

Hypothesis Testing Two-Sample

Course: Statistics 1

Lecturer: Dr. Courtney Pindling



Two-Sample Overview

- Use two samples to hypotheses about two populations (compare two samples means)
- Underlying t -distribution
- H_0 : the samples mean difference = 0
- Cases:
 - Independent Samples: Same variance
 - Independent Samples: Not same variance
 - Dependent Samples: Assumed Correlated or Related
- Test Statistics: $t = \frac{\text{sample mean difference}}{\text{estimated standard error}} = \frac{(M_1 - M_2)}{S_{(M_1 - M_2)}}$

Two Independent Samples

Mean 1
Variance 1

Sample 1

Population 1

Mean 2
Variance 2

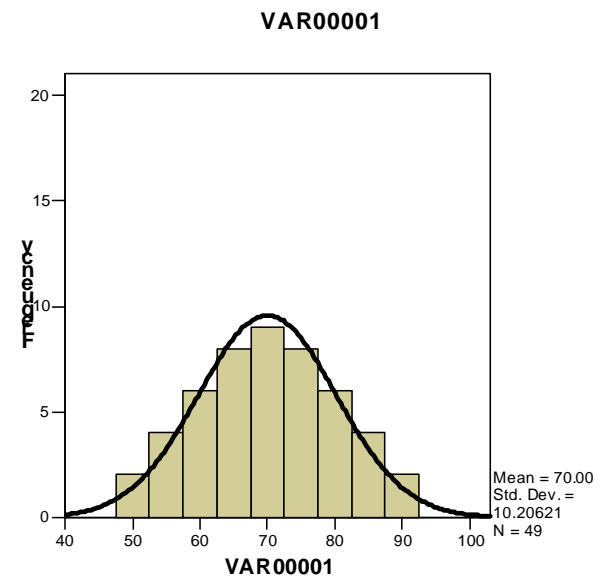
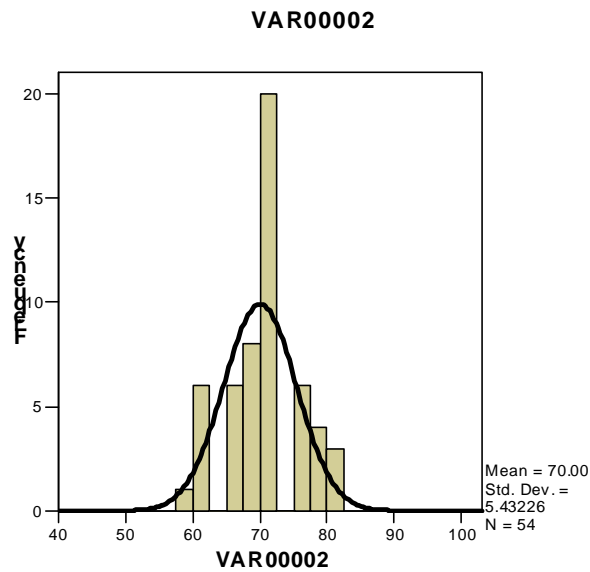
Sample 2

Population 2



Examples: Male – Female, Drug A – Drug B, Blacks - Whites

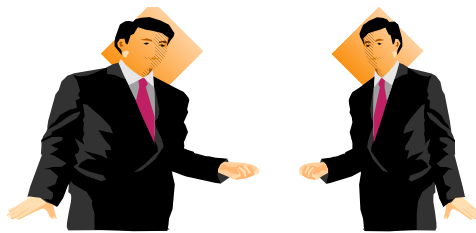
Variances: Independent Samples



Homogeneity of Variance: Are variance the same?

