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Examining Periodic Differences of Suicide Cases with Circular Data Analysis

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ABSTRACT

The aim of this study is to analyze suicide cases with circular data analysis and to compare them with the standard linear analysis method and to guide the implementation of long-term social protective programs. Circular data analysis was used as method. However, standard linear statistics method was also used to compare the results of circular data analysis. Men constitute 74.91% of 15731 cases included in the study. Disease (39.84%) has been identified as the highest risk factor. Despite having a low concentration, the most suicide occurred in May (9.43%). Furthermore, a significant relationship was found between suicide causes and gender and suicide causes and months ($p<0.05$). In the analyses performed by circular data analysis, although the mean direction of suicides indicated May 29 (148.11°), suicides spread throughout the year according to circular variance (0.96). It was determined that the mean directions of suicide causes among from 1 April (90.02°) to 19 July (199.69°), so the concentration of suicide was in this interval. However, according to the distribution measures, all causes of suicide, except educational failure, showed a multimodal distribution. It can be stated that at least one sample distribution, mean direction, condensation parameter differs from other sample parameters in terms of itself species ($p<0.05$). Suicide cases were seen more common among men and during the spring-summer months. It is recommended to take preventive measures according to risk factors in order to prevent suicides, especially in periods determined.

Keywords: Circular data, dispersion, mean direction, rose diagram, suicide

Introduction

Death directly or indirectly caused by the individual's acts of aggression against himself/herself although he/she knows that it will result in death has been defined as suicide (1, 2). Suicide is not only occurred in people with severe mental disturbances but also normal people living under intense stressful conditions in society and reacting to these living conditions. In cases where unbearable pain is felt and there are severe problems, it generally arises as a result of the lack of alternative solutions to deal with them and inadequate existing methods (3, 4). The suicide case should be discussed based on completed suicide, suicide attempt and suicide ideation (2).

Many people believe that suicide e(?) cases are frequently seen during the winter months and especially in December (5). However, the studies and statistics after the 19th century consistently show that suicide cases are low during the winter months and high during the spring and summer months (1). The available studies showed that suicide cases had the lowest frequency, especially in December (6).

Many studies addressing suicide cases have been carried out. In almost all of these studies, frequency tables and χ^2 test statistics were used for linear data. However, it will be more appropriate to analyze the data with cyclical structure such as hours, days, months and years by circular data analysis method. Otherwise, misleading results can be obtained (7). For example, if the mean value of data relating to the events occurring between the 12th (December) and 2th (February) months is calculated without considering the cyclical structure, a false result such as 7 (July) will be encountered, whereas the actual mean value of these data is still within this range (such as January). For these data are different from linear data due to their periodic structure (8). However, in most of the studies conducted with these data, monthly distributions were examined according to frequency distributions and the effects of categories on each other were ignored. In this case, it is accepted that these data are similar although there is a significant difference between the data in-between the beginning and the end of a month. It is accepted that these data are different from each other although there is a slight difference between the data in the end and the beginning of the next month.

Circular data is widely common in different areas of cognitive and experimental psychology. However,

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there are a limited number of studies in which such data are analyzed using circular data analysis (8). The most significant difference of this study from other studies is that it may be considered to one of the first studies to demonstrate the application of circular data analysis in the field of health. In the literature, the circular data analysis has been used more often in the data obtained with angle rather than the data obtained with the time cycle. However, cyclical data are misused by models that do not take into account the natural cyclical of some phenomena (9). The linear descriptive statistics may be failure to exactly describe the central tendency of circular distributions. Additionally, the use of linear statistical methods to identify circular data by ignoring the circular scale may cause some problems in statistical inference. Thus considering the time in normal time series analysis, which found in a cycle and which is a linear variable, it would be more useful to consider it as a circular variable (10). Furthermore, circular data analysis is more functional than categorical data analysis for analysis of data in a cycle.

The aim of this study was to provide descriptive statistics on suicide cases in Turkey between the years 2008 and 2018, to analyze the distribution of these cases by months by circular data analysis and, to emphasize that there is a need to use circular data analysis for such data by determining whether there is a difference between the causes of suicide by months.

