



# The High Suicide Rates at High Altitudes May Be Related to Divorce

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## Abstract

**Aim:** Many studies have found that high altitudes are associated with suicide. Despite numerous studies in the literature, the mechanism by which high altitude increases suicide rates is not known. In this study, we investigated whether divorce affects the suicide rate at high altitudes.

**Material and Method:** Using publicly available data from the Turkish Statistical Institute (TUIK), the average altitude above sea level, suicide rate, and divorce rate of each province over the last 14 years were calculated. Divorce rates, suicide rates, and altitudes were statistically compared at the end of the study.

**Results:** The mean suicide rate did not differ according to altitude ( $r=0.112$ ;  $p=0.322$ ). The mean divorce rate differed according to altitude. The highest mean divorce rate was observed in the group with an altitude of less than 500 m ( $p<0.001$ ). In the correlation analysis, it was found that altitude was negatively correlated with the divorce rate, divorce, and suicide rates were positively correlated, and in the regression analysis, high altitude and divorce rate increased the suicide rate ( $<0.05$ ).

**Conclusion:** Our study suggests that divorced people in high-altitude areas are in the high-risk group for suicide and that mental health protective interventions, especially for this group, may be appropriate for prevention. In conclusion, this study is important, as it is the first to investigate the relationship between altitude, divorce, and suicide. Larger-scale studies in which individual factors were excluded are required.

**Keywords:** Altitude, divorce, suicide, family ties, geographical region

## INTRODUCTION

Suicide is the voluntary ending of one's life. Its etiology is multifactorial. Suicide attempts may occur due to biological, sociological, and psychological reasons. Suicide is among the leading causes of death worldwide, with more deaths due to suicide than to malaria, Human Immunodeficiency Virus (HIV)/Acquired Immunodeficiency Syndrome (AIDS), breast cancer, war, and homicide. More than one in every 100 deaths (1.3%) in 2019 were the result of suicide. According to the World Health Organisation (WHO), 700,000 people died by taking their own lives in 2019 (1). It is estimated that suicidal acts are 10 times higher than this number. Suicide and suicide attempts have become a public health problem

in many countries because they leave severe traumas on the immediate environment and society. For this reason, every country is trying to develop various policies and measures to prevent suicide. Despite this, the number of people dying by suicide is increasing day by day. The biggest obstacle to early intervention is the lack of knowledge of the population at risk. Many studies have identified various risk factors that may be associated with suicide. The biggest risk factor is psychiatric diseases especially depressive disorder (2). The high suicide rate in some families indicates that the event may be genetically related (3). The concept of suicide has been handled from psychological, sociological, biological, and economic perspectives and various theories have been developed

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on its causes. When we look at sociological risks, it has been reported that weak social ties may constitute a risk for suicide. Other sociological risk factors include family discord, divorce, forced migration, inability to find a job, course failure, etc. (4). Most studies have focused on the biological and psychological causes of suicide. Recent studies have focused on natural environmental factors, such as altitude, temperature, and climatic factors. A study conducted in Türkiye found that high altitude and low temperature were associated with female suicide (5). A meta-analysis reported a positive relationship between high altitude and suicide in 17 of 19 studies (United States (n=11), Türkiye (n=2), Ecuador (n=1), Japan (n=1), South Korea (n=1), Austria (n=1), Italy (n=1), and one study that encompassed sixty-two nations.) (6). It is not known exactly which factors affect suicide rates at high altitudes. However, most studies conducted on the sociological causes of suicide reported that divorce was positively associated with suicide. Being divorced or separated is associated with a higher suicide risk than never being married, for both sexes. The separated have an odds ratio over five times as high as married do (7). Some studies have reported that divorce is negatively associated with suicide in some groups (8). Individual factors have been ignored in most studies. Although many studies have been conducted on which factors mediate the high suicide rate at high altitudes, no definite conclusion has been reached. In this study, we investigated whether the divorce rate mediates the suicide rate at high altitudes.

