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STATİSTİCAL METHOD SELECTİON İN MEDİCAL RESEARCH

TIBBİ ARAŞTIRMALARDA İSTATİSTİKSEL YÖNTEM SEÇİMİ

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ABSTRACT

In medical research, statistics are usually used for data collection, summarizing data with tables and graphs, interpreting the obtained data, explaining the degree of confidence in the results obtained from experiments, observations or cases, generalizing these results to the population, making predictions about the future and identifying the relationships between the categories. Data from case studies, surgeries, experimental animals and assays from medical studies are often small, difficult to obtain and costly. Therefore, the good results of the planned research should be evaluated with the appropriate statistical analysis of the valuable data obtained from these sources. For this reason, in this study, the "statistical method selection algorithm, which provides the decision of the statistical methods suitable for the interpretation of the obtained data, is shoved the procedure. Appropriate analysis and interpretation of the data with the decision algorithm will prevent labor, time and material losses, and result in the conclusion of the studies in a suitable way.

Keywords: Statistics, Decision algorithm, Analysis

ÖZ

Tıbbi araştırmalarda istatistik, genellikle veri toplama, verilerin tablo ve grafikler ile özetlenmesi, elde edilen verilerin yorumlanması, deney, gözlem veya vakalardan elde edilen sonuçların güven derecelerinin açıklanması, bu sonuçları ana kitleye genelleme, geleceğe dair tahminlerde bulunma ve kategoriler arasındaki ilişkileri belirmek için kullanılmaktadır. Tıbbi araştırmalardan vaka, ameliyatlar, deney hayvanları ve tahlillerden sağlanan veriler, çoğu zaman az sayıda, elde edilmesi güç ve masraflıdır. Bu nedenle planlanan araştırmanın iyi bir biçimde sonuçlanabilmesi bu kaynaklardan sağlanan kıymetli verilerin uygun bir biçimde istatistiksel analiz ile değerlendirilmesi gerekir. Bu nedenle bu çalışmada araştırmacılara yol göstermesi bakımından, elde olan verilerin yorumlanması için uygun olan istatistik yöntemlere karar verilmesini sağlayan "istatistiksel yöntem seçimi" algoritmasına değinilmiştir. Karar algoritması ile verilerin uygun bir biçimde analiz edilip yorumlanması işgücü, zaman ve maddi kayıpların önüne geçecek, çalışmaların amacına uygun bir biçimde sonuçlanmasını sağlayacaktır.

Anahtar Kelimeler: İstatistik, Karar algoritması, Analiz

1. INTRODUCTİON

The origin of the word statistics is based on Latin and Italian. It is derived from the words statisticum collegium (state council) in Latin and the statist (statesman, politician) in Italian. The word "statistic" was first used by German Gottfried Achenwall in his Statist (1749). This work included information on population data, for example, numerical data. In this period, the word statistic was written as political

arithmetic. The mathematical foundations of statistics are based on correspondence between Pierre Fermat and Blaise Pascal, which lasted until the year 1654.

The foundations of biostatistics are based on the work of Mendel. Darwin's theory of evolution and the development of genetics have affected the development of biostatistics in the early 1900s. Walter Weldon, Karl Pearson, Charles Davenport, William Bateson and Wilhelm Johannsen conducted important studies in this period. In the 1930s, Sir Ronald A. Fisher's Genetic Theory of Natural Selection, Sewall G. Wright's work on population genetics and J. B. S Haldane's The Causes of Evolution were examples of the important works of that period.

Biostatistics is now used in public health, epidemiology, nutrition and dietetics, environmental health, medical and clinical sciences, genome research, statistical genetics, population genetics, ecology and sequence analysis.

Statistics subjects can be placed in two different classes as descriptive and inferential statistics according to their functions. Descriptive statistics can be used to summarize the sample numerically or graphically. As a basic example, numerical and standard deviations can be shown. Graphical summaries include various types of graphs and tables. Inferential statistics are used to model the overlaps in the data, take the possibility and draw conclusions about a larger statistical stack. These results may be yes / no answers (hypothesis testing), estimation of numerical properties, statistical prediction, predicting future values, statistical prediction, interpretation of the linear relationship between data, or modeling of these relationships (regression analysis). Other major mathematical modeling techniques are variance analysis ANOVA, time series, and data mining. Descriptive and inferential statistical methods are commonly used in biostatistical studies.