Materials and Methods

In the study, the data on suicide cases taken from TURKSTAT and occurred between 2008-2019 were used as materials (11). Between the dates given, 30984 suicide cases occurred. The causes of suicide in these cases were recorded as unknown (15253), domestic violence (2290), other causes (2992), livelihood difficulty (2583), disease (6267), emotional relationship and unable to marry with the desired person (ERUMDP) (1074), business failure (408) and educational failure (117). However, by excluding suicides of unknown cause, these data consisted of gender, the month of suicide cases, and a total of 15731 observations of 7 different causes of suicide. Furthermore, 72.16% of suicide cases with unknown cause are men and 27.84% are women. Suicides of unknown cause occurred at most in July (9.78%) and at least in November (6.94%).

Statistical method: Graphical representation constitutes one of the important stages to get an idea about the circular data, to analyze and interpret the data. These graphics are used to summarize the data set and to get an idea about the data distribution before the statistical calculations. Since the relationship between the directions at the circular statistic is examined, the vector quantities of data points have no importance and it is assumed that these data points are distributed on the perimeter of the unit circle due to the ease of operations. Thus, the distance of the data at any point on the circle to the origin is 1 (12).

The suicide data recorded by months are converted to angle in degrees using equation (1).

$$\theta = \frac{360.a}{k}$$

In equation (1), a represents the data on the original scale and k represents the whole cycle on the scale on which a is measured (13).

Before calculation of the mean direction for a data set concentrated towards one direction, the components of p_i (i=1, 2,..., n) unit vectors on the perimeter of the unit circle corresponding to θ_i angle according to rectangular coordinate system must be calculated with the help of equation (2).

$$C = \sum_{i=1}^{n} cos\theta_i \ , \qquad S = \sum_{i=1}^{n} sin\theta_i$$

According to C and S components, resultant length and mean resultant length are calculated by the equation (3),

$$R = \sqrt{C^2 + S^2} \quad \text{and} \quad \bar{R} = R/n$$

and the mean direction ($\bar{\theta}$) is calculated by equation (4) (13–15),

$$\bar{\theta} = \begin{cases} tan^{-1}(S/C) & if\ C > 0, \quad S \geq 0 \\ \pi/2 & if\ C = 0, \quad S > 0 \\ tan^{-1}(S/C) + \pi & if\ C < 0 \\ tan^{-1}(S/C) + 2\pi & if\ C \geq 0, \quad S < 0 \\ undefined & if\ C = 0, \quad S = 0 \end{cases}$$

The mean direction would be undefined if the resultant length (R) is equal to 0. This indicates that the data set is not concentrated towards any direction on the unit circle and does not have any mean direction. If R=n, it indicates that the data set has a mean direction and all observations are concentrated towards the mean direction (14,16).

Since the resultant vector length mean ($\bar{R}$) is a measure of dispersion which shows to what extent the observations are concentrated around the center, it has a close relationship with the variance. The sample variance for circular data is calculated with equation (5).

$$V = 1 - \bar{R}$$

As in linear data, the distribution becomes homogeneous as the sample variance gets smaller in

circular data. However, unlike linear variance, circular variance ranges from 0 to 1. If all observations are in the same direction, variance will be minimum. Variance will be 1 if the observations are uniformly distribution on the circumference of the circle (12,15).

The sample standard deviation for circular data is calculated by equation (6) (13,14).

$$v = \frac{180^{o}}{\pi}\sqrt{2(1-\bar{R})} \quad (6)$$

Another measure of circular scatter is circular dispersion measure. The increase in dispersion measurement shows that the data distribute uniformly over the circle and the reduction of it shows that the data concentrate in the mean direction (7,17). Circular dispersion measure is calculated by equation (7) (18).

$$\delta = \frac{1-\rho_2}{2\bar{R}^2} \quad (7)$$

The concentration parameter is represented by κ. This parameter indicates whether the data set is distributed homogeneously on the circle or is concentrated in the reference direction. The fact that this value is 0 indicates that the data set is distributed homogeneously on the circle while the fact that it is greater than 2 indicates that there are significant deviations from homogeneity (14). The concentration parameter is calculated as the following;

$$\hat{\kappa} = \begin{cases} 2\bar{R} + \bar{R}^3 + 5\bar{R}^5/6 & \bar{R} < 0.53 \\ -0.4 + 1.39\bar{R} + \dfrac{0.43}{(1-\bar{R})} & 0.53 \le \bar{R} < 0.85 \\ 1/(\bar{R}^3 - 4\bar{R}^2 + 3\bar{R}) & \bar{R} \ge 0.85 \end{cases} \quad (8)$$

