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ORIGINAL ARTICLE

Trend of years of life lost due to suicide in Iran (2006–2015)

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Abstract

Objectives Suicide is a major global public health problem and much burden in the societies. This study aims to calculate the years of life lost (YLL) due to suicide and investigate its trend in Iran.

Methods Information on deaths due to suicide in Iran was extracted from Iran Legal Medicine Organization. The years of life lost was calculated in each year according to gender and age-groups. To examine the trend for different years, joinpoint regression was used.

Results The 35,297 deaths due to suicide were recorded in 2006–2015. The total YLL in the 10-year period was 34.52 per 1000 persons in males, 13.61 per 1000 persons in females and 23.35 per 1000 persons in both sexes. Hanging comprised the largest YLL of suicide. The annual percent change of YLL rate was 3.3%.

Conclusions The results revealed that male shows an increasing trend in YLL specifically among youth and adult, while there is no improvement in females. There is a national need to implement an effective health policy intervention in Iran.

Keywords Trend · Years of life lost · Suicide · Iran

Introduction

Suicide is a major global public health problem, resulting in loss of lives, and much burden in the societies (Brazinova et al. 2017). It has been estimated that over 800,000 people die by suicide annually, with numerous suicide attempts made prior to death in which 78% of them happen in low- and middle-income countries (Nakanishi et al. 2017; Prince et al. 2007; WHO 2015a, b).

The worldwide suicide rate estimated by the World Health Organization is approximately 11.4 per 100,000 persons (WHO 2014). Suicide is among the top three leading causes of death in those aged 15–44 years (WHO 2007) and is currently the leading external cause of death in men of working and elderly people worldwide (Brazinova et al. 2017; Turecki and Brent 2016). It is the seventh leading cause of death for males and the 14th leading cause for females (CDC 2013). Females are more likely to have suicidal thoughts than males (National Survey on Drug Use and Health 2014). The most commonly used method of suicide is firearms and poisoning among males (56.9%) and females (34.8%), respectively (CDC 2013). Suicide is closely associated with gender, age, ethnicity, employment status, mental health issues, seasonality, socioeconomic status and education (Fountoulakis et al. 2014).

It leads to loss of lives and represents 1.5% of the global burden of disease, which leads to around a million deaths per year (WHO 2014). About 90% of suicides are due to underlying mental illnesses (Arsenault-Lapierre et al. 2004). Mental and substance abuse disorders were

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responsible for 22.5 million of the 36.2 million disability-adjusted life years (DALYs) allocated to suicide in 2010 with depression contributing the most (46.1%) to the suicide DALYs (Ferrari et al. 2014). DALY is calculated by the sum of the years of life lost (YLL) and the years lived with disability (YLD). The years of life lost, which denotes death at a younger age, is often used to assess the social cost of disease (Kamel et al. 2012). This index provides a simple method to identify important causes of death in need of intervention.

Iran has been experiencing a rapid increase in suicide rates during recent years, and some of major DALYs' causes related to injuries, such as accidental falls, interpersonal violence and suicides, showed an increasing trend in the two-decade interval (Forouzanfar et al. 2014; Naghavi et al. 2014). A recent national study in Iran estimated the mean national suicide mortality rate to be about 4.9 per 100,000 population in 2010 (Kiadaliri et al. 2014). While the mortality rate due to suicide in Iran is much lower than European countries, YLL rate is similar representing death in lower ages (less than 15 years) in Iran compared to European countries. Based on National Violent Death Reporting System (NVDRS) data from 2005 to 2010 in 16 states of America with a focus on those aged 40–64 years, suicide rate is rising among middle-aged adults (Hempstead and Phillips 2015). After 1990, there has been a decreasing trend in suicide mortality in many European countries and in the USA (Fond et al. 2016; Puzo et al. 2016). But in Iran, the suicide death rate, after adjusting for population growth and population age pattern, grew by 75% (Naghavi et al. 2014). Therefore, suicide is a serious public health problem around the world. Trends of suicide rates fluctuate in individual regions and countries over time, and this value had not been provided for Iran before just some estimates had been calculated; thus, this study aims to calculate the mortality rate and years of life lost due to suicide and investigate trend of YLL in Iran during 2006–2015.

