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STATISTICAL RELATIONS MEASURES

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ABSTRACT. In this study, starting with the researches method and studies, which scale used and in accordance with this scale, which data statistical relationship measures to be applicated were given. In accordance with this aim, 18 tests were taken into consideration which consisted of statistical relationship measures tests. Also, data sets which were taken from2148 students from three different high schools in Kahramanmaraş were examined practically on statistical relationship measures. With the aim of this, knowledge that were taken from the students from Science High School and Vocational High School were used. In the study, the effects of the factors like gender, education status of the father, private room status, number of siblings, computer status, living place,taking private lesson status, age of the student, body weight of the student and the income of the family on the effect of high school type were evaluated with the statistical relationship measures. Parametric test were applied to the data sets which are intermittent scale or proportional scale. And non parametric testa were applied to the data sets which are classifier scale or sequential scale. As a result, in the thesis study, the effect of factors that were thought to effect the student's high school type, effect degree and direction were tried to be determined with the relationship measures test.

1. INTRODUCTION

The word statistics comes from the root of the Latin word "status". Statistics; collecting data, summarizing and presenting in the form of figures and graphics, tables, texts is the science that creates methods and theories about data analysis, evaluation, interpretation, decision making. Also, to observe, count and measure a large number of units to investigate collective (collective) events; It is a method of analyzing the results in order to group and interpret them (Alpar, 1995). As a result of field studies, tests are needed to interpret scientific and objective results. No matter how good the theoretical part of a study is, if the statistical tests used for the application of the study are not scientifically appropriate, the expected results from the studies are not obtained. In this case, when deciding on the statistical tests of a study, it should be well determined which statistical techniques can be analyzed for the data obtained. The degree of relationship between the data is shown by the correlation coefficients. Parametric tests are used if the received data is intermittent or proportional, non-parametric tests are used if it is classifier or sequencer.

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Parametric tests are inflexible statistical methods applied according to the relevant parameter, an appropriate distribution and variance. Non-parametric tests, on the other hand, are statistical methods that do not depend on the relevant parameter, an appropriate distribution and variance, and are performed by taking their ranking scores instead of the data. In order to apply parametric tests, the data should be normally distributed and the variances should be homogeneous. On the other hand, non-parametric tests do not need these requirements and do not make assumptions about sample distribution [14].
In the study, information is given about which scale the data will be handled and which statistical method will be applied to the data in line with this scale when starting the researchers' methods and studies. For this purpose, a total of 18 tests consisting of statistical measures tests were examined. In addition, using the data obtained from 2148 students in three different types of high schools in Kahramanmaras, the correlation coefficients that can determine the relationship between the variables are emphasized. As an application, the information obtained from the students studying at Science High School, Anatolian High School and Vocational High School in Kahramanmaras was used. In the study, correlation coefficients were applied to determine whether factors such as gender, father's education level, private room status, number of siblings, computer status, place of residence, taking private tutoring, student's age, student's body weight and family income are related to high school type. Different test statistics should be applied according to the data obtained from students studying in different high school types. Parametric tests are used if the received data is intermittent or proportional, and non-parametric tests are used if it is classifier or sequencer [7,12].

2. MATERIAL

In the study, preliminary information was given about the relationship measures tests, and then a questionnaire about these tests was applied. From the results of the survey, it is shown whether there is a relationship in the correlation coefficients. In addition, hand-solved examples of relationship measure tests are included in the appendix.

In the study, it was determined whether factors such as gender, father's education level, private room status, number of siblings, computer status, place of residence, taking private lessons, student's age, student's body weight and family income are related to high school type, and if there is a relationship, the direction of this relationship. and its degree are shown with the correlation coefficients.

The survey study consists of students who have been educated in three different types of high schools, residing in the province, district and surrounding villages of Kahramanmaras. Students who did not want to participate in the application were excluded from the scope of the research and the questionnaire was applied to 2148 students in total.

Frequency and percentage distributions for the demographic data of the participants are shown as follows. Percent Residence Frequency Percent

Table 1. Distributions by Demographic Characteristics of Participants

Gender	Frequency	Percent	Residence	Frequency	Percent
Female	1198	55,3	Provincial	1304	60,7
Male	960	44,7	Town	308	14,3
Father Educational Status			Village	536	25,0
Primary school	764	35,6	Private Lesson Status		
Middle School	616	28,7	Yes	160	7,4

High school	492	22,9	No	1988	92,6
University	276	12,8	High School Type		
Private Room Status			Vocational high School	556	25,9
Yes	1340	62,4	Anatolian High School	1068	49,7
No	800	37,6	Science High School	524	24,4
Number of siblings			Family Income Status		
0	36	1,7	2000 and below	1032	48,0
1	136	6,3	2000-3000	672	31,3
2	432	20,1	3000-4000	276	12,8
3 and more	1544	71,9	4000 and over	168	7,8
Computer Status					
Yes	1184	55,1			
No	964	44,9			

3.METHOD

In this study, statistical terms and descriptive statistics are defined and then given in detail on statistical measure tests. The solution of a numerical example for each test is also shown.

