Original Article

Trends in Suicide Mortality Rates for Turkey from 1987 to 2011: A Joinpoint Regression Analysis

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Abstract

Background: Suicide is among the top 20 leading causes of death globally in all age groups and it is still a significant social and public health problem.

Methods: Data on suicide deaths in 1987–2011 were extracted from the Turkish Statistical Institute mortality dataset based on ICD-9 and ICD-10 codes. The temporal trend in age-standardized suicide rates was tested for age, gender and methods using Joinpoint Regression Analysis.

Results: The average of age-standardized suicide rates of the period 1987–2011 were 3.08 per 100,000 people, 3.95 for male and 2.21 for female. Significant increases were observed in males in all age groups, but no significant changes were observed in females over the age of 45. The most common methods of suicide among people who live in Turkey were hanging, poisoning, firearms and jumping.

Conclusion: High-risk groups could benefit from targeted strategies of suicide prevention. To understand the important influences on suicide risk in different age groups, future studies must investigate the experiences of older and younger individuals separately.

Keywords: Joinpoint regression analysis, mortality data, suicide, suicide methods, trend

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Introduction

Suicide is among the top 20 leading causes of death globally for all ages and it remains a significant social and public health problem. According to the World Health Organization statistics, about one million people worldwide die from suicide every year (mean mortality rate: 16 per 100,000), that is, one death every 40 seconds.[1] In 2009, the Lancet identified Lithuania, Finland, Latvia, Hungary, China, Japan and Kazakhstan as all having exceptionally high rates of suicide, 20 per 100,000 people or higher.[2] There are marked differences in suicidal behavior between developed and developing countries.[3] Low suicide rates in the Gulf States may reflect religious norms and low alcohol use. In general, a gradient has been described whereupon agnostics show the highest suicide rates, Muslims have the lowest, while Christians, Buddhists and Hindus are in the middle.[4,5]

Globally, during the last few decades suicide rates have been highest in the elderly.[5] However, according to the World Health Organization's Suicide Prevention Program website, suicide rates have increased among young people so that adolescents and young adults represent the group at the highest risk for suicide.[6] Worldwide, suicide is one of the three leading causes of death among those in the most economically productive age group (15–44 years), and the second leading cause of death in the 15–19 years age group. A total of 2.6 million deaths occurred in people aged 10–24 years in 2004. Of these, 2.56 million were in low-income and middle-income countries, and almost two thirds were in sub-Saharan Africa and southeast Asia. Pronounced rises in mortality rates were recorded from early adolescence (10–14 years) to young adulthood (20–24 years).[7] In developed countries, suicide rate is high in the age group of 15 to 24 years and highest in the elderly. In developing countries, the highest rate is found in the young (below 30 years) and the married females are at a higher risk.[3]

Overall, rates of completed suicide are higher in males than in females.[5] Studies have shown that rates of suicide and the male-to-female suicide ratio vary from one country to another. The male-to-female suicide ratio is highest in the European Region and the lowest in the Eastern Mediterranean region.[8] Females from South-East Asia have a remarkably high suicide rate among 15–29-year-olds. Among females, South Korea is at the top of world with a suicide rate of 22.1.[8] Suicide is also the world leading cause of death in females aged 15–24 years, mainly in low-income and middle-income countries, according to Patton, *et al*.[7]

Suicide methods vary across countries. The methods used in developed countries are firearms, car exhaust and poisoning, whereas in developing countries, they are pesticide poisoning, hanging, and self-immolation.[3] Also, firearm suicide was the most common method in the United States.[9] Suicide by hanging is the most common method of suicide in many Asian countries, in many Western countries and fifteen European countries.[10–12] Also, hanging is the preferred method for both genders and for most of the age groups in Turkey.[13]

Regional variations in suicide rates reflect varying environmental and social risk factors. Risk factors for suicide include mental and physical illness, alcohol or drug abuse, chronic illness, acute emotional distress, violence, a sudden and major change in an individual's life, such as loss of employment, separation from a

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partner, or other adverse events or, in many cases, a combination of these factors, but the reasons vary by region and sex.[14]

The aims of this study were as follows: (a) to provide the use of joinpoint regressions analysis (b) to describe the changing trends over distinct periods of time (c) to determine significant increases or decreases in suicide mortality (d) to describe suicide methods for males and females (e) to describe the age distribution of males and females.