Methods

Data source

In this study, information on deaths due to suicide (35,297 deaths) in Iran was extracted from Iran legal medicine organization (LMO) which is the gold standard of suicide mortality data. According to the Iran law, the death certificate for all of the suspicious death should be issued by the legal medicine organization centers in each city and province, and suicide is one of the examples of suspicious deaths. Hence, all suicide cases should be reported to the LMO. These data cover a scope of 10 years (2006–2015). The main recorded variables in LMO for each death are name, age, gender, marital status, nationality, month and year of death, province and methods of suicide.

In the present study, International Classification of Disease, 10th edition (ICD-10) codes X60-84, is assigned for deaths due to suicide as the external cause of death. We used the following ICD-10 codes for classification according to the method of suicide: (hanging (X70), self-immolation (X76-77), medication (X60-64), chemical (X68-69), drowning (X71), firearm (X72-74), and explosive (X75), sharp, blunt object (X78-79), fall (X80-81), etc.). YLL was calculated in each year according to gender, age-groups and also method of suicide.

In this study, the data of age were missing for 277 suicide persons. These cases were redistributed among different age and gender categories proportional to their size in each year. Considering marital status and education level there were also 20 impossible numbers for the age of suicide in which these numbers were changed to missing and redistributed the proportional to their size (same way used for missing age data). After cleaning the data, YLL calculation was performed by WHO excel template for calculation of YLL.

Statistical Analysis

For calculation of YLL, we used the following formula according to global and regional mortality from Global Burden of Disease Study 2010 (GBD-2010) (Lozano et al. 2012).

$$\text{Years of life lost (YLL)} = \sum N_x \times L_x \,(x \text{ is 5 years cross-classification of age and gender categories})$$

(N_x): *The number of suicide deaths in each 5-year age-gender category* for which we used LMO data to calculate. Age-groups were 5–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84 and $\geq$ 85 in initial calculation, and then, we reported age-groups of 5–14, 15–29, 30–44, 45–59, 60–69, 70–79 and $\geq$ 80 in the results.

(L_x): Standard life expectancy in each 5-year age-gender category GBD 2010 provided the new reference life table with a life expectancy at birth of 86.02 years and used the same reference standard for males and females (Murray et al. 2012). In this study, YLL was calculated according to the new reference-standard life expectancy for each gender and age-group. The gender-stratified mid-year populations for each age-group of the Iran population in different years from 2006 to 2015 were provided by Iran National Statistics Center. The estimation of population count of

different years was based on 2006 and 2011 national censuses. Crude rates were calculated, and then, age-standardized rate (ASR) via world standard population was measured to enable figures comparison. "The base case for DALYs in GBD 2010, on the basis of broad consultation, has been simplified to omit both discounting and age-weighting" (Murray et al. 2012), so age-weight and discount rate were not applied in this study.

To examine the trend for different years, joinpoint regression based on the log-linear model was used. Joinpoint regression analysis describes changing trends over successive segments of time and the amount of increase or decrease within each segment. The resulting line segment between joinpoints is described by the annual percent change (APC) that is based on the slope of the line segment and the average annual percent change (AAPC). The analysis for the trend was carried out by Joinpoint Regression Program 4.3.1.0.

Results

In 2006–2015, the LMO recorded 35,297 deaths due to suicide (70.08% in males and 29.92% in females) (sex ratio: 2.34, male/female). The mean age at the time of death was 32.93 ± 15.08 in men, 29.85 ± 14.17 in women and 32.01 ± 14.88 in both genders. The most frequent marital status was married (48.95%). The main method of death in most cases was hanging (52.49%) (Table 1).

Mortality rate due to suicide

The mortality rate by suicide in Iran was 4.23 per 100,000 population (5.99 and 2.41 per 100,000 population for males and females, respectively) in 2006 and increased to 4.70 per 100,000 population (P for trend = 0.04) (6.73 and 2.64 per 100,000 people in males (P for trend = 0.004) and females (P for trend = 0.14), respectively) in 2015 (Table 2).

YLL due to suicide

The total years of life lost due to premature death in the 10-year period was 1298,497 (34.52 per 1000 persons) in males, 586,832 in females (13.61 per 1000 persons) and 1885,329 (23.35 per 1000 persons) in both genders. Among all age-groups, suicide had the largest years of life lost due to premature death in persons aged 15–29 years, and in decreasing order among persons aged 30–44 and 45–59 years (Tables 3, 4). Hanging (976,333, 12.09 per 1000) comprised the largest YLL category between different methods of suicide (Table 5).