Dependent Samples

Paired-Samples or Correlated Sample



240 lbs

145 lbs



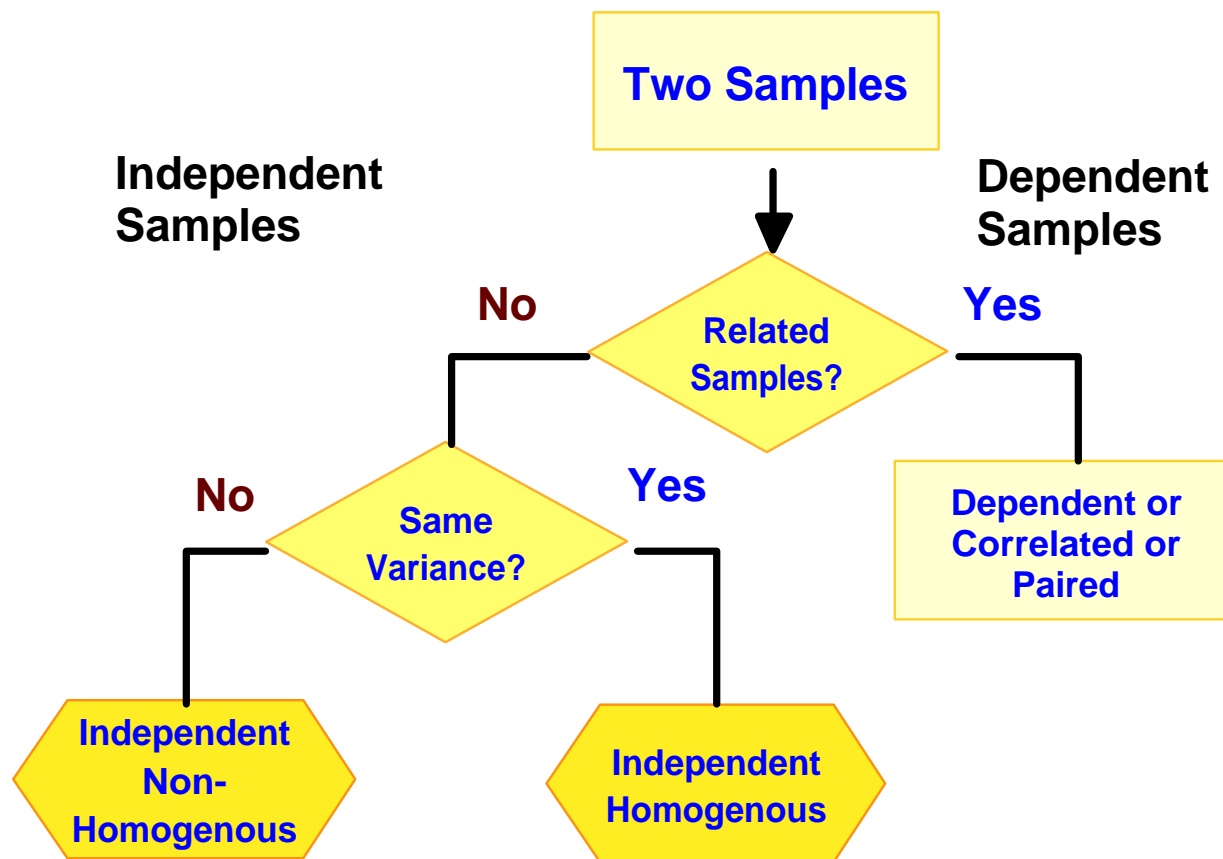
Examples:

Before - After,

Twins,

Husband - Wife

Decision Tree



Hypotheses

- Null, H_0 (*no difference in means*)

$$\mu_1 - \mu_2 = 0$$

- Alternative, H_a

$$\mu_1 - \mu_2 \neq 0$$

$$\mu_1 > \mu_2$$

$$\mu_1 < \mu_2$$

df varies with cases of two-sample mean test

Standard Error

- The amount of error expected when a sample difference is used to represent a population difference, $S_{(M1-M2)}$
- Each sample error is pooled or combined to provide an estimated standard error for both

Homogeneity of Variance

- Hartley's F -max Test
- F -max Procedure:
 - Compute sample variances: s^2
 - Select largest and smallest variances and compute,

$$F\text{-max} = \frac{s^2(\text{largest})}{s^2(\text{smallest})}$$

- Look up critical value for F_{cv} (Given df and α)
- Reject H_0 that variances are same if:
 - $F\text{-max} \geq F_{cv}$

SPSS: Independent Samples

Variable	Group
12	1
13	2
11	1
12	1
9	2

The screenshot shows the SPSS Data Editor interface. The 'Analyze' menu is open, and the path 'Analyze > Compare Means > Independent-Samples T Test...' is highlighted. The 'Independent-Samples T Test' dialog box is open, showing 'quant' and 'VAR00001' in the 'Test Variable(s)' list and 'VAR000021 Z1' as the 'Grouping Variable'. The 'Define Groups...' button is visible at the bottom of the dialog box.

SPSS Output: Independent Samples

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
verbal	Equal variance assumed	.000	1.000	-1.096	16	.289	-6.33333	5.78072	8.58790	5.92124
	Equal variance not assumed			-1.096	15.973	.289	-6.33333	5.78072	8.58955	5.92289

Null hypothesis: variance are same or homogenous ($p\text{-value} > 0.05$ or α)
 Decide of Homogeneity of Variance from the significance or p-value of the Levene's F-test

SPSS: Dependent Samples

Subjects	Sample 1	Sample 2
1	11	23
2	12	26
3	11	21
4	11	20
5	10	18

The screenshot shows the SPSS Data Editor interface. The 'Analyze' menu is open, and the 'Compare Means' option is selected, which has opened a sub-menu. In this sub-menu, the 'Paired-Samples T Test...' option is highlighted. Below the menu, the 'Paired-Samples T Test' dialog box is open. The 'Paired Variables' field contains 'verbal - quant'. The 'Current Selections' section shows 'Variable 1:' and 'Variable 2:' fields, which are currently empty. The dialog box also includes buttons for 'OK', 'Paste', 'Reset', 'Cancel', 'Help', and 'Options...'. The background shows the SPSS Data Editor window with the 'aSet1] - SPSS Data Editor' title bar and various menu options like 'Analyze', 'Graphs', 'Utilities', 'Add-ons', 'Window', and 'Help'. The data grid is partially visible, showing values for 'verbal' and 'quant' variables.