Materials and Methods

Suicide data

Mortality data for the period 1987–2011 were obtained from the Turkish Statistical Institute death database. Turkish Statistical Institute (TurkStat) has collected data on suicide events for the country since 1962. Annual Reports of Suicide Statistics have been published as a separate publication since 1974. Estimates of the population at risk in each year were obtained from TurkStat. We included all male and female deaths.[15] Suicide codes are defined according to the International Classification of Diseases (ICD), 9th revision (E950-E959) for the period of 1987–1999[16] and 10th revision (X60-X84) for the period of 2000–2011.[17]

Statistical analysis

Joinpoint regression is a statistical modeling technique that explains the relationship between two variables by means of a segmented linear regression constrained to be continuous everywhere, in particular, in those places where the slope of the regression function changes. This technique is widely applied to the modeling of time trends in mortality or incidence series in epidemiological studies.[18]

Trends in age-standardized suicide rates were calculated by joinpoint regression using Joinpoint software version 4.0.4.[19] Joinpoint regression was used to detect points (i.e., "joinpoints") where the trends changed significantly. The analysis starts with the minimum number of joinpoints and tests whether one or more joinpoints are statistically significant and must be added to the model. The number of joinpoints were determined by performing permutation tests, each of which had a correct asymptotic significance level. These significance level were found using Monte Carlo methods and applying Bonferroni corrections.[20] The final model shows (the autocorrelation is adjusted for in the joinpoint regression analysis and the autocorrelation parameter is estimated separately for each by-group) the best fitting joinpoints where the rate changes significantly. Each joinpoint informs of a statistically significant change, an estimated annual percent change (APC) and average annual percent change (AAPC) that are computed along with its 95% confidence intervals (95% CI). AAPC is the geometric mean of the annual changes from all of the partitions. Also, AAPC takes into account trend transitions.[21] Finally, we tested whether male and female suicide rates were parallel or not during 1987–2011.[22]

In this study, each of detected trends was calculated by fitting a regression line to the natural logarithm of the rates, using calendar year as regressor variable [ln(rate) = a + bx], where x is calendar year; APC was estimated as $\left[100*\left(e^{b}-1\right)\right]$. The APC was considered significant if the confidence interval did not include zero. The parameters were allowed with maximum of four joinpoints to enter the final model while having minimum of 4 years between two joinpoints. The analyses were applied with a significance level of 0.05.

All analyses were performed separately for males and females as several aspects in suicide differ between genders. Age-standardized death rates per 100,000 people (using WHO standard population) were calculated for each calendar year using direct standardization the changes in the age-standardized mortality rate over the 25-year period were analyzed for suicide by fitting the joinpoint regression model. Ten-year age groups were used for the standardization. This approach adjusts crude rates according to the age distribution, so it is useful for comparing populations of different cities or countries.[23] The subgroup analyses were also performed for age (divided in six strata: 15–24, 25–34, 35–44, 45–54, 55–64, and 65 years and over) and suicide methods (five groups were considered: hanging; firearms; poisoning (using natural gas or lpg etc., taking chemicals and drug); jumping (from a high place, into the water and jumping off a train or another motorized vehicle) and other methods (by burning, using a sharp instrument and undetermined).

Results

Overall trends

There were 50642 deaths recorded as suicides during the time period investigated (1987–2011), of which 63.71% occurred in males (n = 32269) and 36.28% in females (n = 18373). The joinpoint regression was performed to the data and quantified the observed changes. The average of age-standardized suicide rates in Turkey from 1987 (2.33 death/100,000) to 2011 (3.34 deaths/100,000) were 3.08 per 100,000 people, 3.95 for males and 2.21 for females.

The age-standardized suicide rates presented a significant increase of 3.19% per year from 1992 to 2000. The age-standardized suicide rates for females presented a significant increase of 8.45% per year from 1992 to 1997, and a significant decline of 5.41% per year from 2003 onwards. The age-standardized suicide rates for males remained stable during the time period with a significant increase of 2.8% (Figure 1).

In this study, the average male-to-female suicide ratio was found to be 1.8 for the period 1987–2011. This ratio was the highest for the age group "65 years and over" (3.5), while it was the lowest for the age group "15–24" (0.96), in which the suicide rate of females was greater than the males'.

Gender and age groups

The results of the joinpoint regression analysis (i.e., the points in which the rates are changed significiantly), the APC for each trend, and the AAPC for both genders (according to age-strata) are shown in Table 1.