In general, a statistical test generalized to the determination of a hypothesis (H_0),

$$\text{Test statistic} = \frac{\text{statistics} - \text{parameter}}{\sqrt{\text{var(statistics)}}} \quad (1)$$

is in the form. As shown in the equation, it is created for the distribution of the statistics and is determined by comparing it with the critical values showing the rejection regions of H_0 with a certain probability (type error) [4,8].

Relationship Measures Tests

It is desired to know how the relationship between two different data sets is. It is necessary to create a separate test statistic according to the data taken from the data set [10,13]. The data are analyzed under the headings of classifier, ordinal, interval, interval or proportional scale, and classifier or ordinal scale variables.

Classifier Scale Variables

Goodman and Kruskal Gamma Statistics

Goodman and Kruskal Gamma statistics, known as the gamma test, creates a symmetric measure of the measurement link in two ordinal variables. Goodmann and Kruskal Gamma statistics indicate a difference between the (P) congruent and (Q) discordant pair. When the value of the Goodman and Kruskal Gamma statistic is 1 or close to 1, the connection level increases, and when it is close to 0, the connection level decreases. The same method is used to calculate the Somers D statistics [1,3].

Cramer V Statistics

Although the probability coefficient is widely used in social sciences and sciences, it also has a disadvantage. In order to calculate the Cramer V statistic, nxn of the tables, that is, rows and columns, must be equal. For example, it is applied to tables created as 3x3, 4x4, 5x5 ... instead of 2x3, 3x4, 5x4 tables. [2,9].

Phi Coefficient

Phi coefficient is explained as a non-parametric test applied to find the correlation coefficient of data in 2x2 size tables created with nominal scales. It is also known as a correlation coefficient that calculates the size of the link between two variables. Phi coefficient is also known as Kendall's correlation coefficient. It explains the relationship dimension of the variables that are qualitatively dichotomous (hardworking-lazy, bad-good, thin-fat) between two variables. Phi coefficient is determined by the symbol .

Lambda λ Statistic

Lambda λ statistics, also called Gutman's estimation coefficient, in which dependent and independent variables affect each other, are applied in error rates. Lambda λ statistics, which is a classifying scale, is applied as a correlation statistic that compares more than one group or category, as in Cramer V, Phi and Probability coefficient. The feature that distinguishes the lambda λ statistic from other statistics is that it has an asymmetric structure. Lambda λ statistic is also applied symmetrically. In the Lambda λ statistic, it takes values between [5].

Probability Coefficient C Statistic

Probability coefficient C statistic, created with a classifier scale, is defined as a non-parametric statistics created to indicate the correlation coefficient of groups or figures rather than 2x2 tables. The probability coefficient C statistic is determined as a symmetrical structure [3,4].

Relative Risk

It shows the measure of the connection between the occurrence or absence of a situation or an event. Relative Risk also creates risk estimates for the future.

Odds Ratio

The 'odds ratio', also known as the relative odds ratio or estimated relative risk, is defined as a measure of effect size. Odds ratio is applied to determine the risk of the population as a result of retrospective studies of the variables [2,6].

Sorter Scale Variables

Somers D Statistics

Somers D statistic is preferred for asymmetric measurements calculated to show the compatibility or connection between two ordinal variables such as x and y. Somers D Coefficient is expressed between (-1,1) values. That is, it takes a value between $-1 < S_d < +1$. Somers D Statistics model is created as at least 2x2.

Kendall Tau b Statistics

It is among the non-parametric tests. Bi-order variables are also statistical measures that indicate the strength and wool of the connection. Kendall Tau b statistic takes a value between $-1 \leq \tau \leq +1$. In Kendall Tau b statistics, when the number of samples is more than 10, it approaches the normal distribution [9,10].

Kendall Tau c Statistics

The Kendall Tau c statistic is calculated in cases that are rectangular or square. In cases where the Kendall Tau b statistic is not calculated, it is the statistical test that can be calculated. The Kendall tau c statistic is also called Stuart's Tauc or Kendall-Stuart Tau c. In addition, in this test, at least one of the data must be ordinal [9].