Table 1 Absolute and relative frequency of successful suicide according to the marital status and methods of suicide, Iran, 2006–2015

Variables	No	%
Marital status		
Single	16,425	47.25
Married	17,013	48.95
Divorced	652	1.88
Widow	485	1.40
Remarriage	184	0.53
Total	34,759	100
Methods		
Hanging	18,482	52.49
Self-immolation	4545	12.91
Medication	2946	8.37
Chemical	4984	14.16
Firearm	2514	7.14
Sharp, blunt object	275	0.78
Drowning	200	0.57
Fall	835	2.37
Explosive	6	0.02
Cold weapon	271	0.77
Electrocution	16	0.05
Total	35,208	100

Table 2 Frequency and mortality rate (per 100,000 population) by gender, Iran, 2006–2015

Year	Male		Female		Total	
	No	Rate	No	Rate	No	Rate
2006	2149	5.99	833	2.41	2982	4.23
2007	2122	5.87	889	2.21	3011	3.93
2008	2235	6.12	1107	2.36	3342	4
2009	2095	5.68	899	1.64	2994	3.26
2010	2515	6.73	1020	1.59	3535	3.48
2011	2623	6.97	1034	2.78	3657	4.87
2012	2589	6.78	1175	3.13	3764	4.97
2013	2775	7.19	1315	3.46	4090	5.34
2014	2923	7.48	1251	3.25	4174	5.38
2015	2669	6.73	1033	2.64	3702	4.70

Trend of YLL due to suicide

According to the joinpoint regression, the 10-year trend of YLL rate due to premature mortality was increasing: annual percent change (APC) was 2% (95% CI 0.4–3.5; $P < 0.05$) for male, 4.6% (95% CI − 1.5 to 11; $P > 0.05$) for female and 3.3% (95% CI − 0.3 to 7.1; $P > 0.05$) for

Table 3 Years of life lost (YLL) by age-groups and gender, Iran, 2006–2015

Age-groups	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Male										
5–14	2714	2963	2889	1864	2366	2825	3174	3189	3706	3925
15–29	76,648	72,504	74,667	69,993	82,549	83,893	79,314	79,394	83,660	73,383
30–44	24,800	25,351	29,706	26,107	33,654	40,239	38,432	43,250	44,337	41,744
45–59	9252	9670	9526	9880	11,710	9816	11,125	14,372	14,744	14,067
60–69	1716	1486	1726	1677	2053	1750	2158	2141	2762	2731
70-79	754	972	728	803	778	847	963	889	1033	922
+ 80	185	151	234	199	174	216	218	283	321	227
Total	116,069	113,097	119,475	110,523	133,285	139,585	135,383	143,518	150,563	136,999
Female										
5–14	1264	2008	1964	1957	2078	2089	2448	3658	3789	2977
15–29	32,965	35,526	43,074	34,059	39,433	39,242	42,600	47,556	40,984	34,541
30–44	9174	8614	12,333	10,640	10,442	12,334	15,303	15,962	17,580	13,560
45–59	2551	3293	3439	2692	3950	3465	4047	4609	4856	3817
60–69	592	546	721	606	655	496	689	825	949	992
70–79	213	193	286	251	206	168	247	213	273	247
+ 80	43	25	62	53	48	78	48	106	42	91
Total	46,802	50,205	61,879	50,258	56,811	57,871	65,382	72,928	68,473	56,223
Total										
5–14	3977	4971	4852	3821	4444	4914	5622	6846	7494	6901
15–29	109,613	108,030	117,740	104,052	121,982	123,135	121,914	126,950	124,644	107,923
30–44	33,974	33,965	42,039	36,747	44,096	52,573	53,735	59,213	61,917	55,304
45–59	11,803	12,963	12,965	12,571	15,660	13,281	15,171	18,981	19,600	17,884
60–69	2308	2031	2447	2284	2707	2245	2847	2965	3711	3723
70–79	967	1165	1014	1054	984	1014	1210	1102	1306	1168
+ 80	229	176	296	252	222	294	266	389	364	318
Total	162,872	163,302	181,354	160,780	190,096	197,456	200,765	216,446	219,036	193,223

both genders (Fig. 1). The model did not show any joinpoint, and hence, the AAPC (average annual percent change) is the same as APC.