## MATERIAL AND METHOD

Ethical approval for the study was obtained with the permission of the Karamanoğlu Mehmetbey University Ethics Committee, dated February 27, 2024, and numbered 01-2024/04. The data in this study were obtained from the web pages of the Turkish Statistical Institute (TUIK) (9). The suicide rate and divorce rate of all provinces in Türkiye (81 provinces) were calculated by taking the average of 14 years between 2009 and 2022. Crude suicide rate refers to the number of suicides per hundred thousand population (10). The crude divorce rate refers to the number of divorces per thousand population (11). The provinces were grouped at three different altitudes: 0-499m, 500-999m, and above 1000m (12). At the end of the study, divorce rate, suicide rate, and altitude were compared statistically.

### Statistical Analysis

All data were analyzed in a computer environment using SPSS 25.0. The conformity of the data to a normal distribution was evaluated using the Kolmogorov-Smirnov test. ANOVA test was used to determine the differences between groups in the analysis of normally distributed continuous variables. The Post Hoc Tamhane test was used to evaluate differences between the groups. Pearson's Correlation test was used to analyze

the relationships between continuous variables. The correlation coefficient was interpreted according to the correlation coefficients reported by Sumbuloglu (2007) (Low=0.01-0.49; Medium=0.50-0.69; High=0.70-1.00) (13). Linear regression analysis was used to examine the factors predicting mean suicide rates. In regression analyses, autocorrelation was evaluated with Durbin-Watson, and multicollinearity was evaluated using tolerance and variance inflation factor (VIF). A statistical significance level of  $p < 0.05$  was accepted in the study.

## RESULTS

Changes in suicide and divorce rates in Türkiye by years are given in Figure 1.

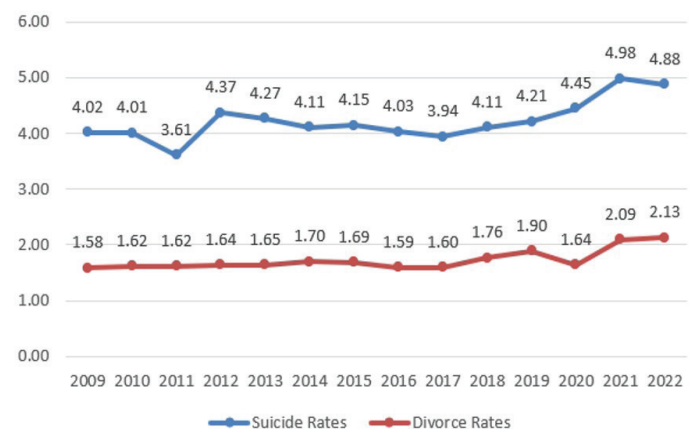


Figure 1. Changes in suicide and divorce rates by years (2009-2022)

The averages of suicide rates and divorce rates in all provinces between 2009 and 2022 are presented in Table 1.

When the correlation between altitude, suicide rates, and divorce rates of the provinces was analyzed, it was observed that there was a negative, moderate correlation between altitude and divorce rate, and a positive, weak correlation between suicide and divorce rates (Table 2).

The suicide rate averages did not differ according to altitude. However, the mean divorce rates differed between the groups, and the highest mean divorce rate was observed in the 0-499-meter altitude group ( $p < 0.001$ ) (Table 3).

In the regression model established between the mean crude suicide rates and the mean altitude and divorce rates, it was determined that there was no autocorrelation (Durbin-Watson=1.797), there was no multicollinearity problem, and the standardized residuals of the variables fit a normal distribution. The model explained 16.1% of the change in mean crude suicide rate ( $F=8.556$ ; Adj.  $R^2=0.161$ ;  $p < 0.001$ ). When the significance level of the  $\beta$  coefficient in the model was analyzed, it was observed that altitude made a positive ( $t=3.053$ ;  $p < 0.001$ ) and independent contribution to the model ( $t=3.991$ ;  $p < 0.001$ ) (Table 4).