Evaluated according to the age, single joinpoint model (in 2005) is found to be the best-fit model for male suicide rates in the age group 15–24. In other age groups, zero joinpoint model (a steady significant increase in the range of 1.5% to 3.3% during the period observed) was determined as the best model. In females aged 15-24 years, four joinpoint models were obtained as the best model. Suicide rates presented a significant increase of 11.28% per year from 1991 to 1997, and a significant decline of 9.71% per year from 2004 to 2011. For suicide rates in the age group 25–34, one joinpoint model (in 2003) was obtained as the best-fit model. Suicide rates presented a significant increase of 4.57% per year from 1987 to 2003, and a significant decline of 4.63% per year from 2003 onwards. In other age groups, females did not present

Table 1. Suicide mortality trends by age-strata and gender, Turkey 1987–2011: joinpoint analysis.

Age (years)	Male					Female					
Joinpoints (Years)	**Time Period**	**APC[1] (95%CI[2])**	***P* -value**	**AAPC[3] 2002-2011 (95%CI)**	***P*-value**	**Joinpoints (Years)**	**Time Period**	**APC (95%CI)**	***P*-value**	**AAPC 2002-2011 (95%CI)**	***P*-value**
15–24 1 joinpoint 2005	1987–2005 2005–2011	^4.9 (3.7; 6.0) -2.5 (-8.0; 3.3)	<0.001 0.36	-0.1 (-3.7; 3.6)	0.95	4 joinpoint1991 1997 2000 2004	1987–1991 1991–1997 1997–2000 2000–2004 2004–2011	-2.3 (-11.1; 7.5) ^11.3 (4.0; 19.0) -6.1 (-30.6; 26.9) 14.3 (-1.7; 32.9) ^-9.7 (-13.3; -6.0)	0.59 <0.001 0.65 0.052 <0.001	^-4.9 (-8.7; -0.9)	0.017
25–34 0 joinpoint	1987–2011	^3.0 (2.3; 3.7)	<0.001	^3.0 (2.3; 3.7)	<0.001	1 joinpoint 2003	1987–2003 2003–2011	^4.6 (2.9; 6.3) ^-4.6 (-9.0; 0.0)	<0.001 0.036	-3.7 (-7.4; 0.2)	0.064
35–44 0 joinpoint	1987–2011	^2.9 (2.2; 3.6)	<0.001	^2.9 (2.2; 3.6)	<0.001	0 joinpoint	1987–2011	^1.5 (0.5; 2.5)	0.002	^1.5 (0.5; 2.5)	0.004
45–54 0 joinpoint	1987–2011	^3.3 (2.5; 4.1)	<0.001	^3.3 (2.5; 4.1)	<0.001	0 joinpoint	1991–1997	0.4 (-0.7; 1.6)	0.45	0.4 (-0.7; 1.6)	0.46
55–64 0 joinpoint	1987–2011	^2.0 (0.8; 3.2)	<0.001	^2.0 (0.8; 3.2)	<0.001	0 joinpoint	1987–2011	0.3 (-0.9; 1.4)	0.64	0.3 (-0.9; 1.4)	0.65
65+ 0 joinpoint	1987–2011	^1.5 (0.4; 2.7)	<0.001	^1.5 (0.4; 2.7)	<0.001	0 joinpoint	1987–2011	0.0 (-0.9; 0.9)	0.99	0.0 (-0.9; 0.9)	0.99

[1]APC :annual percent change; [2] CI: Confidence Interval; [3] AAPC: average annual percent change; ^APC and AAPC are statistically significantly different from zero (two-sided $P < 0.05$).

