.725	2.086	2.528	2.845	3.850
21	.686	.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819
22	.686	.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23	.685	.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767
24	.685	.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25	.684	.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725
26	.684	.856	1.058	1.315	1.706	2.056	2.479	2.779	3.70
27	.684	.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690
28	.683	.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29	.683	.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659
30	.683	.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646
40	.681	.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551
60	.679	.848	1.046	1.296	1.671	2.000	2.390	2.660	3.460
120	.677	.845	1.041	1.289	1.658	1.980	2.358	2.617	3.373
∞	.674	.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291

$$t_{38;0,05} = 2,042$$

Since t_{calc} =2,46 is greater than 2,042;

Reject the null hypothesis *(average cholesterol level of males who are on a low calorie diet is equal to that of men on an exercise program)* if the calculated value of t is greater that the critical value of t.

Conclusion

Cholesterol level amongst males who are in an exercise program differs from cholesterol level of males in a low-calorie diet program

Estimate range of a p-value

- Check where the calculated value of t lie at the relevant degrees of freedom and level of significance

t_{calc} =2,46

- Check where 2,46 lie at 38 degrees of freedom

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- At 38 degrees of freedom; 2,46 lie between 0,02 and 0,01.

$$0{,}01 < p < 0{,}02$$

Questions ?