Table 1. Altitude, average suicide rate (2009-2022) and average divorce rate (2009-2022)

Province name	Altitude (m)	Average suicide rates	Average divorce rates	Province name	Altitude (m)	Average suicide rates	Average divorce rates	Province name	Altitude (m)	Average suicide rates	Average divorce rates
Erzurum	1890	3.65	0.67	Kütahya	950	4.51	1.57	Kırklareli	209	5.02	1.87
Ardahan	1870	7.11	0.67	Mardin	938	3.25	0.47	Bursa	155	4.3	1.85
Kars	1768	5.94	0.6	Tunceli	914	9.62	1.62	Osmaniye	150	3.94	1.44
Hakkari	1748	4.04	0.2	Uşak	906	5.5	2.31	Düzce	146	3.32	1.78
Van	1727	4.37	0.37	Siirt	902	4.29	0.3	Balıkesir	139	5.15	2.07
Ağrı	1640	4.28	0.4	Iğdır	860	5.06	1.17	İstanbul	120	3.3	1.98
Bayburt	1556		0.65	Ankara	850	4.04	2.22	Hatay	85	2.85	1.52
Bitlis	1500	3.43	0.29	Gaziantep	843	3.77	1.42	Manisa	74	4.43	1.84
Muş	1404	5.7	0.29	Çorum	801	4.84	1.55	Aydın	64	7.03	2.27
Şırnak	1350	3.96	0.24	Kastamonu	798	5.11	1.2	Edirne	42	6.09	1.8
Yozgat	1301	3.38	1.47	Eskişehir	782	5.87	2.19	Antalya	39	4.93	2.72
Sivas	1285	4.37	1.2	Bolu	725	4.13	1.51	Sakarya	31	2.96	1.62
Nevşehir	1250	4.18	2.03	Çankırı	723	3.35	1.22	Adana	23	4.83	1.96
Niğde	1229	4.72	1.58	Kırkkale	700	4.63	2.07	Bartın	19	4.91	1.59
Erzincan	1214	4.07	1.25	Diyarbakır	670	4.77	0.56	Sinop	17	4.79	1.54
Gümüşhane	1153	1.76	0.65	Adıyaman	669	3.74	0.91	Tekirdağ	10	4.61	2.05
Bingöl	1151	5.39	0.55	Kilis	640	4.65	1.18	Trabzon	10	3.37	0.96
Kayseri	1071	5.06	1.93	Tokat	640	4.1	1.2	Zonguldak	10	4.93	1.81
Elazığ	1067	5.15	1.19	Muğla	625	6.21	2.58	Mersin	6	5.32	2.15
Karaman	1038	5.95	1.98	K.maraş	568	3.6	1.53	Rize	6	3.08	0.95
Isparta	1035	5.68	1.56	Batman	525	3.8	0.4	Giresun	5	3.12	1.32
Afyonkarahisar	1021	4.93	1.47	Artvin	520	3.18	1.01	Yalova	5	3.79	1.91
Konya	1016	4.12	1.77	Şanlıurfa	518	3.05	0.58	Samsun	4	4.21	1.52
Kırşehir	978	4.91	1.81	Bilecik	500	5.25	1.63	Çanakkale	3	5.42	1.84
Aksaray	975	3.6	2.12	Amasya	392	3.58	1.39	Kocaeli	3	3.5	1.81
Malatya	964	3.84	1.3	Denizli	354	6.23	2.38	Ordu	3	3.99	1.25
Burdur	950	6.45	1.67	Karabük	258	4.13	1.65	İzmir	2	4.98	2.77

Table 2. Correlation between altitude, average suicide rates, and average divorce rates of provinces

		Average suicide rates	Average divorce rates
Altitude (m)	r	0.112	-.546**
	p	0.322	<0.001
Average suicide rates	r	1	.288**
	p		0.010

\*\* Pearson's correlation test

Table 3. Comparison of the average suicide rate and average divorce rate of provinces by altitude

	Altitude (m)	n	Mean	Std. Dev	Min	Max	p*	p1	p2	p3
Average suicide rates	0-499 (1)	30	4.40	1.04	2.85	7.03	0.758			
	500-999 (2)	28	4.61	1.33	3.05	9.62				
	1000 and above (3)	23	4.60	1.13	1.76	7.11				
Average divorce rates	0-499 (1)	30	1.79	0.43	0.95	2.77	<0.001	<0.05	<0.05	>0.05
	500-999 (2)	28	1.40	0.61	0.30	2.58				
	1000 and above (3)	23	1.00	0.62	0.20	2.03				

\*ANOVA Test, p1=1 vs 2, p2=1 vs 3, p3=2 vs 3

Table 4. Effect of altitude and average divorce rate on predicting suicide rates of provinces

