***Compare proportions***

SPSS macros by Kirill Orlov

kior@akado.ru, ttnphns@gmail.com

<https://www.spsstools.net/en/KO-spssmacros>

All rights reserved

*Compare proportions.* Comparing proportions of the categories defined by one categorical variable (“single response” variable) or proportions of the positive response in a set of binary variables (“multiple response” set). Results output is formatted similar to Custom Tables, and the procedure is apt for processing survey data.

*Read “*[*About SPSS macros*](https://www.spsstools.net/en/KO-aboutmacros)*” what are they and how to run them.*

*The “Protected directory” error.* Some of the macros described in the current document write temporary files to hard disc. If you don't have full Administrator rights of your computer, it may cause error saying, among things: *“SPSS Statistics cannot access a file... specifies a protected directory...”*, meaning that the default directory the macro wants to use is protected on your PC. To solve the problem, in Syntax window issue command: CD 'myfolder'., where 'myfolder' is the path/name of some folder where you are allowed to save files to.

# MACRO !KO\_AMONGCATS: COMPARISON OF PROPORTIONS OF CATEGORIES IN CATEGORICAL VARIABLE, OR PROPORTIONS OF POSITIVE RESPONSE IN BINARY VARIABLES SET

Version 1, Mar 2023. Tested on SPSS Statistics 22, 26, 28.

*This macro needs SPSS Statistics with Custom Tables option.*

!KO\_amongcats catvar= *agecat* /\*Categorical variable

/binvars= /\*OR name-by-name list of binary variables

/grvar= *nestvar* /\*Optional grouping variable: nest in this variable

/\*(analysis by subsamples)

/missing= /\*In CATVAR: User-missing categories: exclude (EXCLUDE, default) or

/\*treat them as valid (INCLUDE)

/none= /\*In BINVARS: Respondents given none of positive response:

/\*include (INCLUDE, default) or exclude (EXCLUDE)

/test= ZY /\*Type of pairwise comparison test:

/\*autoselect between Mid-p corrected exact and Z asymptotic (EMZ, default);

/\*autoselect between exact and Yates corrected Z asymptotic (EZY);

/\*Z asymptotic (Z); Yates corrected Z asymptotic (ZY);

/\*post hoc on Dunn-based test (ZD)

/omnibus= /\*Perform omnibus test before comparisons

/\*(and don’t do comparisons if it is nonsignificant): YES or NO (default)

/alpha= *.01* /\*Critical significance level alpha (default 0.05)

/adjust= /\*Multiple comparisons correction: Bonferroni (BONF, default);

/\*Benjamini-Hochberg (BH); don’t apply correction (NONE)

/style= /\*Display style of significant differences: simple (SIMPLE, default)

/\*or APA subscripts (APA)

/showsig= /\*For STYLE=SIMPLE: Show p-value in results when p<alpha:

/\*YES or NO (default)

/merge= /\*Show comparison results in main table (YES) or

/\*in separate table (NO, default)

/sort= /\*Optional: Sort categories/variables in table by ascending (A)

/\*or descending (D) count

/format= /\*Display format of percents in table (default PCT8.1)

/ci= *95* AC /\*Optional: confidence interval for percent: %-level and method (AC or J);

/\*keyword NOTABLE may be in the end

/cibonf= /\*If CI specified: Bonferroni adjustment to interval: YES or NO (п/у)

/barchart= YES /\*Optional: draw barchart: YES or NO (default)

/graph= /\*Optional: draw graph in the form of: NETWORK, GRID, CIRCLE;

/\*next keywords WEIGHT and/or LABEL can be added

/print= YES /\*Print analysis details: YES or NO (default)

/save= /\*Optional: save results as data file (file path/name)

/dataset= RENAME /\*To activate input, working dataset on the end of

/\*the macro run: dataset name or RENAME (default).

Minimal specification CATVAR or BINVARS. DATASET may be needed.

The macro takes one categorical variable (with number of categories *k* from 2 to 100) and compares statistically sizes (proportions) of its categories between each other – a “multiclass” comparison. Or takes a set of *k* (from 2 to 100) binary variables (each of which is understandable as a “category” of a multiple response question) and compares statistically proportions of positive response between them – a “multilabel” comparison.

Comparisons are pairwise. Significant result of a pairwise comparison allows to conclude that, in the population, proportions the two compared categories/variables are not equal. Multiple comparisons adjustment is provided. There is the option to do omnibus (overall) test (not to conduct the comparisons if it occurs nonsignificant). Significant result of the omnibus comparison allows to conclude that, in the population, not all *k* categories/variables are equal by their proportions.

The main result of the macro – the table in Output Viewer similar to how Custom Tables displays results of significant pairwise comparisons between some groups (marking of categories/variables by letters A, B, C, … is utilized).

The macro makes no permanent changes in the data of the input, working dataset. But it creates temporary variables with names bearing five consecutive symbols *$*, for example, *v$$$$$.\_2*. Therefore it is desirable that your dataset has no such variable names in it.

Please familiarize yourself with s/c DATASET before using the macro. It determines which dataset will be active on exit the macro’s work.

DATA used in the EXAMPLES.

data list free /nestvar (f1) anvar (f1) b1 to b4 (4f1).

begin data

1 1 0 0 0 1 1 1 0 0 0 1 1 1 0 0 1 1 1 1 1 1 0 1 1 1 1 0 1 0 1 1 1 1 0 1 1 1 0 0 0 1 1 1 1 0 0 1

1 1 0 0 0 1 1 1 1 1 0 0 1 1 0 0 0 1 1 1 1 1 1 0 1 1 1 0 0 1 1 1 0 0 0 1 1 1 0 1 0 1 1 2 0 0 0 1

1 2 1 0 1 0 1 2 0 0 0 1 1 2 1 1 0 1 1 2 0 0 1 1 1 2 1 0 1 1 1 2 1 1 0 1 1 2 0 0 0 1 1 2 0 0 0 1

1 2 1 1 0 0 1 2 1 0 1 1 1 2 0 0 0 1 1 3 0 0 0 1 1 3 0 0 1 1 1 3 0 0 0 1 1 3 0 0 0 1 1 3 0 1 0 1