If the scientific research is to be supported by statistical methods, if the experimental study data is interpreted by statistical methods, appropriate data should be provided for the statistical method to be used in the study. At the end of the study, trying to determine the statistical method can cause problems in the data number and data type. For these reasons, it should be decided in the statistical method at the beginning of the work planning. In this paper, data types are limited by measurement and count data.

2. DECİSİON ALGORİTHM FOR STATİSTİCAL METHOD SELECTİON

Data were obtained by MEASUREMENT (go to A)

For example, if your results are determined by measurements, the weights of the subjects, the bilirubin level in the blood, the volume of the bladder, etc., these data are called the data obtained by measurement (parametric data).

The data obtained by measurement should show normal distribution. It is understood by the best histogram method whether the data shows normal distribution. The normal distribution of data can also be understood by the Komogorow Smirnow test. But this test is not very useful if the number of samples is low.

If the data analyzed are in separate groups, each group should show normal distribution. In addition, if we will use test paired t test, anova, regression and residuals (differences between expected and observed values) analysis, data should be normal distribution.

Data were obtained by COUNT (go to B)

A. Data obtained by measurement (parametric data)

1. Groups are independent (*go to* 2)

Groups are dependent (*go to* 5)

An example is the comparison of pre- and post-treatment conditions on the same patient or group of subjects.

In independent groups, different groups of test subjects can be compared in measurement and counting.

2. Number of group is two (*go to* 3)

Number of group more than two (*go to* 4)

3 a. Number of test subject is under 30 (Mann - Whitney U test)

It is a non-parametric method used to compare two independent group means in a distribution that does not show normal distribution. If the parametric test fails to fulfill the assumptions, we try to determine whether the difference between the two means is significant or not with the Mann-Whitney U Test. The Mann-Whitney U Test determines whether the scores obtained from two unrelated samples differ significantly from each other. In other words, this test tests whether the two unrelated groups have similar distributions in the universe from the variable of the test. In Mann-Whitney U test; the data of the argument must be expressed in numerical characters, the sample should be selected randomly from each other and, measurements for the dependent variable must be in the order of sort, range or ratio (1-2)

Example: 8 Female and 8 male patients randomly selected for open heart surgery were treated with psychologically relaxing drug A. The psychological status of the patients was evaluated by a test and scored before the operation. Is the drug causing a difference between male and female patients of improving pre-operative psychological status of patients? (Table 1,2)

Table 1. Sorted status of test scores of male and female patients

M	F	F	F	F	M	M	M	M	F	M	F	F	M	F	M
12	23	25	34	34	37	44	45	49	65	70	74	80	83	86	92
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 2. Psychological scores of patients

Scores of female patients	**Ranking points (R1)**	**Scores of male patients**	**Ranking points (R2)**
34	4	43	6
25	3	83	14
86	15	12	1
74	12	49	9
65	10	70	11
80	13	45	8
23	2	92	16
37	5	44	7
Sum	R1=64		R2=72

Calculations:

$U1 = n1 * n2 + (n1(n1 +1)/2) – R1 = 8*8+(8(8+1)/2)-64 = 36$

$U2 = n1 * n2 + (n2(n2 +1)/2) – R2 = 8*8+(8(8+1)/2)-72 = 36$

$z = (28-(8)(8)/2) \ / \ \sqrt{((8)(8)(8+8+1) / 12)} = -0.420$

U=28, Z=-0.420, P>0.05

Interpretation of the result: A drug does not cause a difference of men and women in improvement.

Analysis in SPSS:

“SPSS »ANALYZE» NONPARAMETRIC TESTS »2 INDEPENDENT SAMPLES” is selected. In the “Define groups” option, the minimum and maximum values of the group codes are selected. The test variable list option specifies the data set name that contains the variables. (Figure 1,2). Test results are obtained by clicking the “Continue” button (Table 3).