	Beta	Std. error	t	B	95.0% CI for B		Collinearity statistics	
					Lower bound	Upper bound	Tolerance	VIF
(Constant)		0.458	5.901*	2.705	1.792	3.617		
Altitude (m)	0.372	0.000	3.053*	0.001	0.000	0.001	0.714	1.400
Average divorce rates	0.487	0.226	3.991*	0.901	0.451	1.350	0.714	1.400

\* Linear regression analysis

## DISCUSSION

In our study, the suicide rate was found to be more related to the divorce rate in high-altitude areas than in low-altitude areas. According to our study, as the divorce rate increases in high-altitude areas, the suicide rate also increases. No studies in the literature have compared these three parameters: altitude, divorce rate, and suicide rate. Therefore, our study may lead to new research and contribute to the literature.

According to our study, there was no direct relationship between altitude and suicide rates. Several studies have investigated the relationship between altitude and suicide. In a meta-analysis, a positive relationship was found between high altitude and suicide rates in the majority of studies (6). The reason for the relationship between high altitude and suicide remains unknown. However, there are conflicting results for these reasons. A large-scale study conducted in China concluded that suicide rates were not directly related to the place of residence and that high suicide rates at high altitudes were related to low socioeconomic status (14). In contrast to this study, another study reported that suicide rates were still higher at high altitudes, even after excluding low socioeconomic levels, age, sex, and ethnic origin (15). Possible reasons for the lack of difference between the two variables in our study may be socioeconomic status, educational status, deficiency in keeping records, etc. However, suicide rate is not directly related to high altitude, suggesting that the increase in divorce rate at high altitude may mediate the increase in suicide rate.

A negative relationship was found between the divorce rate and altitude. The divorce rate was higher in provinces with low altitudes (0-499m) and lower in provinces with high altitudes (1000m and above).

The divorce rate was positively associated with the suicide rate in high-altitude areas. The fact that the divorce rate was positively associated with the suicide rate in high-altitude areas may be related to the fact that family ties are culturally strong in high-altitude areas and isolation as a result of divorce. The finding that the divorce rate was lower in high-altitude areas supports our hypothesis that the importance given to families is higher. There are no studies in the literature that investigate the relationship between altitude and divorce. In this respect, our study may lead to further research.

In this study, the positive relationship between the divorce rate and the suicide rate is consistent with the literature

(16-18). Although the positive relationship between divorce and suicidal behavior has been documented in many studies, the reasons for mediating this relationship are not fully known (19). Understanding the reason for the relationship between divorce and suicidal behavior and the conditions that play a role is important for the identification of the population at risk of suicide, screening, and early intervention. The fact that industrialization, urbanization, and education levels are higher in low-altitude provinces than in high-altitude provinces may have decreased the suicide rate as a result of divorce. The fact that divorces with religious marriages, which do not have legal validity in high altitude and rural areas, are not reflected in the statistics, on the other hand, traditional social pressures on marriage are higher in rural areas may have led to these results. In addition, the higher divorce rate in low-altitude areas may indicate culturally weak family ties. This may explain why the importance given to the family in low-altitude areas may be less than in high-altitude areas, and therefore, the divorce rate may have less effect on the suicide rate.

Our study had some limitations. First, individual factors such as educational status, socioeconomic status, age, and gender, which are confounding factors, were not considered. Provinces located at the same altitude but in different geographical regions were not compared. In Türkiye, death records are kept through the "Death Notification System" of the Ministry of Health. The causes of death entered into this system may be incomplete, which may make the number of suicides appear different than it is. In addition, data from only one country were evaluated. It should be taken into consideration that there may be cultural and behavioral differences between regions within the country

## CONCLUSION

The relationship between altitude and suicide is an emerging science and there is a small but growing literature suggesting that altitude is associated with increased suicide risk. This study suggests that divorce at high altitudes is not associated with suicide at the same rate as divorce at low altitudes, that divorced people at high altitudes are in the high-risk group for suicide, and that mental health interventions, especially those targeting this group, may be appropriate for prevention. In conclusion, this study is important, as it is the first to investigate the relationship between altitude, divorce, and suicide. Larger-scale studies in which individual factors were excluded are required.

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**Conflict of interest:** The authors have no conflicts of interest to declare.

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