1 3 0 0 0 1 1 3 1 0 0 1 1 4 1 0 0 1 1 4 0 0 0 1 1 4 0 1 0 0 1 4 1 0 0 1 1 4 0 1 1 1 1 4 0 1 0 1

2 1 0 0 0 0 2 1 1 1 0 1 2 1 1 0 0 1 2 1 1 0 0 1 2 1 0 0 1 0 2 1 1 0 0 1 2 2 1 0 1 1 2 2 1 1 0 1

2 2 1 0 1 0 2 2 1 1 0 1 2 2 0 1 0 0 2 2 1 0 0 1 2 2 0 0 0 1 2 2 1 0 1 0 2 2 0 0 0 0 2 2 1 0 1 1

2 2 1 0 0 1 2 2 1 1 0 1 2 2 1 1 0 1 2 2 0 0 0 1 2 2 0 0 0 1 2 2 1 1 0 1 2 2 1 0 0 1 2 3 0 1 0 1

2 3 1 1 0 1 2 3 0 1 0 1 2 3 0 0 0 0 2 3 1 1 0 1 2 3 1 0 0 0 2 3 1 0 0 1 2 3 1 1 1 0 2 3 0 1 0 0

2 3 0 1 0 0 2 4 0 0 0 1 2 4 0 0 1 0 2 4 0 0 0 1 2 4 0 0 0 1 2 4 1 0 0 1 3 1 0 0 0 1 3 1 0 0 1 1

3 1 0 0 0 1 3 1 1 1 1 0 3 1 1 0 1 1 3 1 0 0 0 0 3 1 1 0 1 1 3 1 1 1 0 0 3 1 1 1 1 1 3 1 0 0 0 0

3 1 1 1 0 0 3 1 1 1 0 1 3 1 1 1 1 0 3 1 0 0 0 1 3 1 0 0 0 1 3 1 0 0 1 0 3 1 1 1 1 1 3 2 0 0 1 1

3 2 0 0 0 0 3 2 1 1 1 1 3 2 0 0 0 1 3 2 0 0 0 1 3 2 0 0 0 0 3 3 0 0 0 1 3 3 0 0 0 1 3 3 1 0 1 1

3 3 0 1 0 0 3 3 0 0 0 1 3 3 0 1 0 0 3 3 1 1 1 1 3 3 0 0 0 0 3 3 1 1 0 0 3 3 0 0 0 0 3 3 1 1 0 1

3 4 0 1 0 0 3 4 1 0 0 1 3 4 0 1 0 1

end data.

variable label nestvar 'Nesting variable' anvar 'Analyzed variable'

b1 'Binar1' b2 'Binar2' b3 'Binar3' b4 'Binar4'.

value label nestvar 1 'Group\_I' 2 'Group\_II' 3 'Group\_III'

/anvar 1 'Categ1' 2 'Categ2' 3 'Categ3' 4 'Categ4'.

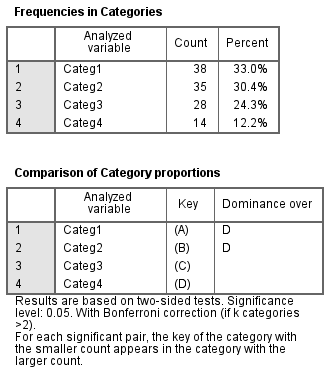
variable level nestvar anvar (nominal) b1 to b4 (ordinal).

dataset name mydata.

* The data entered and the dataset is called *MYDATA*. It contains 115 valid cases.

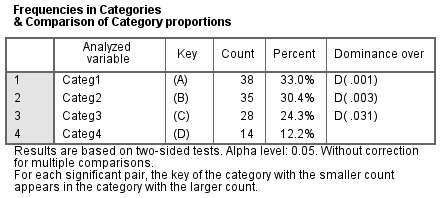
EXAMPLE 1. One categorical variable (single response question).

!KO\_amongcats catvar= anvar /dataset= mydata.



* Results output is formally similar to the one Custom Tables procedure makes when doing pairwise comparisons.
* Four valid categories of *ANVAR* variable are compared pairwisely by their proportions (percents “Percent”).
* By default, the comparison test used is the autoselect (dependent on the total count) between exact binomial with Mid-p correction and asymptotic binomial based on normal Z score. Bonferroni adjustment is applied. Critical alpha level of significance = 0.05.
* Categ1 (33%) and Categ2 (30.4%) significantly differ from Categ4 (12.2%). The significance is 2-sided, i.e., the alternative hypothesis: “proportions in the population are not equal”.
* Key in column “Dominance over” shows the aforementioned significant differences and specifies in which category the proportion is higher/lower. In this example, key D – the marker of category Categ4 – is found opposite categories Categ1 and Categ2, what means that proportion in Categ1 is higher than in Categ4, and proportion in Categ2 is higher than in Categ4.
* DATASET=*MYDATA* returns activity to the dataset *MYDATA*.

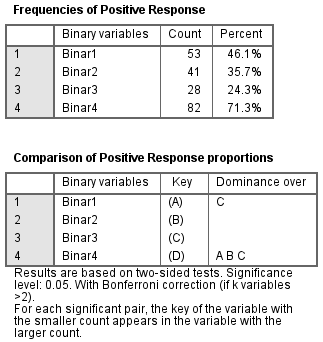
!KO\_amongcats catvar= anvar /adjust= NONE /showsig= YES /merge= YES /dataset= mydata.



* In this run, the adjustment for multiple comparisons is switched off (ADJUST=NONE). So, more differences accepted as significant came to light.
* Because MERGE=YES, results of comparisons are displayed not in a separate table but in the main table with frequencies.
* Because SHOWSIG=YES, the significances themselves (*p*-values) are shown, for significant results, in parentheses next the key (the marker of the category over which there is the dominance).

EXAMPLE 2. A set of binary variables (multiple response question).

!KO\_amongcats binvars= b1 b2 b3 b4 /dataset= mydata.