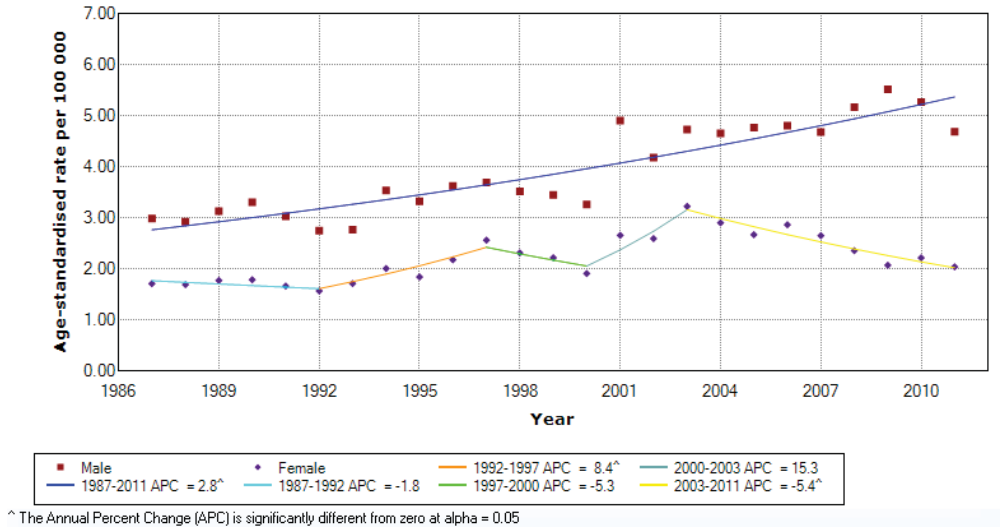

Figure 1. Age-standardized suicide mortality rate by gender. Age-suicide rates (symbols), estimated trends (straight lines) (joinpoint analysis) aged 15 years and over, Turkey, 1987–2011.

Table 2. Trends in Methods of Suicide for males and females in Turkey 1987–2011 : joinpoint analysis.

Suicide Methods	Male					Female				
Joinpoints (Years)	**Time Period**	**APC[1] (95%CI[2])**	***P*-value**	**AAPC[3] 2002–2011 (95%CI)**	***P*-value**	**Joinpoints (Years)**	**Time Period**	**APC (95%CI)**	***P*-value**	**AAPC 2002–2011 (95%CI)**	***P*-value**
Hanging 0 joinpoint	1987–2011	^2.3 (1.7; 3.0)	<0.001	^2.3 (1.7; 3.0)	<0.001	4 joinpoint 1991 1997 2000 2003	1987–1991 1991–1997 1997–2000 2000–2003 2003–2011	-3.1 (-7.0; 0.9) ^3.2 (0.4; 6.0) -6.4 (-21.0; 10.9) 12.8 (-4.8; 33.6) -1.1 (-2.3; 0.1)	0.089 0.011 0.39 0.12 0.052	0.3 (-1.6; 2.3)	0.73
Poisoning 4 joinpoint	1987–1990 1990–1994 1994–1999 1999–2002 2002–2011	12.8 (-2.9; 31.1) -11.1 (-22.7; 2.2) 3.3 (-4.7; 11.9) 22.2 (-15.7; 77.0) ^-7.8 (-9.6; -5.8)	0.07 0.06 0.38 0.23 <0.001	^-7.8 (-9.6; -5.8)	<0.001	1 joinpoint 2006	1987–2006 2006–2011	^5.6 (3.8; 7.4) ^-31.2 (-40.2; -20.8)	<0.001 <0.001	^-16.8 (-22.7; -10.4)	<0.001
Firearms 3 joinpoint	1987–1992 1992–1997 1997–2009 2009–2011	3.8 (-1.3; 9.2) ^13.8 (5.7; 22.5) ^5.4 (3.8; 6.7) -2.6 (-14.5; 10.9)	0.11 <0.001 <0.001 0.66	2.6 (-1.4; 6.9)	0.20	4 joinpoint 1994 1997 2000 2005	1987–1994 1994–1997 1997–2000 2000–2005 2005–2011	^12.6 (7.9; 17.5) 41.8 (-12.1; 128.8) -15.5 (-47.6; 36.4) 8.4 (-2.7; 20.7) -3.7 (-8.8; 1.8)	<0.001 0.11 0.44 0.10 0.13	0.2 (-4.3; 4.9)	0.93
Jumping 0 joinpoint	1987–2011	0.2 (-0.3; 0.7)	0.40	0.2 (-0.3; 0.7)	0.41	1 joinpoint 2003	1987–2003 2003–2011	^2.3 (1.3; 3.4) ^-3.1 (-6.0; -0.1)	<0.001 0.03	-2.5 (-4.9; 0.0)	0.054
Other 1 joinpoint	1987–1993 1993–2011	-10.1 (-21.2; 2.5) ^5.1 (2.6; 7.5)	0.09 <0.001	^5.1 (2.6; 7.5)	<0.001	2 joinpoint 1996 2003	1987–1996 1996–2003 2003–2011	^-7.5 (-12.4; -2.3) ^23.1 (11.0; 36.5) -0.7 (-7.0; 6.0)	0.003 <0.001 0.82	1.7 (-3.8; 7.5)	0.56

