WEEK 12

COMPARING PROPORTIONS: THE CHI-SQUARED TEST

CHI SQUARE TEST

- Aim is to test hypothesis for proportion, a parameter that summarizes the observations of binary variable
  - Binary variable: categorical variable with only two categories of response (Success vs failure).

- It is performed to assess whether two categorical variables are related to each other

- Test is based on the Chi- squared distribution

ANALYZING TWO CATEGORICAL VARIABLES

- Calculating the mean of a categorical variable >>> meaningless…
- We analyze frequencies…

Analyze the number of things that fall into each combination of categories.

An example of 2*2 Contingency table

Cell

	Cured	Not Cured	TOTAL
Medicine x	28	48	76
Medicine y	24	38	62
TOTAL	52	86	138

- 2 x 2 Contingency table
- Table has 4 cells

LARGER CONTINGENCY TABLES (2XM, NX2, NXM TABLOLAR)

2x3

	Success		
Diet	Good	Medium	Bad
A	60	30	10
B	30	30	40

4x3

	Health Status		
Treatment Method	Good	Medium	Bad
A	50	30	20
B	10	30	60
C	25	25	50
D	90	5	5

THE LOGIC OF CHI-SQUARE TEST

- To determine whether observed frequencies are significantly different from expected frequencies

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

O = Observed
E = Expected

ASSUMPTIONS OF CHI SQUARE TEST

- Independence of the data
  - Each subject or animal in contributes to only one cell of the contingency table.
    - Note that you can’t use it on a repeated measures design)

- The expected frequencies should be greater than 5
  - However, it is acceptable in larger contingency tables to have up to 20% of expected frequencies below 5

1. Increase the number of subjects,
2. Merge rows or columns,
3. Use chi square with Continuity Correction (Yates correction).
4. Use Fisher’s exact test (For only 2 x 2 tables)

- No expected frequencies should be below 1.

EXAMPLE

Suppose that you designed a study to evaluate the effect of a new therapy in dogs with canine parvovirus. For this purpose you treated 200 dogs with two available treatment. Results are as follows:

	Survival		
Treatment	Survived	Non Survived	Total
New	20	80	100
Available	5	95	100
Total	25	175	200

- H_0: There is no association between the survival and treatment type
- H_1: There is a association between the survival and treatment type

SOLUTION

STEP 1: Calculate the expected frequencies.

Expected Frequency:
(25/200)*100 = 12,5

Expected Frequency :
(175/200)*100 = 87,5

	Survival		
Treatment	Survived	Non Survived	Total
New	20	80	100
Available	5	95	100
Total	25	175	200

Expected Frequency:
(25/200)*100 = 12,5

Expected Frequency:
(175/200)*100 = 87,5

STEP 2: Calculate the chi square value using the formula.

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

$$\chi^2 = \frac{(20-12.5)^2}{12.5} + \frac{(80-87.5)^2}{87.5} + \frac{(5-12.5)^2}{12.5} + \frac{(95-87.5)^2}{87.5}$$
$$= 10,286$$

STEP 3: Compare the computed chi square value with the theoretical table values.

Table chi square value with 1 df = 3,841
Calculated test statistics = 10.286
so calculated test statistics is bigger than theoretical table value

STEP 4: Make a decision whether or not reject the null hypothesis.

H0 is rejected. => There is a association between the survival and treatment type