* The variables are enumerated name-by-name, as the macro requires.
* Binary variables can have only two valid values: 0 and 1. 1 corresponds to “selected”, positive response. Each variable – a response variant. Counts and percents of positive response are shown in the 1st table. The base – all cases of the dataset (respondents) which have not a single missing in the analyzed variables (in our example these are all 115 cases of the dataset).
* Results output is formally similar to the one Custom Tables procedure makes when doing pairwise comparisons.
* Four variables are compared pairwisely by their proportions of positive response (percents “Percent”).
* By default, the comparison test used is the autoselect (dependent on the mismatch count) between exact McNemar with Mid-p correction and asymptotic McNemar based on normal Z score. Bonferroni adjustment is applied. Critical alpha level of significance = 0.05.
* Binar4 (71.3%) significantly differs from the rest three response variants. Also, Binar1 (46.1%) significantly differs from Binar3 (24.3%). The significance is 2-sided, i.e., the alternative hypothesis: “proportions in the population are not equal”.
* Key in column “Dominance over” shows the aforementioned significant differences and specifies in which variable the proportion is higher/lower. In this example, keys A, B, C – the markers of the first three variables – are found opposite variable Binar4, what means that proportion in Binar4 is higher than in those three. Also, key C – the marker of variable Binar3 – is found opposite variable Binar1, what means that proportion in Binar1 is higher than in Binar3.
* DATASET=*MYDATA* returns activity to the dataset *MYDATA*.

**Algorithm**

1. Categorical variable with *k* categories (“single response”)

Pairwise comparisons between sizes (proportions) of categories of a categorical variable are done by the Binomial test (in the wide sense of the word “binomial” – i.e. “or-or”). Synonymic label – One-sample Proportions test. Five test versions are offered to select among: two versions of exact test and three versions of asymptotic test:

1. Exact Binomial test, based on the Binomial distribution.
2. Exact Binomial test, based on the Binomial distribution, with Mid-p correction.
3. Asymptotic Binomial test, based on the Normal Z statistic.
4. Asymptotic Binomial test, based on the Normal Z statistic, with Yates correction.
5. Post hoc asymptotic test based on Dunn’s approach[[1]](#footnote-1).

Versions (1) and (2) are performed by the macro only when the summed frequency in the two being compared categories *n*≤25. Versions (2) and (3) are less conservative (yield lesser *p*-value) than versions (1) and (4). Therefore, the macro offers two regimes to the user: the default more liberal regime: versions (2)+(3), autoselect between them depending on *n*; or more conservative regime: versions (1)+(4), autoselect between them depending on *n*. Besides, one can request just asymptotic version (3) or (4). All the tests are 2-sided.

Version (5) is possible only under omnibus test requested. Unlike the four other variants, in version (5) information from all *k* categories is used in the pairwise comparison, and not just from the two being compared. Therefore, as a post hoc test, version (5) is more logical. When *k*=2, the test is identical to (3).

Optional omnibus (overall) test of equality of proportions of all *k* categories at once. If that test is requested and turns out nonsignificant, pairwise comparisons are not performed. The omnibus test is the One-sample Chi-square test of Agreement with the expected profile “all proportions equal”. Note, when *k*=2, the test is identical to the 2-sided (3) above.

The macro follows the formulae which a user will find in several places of “IBM SPSS Statistics Algorithms”. Exact Binomial test (1) see in NPAR TESTS command algorithms, and a more general equivalent formula – in algorithms of NPTESTS command (= “Nonparametric Tests Algorithms”). Asymptotic Binomial test (4) is contained in NPTESTS command algorithms. If, in its formula, term 0.5 is excluded from the numerator, we get version without Yates (3). The formulae of all the tests (1), (2)[[2]](#footnote-2), (3), (4) you will meet also in PROPORTIONS[[3]](#footnote-3) command algorithms (section One-Sample Proportions Tests). Of (5), read in NPTESTS (section Pairwise Multiple Comparisons > Cochran’s Q Test. The formula read there may be used to compare categories in the one-sample situation, because it retains its correctness for a set of dummy variables either.).Omnibus One-sample Chi-square test is found both in NPAR TESTS and NPTESTS.

1. Set of *k* binary variables (“multiple response”)

Pairwise comparisons between positive response proportions of binary variables are done by the McNemar’s test. Synonymic label – Paired-samples Proportions test. Five test versions are offered to select among: two versions of exact test and three versions of asymptotic test:

1. Exact McNemar’s test, based on the Binomial distribution.
2. Exact McNemar’s test, based on the Binomial distribution, with Mid-p correction.
3. Asymptotic McNemar’s test, based on the Normal Z statistic.
4. Asymptotic McNemar’s test, based on the Normal Z statistic, with Yates correction.
5. Post hoc asymptotic test based on Dunn’s approach[[4]](#footnote-4).

Versions (1) and (2) are performed by the macro only when frequency *n’*≤25; *n’* is the number of cases (respondents) in each of which responses in the two being compared variables differ. Versions (2) and (3) are less conservative (yield lesser *p*-value) than versions (1) and (4). Therefore, the macro offers two regimes to the user: the default more liberal regime: versions (2)+(3), autoselect between them depending on *n’*; or more conservative regime: versions (1)+(4), autoselect between them depending on *n’*. Besides, one can request just asymptotic version (3) or (4). All the tests are 2-sided.

Version (5) is possible only under omnibus test requested. Unlike the four other variants, in version (5) information from all *k* variables is used in the pairwise comparison, and not just from the two being compared. Therefore, as a post hoc test, version (5) is more logical. When *k*=2, the test is identical to (3).

Optional omnibus (overall) test of equality of positive response proportions of all *k* variables at once. If that test is requested and turns out nonsignificant, pairwise comparisons are not performed. The omnibus test is the Cochran’s Q test. Note, when *k*=2, the test is identical to the 2-sided (3) above.

The macro follows the formulae which a user will find in several places of “IBM SPSS Statistics Algorithms”. Exact McNemar’s test (1) see in NPAR TESTS command algorithms, and in NPTESTS command (= “Nonparametric Tests Algorithms”). In both these places you will meet the asymptotic (4). If, in its formula, subtrahend 1 is excluded from the numerator, we get version without Yates (3). The formulae of all the tests (1), (2), (3), (4) you will meet also in PROPORTIONS command algorithms (section Paired-Samples Proportions Tests). Of (5), read in NPTESTS (section Pairwise Multiple Comparisons > Cochran’s Q Test). Omnibus Cochran’s Q test is found both in NPAR TESTS and NPTESTS.