[1]APC = annual percent change; [2] CI = confidence interval; [3] AAPC = average annual percent change; ^APC and AAPC are statistically significantly different from zero (two-sided $P < 0.05$)

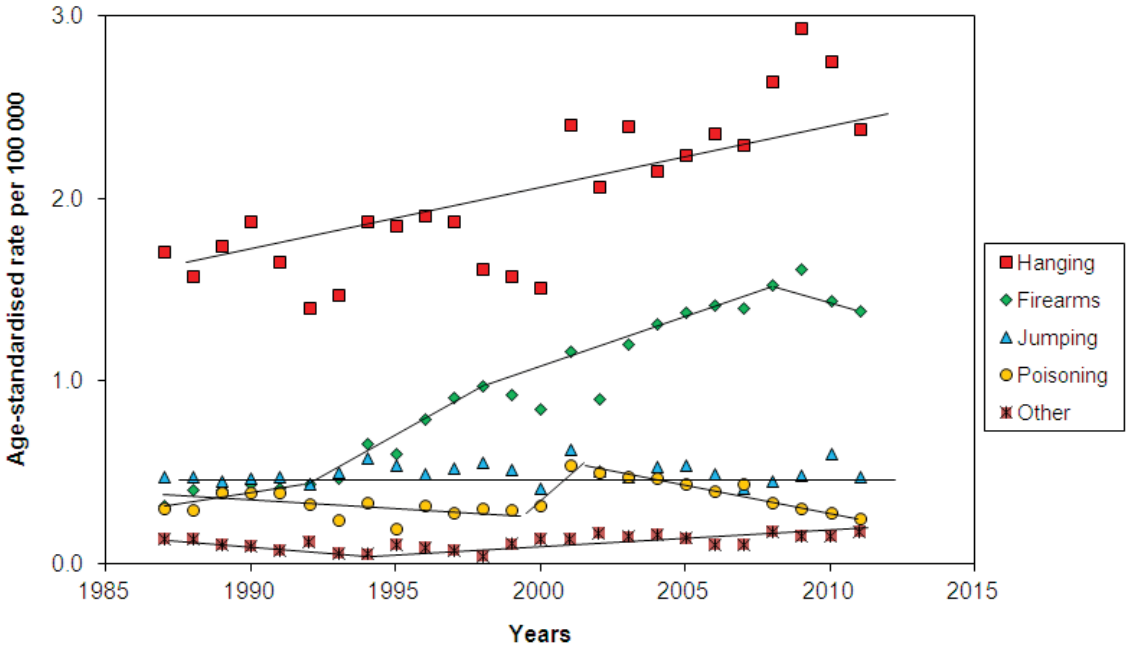

Figure 2. Suicide mortality rate by methods. Age-standardized suicide rates (symbols), estimated trends (straight lines) (joinpoint analysis) male aged 15 years and over, Turkey, 1987–2 011.