Suicide months of the year, gender of the person who committed suicide (1: Male, 2: Female) and the cause of suicide (1: Domestic violence, 2: Other reasons, 3: Livelihood difficulty, 4: Disease, 5: ERUMDP, 6: Business failure, 7: Educational failure) were taken into account in the evaluation of suicide cases. For circular data analysis, the starting direction was the north and the rotating direction was taken clockwise, Months during which suicide cases occurred were first converted into day and then angle. These data were subjected to circular data analysis methods. Furthermore, frequency tables were formed to compare the results and χ^2 test statistic was performed. NCSS 2007 statistical package program was used for statistical analysis and evaluations (19).

Results

Table 1 presents the distribution of suicide causes by gender and months. Suicide cases consisted of 74.91% men and 25.09% women. However, in most of the studies carried out based on regions or provinces in Turkey, it is argued that female suicide cases are very high compared to males. In this study, the highest and the lowest risk factor among the causes of suicide were disease (39.84%) and educational failure (0.74%), respectively. Furthermore, while suicide cases due to disease constituted the highest risk in both men (36.79%) and women (48.95%), the lowest risk in men and women constituted educational failure (0.60%) and business failure (0.23%), respectively. Between men and women, business failure (97.79% in men and 2.21% in women) had the widest range and educational failure (60.68% in men and 39.32% in women) had the narrowest range. A significant relationship was found between gender and the causes of suicide ($p<0.05$).

The most and least suicide cases were observed in May (9.43%) and November (7.77%) respectively. Although suicide cases are generally distributed over all months, they have occurred more intensely between March and August. The suicide cases are more common in July (10.04%) due to domestic violence, in May (9.89%, 9.87%, 9.14% and 10.06%, respectively) due to other causes, livelihood difficulty, disease and ERUMDP, in April (11.52%) due to business failure, and in June (16.24%) due to educational failure. Although the disease-related cases showed a slight increase in May, they show an equal distribution approximately every month. In contrast, 40.18% of cases due to educational failure are concentrated in April (11.97%), June (16.24%) and July (11.97%). With this feature, educational failure is distinguished significantly from other 6 reasons. Thus, a significant relationship was found between suicide months and suicide causes ($p<0.05$).

From the Table 2 and Figure 1, it can be noted that there are differences between Figure 1 and Table 1. These differences arise from the topographic structure of the circular data. Thus, it is expected that such different results will be obtained when standard linear statistic data analysis methods are applied to the circular data.

In order to examine the status during the year of the suicides, descriptive statistics according to suicide and suicide causes are given in Table 2.

As can be seen in Table 2, the general mean direction for the suicide months is ($\bar{\theta}$) 148.11°. In the calculation made with equation 1 according to the angle of 148.11°, the mean suicide date was determined as May 29. The mean resultant length ($\bar{R}$), circular variance (v), circular dispersion measure (δ) and concentration parameter (κ) are indicators of the distribution in the dataset. The distribution of the data on the circle can be predicted by using any of