*Note*. If as *k* binary variables one uses *k* dummy variables obtained from single categorical variable, the tests listed in section B turn into their correspondent (going under the same number) tests of section A; and results of the omnibus tests also coincide.

1. Multiple comparisons adjustments

Bonferroni and Benjamini–Hochberg corrections – see in “IBM SPSS Statistics Algorithms”, CTABLES command. The Bonferroni correction is applied by default.

1. Display of significant differences

If “APA subscripts” display style is requested, the macro uses Bron–Kerbosch maximal cliques algorithm to detect subsets of categories/variables with significant differences absent inside.

1. Confidence interval for proportion

See formulae of Agresti–Coull and Jeffreys methods in “IBM SPSS Statistics Algorithms”, PROPORTIONS command. Jeffreys can be seen also in CTABLES and NPTESTS. Optional Bonferroni expansion of an interval is done so: let L be the confidence level specified by the user; then the critical level alpha for the original (individual) confidence interval is 1-L/100; and then alpha for the widened interval will equal alpha/*k* in case of binary variables or alpha/(*k*-1) in case of categorical variable.

***Subcommands***

**CATVAR, BINVARS**

You must specify one of these two subcommands. In CATVAR, indicate categorical numeric or string variable for the analysis. From 2 to 100 valid categories in the variable are permitted. Variable coding is arbitrary, and each distinct value in it is a category.

The macro will compare valid categories of CATVAR variable with each other for the equality of their proportions (sizes). Categories having labels but absent in the data are not analyzed by the macro (they are silently excluded from analysis).

If GRVAR variable is specified, the number and composition of categories of CATVAR variable must coincide on different levels of GRVAR variable, else the macro notifies of the error[[5]](#footnote-5).

In BINVARS, indicate name-by-name (i.e., without using “to”) list of 2 to 100 binary numeric variables. They perform as a “multiple response set”, yet they need not be registered in the file as an MR set[[6]](#footnote-6). Each variable is a response variant, a “category”. Value 1 has the meaning of positive response, “selected”; value 0 has the meaning of negative response, “not selected”. Besides these two values, only missings may be present (the macro will sift out missings listwise: a case does not enter the analysis if it is missing at least in one of BINVARS). The macro does not check if the variables are indeed binary, so watch after that yourself[[7]](#footnote-7).

The macro will compare BINVARS variables with each other for the equality their distributions, that is, the equality of proportions of positive response.

The macro notifies of the error if some of BINVARS variables are constant – contain valid only 0 or only 1.

**GRVAR**

You may indicate one categorical variable, for analysis by subsamples. Then the analysis (of CATVAR variable or the set of BINVARS variables) will be conducted several times – separately and independently for each level (valid category) of GRVAR variable. In the resultant table, the analyzed variable/s will appear nested in the GRVAR variable.

If GRVAR variable is string, its values should be not longer than 8 bytes.

If for some reason (for example, transformations before the macro run) some level of GRVAR variable lacks valid cases to analyze, that level won’t be taken and won’t appear in the resultant tables.

EXAMPLE 3.

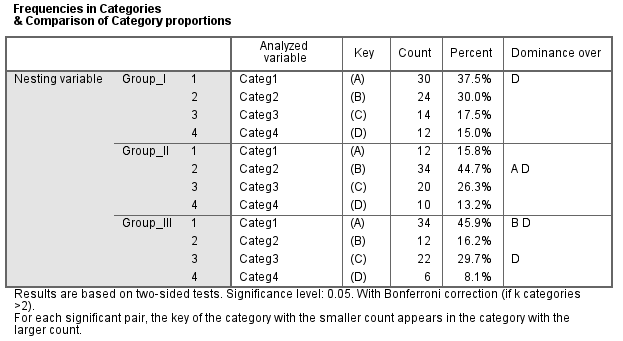
compute weivar= 2.

execute.

weight by weivar.

!KO\_amongcats catvar= anvar /grvar= nestvar /merge= YES /dataset= mydata.

weight off.



* Variable *WEIVAR* weights the dataset and inflates the sample size twice.
* Variable *ANVAR* is analyzed separately on different levels (in groups) of variable *NESTVAR*: in the table, *ANVAR* is nested in *NESTVAR* (GRVAR=*NESTVAR*). All four valid categories of the analyzed variable must be present – have nonzero count – on all levels of the grouping variable; if that is not so, the macro will issue an error.
* MERGE=YES requests to output single table, where both frequencies and results of comparisons are shown.
* DATASET=*MYDATA* returns activity to the dataset *MYDATA*. Weighting is turned off.

EXAMPLE 4.

temporary.

if nestvar=3 b1= $sysmis.

!KO\_amongcats binvars= b1 b2 b3 b4 /grvar= nestvar /dataset= mydata.

* Before the macro run, some transforms are done, namely: all cases of group *NESTVAR*=3 become missing in variable *B1*.
* Because the macro excludes nonvalid cases in BINVARS variables listwise, no cases of the mentioned group 3 will enter the analysis; so only two groups (levels) of *NESTVAR* will present in the analysis.
* The transform is transient (under TEMPORARY), therefore the input dataset *MYDATA* won’t be altered in the end, at the exit from the macro.
* DATASET=*MYDATA* returns activity to the dataset *MYDATA*.

**MISSING, NONE**

MISSING subcommand concerns categorical CATVAR variable. By default and MISSING=EXCLUDE, user-missing values are considered missing and are excluded. MISSING=INCLUDE accepts user-missing values (categories) in CATVAR variable as valid ones.

NONE subcommand concerns binary BINVARS variable set. By default and NONE=INCLUDE, cases which lack positive response (value 1), are accepted for the analysis. It is respondents who selected nothing of the *k* response variants. NONE=EXCLUDE excludes such cases. Only respondents who selected something will enter the analysis then. As for the missings, they always are excluded, listwise.

