INFLUENCE OF BIRTH COHORT, AGE AND PERIOD ON SUICIDE MORTALITY RATE IN TURKEY, 1983–2013

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SUMMARY

Objective: This study is designed to evaluate the potential effects of age, period and cohort (APC) on trends in suicide between 1983 and 2013 in Turkey.

Methods: Mortality data were obtained from the Turkish Statistical Institute. The data were grouped into seven age groups, four periods and ten birth cohorts. A nonlinear regression model was estimated for both sexes. The effects of age, period and cohort were parameterized using natural spline smoothing functions.

Results: There were 61,795 deaths recorded as suicides during the investigated time period, where 64.5% occurred in males (n = 39,862) and 35.5% in females (n = 21,933). There is an upward trend in mortality by age until the end of the study period for males and females. Age effect is decreased until the forties, kept decreasing during the middle ages, and sharply increased after the sixties. The death rates for females declined from 1999 until the end of the study period. For males, the death rates increased until the end of the study period.

Conclusion: If the current trends continue, it can be expected that these effects will continue to reduce female mortality and increase male mortality. Future studies on suicide, strongly focused on specific factors attributed to period effects, are needed in Turkey.

Key words: age-period-cohort effect, suicide, mortality

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INTRODUCTION

Suicide is a major public health problem in every country and every community worldwide. There were an estimated 804,000 suicide deaths worldwide in 2012. This indicates an annual global age-standardized suicide rate of 11.4 per 100,000 population which is 15.0 for males and 8.0 for females (1). In 2012, suicide accounted for 1.4% of all deaths worldwide, making it the 15th leading cause of death. These unexpected deaths – that predominantly occur in young and middle-aged adults – result in a huge economic, social and psychological burden for individuals, families, communities and countries. Approximately 75 percent of suicides occur among people from poor or middle-income countries. Central and Eastern Europe and Asia had the majority, with the biggest problem in Southeast Asia. In richer countries, three times more men die of suicide than women, but in low and middle-income countries the male-to-female ratio is much lower at 1.5 men to each woman (1).

Demographers, sociologists and epidemiologists have frequently attempted to separate age, period and cohort effects because such a decomposition of data can provide important clues for the causes of trends in various outcomes including fertility, mortality, crime rates, and disease incidence. Age-period-cohort (APC) models are designed to estimate the independent effects of age, period and cohort. Over the last few decades the APC model has become one of the core approaches in demography and sociology to study the trends of a multitude of social phenomena. The application and impact of APC models has spread beyond areas in social sciences to epidemiology and biostatistics (2, 3).

The purpose of an APC analysis is to separate the contribution of age, period and cohort effects on mortality patterns. Although age at death, year of death (period) and year of birth (cohort) do not directly explain the variation in death rates, they are proxies for underlying biological, social and economic factors that influence mortality.

In this analysis, age effect (physiological changes, accumulation of social experience, changes in social role or status changes, or a combination of these) reflects biological and social processes of aging internal to individuals and represent developmental changes across the life course. Period effects represent a complex set of historical events and environmental factors, such as wars, economic crisis and contraction. Shifts in social, economic, or physical environments may in turn induce similar changes in the lives of individuals at a point in time. Cohort effects are changes across groups of individuals who experience an initial event such as birth or marriage in the same year (4).

The study is planned to verify the presence of age, period and cohort effects on both male and female deaths from suicide in Turkey, during the period between 1983 and 2013, using the continuous-time statistical models.

MATERIALS AND METHODS

Data

Mortality data were obtained from the Turkish Statistical Institute (TurkStat) mortality dataset based on ICD-9 and ICD-10 codes (Annual Reports of Suicide Statistics has been published as a separate publication since 1974) (5). Suicide mortality rates were aggregated by 10-year period intervals for each sex and by 10-year age intervals using the corresponding census population estimates from census data. The mortality data were grouped into seven age groups (15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75 and over), four periods (1974–1983, 1984–1993, 1994–2003, and 2004–2013) and ten birth cohorts (started in 1899 and finished in 1989), the rates are per 100,000 inhabitants. The average mortality of suicide per 100,000 inhabitants for every ten calendar years was calculated based on the weighted average of the number of cases reported during the period, that is divided by the period's average population, multiplied by 100,000. We excluded the age groups of 0–14 years, because suicide rates for these cohorts were mostly zero or very small. Also, we summed up the categories over the age of 75 into one category of 75 years and over.