Table 1. Distribution of Suicide Cases by Month and Gender

	Suicide Cause	Domestic violence	Other Causes	Livelihood Difficulty	Disease	ERUMDP	Business Failure	Educational Failure	Total
Suicide Month	January	145	250	221	483	92	31	8	1230
	%(+)	6.33%	8.36%	8.56%	7.71%	8.57%	7.60%	6.84%	7.82%
	February	192	209	226	475	85	35	9	1231
	%(+)	8.38%	6.99%	8.75%	7.58%	7.91%	8.58%	7.69%	7.83%
	March	160	224	251	567	89	44	8	1343
	%(+)	6.99%	7.49%	9.72%	9.05%	8.29%	10.78%	6.84%	8.54%
	April	182	258	236	558	97	47	14	1392
	%(+)	7.95%	8.62%	9.14%	8.90%	9.03%	11.52%	11.97%	8.85%
	May	211	296	255	573	108	31	9	1483
	%(+)	9.21%	9.89%	9.87%	9.14%	10.06%	7.60%	7.69%	9.43%
	June	206	262	215	550	104	41	19	1397
	%(+)	9.00%	8.76%	8.32%	8.78%	9.68%	10.05%	16.24%	8.88%
	July	230	248	217	535	94	27	14	1365
	%(+)	10.04%	8.29%	8.40%	8.54%	8.75%	6.62%	11.97%	8.68%
	August	219	271	185	518	85	37	5	1320
	%(+)	9.56%	9.06%	7.16%	8.27%	7.91%	9.07%	4.27%	8.39%
	September	216	255	169	524	82	23	8	1277
	%(+)	9.43%	8.52%	6.54%	8.36%	7.64%	5.64%	6.84%	8.12%
	October	192	243	200	483	76	31	7	1232
	%(+)	8.38%	8.12%	7.74%	7.71%	7.08%	7.60%	5.98%	7.83%
	November	166	221	199	520	75	33	9	1223
	%(+)	7.25%	7.39%	7.70%	8.30%	6.98%	8.09%	7.69%	7.77%
	December	171	255	209	481	87	28	7	1238
	%(+)	7.47%	8.52%	8.09%	7.68%	8.10%	6.86%	5.98%	7.87%
		2290	2992	2583	6267	1074	408	117	15731
	%(-)	14.56%	19.02%	16.42%	39.84%	6.83%	2.59%	0.74%	100.00 %
Gender	Male	1549	2197	2438	4335	795	399	71	11784
	%(-)	13.14%	18.64%	20.69%	36.79%	6.75%	3.39%	0.60%	100.00 %
	%(*)	67.64%	73.43%	94.39%	69.17%	74.02%	97.79%	60.68%	74.91%
	Female	741	795	145	1932	279	9	46	3947
	%(-)	18.77%	20.14%	3.67%	48.95%	7.07%	0.23%	1.17%	100.00 %
	%(*)	32.36%	26.57%	5.61%	30.83%	25.98%	2.21%	39.32%	25.09%

Suicide cause and month χ^2=108.49. sd=66. p=0.001; Suicide cause and gender χ^2=825.676. sd=6. p=0.001
% of the distribution of the suicide cause by months (% of columns) +; % of the distribution of the suicide cause by gender (% of columns) *; % of rows

these measurements (14,15,20). These values for the whole dataset were found 0.04, 0.96, 286.20 and 0.08, respectively. The data have showed a high variation on the circle according to the mean resultant length or circular variance value, a low scattering according to circular dispersion measure and a homogeneous distribution according to concentration parameter. Thus, it can be noted that suicide cases are distributed equally approximately during the year. In addition, the circular standard deviation is 144.51°.

Table 2. Circular Descriptive Statistics for Suicide and Suicide Causes

Suicide Causes	Sample Size (N)	%	Mean Direction (Degree)	Mean Resultant Length	Circular Variance	Circular Standard Deviation	Circular Dispersion	Von Mises Concentration
1	2290	%14.56	199.69	0.08	0.92	127.87	71.68	0.17
2	2992	%19.02	181.98	0.04	0.96	146.53	338.85	0.08
3	2583	%16.42	90.20	0.07	0.93	131.54	95.64	0.14
4	6267	%39.84	146.98	0.04	0.96	147.28	364.08	0.07
5	1074	%6.83	129.86	0.07	0.93	133.66	111.86	0.13
6	408	%2.59	101.22	0.09	0.91	124.81	55.29	0.19
7	117	%0.74	145.76	0.17	0.83	108.00	15.29	0.34
Total	15731	%100.00	148.11	0.04	0.96	144.51	286.20	0.08

1: Domestic Violence, 2: Other Causes, 3: Livelihood Difficulty, 4: Disease, 5: ERUMDP, 6: Business Failure, 7: Educational Failure, Total: All Suicide Cases (General)

Table 3. Hypothesis Tests for Group Comparisons

Null Hypothesis		Test	Test Statistic	Prob. Level	Reject H0 at 0.05 Level
Equal Distributions		Uniform Scores Test	52.96	0.001	Yes
First Group	Second Group				
1	2		6.30	0.043	Yes
1	3		38.89	0.001	Yes
1	4		15.75	0.001	Yes
1	5		11.07	0.001	Yes
1	6		12.52	0.001	Yes
2	3		18.97	0.001	Yes
2	6		6.49	0.039	Yes
3	4		12.97	0.001	Yes
Equal Directions		Watson-Williams F Test	187.77	0.001	Yes
3	6		2.21	0.137	No
4	7		0.03	0.874	No
5	7		2.23	0.135	No
Equal Concentrations		Concentration Homogeneity Test	15.37	0.017	Yes
1	2		5.25	0.022	Yes
1	4		7.18	0.007	Yes
3	4		4.48	0.034	Yes
4	7		3.97	0.046	Yes