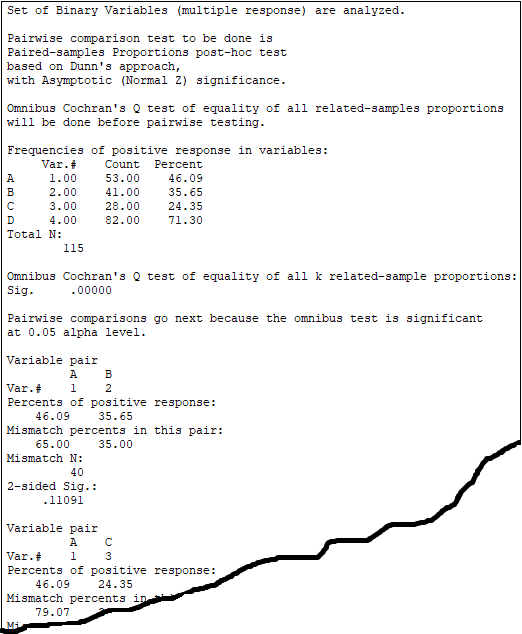
In GRVAR variable, missings are always excluded.

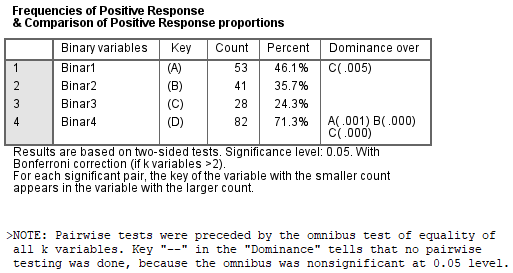
EXAMPLE 5.

!KO\_amongcats binvars= b1 b2 b3 b4 /omnibus= YES /test= ZD /print= YES

/merge= YES /showsig= YES /dataset= RENAME.

frequencies nestvar.

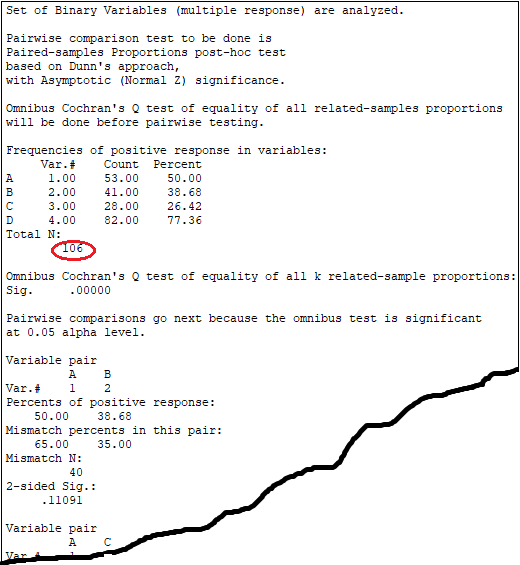


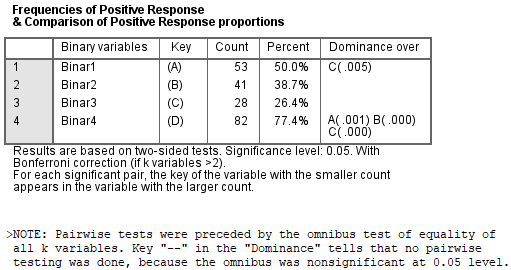


* Four binary variables are compared (*B1*, *B2*, *B3*, *B4*). Omnibus Cochran’s test is requested, and pairwise post hoc comparisons by asymptotic Dunn’s method are executed only if the omnibus test is significant. In this example, it is strongly significant.
* Details of the analysis are requested to output (PRINT=YES).
* Requested is to show comparison results in the main table with frequencies (MERGE=YES) and to accompany significant differences with their corresponding *p*-values (SHOWSIG=YES).
* S/c DATASET=RENAME allows the macro to rename the working dataset. The new name of the dataset: *KO\_AMONGCATS#$.\_*. (This is also the default behaviour of the macro if s/c DATASET is omitted.)

!KO\_amongcats binvars= b1 b2 b3 b4 /none= EXCLUDE /omnibus= YES /test= ZD /print= YES

/merge= YES /showsig= YES /dataset= RENAME.





* This run of the macro differs from the previous by introducing subcommand NONE=EXCLUDE. Dataset cases with horizontal sum 0, i.e., respondents having selected none of the four variants, won’t enter the analysis.
* So, notice in the protocol: the sample size is 106 (and not 115, as before). Nine cases were excluded from the analysis as having none of positive responses.

**TEST**

Request the version of the test for pairwise comparison between categories or variables:

EMZ - (default) Mid-p corrected exact test in case of small sample (*m*≤25), and asymptotic (Normal Z approximation) test in case of *m* of greater size.

EZY - exact test in case of small sample (*m*≤25), and Yates corrected asymptotic (Normal Z approximation) test in case of *m* of greater size. This regime is more conservative (less powerful) than EMZ.

Z - asymptotic (Normal Z approximation) test to do for *m* of any size.

ZY - Yates corrected asymptotic (Normal Z approximation) test to do for *m* of any size. It is more conservative than Z.

The tests implied are: Binomial (One-sample) test, if categorical CATVAR variable is specified, and McNemar’s (Paired-samples) test, if binary BINVARS variables are specified. In the first instance *m* is the combined count in the two categories, *n*. In the second instance *m* is the number of cases in which the responses in the two variables mismatch, *n’*. If you want to know, under EMZ or EZY, which test – exact or asymptotic – was applied in a specific pair, focus on *n* (or *n’*) in the pair. PRINT=YES shows particulars of the analysis, including *n* (“Combined N”) and *n’* (“Mismatch N”).

Besides the listed above, you can request one more variant:

ZD - asymptotic (Normal Z approximation) post hoc test done on Dunn’s approach. Needs OMNIBUS=YES. It is the modification of the Z version, where during the comparison between two categories/variables information about all *k* categories/variables, not only about those two, is considered. As a post hoc test, this variant is more “logical” than the others, but it demands “large enough” sample.