Kendall Goodness of Fit Coefficient W Statistic

Spearman, Kendall Tau b and Kendall Tau c statistics are applied to calculate the correlation between two ordinal variables. However, when the ordinal variable value is greater than 3, Kendall W statistics is applied. The Kendall W statistic can be calculated until the ordinal variable value, that is, is $n \leq 7$. In case the ordinal variable value is greater than 7, the distribution of the sample constitutes the Chi-square distribution. Therefore, it is calculated with the chi-square ruler. Kendall W statistics are formed between $0 \leq W \leq 1$ values [3,12].

Spearman Rank Correlation Coefficient

Spearman Rho is applied when there is a linear relationship between the two ordinal variables or between the variables for which the connection is investigated, when one of the variables moves away from the normal distribution. That is, it is used to investigate the connection between two ordinal variables. Spearman Rho is explained as the non-parametric Pearson Correlation coefficient. The most important difference between the two tests is that Spearman deals with Rho's ordinal numbers and Pearson's raw values.

Linear by Linear Relationship Statistics

Variables must be obtained in ordinal scale and created in double-order rxc size. Chi-square test statistics are applied until the sample number of linear statistics is 0. Linear by Linear relationship statistics are also defined as Mantel-Haenszel test [9].

Cohen Kappa Statistics

Evaluation at different locations or by a different observer also examines the similarities between the observer or two different places. Cohen Kappa coefficient takes values between -1 and $+1$. When the value of Cohen Kappa coefficient approaches 1, it explains a complete fit, a value close to 0 explains inconsistency, and a value close to -1 explains the reverse fit [13,15].

Interval Scale Variables

Pearson Correlation Coefficient

It is used to give information about the strength and direction of the linear relationship between two variables indicated by measurement. When both variables are normally distributed, the graph is continuously variable. To properly use the Pearson correlation coefficient, the data between variables should be applied with an interval scale, both variables should be normally distributed, and both variables should be randomly selected from the population. In other words, it is applied when the relationship between two different x and y variables is linear [4].

Intermittent and Proportional Scale Variables

Eta Coefficient

The eta coefficient is a nonlinear correlation coefficient. It is used for two continuous variables that do not have a linear relationship between them. For this reason, it is also called the relationship ratio. It is also applied for data created with interval and proportional scale. Eta coefficient takes a value between 0 and 1. When the value

of Eta is close to 1, the relationship level increases, and when it takes a value close to 0, the relationship level decreases. The eta coefficient is a special case of the Pearson coefficient.

Classifier or Orderer Scale Variables

Yule Q Statistics

The Yule Q statistic is explained as a symmetric measure based on the difference in congruent and incompatible pairs. Yule Q statistic is calculated in 2x2 size tables. Unlike the Phi coefficient, the data can be calculated on a scaled or ordinal scale. Yule takes a value in the range of $-1 \leq \gamma \leq +1$ [11].

Yule Y Statistics

The Yule Y statistic is shown as the rank coefficient. In this test, it is obtained by taking the geometric mean of Yule. In Yule Y statistics, the difference between the marginal distribution (which can be variable in unit sense) between two variables is weaker than Yule Q statistics [3,14].

4. FINDINGS AND DISCUSSION

In the study, correlation coefficients were applied to determine whether factors such as gender, father's education level, private room status, number of siblings, computer status, place of residence, taking private tutoring, student's age, student's body weight and family income are related to high school type. Analyzes were created according to the 5% significance level. Therefore, the results are stated as 'relation' if the sign value is less than 0.05, and 'no relationship' if the sign value is greater than 0.05.

Table 2. Analysis of High School Type by Gender

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	899,215	0,000
Linear by Linear Relation	759,545	0,000
Lambda Statistics	0,343	0,000
Goodman and Kruskal Statistics	0,301	0,000
Uncertainty Coefficient	0,559	0,000
Somers D Statistics	0,633	0,000
Eta Coefficient	0,595	0,000
Phi Coefficient	0,647	0,000
Cramer V Statistics	0,647	0,000
Kendal Tau b Statistics	0,562	0,000
Kendal Tau c Statistics	0,626	0,000
Spearman Rank Correlation Coefficient	0,593	0,000
Cohen Koppa Statistics	0,023	0,000

As a result of the analysis of the relationship measures tests according to Table 2, it was decided that the type of high school was dependent on gender ($p < 0{,}01$).