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Example

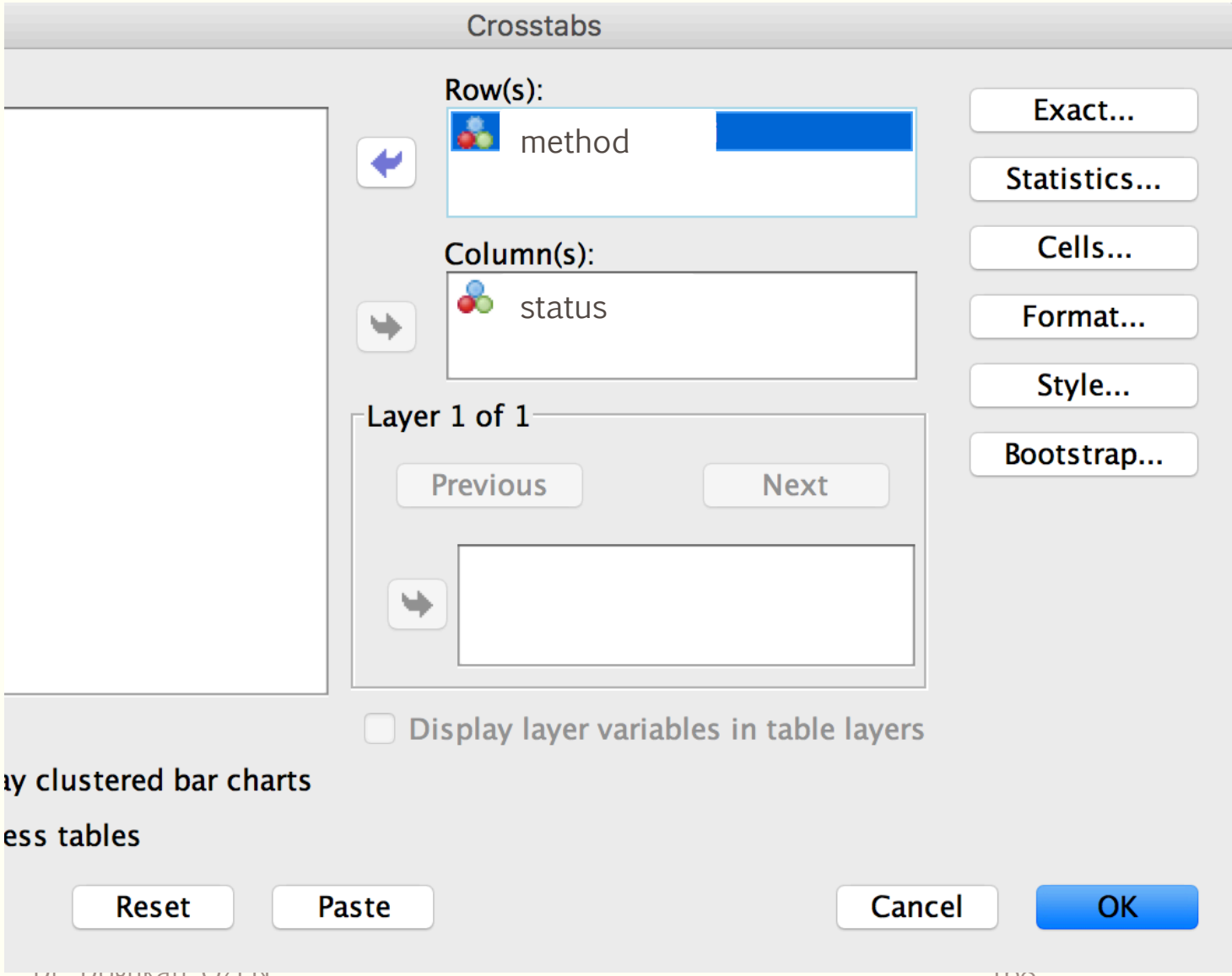
	Method	Status
1	tratment A	Not cured
2	tratment A	Not cured
3	tratment A	Not cured
4	treatment B	Not cured
5	tratment A	Not cured
6	tratment A	Not cured
7	tratment A	Not cured
8	treatment B	Not cured
9	tratment A	Not cured
10	treatment B	Not cured
11	treatment B	Not cured
12	tratment A	Not cured
13	treatment B	Not cured
14	tratment A	Not cured
15	treatment B	Not cured
16	tratment A	Not cured