According to the sample sizes, the highest and lowest risk factors are disease (39.84%) and educational failure (0.74%), respectively. The mean directions of the samples vary between 90.02° and 199.69°. The livelihood difficulty which shows the lowest mean direction of these causes with an angle of 90.02° indicates the beginning of April while the domestic violence which shows the highest mean direction with an angle of 199.69° indicates the third quarter of July. The mean direction of suicide cases belonging to the other 5 reasons; the other causes takes part in the first quarter of July, the disease in the last quarter of May, ERUMDP in the second quarter of May, business failure in the second quarter of April, and education failure in the last quarter of May. Thus, it can be stated that the mean directions of these 7 causes of suicide vary between April and July. According to four measurements, it was observed that all groups except educational failure were homogeneously dispersed throughout the year. However, the fact that

Table 4. Uniform Distribution Goodness-Of-Fit Tests

Suicide Causes	Sample Size (N)	Rayleigh		Kuiper	
		Test Statistic	Prob. Level	Test Statistic	Prob. Level
1	2290	31.52	0.001	6.71	0.001
2	2992	8.64	0.013	6.30	0.001
3	2583	26.57	0.001	6.50	0.001
4	6267	16.14	0.001	8.78	0.001
5	1074	9.31	0.010	4.12	0.001
6	408	7.10	0.029	3.09	0.001
7	117	6.72	0.035	2.51	0.001
Total	15731	54.37	0.001	13.93	0.001

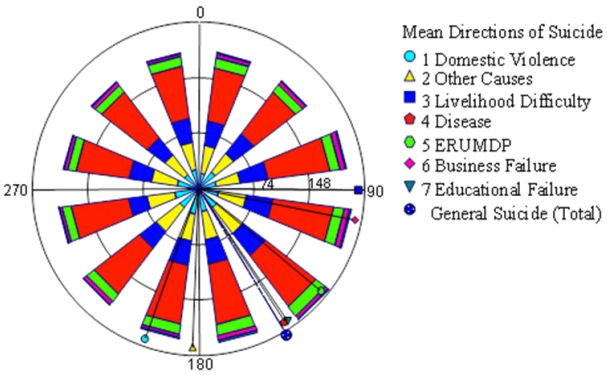

Fig. 1. Rose Diagram of Monthly Distributions of General Suicide and Suicide Causes

the suicide cases due to educational failure have a very low circular dispersion value as 15.29 indicates that the data are concentrated at certain points on the circle. The standard deviation of suicide cases due to educational failure was also found lower as compared to others. Thus, by knowing any of $\bar{R}$, V, δ and κ parameters, it can be estimated whether the data set is concentrated at any point on the perimeter of circle or how it is dispersed.

Calculated $\bar{R}$, V, δ and κ parameters show that suicide cases except for educational failure are distributed properly for approximately 12 months. However, uniform distribution plays a pivotal role in circular analysis due to representation of the state of not having "mean direction". It is called random distribution because here all of directions have equally possibility (12,14,19). Therefore, the suicide cases follow multimodal distribution for the first six samples.

The probability density function of the circular uniform distribution is (14,15);

$$f(\theta) = \frac{1}{2\pi} \qquad 0 \leq \theta < 2\pi$$

In Table 3, test statistics similar to Post-hoc tests were given for group comparisons. Whether sample distributions, mean directions, and concentration parameters are equal to each other was tested with this test statistic. The null hypothesis was rejected ($p<0.05$) for all three parameters. Thus, it can be stated that at least one sample distribution according to the Uniform Scores test ($p<0.05$), at least one sample mean direction according to the Watson-Williams F test ($p<0.05$), at least one sample condensation parameter according to the Concentration Homogeneity test ($p<0.05$) were different from the others at the level of $\alpha=0.05$ significance.

In order to determine which groups the difference originated from, binary group comparisons were performed, which perform the same function as multiple comparison tests in the linear data. Thus, 21 comparisons were made for each feature and some results expressing acceptance or rejection of the difference are given in Table 3. Accordingly, the equality of the sample distributions was rejected for 8 comparisons ($p<0.05$), while the remaining 13 which are not given in the Table 3 were accepted for comparison. From the 21 comparisons made for the equality of sample mean directions, it was accepted that the mean direction of only 3 group were not different ($p>0.05$) from each other at the level of $\alpha=0.05$ significance. On the other hand, from comparisons made for the equality of sample concentration parameters, it was accepted that the concentration parameter of only 4 group were different ($p<0.05$) from each other at the level of $\alpha=0.05$ significance.