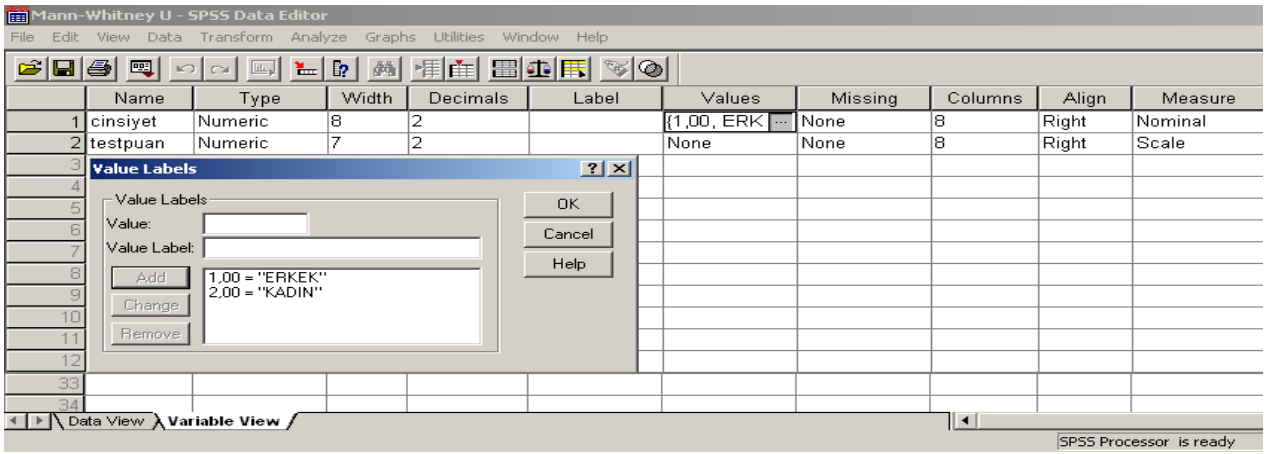

Figure 1. Specifying data types from SPSS and assigning data labels.

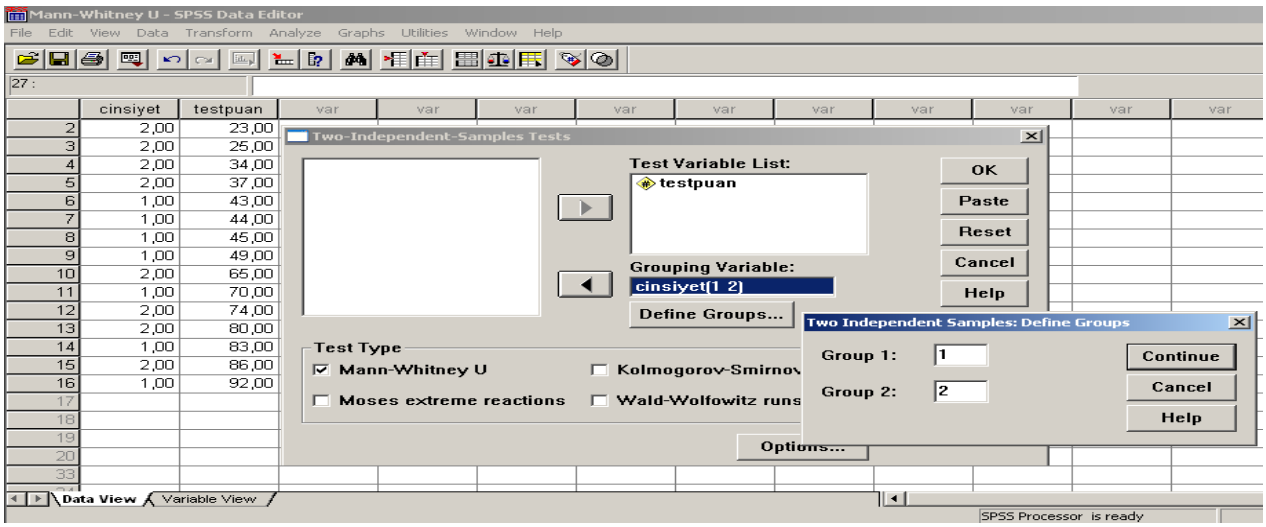

Figure 2. Specifying the test variable list and grouping variable options in SPSS**.**

