

## Steps of One-Way Anova

Suppose a teacher is interested in determining whether there is a difference in reading achievement results using three different reading approaches. She randomly assigns 5 children to each of the three reading programs.

We use our seven-step approach.

**Step 1 and 2.** *State the null- and the alternative hypothesis: H<sub>0</sub> and H<sub>a</sub>.*

H<sub>0</sub>:  $\mu_1 = \mu_2 = \mu_3$ , there is no difference in means of achievement results (

H<sub>a</sub>: achievement results are different, at least two means are not equal

**Step 3.** *Select the  $\alpha$ , the probability of Type I error, or the  $(1-\alpha)100\%$  significance level.*

$\alpha = .05$

**Step 4.** *Choose the size  $n$  of the random sample*

$n_1 = n_2 = n_3 = 5$

**Step 5.** *Select a random sample from the appropriate population and obtain your data.*

Group 1: 48 50 53 52 50

Group 2: 51 50 51 50 51

Group 3: 61 62 60 63 60

**Step 6.** *Calculate the decision rule.*

Calculate the F statistic, and degrees of freedom, or find the p-value

$F(2,12) = 96.862$ ,  $p = .000$  (that is,  $p < 0.0005$ )

**Step 7.** *Decision.*

a) Reject the null hypothesis and claim that your alternative hypothesis was correct the difference is significant at  $(1-\alpha)100\%$  level.

b) Fail to reject the null hypothesis correct the difference is not significant at  $(1-\alpha)100\%$  level

Compare the computed F value with  $F_{table}$ , or compare the p-value with  $\alpha$

$F(2,12) = 88.935 > F_{table} = 3.88$ ,  $p < .05$

The means of the three groups are significantly different. There are differences in reading depending upon which reading treatment a child was assigned .

### Assumptions

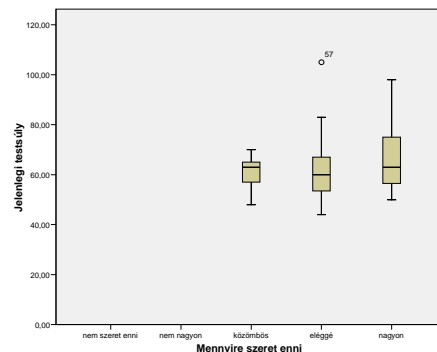
To conduct an analysis of variance, certain assumptions must be made.

- It is assumed that subjects are assigned to the treatment conditions using a random and independent procedure.
- The population of scores for the dependent variable should be **normally distributed**.
- The **variances** of the populations from which the groups are drawn are assumed to be **equal**.
- Finally, the scores for the dependent variable must be continuous (interval or ratio).

### Multiple Comparisons

As we noted earlier, when we reject the null hypothesis using ANOVA, we know there is a difference between our groups. Unfortunately, we don't know where that difference is. A significant F statistic tells us that at least two of the groups were different, but not which ones. Multiple comparison tests are used to discover which groups are different without inflating the type 1 error. There are lots of these multiple comparison tests. Some major statistics packages allow users to chose about a dozen different tests: least-significant difference test(LSD) test, Bonferroni-correction, Scheffé test..

8.1. Pharmacy students were asked about their eating habits in 2009. Examine the mean body weight in the groups of eating (indifferent, like to eat, like to eat very much) ! (File KERD09.SAV ).



How do you like to eat?	N	Mean	Std. Deviáció	Std. Error
Indifferent	17	59.8235	6.88509	1.66988
I like to eat	27	61.9630	12.52837	2.41109
I like to eat very much	23	66.4783	12.50043	2.60652

To compare the mean of several groups, what is the appropriate test:.....

What is the null hypothesis?.....

Assumptions of the test:.....

Subjective opinion about the equality of variances based on STD. Deviations .....

Equality of variances by SPSS (Levene test):. Nullhypothesis:.....

**Test of Homogeneity of Variances**

Jelenlegi testsúly			
Levene Statistic	df1	df2	Sig.
1.969	2	64	.148

Result of the test of homogeneity of variances:.....

Subjective opinion about the equality of group means.....

The ANOVA table

**ANOVA**

Jelenlegi testsúly					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	478.768	2	239.384	1.851	.165
Within Groups	8277.173	64	129.331		
Total	8755.940	66			

Value of the Between Groups variance:..... its calculation?.....

Value of the Within Groups variance:..... its calculation?.....

Value of the F statistic ..... its calculation?.....

Degrees of freedom ....., .....

F-value in the table:.....

Decision based on table: .....

Decision based on p-value:.....

Do we need further pairwise comparisons? .....

.....

## Problems to be solved by SPSS

8.1.1. People who are concerned about their health may prefer hot dogs that are low in salt and calories. The "Hot dogs" datafile contains data on the sodium and calories contained in each of 54 major hot dog brands. The hot dogs are classified by type: beef, poultry, and meat (mostly pork and beef, but up to 15% poultry meat). Can we state that the mean calories of the 3 types of hotdogs is the same in the population? Perform the appropriate analysis ( $\alpha=0.05$ )

Data are in the file HOTDOG.SAV, variables are the following:

1. Type: Type of hotdog (1=beef, 2=meat, 3=poultry)
2. Calories: Calories per hot dog
3. Sodium: Milligrams of sodium per hot dog

### Compare the mean calories by the type of hotdog!

Give a boxplot of calories in these groups (Explore)

Explain what you see.....

Name of the test.....

Null hypothesis ..... Alternative hypothesis .....

Assumptions of the test.....

*(Analyse/Compare Means/One-way ANOVA/ variables calories and type/Options descriptives, Homogeneity of variances),*

### Descriptive statistics

	Number of cases	Mean	Standard dev.
Beef:	.....	.....	.....
Meat	.....	.....	.....
Poultry	.....	.....	.....

**Assumption, equality of variances.** p..... significance.....equality.....

**Equality of means.** F.....df.....p.....significance.....

Equality of means in words.....

**Pairwise comparisons** *(Analyse/Compare Means/One-way ANOVA/ variables calories and type/Post hoc LSD Boferroni, )*,

8.1.2. Repeat the same process on the sodium content of hotdogs. Compare the mean calories by the type of hotdog!

H0:.....HA:.....

### Descriptive statistics

**Assumption, equality of variances.** p..... significance.....equality.....

**Equality of means.** F.....df.....p.....significance.....

### Pairwise comparisons

8.1.3. Open the file QUEST2010.SAV. Compare the mean body mass (variable mass) in the groups of eat (How do you like to eat?)

H0:.....HA:.....

### Descriptive statistics

**Assumption, equality of variances.** p..... significance.....equality.....

**Equality of means.** F.....df.....p.....significance.....

### Pairwise comparisons