Table 3. Analysis of High School Type by Father's Educational Status

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	416,557	0,000
Linear by Linear Relation	280,227	0,000
Lambda Statistics	0,089	0,000
Goodman and Kruskal Statistics	0,76	0,000
Uncertainty Coefficient	0,312	0,000
Somers D Statistics	0,292	0,000
Eta Coefficient	0,365	0,000
Phi Coefficient	0,440	0,000
Cramer V Statistics	0,311	0,000
Kendal Tau b Statistics	0,313	0,000
Kendal Tau c Statistics	0,316	0,000
Spearman Rank Correlation Coefficient	0,351	0,000
Cohen Koppa Statistics	0,131	0,106

According to Table 3, it is seen that there is an independent relationship between father's education level and high school type in Cohen Koppa statistical analysis ($p > 0{,}05$). However, in the analysis of other relationship measures, it is seen that there is a positive significant relationship between father's education status and high school type($p < 0{,}01$).

Table 4. Analysis of High School Type by Private Room Status

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	17,328	0,008
Linear by Linear Relation	0,980	0,322
Lambda Statistics	0,002	0,045
Goodman and Kruskal Statistics	0,005	0,007
Uncertainty Coefficient	0,002	0,915
Somers D Statistics	0,002	0,915

Eta Coefficient	0,036	0,000
Phi Coefficient	0,90	0,008
Cramer V Statistics	0,64	0,008
Kendal Tau b Statistics	0,002	0,915
Kendal Tau c Statistics	0,002	0,915
Spearman Rank Correlation Coefficient	0,21	0,916
Cohen Koppa Statistics	0,11	0,322

According to Table 4, in the statistical analysis of Eta Coefficient, it is seen that there is a positive significant relationship between private room status and high school type ($p < 0{,}01$). However, in the analysis of other relationship measure tests, it is seen that there is no relationship between private room status and high school type ($p > 0{,}05$).

Table 5. Analysis of High School Type by Number of Siblings

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	31,211	0,000
Linear by Linear Relation	14,164	0,000
Lambda Statistics	0,002	0,689
Goodman and Kruskal Statistics	0,008	0,000
Uncertainty Coefficient	-0,069	0,001
Somers D Statistics	-0,058	0,001
Eta Coefficient	0,105	0,000
Phi Coefficient	0,121	0,000
Cramer V Statistics	0,085	0,000
Kendal Tau b Statistics	-0,070	0,001
Kendal Tau c Statistics	-0,055	0,001
Spearman Rank Correlation Coefficient	-0,130	0,001
Cohen Koppa Statistics	-0,076	0,000

According to Table 5, it is seen that there is no relationship between the number of siblings and the type of high school in the Lambda statistical analysis ($p > 0{,}05$). However, in the analysis of other relationship measure

tests, it is seen that there is a positive significant relationship between the number of siblings and high school type ($p < 0{,}01$).

Table 6. Analysis of High School Type by Computer Status

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	75,232	0,000
Linear by Linear Relation	69,742	0,000
Lambda Statistics	0,041	0,000
Goodman and Kruskal Statistics	0,021	0,000
Uncertainty Coefficient	-0,170	0,000
Somers D Statistics	-0,153	0,000
Eta Coefficient	0,180	0,000
Phi Coefficient	0,187	0,000
Cramer V Statistics	0,132	0,000
Kendal Tau b Statistics	-0,172	0,000
Kendal Tau c Statistics	-0,144	0,000
Spearman Rank Correlation Coefficient	-0,304	0,000
Cohen Koppa Statistics	-0,181	0,000

According to Table 6, it is seen that there is a positive significant relationship between the number of siblings and the type of high school in the analysis of all relationship measure tests ($p < 0{,}01$).

Table 7. Analysis of High School Type by Place of Residence

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	27,926	0,000
Linear by Linear Relation	0,957	0,328
Lambda Statistics	0,000	0,000
Goodman and Kruskal Statistics	0,007	0,000
Uncertainty Coefficient	-0,011	0,576
Somers D Statistics	-0,010	0,576
Eta Coefficient	0,063	0,000

Phi Coefficient	0,114	0,000
Cramer V Statistics	0,081	0,000
Kendal Tau b Statistics	-0,011	0,576
Kendal Tau c Statistics	-0,010	0,576
Spearman Rank Correlation Coefficient	-0,019	0,576
Cohen Koppa Statistics	-0,011	0,595

According to Table 7, in the statistical analysis of Pearson Correlation Coefficient, Lambda statistic, Goodman and Kruskal statistic, Eta Coefficient and Phi Coefficient, it is seen that there is a positive significant relationship between the place of residence and the type of high school ($p < 0{,}01$). However, in the analysis of other relationship measures, it is seen that there is no relationship between the place of residence and the type of high school ($p > 0{,}05$)