Test Statistics [b]

	TESTPUAN
Mann-Whitney U	28,000
Wilcoxon W	64,000
Z	-,420
Asymp. Sig. (2-tailed)	,674
Exact Sig. [2*(1-tailed Sig.)]	,721[a]

a. Not corrected for ties.

b. Grouping Variable: CINSIYET

Table 3. SPSS analysis result output.

Interpretation of the result: P> 0.05 (0.674) There does not any difference in treatment of male and female patients.

b. The number of test subject is over 30 (Student t test)

Student t test, the difference between the mean of the previous and subsequent values of the test is different from 0 is to be tested. If the distribution of data is not normal, a nonparametric like t test is used as Wilcoxon signed sequence test or sign test. With this test, the difference between the mean is controlled (3).

t = (X1-X2) / SE

The t value is calculated from the above formula. In cases where the number of samples is under 30, a normal distribution is difficult. For this reason, proof is made by using the Student t scale.

Analysis in SPSS:

"SPSS »ANALYZE, COMPARE MEANS, INDEPENDENT-SAMPLES T TEST"

4. The number of test subject is under 30 (Kuruskal Wallis Analysis of Variance)

The nonparametric equivalent of one-way analysis of variance. As in other nonparametric methods, the mean of the groups is not compared, but the median is compared. If the median is not equal with Kruskal-Wallis (ie p <0.05 is found) post hoc as a multi-comparison method, by pulling down the level of error, Bonferroni corrected Mann-Whitney U test is applied.

There is no generally accepted nonparametric response to two-way analysis of variance. Therefore, if assumptions are not made, two-way analysis of variance can be performed by applying transformation to the data (4).

Analysis in SPSS:

"SPSS »ANALYZE» NONPARAMETRIC TESTS »INDEPENDENT SAMPLE" (Fig. 3)

The number of test subject is over 30 (Variance analysis (Tukey or Dunnet method))

In the independent samples one-way analysis of variance, the mean of more than two groups are compared. The analysis of variance indicates whether different groups are different from each other. However, it does not contain information about the differences among the groups. In order to do this, it is useful to carry out the Turkey test in addition to the analysis of variance (5).

Analysis in SPSS:

"SPSS »ANALYZE» COMPARE MEANS »ONE WAY ANOVA» POST HOC"