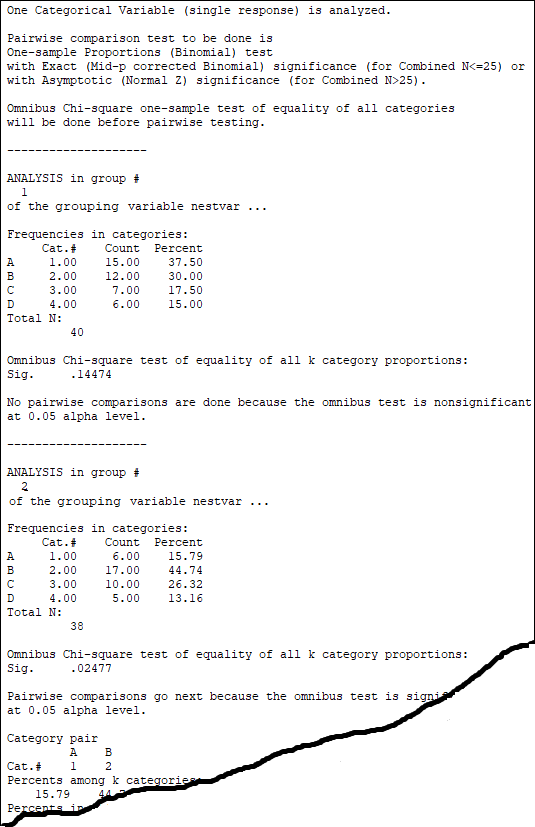
**OMNIBUS**

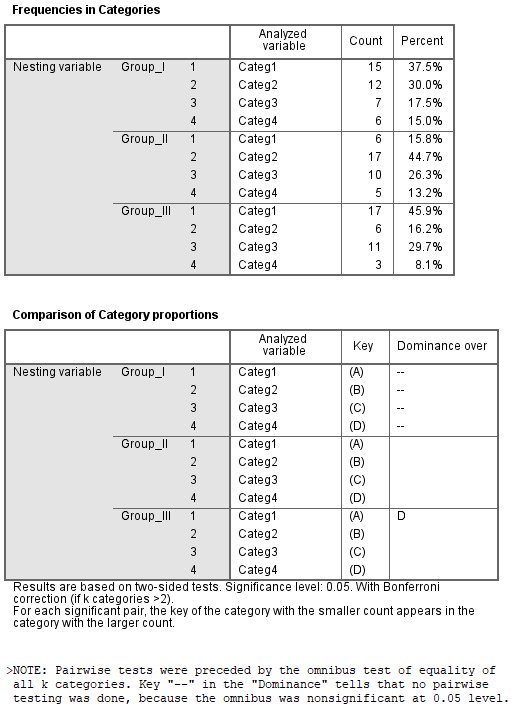
By default and OMNIBUS=NO, the macro starts doing pairwise comparisons immediately. With OMNIBUS=YES, it first will do a test for equality of proportions of all *k* categories/variables at once. The test is the Chi-square of Agreement (aka Goodness-of-fit) test, if s/c CATVAR is specified, or the Cochran’s Q test, if s/c BINVARS is specified. If the omnibus test turns out to be significant, only then the pairwise comparisons between the categories/variables will be conducted.

If the sample is large, using omnibus test is justified both statistically and in views of time saving. If the sample is small, better not to use omnibus test because it is asymptotic. The macro issues a warning if it regards that the sample size questions application of the omnibus test. For the Chi-square of Agreement, it is the situation when the expected count, *N* of sample / *k*, is less than 5. For the Cochran’s test it is the situation when the number of cases *N’* in which both positive and negative responses are present, is less than 4 or *N’k* is less than 24.

EXAMPLE 6.

!KO\_amongcats catvar= anvar /grvar= nestvar /omnibus= YES /print= YES.





* Analysis of *ANVAR* is done separately on the levels of the grouping variable *NESTVAR*. Omnibus test is requested (OMNIBUS=YES) as well as printout of analysis details (PRINT=YES).
* In Group\_I, omnibus test appeared nonsignificant, so no pairwise comparisons are done there. In Group\_II and Group\_III, omnibus test is significant, and pairwise comparisons are done. In Group\_III, one significant difference is found.
* Theoretically, if an omnibus test is significant, we may conclude not all categories are equal in the population. Then we are in the right to expect that pairwise testing will yield at least one significant pairwise difference. In practice, it proves so not always; sometimes it fails to reveal significant differences. So was in case of Group\_II. There can be several reasons for such “unfortune”, among which: (a) the omnibus test and the pairwise tests are not quite kindred; (b) the omnibus test is not fully justified because the sample size is small (or assumptions are not met); (c) multiple comparison adjustment did not notice significant differences due to its protectiveness. In our example, if one annuls the adjustment completely (ADJUST=NONE), significant differences will show up in Group\_II. But a careful researcher should not take them with confidence.

**ALPHA**

Specify the critical significance level (alpha), it is used both in pairwise tests and omnibus one. In pairwise tests it is alpha for 2-sided *p*-value. Alpha must be a number above 0 and below 1. By default, ALPHA=0.05.

**ADJUST**

Significance correction for multiple pairwise comparisons. The corrected *p*-value will be compared with the alpha level. Choose method:

BONF - (default) Bonferroni correction; it is based on the idea of family-wise error rate. *p*-value with correction = *p*-value without correction ∙ number of comparisons; number of comparisons = *k*(*k*-1)/2.

BH - Benjamini–Hochberg correction, based on the idea of false discovery rate. It is a less conservative correction than Bonferroni.

NONE - don’t use correction for multiple comparisons. The uncorrected *p*-value will be compared with the alpha level. It is the most liberal stance.

**STYLE**

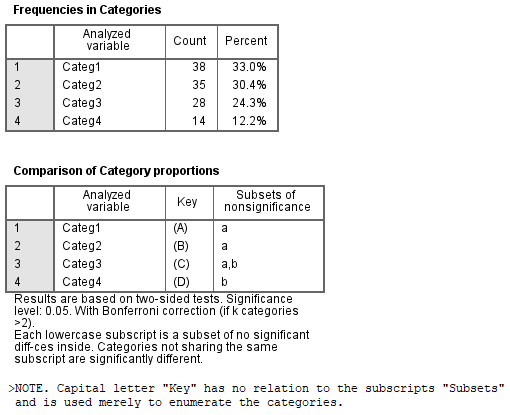
Display style of significant differences in the table:

SIMPLE - (default) each category/variable is assigned a capital letter identifier, key A, B,… For each significant pair, the key of the category/variable with the smaller proportion appears opposite the category/variable with the larger proportion.