The Rayleigh and Kuiper test statistics to test whether the groups are compatible with uniform distribution are presented in Table 4. The compliance of the groups to uniform distribution was rejected at the level of 0.05 significance since the p values belonging to all groups of the two tests were less than 0.05. Thus, it can be stated that the suicide and the suicide

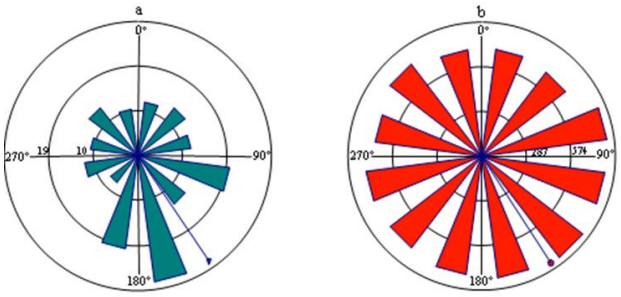

Fig. 2. Rose Diagram Belonging to Suicide Causes Related to Disease and to Education Failure

cases according to causes do not show uniform distribution on the circle.

The rose diagram showing monthly distribution of suicide cases according to suicide causes is presented in Figure 1. The starting direction, the north and the rotating direction were taken clockwise. So, 0° indicates the first day of January. In the diagram, the bar and each of the spaces following the bar consist of angles of 15°. For this reason, each the bar segment and the sum of the half of the spaces before and after the bar is by 30°. Thus, 1 month corresponds to an angle of about 30°, and the area belonging to 1 bar without any color separation, shows the total cases of suicide in that month.

From the rose diagram, it can be stated that suicides are uniformly distributed in general and therefore, there is no a mean direction. However, in spite of not significant, it is indicated that the general mean direction is between 90° and 180° and in the last quarter of the 5th bar area. This range observed in the Figure 1 can be found approximately 148° by using equation (4) as well. Observed or calculated value indicates that the general suicide mean direction coincides with the end of May.

The mean directions related with suicide causes are between about 90° (beginning of April) and 200° (the last quarter of July). In addition, it is stated that the mean directions of suicides due to general, disease and educational failure are very close to each other. It is clearly observed from Table 3 that there is no difference between the mean directions of suicide cases due to disease and educational failure. It can be stated that the all groups generally show a distribution close to uniform distribution. However, in order to make decisions about the distributions of each cause, it would be more accurate to just look at the rose diagram related that cause.

The rose diagram showing the distribution of suicide cases caused by the disease by months is presented in Figure 2-a, while the rose diagram showing the distribution of suicide cases caused by the education failure by months is presented in Figure 2-b as well. According to Figure 2-a, it is appear that nearly all of the data is distributed equally on the perimeter of the circle. This is also valid for suicide cases due to 5 other reasons, except for suicide cases related the education failure shown in Figure 2-b. Therefore, it can be stated that the scattering of suicide cases belonging to 6 suicide causes are high, don't show a significant concentration at any point and are distributed throughout the year. In addition, it can be observed that they have multimodal distributions. However, in Figure 2-b, the scattering of the data is very lower and the data mainly shows a large concentration between 150° and 210°. This interval, in which the data are concentrated, corresponds to June and July. Furthermore, the mean direction in the last quarter of the 5th bar shows that the mean of suicide cases due to educational failure is the end of May.

The validity of the statistical data analysis method to be used in the studies is directly related to the data structure and the scale type. However, it is necessary to choose an analysis method appropriate to the scale type and data structure since similar statistical analysis method cannot be applied to the data obtained from each scientific research. The fact that the topographic structure of the circle and the line is different from each other also makes the data structure and scale type defined on them different from each other. Therefore, it can be stated that it would be more appropriate to apply circular statistical methods to such periodic data, since the application of linear statistical methods to the data obtained with an angle or the time cycle can give misleading results (21).