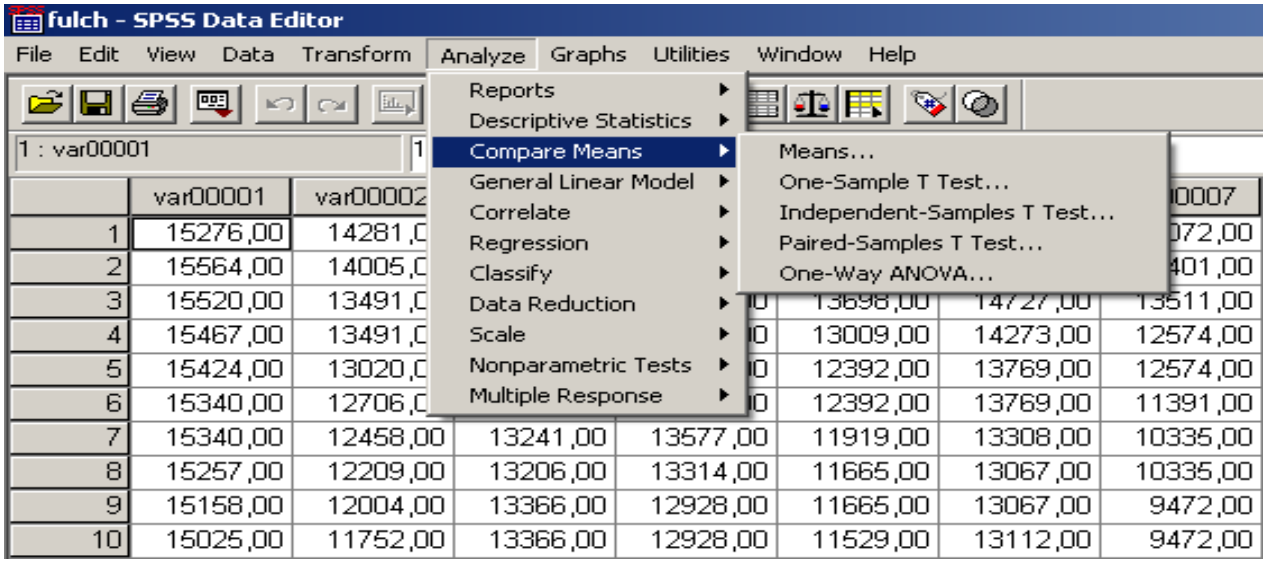

Figure 3. Steudent t test in SPSS

5. Number of group is two (*go to* 6)

Number of group more than two (*go to* 7)

6. A. The number of test subject is under 30 (*go to* 6.a)

6.A.1. All samples were measured. (Wilcoxon two sample tests)

The Wilcoxon test should be used when the data is normally disturbuted. Requirements; I- Data must be expressed in numerical characters. II- It must be continuous data and must be range or rate scale (5).

Analysis in SPSS:

"SPSS »ANALYZE> NONPARAMETRIC TESTS> TWO RELATED SAMPLES"

6.a.2.All samples are not measured.

The Sign Test is applied to matched samples. It is used to quickly determine whether the difference between the two laboratory methods applied to a group of samples is meaningful. The same method is used to quickly determine whether the difference between the results obtained from two different sample types is significant (6).

Analysis in SPSS:

"SPSS »ANALYZE> NONPARAMETRIC TESTS> TWO RELATED SAMPLES"

6.b. The number of test subject is over 30 (*go to* 6.b)

6.B.1. All samples were measured (significance test of the difference between two peers)

Analysis in SPSS:

"SPSS »ANALYZE, COMPARE MEANS, PAIRED-SAMPLES T TESTING"

The "t test" is the most commonly used method in hypothesis testing. t test is used to compare the mean of the two groups and to decide whether the difference is either random or statistically significant. The t distribution, also known as the small sampling theory, makes it possible for researchers to work with small samples. Using the "t" test when the sample size is small and the standard deviations of the main mass are unknown;- Whether the mean value of a group is different from the predetermined value for a examined variable, - Whether there is a difference between the two independent groups in terms of a examined

variable,- It is an analysis method developed to test the hypothesis of whether there is a difference in the reactions of any group under different conditions in terms of a examined variable (7). However, in controlled and experimental studies, it may be necessary to examine how the same subjects behave in different situations. The aim is to investigate whether the results obtained in two different conditions are different (8).

6.b.2.All samples are not measured

The data should be obtained from a single sample group. (*go to* 7)

7.The number of the test subjects does not matter (Variance analysis test in repeated measurements (Tukey))

Analysis in SPSS:

"SPSS »ANALYZE» COMPARE MEANS »ONE WAY ANOVA» POST HOC"

B. Samples obtained by non-parametric data

If you have identified your data by count, for example, the number of those who have recovered, those with and without translocation, those with necrosis, those who die, etc., these data are called data obtained by counting (non-parametric data).

1. Groups is independent (*go to* 2)

Group is dependent (*go to* 5)

Number of group is two (*go to* 3)

Number of group is more than two

(Number of test subject doesn't change)

It is used to test whether the incidence of the event in question is equal to a certain value. For this test to be used; Data must be obtained from a single group, The data must be qualitative The number of data should be sufficient (9)

Analysis in SPSS:

"ANALYZE, COMPARE MEANS, MEANS"

3. The number of test subject is 5 (Fisher's Chi-Square test)

The most important assumption of the chi-square test is that the groups in which the ratios are compared are independent. The expected number of chi-square tests should not be too small.