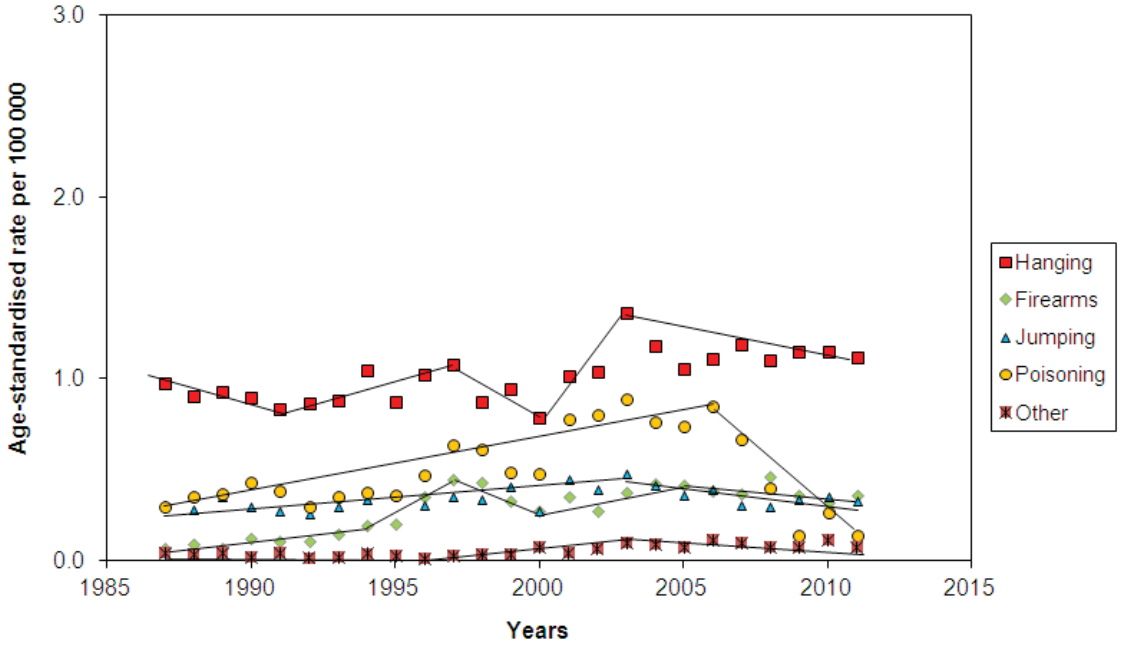

Figure 3. Suicide mortality rate by methods. Age-suicide rates (symbols), estimated trends (straight lines) (joinpoint analysis) female aged 15 years and over, Turkey, 1987–2011.

significant trend changes.

Significant increases were observed in males for all age groups. Unlike males, no significant changes were observed in females over the age of 45.

Gender and methods of suicide

The results of the joinpoint regression analysis (i.e., the points in which rates changed significiantly), the APC for each trend, and the AAPC in both genders (according to suicide methods) during the period 1987–2011 are shown in Table 2.

The most common methods of suicide among people who live in Turkey were hanging, firearm, poisoning with solid or liquid substances and jumping (Figure 2).

Suicide methods preferred by males and females also vary. For males, the most common method was hanging, with a significant increase of 4.04% per year from 1999 to 2011. Firearm was in the second place with a significant increase of 13.84% per year from 1992 to 1997, and a significant increase of 5.28% per year from

1997 to 2009. Poisoning was in the third place with a significant increase of 10.36% per year from 1995 to 2003, and a significant decline of 8.13% per year from 2003 to 2011. During the period, jumping did not show any significant change (suicide rates were stable from 1987 to 2011). For other suicide methods for males, there was a single significant joinpoint during the evaluated period (significant increase of 5.067% per year from 1993 to 2011) (Figure 3).

For females, the most common method was hanging, with a significant increase of 3.16% per year from 1991 to 1997 and there were no significant changes until 2011. Poisoning was in the second place and presented a significant increase of 5.60% per year from 1987 to 2006, and a significant decline of 31.18% per year from 2006 to 2011. Jumping was in the third place with a significant increase of 2.34% per year from 1987 to 2003 and a significant decrease of 3.06% per year from 2003 to 2011. Firearm was in the fourth place with a significant increase of 12.61% per year from 1987 to 1994 and there were not any significant changes until 2011. Other suicide methods significantly declined by 7.5% per year from 1987 to 1996 and significantly increased by 23.07% per year from 1996 to 2003 (Table 2).

Between the years 2002–2011, in males, while a significant decrease is observed in suicide by poisoning (AAPC = -7.8, $P < 0.001$), there is a significant increase in suicide by hanging (AAPC = 2.3, $P < 0.001$). In the same period of time, it is observed that there is a significant decrease in the poisoning method (AAPC = -16.8, $P < 0.001$) in females. Moreover, no significant changes are observed in other methods of suicide.

Discussion

Suicides rates in the Turkish population are one of the lowest in Europe and lower than many countries in the world. However, there is an increasing trend in the suicide rates from 1987 to 2011. Nearly half of the males who commit suicide in Turkey are under the age of 35 and the main causes are reported to be economic problems. On the other hand, nearly half of the females who commit suicide are under 25 and do so because of psychological problems.[24] TurkStat emphasized that 10.7% of the females suicide because of psychological problems and 6.7% of females suicide because of family pressure. The report states that around 23% of males commit suicide because of economic difficulty and 19.2% end their lives because of psychological problems.