Since the data in the study have a categorical data structure, frequency tables related to the relevant data were created in accordance with the literature and χ^2 test statistics were computed. In conclusion, it was concluded that suicide cases were more common among men, disease constituted a high risk factor, maximum suicide cases occurred in May, and there was a significant difference between gender and the causes of suicide. In addition, it was determined that data related to 6 suicide causes other than educational failure was distributed to 12 months. It was observed that suicide related to education failure was concentrated especially in June and July. Thus, a significant relationship was found between the suicide months and the causes of suicide ($p<0.05$).

Circular data analysis results; According to the mean direction (148.11°), the mean suicide date was calculated as May 29. According to the 4 measurements showing the data distribution, it was determined that the data set shows a low variation compared to the months and did not show a significant concentration at any point. In addition, according to the suicide causes, it was determined that

the disease was the highest risk factor and the mean direction of suicide causes ranged from April (90.20°) to July (199.69°). It has been observed that suicides due to reasons other than educational failure are low distribution in terms of months. Most importantly, group comparisons were made for circular data and it was determined from which groups the difference originated.

When the suicide attempts in Ankara were examined, it was observed that 65.33% of these cases were women, the suicide attempts were most frequently in June (10.60%) and August (10.48%) (22). 333 cases brought to the Erciyes University Faculty of Medicine Emergency Department due to suicide attempt were examined. It was observed that 63.0% of the cases were female, and that 25% of the cases occurred in July. The domestic violence (27.0%) was determined as a risk factor (23). 210 suicide attempts in Adıyaman were addressed, and 71.90% of them were women. It was observed that there was no significant difference between monthly distributions, however the highest suicide attempt occurred in February (12.35%) and risk factors differ between men and women (4). Suicide-related deaths in Italy were investigated between 1974 and 2003. A strong relationship was found between monthly mean temperature and suicide cases in men. Suicide cases increased with the increase in temperature between May and August while decreased in November and December, and further decreased with temperature especially in January. The relationship between temperature and suicide was found lower in women than in men (24). In Switzerland, 49763 suicide cases recorded according to the day of death between 1969 and 2003 were examined and 70.5% of them were observed the male. Furthermore, the most suicide occurred on May 13 (183) and the least on December 25 (80) (6). 4918 suicide cases (63.02% male, 36.98% female) in Budapest were examined. It has been stated that suicide cases indicated a low variation compared to the seasons, but were higher in low humidity and hot weather (25). 22350 suicide cases occurred in Turkey between 1996 and 2005 were studied. While men constituted 61.26% of the cases, the disease (29.55%) was identified as the highest risk factor. Furthermore, suicide cases were most frequently observed in July (9.77%) and at least in October (7.07%) (26). 499 suicide attempts in Şanlıurfa were evaluated, and it was determined that the majority of them were female (83.7%) and the highest risk factor was mental depression (41.1%). In addition, cases were most frequently observed in July (13.5%) and at least in October (3.9%) (3). Suicide cases in Korea were examined in terms of some parameters and it was determined that temperature was an important risk factor. In addition, the highest suicide cases occurred in April and followed by August and June (27). 193 cases brought to Kastamonu State Hospital as a result of suicide attempt between 2008 and 2010 were examined. It was emphasized that 77.7% of the cases were female, the highest risk factor was psychiatric disease (40%) and most of the cases were observed in summer (32%), especially in August (13.47%) (2). Suicide cases that took place in Taiwan between 1991 and 2010 were examined, it was determined that suicide cases increased as the temperature increased and 67.85% of 55362 cases were male. Additionally, it was emphasized that monthly temperature increase was more important than economic factors in suicide cases (28). In this study, results consistent with the literature have been obtained. However, the study, in terms of the relationship between gender and suicide cases, only contrasts to the work done in Turkey.

Although frequency tables and χ^2 test give some results close to the circular analysis in the analysis of categorical data, they do not provide as much detailed results as the circular data analysis. In addition, it is impossible to analysis categorical or the data represented by an angle (vector quantity) by linear statistical methods, such as student-t test and ANOVA. If the standard linear statistical methods are used in the analysis of such data, misleading results can be obtained. Thus, the circular data analysis method gives more detailed and accurate results in the analysis of data represented by an angle (such as degree, radian) or in the analysis of categorical data containing the data represented by a time measure (such as hour, day, year). Furthermore, the interpretation of descriptive statistics and hypothesis tests in circular statistical methods is easier and the results are supported by visuals (7).

In conclusion, it was emphasized that standard linear methods for many reasons should not be used in the analysis of circular data. Thus, circular analysis method was recommended for the analysis of such data.

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