Statistical Analysis

Description of mortality rates by age and time is best conceptualized by regarding the observations in a Lexis-diagram. The Lexis-diagram tabulating deaths and person-years by age, period and cohort was used for statistical analysis of the data. The analysis data set will have one record per subset of the Lexis diagram, with number of events and risk time as outcome variables, and mean age, period and cohort as explanatory variables. Since the three variables, age, period and cohort are originally continuous variables, their effect on the death rate was analysed in a continuous model. A nonlinear regression model was estimated for males and females, with the suicide mortality rate observed for each age, year of death and cohort. The formulation of the age-period-cohort model is as follows:

$$\log((\lambda(a,p)) = f_p(a) + \delta(p - p_0) + g(p) + h(c)$$

where h(c) is the cohort function and g(p) is the period function. The period function is 0 on average with 0 slope, interpretable as log RR relative to the age-cohort prediction (residual log RR). To make identifiability, g(p) and h(c) are detrended, with 0 slope; f_p (a) are the age-specific rates in the reference period p0. Reference period for age-effects is chosen as the median date of event: 1998.5. Thus, age-specific rates can be chosen to refer to a specific period (cross-sectional rates). δ is the slope of the log-linear trend in the period (drift). The inclusion of the slope (drift) with the cohort effect makes the age-effects interpretable as cohort-specific rates of mortality (longitudinal rates). The role of cohort and period could be interchanged, in which case the age-effects would be cross-sectional rates for the reference period. The goal of the parametrization is to produce estimates of three functions showing the age, the period and the cohort effects constrained in a sensible way (6).

The age-period-cohort model was fitted with apc.fit, which allows various models (linear splines, cubic splines, factors) and parametrizations to be used. Holford uses weighted and naive approach over all values for the estimated effects to extract the drift (6, 7). For both approaches the drift is included with the cohort effect. The model where natural splines for each of the effects were used, was plotted with the functions apc.frame and apc.lines. The calculations were completed in the statistical R-Project software version 3.1.3 using the apc.fit function from the Epi package (8).

RESULTS

There were 61,795 deaths recorded as suicides between the years 1983 and 2013; 64.5% of them were males (n=39,862) and 35.5% were females (n=21,933). The results are described in terms of trend charts obtained for each age-period-cohort model. In the Figures 1 and 2, the horizontal scale is divided in two parts; one for age and one for cohort/period. The vertical scale is rate scale which is for the age-effect and a relative risk scale for the period and cohort effects. If a reference cohort or period is chosen a dot should be placed at (c_0, 1) or at (p_0, 1) to indicate this.

Each Figure has three curves depicting, from left to right, trends in mortality rate by age for the reference period, suicide mortality risk by the cohort and mortality risk by the year of death (reference period for age-effects is chosen as the median date of event: 1998.5) (Fig. 1). In the Figures, the mortality trend that is shown according to each age parameter, cohort and period was adjusted for the other two parameters.

Age Effect

Figure 1 shows the different age effects of suicide mortality for females. In females, age effect is decreased until the forties, kept decreasing in middle ages, and sharply increased after the sixties. In males (Fig. 2), there is an upward trend in mortality by age until around the age of 75 years. Age effects were relatively highest in adults and in elderly people aged 75 years. The age effect among elderly people was higher in males than in females.

Period Effect

In females, the suicide mortality death rates were increased until 1999 and then decreased sharply towards the end of the study period. For males, the suicide mortality rates were increasing constantly for the whole study period (constrained to be 0 at a reference date, p_0).