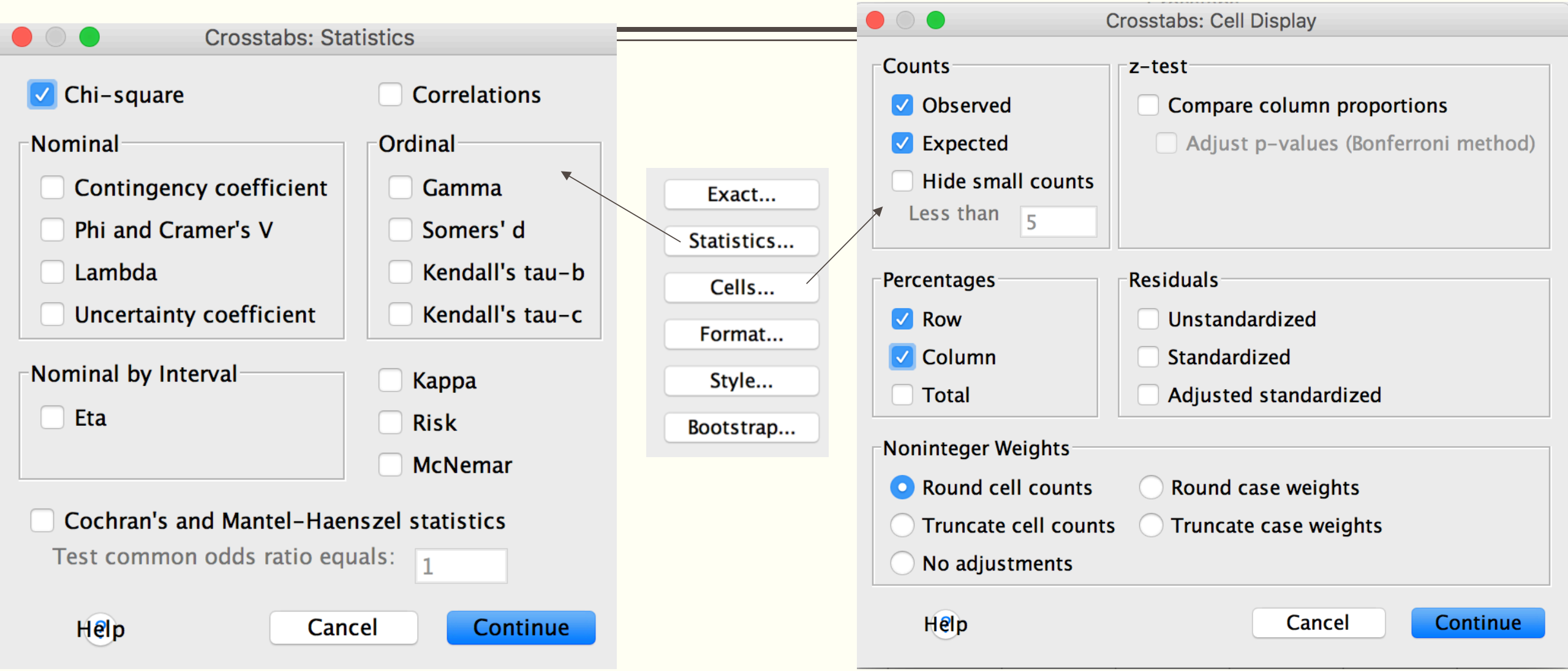
- A researcher wants to compare the efficancy of two different methods (treatment A vs treatment B) used in the treatment of hip anomalies. After the follow up, he records the results as cured or not cured.

- H_0: There is no association between the treatment method and status of the patient
- H_1: There is an association between the treatment method and status of the patient

Dataset > Hiptreatment.sav

Analyze > Descriptive Statistics > Crosstabs




Crosstabs: Statistics
Chi-square
Correlations
Nominal
Contingency coefficient
Phi and Cramer's V
Lambda
Uncertainty coefficient
Ordinal
Gamma
Somers' d
Kendall's tau-b
Kendall's tau-c
Nominal by Interval
Eta
Kappa
Risk
McNemar
Cochran's and Mantel-Haenszel statistics
Test common odds ratio equals: 1
Help
Cancel
Continue
Exact...
Statistics...
Cells...
Format...
Style...
Bootstrap...
Crosstabs: Cell Display
Counts
Observed
Expected
Hide small counts
Less than 5
z-test
Compare column proportions
Adjust p-values (Bonferroni method)
Percentages
Row
Column
Total
Residuals
Unstandardized
Standardized
Adjusted standardized
Noninteger Weights
Round cell counts
Round case weights
Truncate cell counts
Truncate case weights
No adjustments
Help
Cancel
Continue

Method * Status Crosstabulation

			status		
			cured	not cured	Total
Method	Treatment A	Count	15	87	102
		Expected Count	24,0	78,0	102,0
		% within MakulaÖdemitipi	14,7%	85,3%	100,0%
		% within GörmeDurumu	31,9%	56,9%	51,0%
	Treatment B	Count	32	66	98
		Expected Count	23,0	75,0	98,0
		% within MakulaÖdemitipi	32,7%	67,3%	100,0%
		% within GörmeDurumu	68,1%	43,1%	49,0%
Total		Count	47	153	200
		Expected Count	47,0	153,0	
		% within MakulaÖdemitipi	23,5%	76,5%	
		% within GörmeDurumu	100,0%	100,0%	

OUTPUT

H_0 = There is no association between the treatment method (A & B) and the status (cured or not cured) of the patient

P<0.05 => H0 rejected => «There is a statistically significant association between two treatment methods and the status of the patient (p<0.05). Success is higher in patients treated with method B

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8,955[a]	1	,003		
Continuity Correction[b]	7,984	1	,005		
Likelihood Ratio	9,102	1	,003		
Fisher's Exact Test				,004	,002
Linear-by-Linear Association	8,910	1	,003		
N of Valid Cases	200				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 23,03.

b. Computed only for a 2x2 table

If any expected count is less than 5 in 2*2 tables (or more than 20% of the cells in m*n tables), than Fischer exact test should be used instead of Pearson Chi square value.

An alternative way for data entry

Method	status	Frequency
Treatment A	cured	15,00
Treatment A	not cured	87,00
Treatment B	cured	32,00
Treatment B	not cured	66,00

Data > Weight Cases