In this study, the highest suicides rates in the Turkish population are observed among people under 35 years in both females and males. Especially, females aged 15–24 are characterized by a strong increase of suicides between 1991–1997 (APC = 11.3, $P < 0.001$). Suicide risk increases with age. In Switzerland, the highest suicide rate among women is observed in the group of 50–89 years of age.[25]

In this study, the male-to-female suicide ratio was found to be 1.8, which is quite lower than the ratio of the European Region (4.0) and higher than the Eastern Mediterranean region (1.1).[8]

The findings of this study are comparable to those of neighbouring countries including (per 100,000) Georgia (2009, male/female: 4.17), Bulgaria (2008, male/female: 3.03) and Greece (2009, male/female: 6.1), while Syria (1985, male/female: 0.2) and Armenia (2008, male/female: 2.54) show higher rates.[26] Cultural factors and regional differences in socio-economic situations play an important role in differences between countries. This gender difference could be explained by aggressions, more frequent substance use disorder, and more lethal methods that are used by males than females.

Despite the presence of the highest suicide rate for males aged 15–24 years, a steady significant increase in the other age groups was observed during the period. Especially, males aged 15–24 were characterized by a strong increase of suicides between 1987–2005 (APC = 4.9, $P < 0.001$). Previous findings suggest that, among males, the highest suicide rate in the 15–29 age group is in the South-East Asian region, in the 45–59 age group in European males and for ages above 60 in the Western Pacific region.[8]

In this study, in the age groups between 25–64 and 65 and over, male suicide rates were higher than female suicides rates. However, in the age 24 and below, female suicide rates were higher when compared to that of males. A recent study in 15 European countries among youths aged 15–24 years, males had a higher risk of suicide than females.[12]

Suicide rates among middle-aged adults in the United States have increased substantially. Suicide rates increased the most among males and females aged 35–64 years.[9] Younger female resorted to hanging when compared to older females who preferred drowning as a method of suicide. Everything considered, most suicide victims are in the 20–44-year age group followed by 45–64-year age group. Extremes groups of age are the least involved. It is apparent that adolescent females and males in the 45–64-year age group are relatively the more common victims of suicide.[27]

In this study, in overall, two methods – hanging and firearm suicide – dominate country-specific suicide patterns. Hanging was the most common method in both males and females. This study indicates that suicide by hanging and firearms is higher in males, whereas hanging and poisoning were rather more common in females. In the light of these results, we concluded that males prefer more aggressive methods. Jumping and poisoning occasionally appear as important alternative methods. The analysis indicates that hanging is the main suicide method when no other major method is available. A significant male-female difference in mean age is observed only for hanging. Relatively younger females prefer hanging as a method of suicide when compared to males.

Hanging has become a leading method of suicide in many countries that vary in terms of cultural and social features. The most prevalent suicide method among both males and females was hanging. For males, hanging was followed by firearms and poisoning by drugs; for females, by drug poisoning and jumping from a high place. The highest proportions were observed in Eastern Europe in males and females (i.e., Estonia, Latvia, Lithuania, Poland, and Romania).[11] Only in Switzerland hanging ranks as second for males after firearms.[10] Firearms, predominantly hanging, and poisoning (predominantly drug overdose) are the three leading mechanisms of suicide in the United States. In North America, firearms are the most frequent way for young people to commit suicide, followed by hanging, suffocation and self-poisoning.[28] Firearm suicide was the most common method in the United States, but was also prevalent in Argentina, Switzerland and Uruguay. Mok, *et al.* showed that the use of firearms was rare, but was more common in Scotland than in England and Wales.[29]

In Western Europe, by contrast, firearms play a minor role; jumping from high places or before a train is the main method. Jumping from a height plays an important role in small, predominantly urban societies such as Hong Kong and Singapore.[30] This study shows that firearm suicide in males and females holds the

second and third place, respectively. Poisoning by pesticides was common in many Asian countries and Latin America.[11] Especially, it is prevalent in agricultural regions such as China[31] and India.[32] Carbon monoxide poisoning is becoming widespread in some Western Pacific countries (e.g., Taiwan). In Western Europe and North America, over-the-counter drugs are common. In rural Latin American countries (e.g., El Salvador, Nicaragua and Peru), Asian Countries (e.g., Korea and Thailand) and also in Portugal, poisoning with pesticides was a major problem, particularly among females.[11]

Violent and highly lethal methods such as firearm suicide and hanging are more frequent among males, whereas females often choose poisoning or drowning, which are less violent and less lethal.[2,33]

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