APA - “APA subscripts” style. Each subset of categories/variables in which there is no significant pairwise differences is assigned a lowercase letter identifier a, b,… Category/variable is “subscribed” by the identifiers of the subsets it enters. Thus, if two categories/variables share no common subscripts, they are significantly different.

EXAMPLE 7.

!KO\_amongcats catvar= anvar /style= APA.



* Same run as the 1st one in EXAMPLE 1, but STYLE=APA.
* Two subsets with no significant differences inside each: Categ1, Categ2, and Categ3 – one subset, Categ3 and Categ4 – another subset. Between Categ1 and Categ4 there’s no common subscripts, as well as between Categ2 and Categ4. These are pairs of significant differences.

**SHOWSIG**

By default and with SHOWSIG=NO, *p*-values (significances) are not displayed in the tabular results. SHOWSIG=YES displays *p*-values for pairs with significant difference. See EXAMPLE 1, 5.

SHOWSIG=YES is ignored if STYLE=APA.

**MERGE**

By default and with MERGE=NO, the result of statistical comparisons of categories/variables is displayed in the separate table “Comparison of …”. MERGE=YES displays the result in the main table showing frequencies, “Frequencies …”. See EXAMPLE 1, 3, 5.

**SORT**

In the tables of results by default, CATVAR categories go in the ascending order of their code (value), and BINVARS variables go in the order they are listed in BINVARS s/c. SORT allows to request the order by count in the category / count of positive response in the variable. Set SORT=A to sort by count ascendingly and SORT=D to sort by count descendingly.

S/c SORT is incompatible with GRVAR specified, and pertains not to the GRVAR variable; the latter always comes to tables with its values sorted ascendingly.

EXAMPLE 8.

!KO\_amongcats catvar= anvar /sort= A.

* Same as the 1st run in EXAMPLE 1, but the categories will be disposed in the tables by ascending of their count. The order of keys (A, B, …) is always one and the same, so link of a key to a category will be different from what was in EXAMPLE 1.

**FORMAT**

Percents in the table are shown by default in PCT8.1 format, i.e., with one decimal digit and symbol “%”. You may request another format. For example, F8.0 will show the value as integer and without the percent sign.

**CI**

This optional subcommand computes confidence intervals for percents. Specify confidence level as a number between 0 and 100, and, after it, the method to compute the interval – keyword AC or J. AC is the Agresti–Coull method, and J is the Jeffreys method. For example, CI= 95 J means to request 95% confidence interval estimated by Jeffreys method.

Agresti–Coull method is regarded good for large samples (N respondents >40). Jeffreys method is regarded good for small samples (N≤40), but it is not bad for large samples either.

In the end of the command, you may add keyword NOTABLE. In this case, confidence intervals will not be shown in the table, still will appear in the barchart, – provided you specify BARCHART=YES.

*Remark*. A user should not consider confidence intervals, particularly the amount of “overlap” between intervals, as a sufficiently good alternative to the *p*-value obtained in the statistical comparison. Direct statistical comparison of categories (a test) has priority, because it comes from an *a posteriori* reality of the observed difference, while individual confidence intervals do not operate with it. Besides, the tests of pairwise comparisons conducted by the macro have not the same statistical base (N) under them as the individual confidence interval. For example, if there is a categorical variable with three categories, with frequencies *n1*, *n2*, *n3*, then the comparison of the two first categories is done on the N = *n1*+*n2* base, whereas their individual confidence intervals are built on the N = *n1*+*n2*+*n3* base. Confidence intervals and pairwise statistical tests are not enough interchangeable analytic tools, by their content.

**CIBONF**

This subcommand is ignored if s/c CI is not specified. CIBONF=YES enlarges the calculated confidence interval: introduces Bonferroni adjustment to it. It is a tough (conservative) device, but it gives the guarantee that *neither* of *k* intervals will be violated on the confidence level you specify in CI s/c.

By default and with CIBONF=NO, the adjustment is not applied: all *k* confidence intervals are individual intervals, not tied with a joint guarantee.

**BARCHART**

BARCHART=YES plots barchart showing percents of the categories or of positive response, with (if CI s/c is specified) the computed confidence intervals. By default, BARCHART=NO.

EXAMPLE 9.

!KO\_amongcats binvars= b1 b2 b3 b4 /ci= 95 AC NOTABLE /barchart= YES.

* Barchart of percents is requested.
* Because s/c CI is specified, there will be confidence intervals. They won’t be displayed in the table though, because of NOTABLE.

**GRAPH**

Optional subcommand to build a figure, the graph. Graph is points (“vertices”) connected by lines (“edges”). Points represent the categories (or the variables) and are labelled by letters (key) as in the table with comparisons. Point size reflects the category percent (or positive response percent). Connecting line colour between points shows whether the difference is significant or nonsignificant. Indicate in GRAPH s/c the type of graph layout. The types differ by what spatial-structural constraint for placing of points is imposed:

NETWORK - network. Constraint is not imposed and points are placed on a plane as the mapping algorithm likes.

GRID - grid. Moderate constraint is imposed: points must place in some of equally spaced knots on a plane. The graph resembles lattice or web.

CIRCLE - circle. High constraint is imposed: points must place uniformly on a circumference. The graph resembles clock.

After the main keyword you may optionally add one or both of the following keywords: LABEL and WEIGHT. LABEL labels connecting lines by the observed *p*-values. WEIGHT makes the graph “weighted”: the length of a connecting line then conveys, to a degree feasible, the corresponding *p*-value[[8]](#footnote-8). The smaller is *p*-value, i.e., the more significant is the difference, the longer is the line, i.e., the farther apart will be the two points it connects. WEIGHT produces the strongest effect with NETWORK: since structural constraint is not imposed on network, distances between points have greater opportunity to follow the weights reflecting *p*-values. In the absence of keyword WEIGHT, a point of a specific key (A, B, …) always occupies the same place in the layout of a given type and fixed *k*, the number of points.