Table 8. Analysis of High School Type by Taking Private Lessons

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	5,525	0,063
Linear by Linear Relation	1,242	0,265
Lambda Statistics	0,000	0,000[b]
Goodman and Kruskal Statistics	0,002	0,056
Uncertainty Coefficient	0,017	0,234
Somers D Statistics	0,011	0,234
Eta Coefficient	0,051	0,000
Phi Coefficient	0,051	0,063
Cramer V Statistics	0,051	0,063
Kendal Tau b Statistics	0,023	0,234
Kendal Tau c Statistics	0,013	0,234
Spearman Rank Correlation Coefficient	0,079	0,234
Cohen Koppa Statistics	0,024	0,271

According to Table 8, in the statistical analysis of Lambda Statistics and Eta Coefficient, it is seen that there is a positive significant relationship between taking private lessons and high school type($p < 0{,}01$). However, in the analysis of other relationship measure tests, it is seen that there is no relationship between taking private lessons and high school type($p > 0{,}05$).

Table 9. Analysis of High School Type by Family Income Status

Relationship Measures	Coefficients	P
Pearson Correlation Coefficient	244,789	0,000
Linear by Linear Relation	182,873	0,000
Lambda Statistics	0,027	0,002
Goodman and Kruskal Statistics	0,055	0,000
Uncertainty Coefficient	0,230	0,000
Somers D Statistics	0,234	0,000
Eta Coefficient	0,316	0,000
Phi Coefficient	0,338	0,000
Cramer V Statistics	0,239	0,000
Kendal Tau b Statistics	0,230	0,000
Kendal Tau c Statistics	0,220	0,000
Spearman Rank Correlation Coefficient	0,352	0,000
Cohen Koppa Statistics	0,081	0,000

According to Table 9, it is seen that there is a positive significant relationship between family income status and high school type in the analysis of all relationship measure tests ($p < 0{,}01$).

5. CONCLUSIONS

In this study, correlation measures tests were examined under the headings of classifier scaled variables, ordinal scaled variables, intermittent scaled variables, interval scaled-ratio scaled variables, and classifier-ordered scaled variables. For this purpose, a total of 18 tests consisting of statistical measures tests were examined. In the study, the correlation coefficients that can determine the relationship between the variables were emphasized by using the data obtained from 2148 students in three different types of high schools in Kahramanmaras. As an application, the information obtained from the students studying at Science High School, Anatolian High School and Vocational High School in Kahramanmaras was used.

In line with this study, factors such as gender, father's education level, private room status, number of siblings, computer status, place of residence, taking private lessons, student's age, student's body weight, and family income were determined correlation coefficients were applied to determine whether it is related to the type of high school. Different test statistics were applied according to the data obtained from students studying in different types of high schools. Parametric tests were used if the data were intermittent or proportional, and non-parametric tests were used if they were classifiers or sequencers.

As a result, in the analysis of all statistical relationship measures between the type of high school and gender, computer status and income status of the family, it was seen that there was a positive significant relationship ($p < 0{,}05$). In the Cohen Koppa statistic analysis made between high school type and father's education level, it was found that there was no relationship. However, in the analysis of other statistical measures tests, it was observed that there was a positive significant relationship ($p < 0{,}05$). In the statistical analysis of the Eta coefficient between the high school type and the private room status of the student, it was seen that there was a positive significant relationship ($p < 0{,}05$). No relationship was found in the analysis of other statistical measures tests ($p > 0{,}05$). It was revealed that there was no relationship in the Lambda statistic analysis made between the type of high school and the number of siblings, but there was a positive significant relationship in the analysis of other statistical measures tests. In the statistical analysis of Pearson Correlation Coefficient, Lambda statistic, Goodman and Kruskal statistic, Eta Coefficient and Phi Coefficient between high school type and place of residence, there was a positive significant relationship ($p < 0{,}05$). However, in the analysis of other relationship measure tests, no relationship was found between the place of residence and the type of high school ($p > 0{,}05$). In the statistical analysis of Lambda statistics and Eta coefficient between the high school type and the student's taking private lessons, it was seen that there was a positive significant relationship ($p < 0{,}05$). In the analysis of other relationship measure tests, it was seen that there was no relationship ($p > 0{,}05$).

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The author(s) declared that they comply with the scientific, ethical, and citation rules of Journal of Universal Mathematics in all processes of the study and that they do not make any falsification on the data collected. Besides, the author(s) declared that Journal of Universal Mathematics and its editorial board have no responsibility for any ethical violations that may be encountered and this study has not been evaluated in any academic publication environment other than Journal of Universal Mathematics.

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