Cohort Effect

The suicide mortality rates for males showed upward trends, according to the reference date, p_0 = 1998.5; there was a decreasing trend for the people who were born before 1940 and then the rate turned upwards for those who were born after this year. The

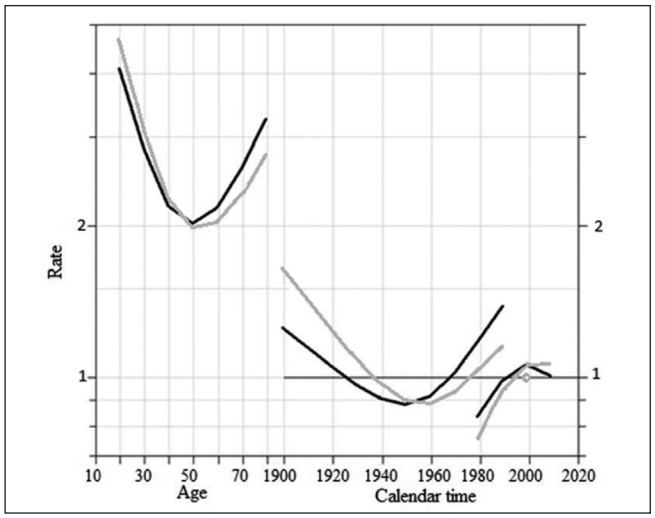

Fig. 1. *Females: estimated effects using the weighted (coloured black) and naive (coloured grey) approach to extract the drift.*

For both approaches the drift is included with the cohort effect (left) and with the period effect (right). The age-effect refers to the 1998.5 period. The cohort curve is the leftmost and longest of the two curves on the calendar time scale, the period curve is the rightmost and shorter one.

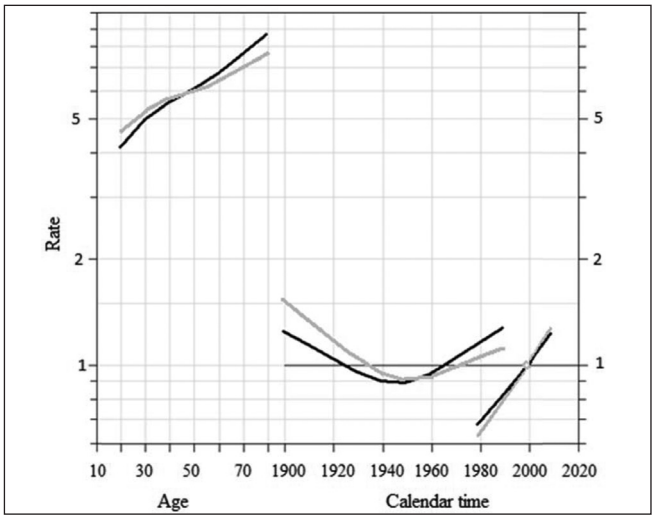

Fig. 2. *Males: estimated effects using the weighted (coloured black) and naive (coloured grey) approach to extract the drift.*

For both approaches the drift is included with the cohort effect (left) and with the period effect (right). The age-effect refers to the 1998.5 period. The cohort curve is the leftmost and longest of the two curves on the calendar time scale, the period curve is the rightmost and shorter one.

death rate for females showed a decreasing trend until 1940 and then it was increasing for the following generations.

DISCUSSION

An age-period-cohort model is a descriptive tool that allows for a comparison of the mortality of suicide with respect to age, cohort and year of diagnosis and provides an overview of the magnitude of the rates, variation with age and time trends in the rates (2, 9–12). This study is the first research that studied age-period-cohort effects in Turkey, in which continuous variables and natural splines smoothing functions in statistical models were used. It is important that the results are less biased than conventional age-period-cohort models and are more proper than separate analysis of age, period or cohort effects on mortality (6). The present work revealed that age, gender, birth cohort and period were important factors in explaining suicide mortality rate in people aged 15 years and older.

Globally, among young adults (15–29 years of age) suicide accounts for 8.5% of all deaths and is ranked as the second leading cause of death (after traffic accidents). With regard to age, suicide rates are lowest in people under 15 years of age and highest in those aged 70 years or older, for both gender, in almost all regions of the world, although the age and sex patterns in suicide rates between the ages of 15 and 70 years vary by region (1).