If the expected number is small, Fisher's chi-square test can be used instead of chi-square test. In the Fisher test, there is no test statistic like t, F, X^2. Returns the p value directly. Calculating manually is quite difficult. For chi-square test, cross-tables of more than 2x2 can be used for cross-table analysis, while Fisher's test can be used only in 2x2-cross tables.

Analysis in SPSS:

"SPSS »ANALYZE -> NONPARAMETRIC TESTS >> CHI SQUARE"

The number of test subject is under 5 (Chi-square test)

The chi-square test in dependent groups should be used when the number of observations is low. The Cochran Q test is the generalization of these two tests for more than 2 groups. The Cochran Q test serves to test the assumption that k-dependent dichotomous variables are derived from the same population. The Mc Nemar test is expanded to test whether the frequencies / ratios of two or more dependent sets differ significantly from each other (9).

Analysis in SPSS:

"SPSS »ANALYZE -> NONPARAMETRIC TESTS >> CHI SQUARE"

"SPSS »ANALYZE, COMPARE MEANS, INDEPENDENT-SAMPLES T TEST"

4. The number of test subject is 5 (Kolmogorov Smirnov test)

Kolmogorov-Smirnov (k-s) Test is used to test whether a randomly generated sample data complies with a particular distribution (uniform, normal, or poison). In principle, (k-s) test is based on comparing the cumulative distribution function of the sample data with the proposed cumulative distribution function. With the help of this test, it is possible to examine whether the data collected from a sample shows normal distribution (10).

Analysis in SPSS:

"SPSS »ANALYZE, NONPARAMETRIC TESTS, 1-SAMPLE K-S."

The number of test subject is under 5 (Chi-Square Test)

"SPSS »ANALYZE -> NONPARAMETRIC TESTS >> CHI SQUARE"

5. NUMBER OF GROUPS

5.a In both observations, all subjects were examined.

"SPSS »ANALYZE -> NONPARAMETRIC TESTS >> CHI SQUARE"

"SPSS »ANALYZE, COMPARE MEANS, PAIRED-SAMPLES T TESTING"

5.b In both observations, all subjects were not examined.

"SPSS »ANALYZE, COMPARE MEANS, MEANS" (11).

3. CONCLUSİON

Statistics in the field of science and medicine are of great importance. Researchers have to express their experimental findings in numbers. The experimental results obtained in the field of social sciences or science must be translated into numerical expressions (12). Our findings may be survey data, be quantitative data, or be data obtained by counting. The common point of all is that they have a mathematical quality. The data are easy to interpret when they acquire a numerical quality (13,14). At this stage, statistical methods are introduced. Istartistik methods help us to find the distributions of our data, the differences between the data and experimental groups, and similarities. Descriptive statistics from the simplest methods allow us to have information about the data by calculating the mean, standard deviations of the data (15). Planning a statistical analysis of the scientific research is a separate area of expertise. For this reason, experimental researchers are required to determine the statistical method they will use in their experiments before planning their experiments. Deciding which static method to select after testing is likely to cause many non-accountable problems. Most of them are the inadequacy of the data types and the inadequacy of the number of samples. For this reason, first of all, it is necessary to determine the characteristics of the data to be obtained from the experiment and then decide on the statistical method to be used. Once the statistical method to be used is finalized, power analysis according to this method should be performed. With Power analysis, the lower limits of the sample numbers should be determined. The result of the power analysis should not be below 80% (16). After the experiment, whether the data show normal distribution should be examined. Then, appropriate statistical analysis should be performed and the results should be interpreted. In this study, an algorithm was used to guide the researchers and explain what statistical method would be appropriate for their research. Armitage et al. (17), Jones and Hunter (18), Brockwell and Gordon (19), Trapp and Dawson (20), Fisher and Yates (21), Yuan and Lin (22) and Wallenstein (23) publications and books mentioned similarly in this study, the choice of statistical methods was given to guide the researchers. Unlike other studies, this study was given to the use of statistical software packages, information and about the statistical methods. As a result, since the choice of statistical test may have a complete impact on the results of a research, the researchers have to make the selection of the test carefully. This study which is prepared for this purpose is guiding the researchers.

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