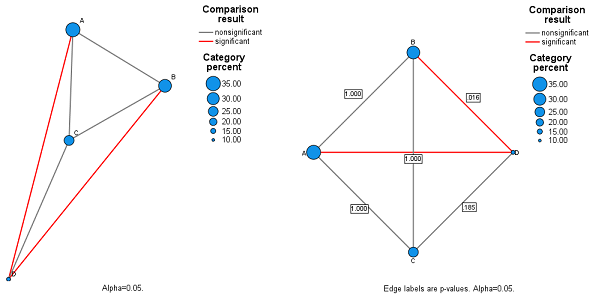
The macro does not support GRAPH when s/c GRVAR is specified, so GRAPH is ignored then.

*Note*. If on the plot produced you are not satisfied with the calibration between the size of points in the graph, on one side, and the size of points in the legend, on the other side – use subcommand /MXSIZE=*integer*, selecting the integer you’ll like. By default, it equals 25 and is optimal for recent (as for 2022) versions of SPSS Statistics.

EXAMPLE 10.

!KO\_amongcats catvar= anvar /graph= NETWORK WEIGHT.

!KO\_amongcats catvar= anvar /graph= CIRCLE LABEL.



* Weighted network (1st run), circle with labels (2nd run).

**PRINT**

Optional subcommand to display the protocol of the analysis done. In particular, you will see all the obtained significant and nonsignificant *p*-values. Specify PRINT=YES. By default and with PRINT=NO, the protocol is not printed, only main, tabular results are displayed.

**SAVE**

You can save the results (those displayed in the tables) as an external .SAV file. Indicate path/name for the file in quotes or apostrophes.

**DATASET**

This subcommand determines which dataset will be active (i.e., immediately available to subsequent syntax commands) on exit from the macro’s job.

*dataset* - the macro will make dataset *dataset* active. Specify the name of an existing dataset (most likely you’ll indicate the name of the input, i.e., your working, dataset).

RENAME - (default of the s/c omitted) The macro will rename the input dataset into *KO\_AMONGCATS#$.\_* and will make it active.

[unspecify the s/c, not omit it] - active will be an invisible unnamed dataset. In order to close it and activate another existing dataset, you will have to command DATASET ACTIVATE …

EXAMPLE 11.

!KO\_amongcats catvar= anvar.

* In this run, s/c DATASET is omitted. This is the same as DATASET=RENAME. The working dataset is again active, but now it is called *KO\_AMONGCATS#$.\_* (besides renaming, the macro modifies nothing in your dataset).

!KO\_amongcats catvar= anvar /dataset= mydata.

* *MYDATA* is an existing dataset (maybe, your working one). This dataset becomes active.

!KO\_amongcats catvar= anvar /dataset= .

dataset activate mydata.

* S/c DATASET is mentioned but is empty. Neither of your datasets becomes active. You must yourself activate the dataset you need with DATASET ACTIVATE command.

***Special regimes***

The macro ignores split-file state of the dataset (use subcommand GRVAR of the macro to analyze by subsamples). If the dataset is weighted, the macro counts frequencies following these weights as they are (possibly fractional), and then rounds the counts to integers. (SPSS procedure Crosstabs does the same way, by default; but Custom Tables, for example, does not do rounding of counts). The macro obeys commands selecting cases (FILTER, USE, SELECT IF, N OF CASES). The macro obeys temporary (standing under TEMPORARY) operations.

***Some questions***

*How does the macro treat empty (with zero frequency) categories in single response question (CATVAR)?* If a category (response variant) has count 0 in CATVAR variable, i.e., is not observed in the data, it is excluded by the macro from the analysis, without special notification on that. However, when GRVAR is specified, it may happen the category is absent only on some levels on GRVAR variable, not on all of them. In such a case the macro issues an error: “number or list of nonempty categories differ on different levels of GRVAR variable”.

*How does the macro treat empty (with zero frequency) “categories” in multiple response question (BINVARS)?* “Category” or response variant in a multiple response question – it is a binary variable from BINVARS list. If some variable of BINVARS has no positive response code, 1 – even on a separate level of GRVAR variable, – the macro issues an error. Thus, empty “category” always produces error. You must yourself exclude the problematic variable from BINVARS list, the macro won’t do it for you.

*How to make the macro not to exclude from analysis an empty category in CATVAR, but instead to issue an error?* You may recode CATVAR variable into the set of dummy variables, which are binary, to enter them to the analysis as BINVARS. (As written in the “Algorithm” section, in case of dummy variables all the tests to compare BINVARS are identical to the comparison tests for CATVAR.)

*How to make categories/variables the columns, not the rows, of the table?* You can manually transpose the tables created by the macro. And if you are on SPSS Statistics version 22 or higher, OUTPUT MODIFY command can do it for you automatically. And there is the menu: Utilities > Style Output, corresponding to OUTPUT MODIFY command. You’ll see option Transpose there.

1. Known also as Minimum Required Difference method. [↑](#footnote-ref-1)
2. About Mid-p correction – you may read in A. Agresti, “Categorical Data Analysis”. [↑](#footnote-ref-2)
3. It was introduced to SPSS Statistics version 27.0.1. [↑](#footnote-ref-3)
4. Known also as Minimum Required Difference method. [↑](#footnote-ref-4)
5. In such a situation, do to the analysis for each level of GRVAR variable by a separate call of the macro. (You may utilize SELECT IF under TEMPORARY before the call, to involve only part of data cases in the analysis.) [↑](#footnote-ref-5)
6. If you have a multiple response set in the form of several categorical variables rather than binary variables, you may use macro !KO\_MRCMRD or !KO\_AMRCMRD/!KO\_AMRCMRD2 to recode those into binary variables. See collection “Categorical - Binary recodings”. [↑](#footnote-ref-6)
7. If the variables are not binary, SPSS will issue warning “During execution … the operand for the logical NOT operator was not one of the valid logical values…”. [↑](#footnote-ref-7)
8. The macro computes edge weight as log10(*p*-value + 0.005) + 2.5, and the connecting line length reflects that weight: the greater is the weight, the shorter is the line. [↑](#footnote-ref-8)