For both genders, suicide mortality rates increase with age, with the highest rates in people aged 65 years or above (13). Also, we know that suicidal behaviour is more lethal in later life than at other points in the life course.

The suicide mortality trends from 1985 to 2006 for Japanese aged between 15 and 79 years were analyzed and age-specific effect showed an overall increase with age in both genders, but a distinct increase was noted only among men aged between 50 and 64 years (14). According to Conwell et al. (15), older adults are the most rapidly growing segment of the population and this age group have higher rates of suicide than other segments of the population. According to Jeon (11), in South Korea the age effects were highest during the elderly period, whereas age effects in Japan were the highest during the fifties age bracket. The highest age effects on suicide rates among Korean elderly people were explained by the lack of social well-being and poor economic status.

We can talk about similar results for this study. In males, there was an upward trend in mortality by age for the whole of Turkey, until around the age of 75 years. Age effect was relatively high in adults and elderly aged ≥ 75. In females, age effect decreased by the age until the forties, kept the lowest level in middle ages, and sharply increased after the sixties. The age effect in elderly people was found to be higher in males than in females. Age effect increased by the age and sharply increased after the sixties for both sexes. The age effect among elderly males was higher than among elderly females. Regarding the other studies and Turkey's social, cultural and traditional conditions elderly people have the risk factors of psychiatric illness, social disconnectedness, functional impairment, physical illness and pain. In Turkey, like in other countries (16, 17), living alone, poor social support, financial stress, physical abuse during childhood, suicide in the family, pain, use of anti-depressants, anxiety and depression, and past suicide attempt are the predictors of suicidal ideation in the elderly. In this study, in females age effect decreased until the forties and sharply increased after the sixties. This increase can be explained by the social, psychological and physical changes in their lives. Following an active life, experiencing the empty nest, menopausal changes and social inactivity can make them feel lonely. Similarly, rates for men peak in old ages when their primary forms of social connection and support disappear and they retire (18).

Jeon (11) shows that period effects have increased in both South Korea and Japan since 1990. In Japan, between 1995 and 2000, which was also a period of economic crisis, period effects greatly increased. Conversely, in South Korea, period effects

showed rapid growth between 2000 and 2005, several years after the economic crisis. Also, in Quebec, period effect is observed and is present especially among males (19). On the other hand, regarding the study by Phillips (10), period effect is similar for both males and females, although the effects appear somewhat more stronger for females than males. These results can cause a thought as period effects commonly linked to fluctuating suicide rates are manifestations of the underlying degree of social integration and regulation within a society.

Using Joinpoint Regression Method, Doğan et al. (20) showed that suicide rate for females presented a significant decrease from 2003 onwards. On the other hand, in males there was a significant increase until the end of study period. In this study similar results were obtained using age-period-cohort method, i.e. a constant increase till 1999 for both genders, but the difference begins after 1999 which is a sharp decrease in females. It is unclear whether the increase in suicide mortality during 2004–2013 reflects the impacts of economic crisis, but it is obvious that the period effects on suicide in Turkey have continued to increase until recently. For Turkish families, more economic responsibility of men can cause more trouble for men which causes the gender differences. After 1999, giving women more social and professional rights and being accepted by the society, maked Turkish women feel better which decreased the number of suicide cases.

In males and females, the cohort effect showed a decreasing trend among the birth cohorts born prior to 1950, thereafter, it switched to an increasing trend among the birth cohorts after 1950. The mechanisms in suicide birth cohort effects must lie within the common dimensions of suicide behaviour, coincident behaviour and the sociocultural context (9). People born after the 1950s have grown during Turkey's social and political crisis. The military coup, which occurred twice, caused a caos to emerge after the economic crisis. This generation has also showed their spiritual imbalance and search for suicide increases.

As it is the primary result, variation in suicide mortality rates is especially linked to age among males and females, whereas period seems to be a more important factor among males. So, we can say that cohort is an important factor for both genders.

CONCLUSIONS

Age (being older), period (as the years passed) and cohort (borned after 1950) have effects on both gender deaths from suicide in Turkey, during the period between 1983 and 2013. As the largest and most rapidly growing segment of the population enters the stage of life with the highest risk for suicide, we should expect the total number (and proportion) of late life suicides to increase dramatically in coming decades. Future studies on suicide, strongly focused on specific factors attributed to period effects, are needed in Turkey.

Conflicts of Interests

None declared

REFERENCES

1. World Health Organization. Preventing suicide: a global imperative. Geneva: WHO; 2014.
2. O'Brien R. Age-period-cohort models: approaches and analyses with aggregate data. Boca Raton: CRC Press; 2015.
3. Mason WM, Wolfinger NH. Cohort analysis. In: Smelser NJ, Baltes PB, editors. International encyclopedia of the social & behavioral sciences. Amsterdam: Elsevier Science; 2001. p. 2189-94.
4. Yang Y, Land KC. Age-period-cohort analysis new models, methods and empirical applications. Boca Raton: CRC Press; 2013.
5. Turkish Statistical Institute. Suicide statistics [Internet]. Ankara: TurkStat [cited 2015 March 2]. Available from: http://www.turkstat.gov.tr/.
6. Carstensen B. Age-period-cohort models for the Lexis diagram. Stat Med. 2007;26(15):3018-45.
7. Holford TR. Approaches to fitting age-period-cohort models with unequal intervals. Stat Med. 2006;25(6):977-93.
8. Carstensen B, Plummer M, Laara E, Hills M. Epi: a package for statistical analysis in epidemiology [Internet]. [cited 2015 Apr 2]. Available from: https://cran.r-project.org/web/packages/Epi/index.html.
9. Ajdacic-Gross V, Bopp M, Gostynski M, Lauber C, Gutzwiller F, Rössler W. Age-period-cohort analysis of Swiss suicide data, 1881-2000. Eur Arch Psychiatry Clin Neurosci. 2006;256(4):207-14.
10. Phillips JA. A changing epidemiology of suicide? The influence of birth cohorts on suicide rates in the United States. Soc Sci Med. 2014;114:151-60.
11. Jeon SY. A Demographic evaluation of increasing rates of suicide mortality in Japan and South Korea [dissertation]. Logan: Utah State University; 2012.
12. Duleeka WK, Metcalfe C, Fernando R, Pearson M, Konradsen F, Eddleston M, et al. Suicide in Sri Lanka 1975-2012: age, period and cohort analysis of police and hospital data. BMC Public Health. 2014;14:839. doi: 10.1186/1471-2458-14-839.
13. Wu R, Cheng Y. Trends in suicide mortality in Taiwan, 1959-2006. Taiwan J Public Health. 2008;27(2):110-20.
14. Odagiri Y, Uchida H, Nakano M. Gender differences in age, period, and birth-cohort effects on the suicide mortality rate in Japan, 1985-2006. Asia Pac J Public Health. 2011;23(4):581-7.
15. Conwell Y, Van Orden K, Caine E. Suicide in older adults. Psychiatr Clin North Am. 2011;34(2):451-68.
16. Almeida OP, Draper B, Snowdon J, Lautenschlager NT, Pirkis J, Byrne G, et al. Factors associated with suicidal thoughts in a large community study of older adults. Br J Psychiatry. 2012;201(6):466-72.
17. Fässberg MM, Östling S, Börjesson-Hanson A, Skoog I, Wærn M. Suicidal feelings in the twilight of life: a cross-sectional population-based study of 97-year-olds. BMJ Open. 2013;3:e002260. doi:10.1136/bmjopen-2012-002260.
18. Grzywacz JG, Almeida DM, McDonald DA. Work-family spillover and daily reports of work and family stress in the adult labor force. Family Relations. 2002;51(1):28-36.
19. Légaré G, Hamel D. An age-period-cohort approach to analyzing trends in suicide in Quebec between 1950 and 2009. Can J Public Health. 2013;104(2):e118-23.
20. Doğan N, Toprak D. Trends in suicide mortality rates for Turkey from 1987 to 2011: a joinpoint regression analysis. Arch Iran Med. 2015;18(6):355-61.

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