We also fitted the joinpoint regression in 15–34 (youth), 35–64 (adult) and also in ≥ 65-years-old age-group (elderly). APC was 3.5% (95% CI − 0.1 to 7.2; $P > 0.05$) in youth and 4% (95% CI 0.2–7.9; $P < 0.05$) in adults (35–64 years). In the elderly one, joinpoints were obtained and APC can be estimated separately for two time periods, − 7.1% (95% CI − 13.9:− 3.9; $P > 0.05$) for 2006–2010 and 10.2% (95% CI 4.4:16.2; $P < 0.05$) for 2010–2015.

Discussion

The aim of this study was to calculate the mortality rate and years of life lost due to suicide and investigate trends and patterns of years of life lost due to suicide in Iran over last 10 years. Over a 10-year period (2006–2015), the mortality rate due to suicide increased from 5.99/100,000 to 6.73/100,000 in men and no improvement in women. Consistent with other studies, men had higher rates of suicide in all age-groups with larger contribution to YLL over the period of study (Brazinova et al. 2017; Curtin et al. 2016; Skinner et al. 2016). The most frequent method of suicide was hanging among men, women (with poisoning) and both genders. In the Austria during 2000–2010, hanging was the most common method, 49.1% for men and 35.0% for women (Etzersdorfer et al. 2015). In Skinner et al. study, suffocation (hanging and strangulation) was the primary method of suicide (46.9%) among Canadians of all ages, followed by poisoning at 23.3% (Skinner et al. 2016). In the USA, about one in four suicides in 2014 was attributable to suffocation (including hanging and strangulation) and poisoning was the most common method of suicide for females in 2014 (Curtin et al. 2016). Over 10 years of the study period, suicide caused 1,885,329 (23.35 per 1000) years of life lost in both genders. Among all age-

Table 4 Years of life lost (YLL) rate per 1000 persons by age-groups and gender, Iran, 2006–2015

Age-groups	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Male										
5–14	0.43	0.48	0.48	0.31	0.40	0.49	0.54	0.54	0.62	0.65
15–29	6.08	5.83	6.09	5.77	6.88	7.05	6.85	7.04	7.61	6.85
30–44	3.34	3.30	3.73	3.16	3.94	4.55	4.18	4.54	4.48	4.06
45–59	2.26	2.26	2.13	2.11	2.39	1.92	2.10	2.61	2.58	2.37
60–69	1.27	1.08	1.22	1.16	1.38	1.15	1.34	1.26	1.54	1.44
70–79	0.78	0.99	0.73	0.80	0.76	0.82	0.95	0.90	1.07	0.98
+ 80	0.55	0.43	0.63	0.50	0.41	0.47	0.54	0.74	0.83	0.51
Total	3.24	3.13	3.27	3	3.57	3.69	3.54	3.72	3.85	3.45
ASR[a]	2.76	2.70	2.84	2.60	3.11	3.21	3.14	3.34	3.51	3.19
Female										
5–14	0.21	0.30	0.26	0.22	0.21	0.38	0.44	0.65	0.67	0.52
15–29	2.67	2.53	2.70	1.87	1.90	3.33	3.72	4.27	3.78	3.27
30–44	1.29	1.01	1.21	0.87	0.72	1.43	1.71	1.72	1.82	1.35
45–59	0.63	0.67	0.59	0.38	0.46	0.68	0.76	0.84	0.86	0.65
60–69	0.45	0.35	0.39	0.27	0.24	0.29	0.39	0.44	0.48	0.48
70–79	0.25	0.19	0.24	0.18	0.12	0.17	0.25	0.21	0.27	0.24
+ 80	0.14	0.06	0.13	0.09	0.07	0.17	0.12	0.27	0.11	0.20
Total	1.35	1.25	1.32	0.92	0.89	1.55	1.74	1.92	1.78	1.44
ASR[a]	1.11	1.03	1.09	0.77	0.75	1.32	1.51	1.70	1.61	1.32
Total										
5–14	0.33	0.38	0.35	0.26	0.28	0.43	0.49	0.59	0.64	0.59
15–29	4.39	4.08	4.17	3.43	3.73	5.20	5.29	5.66	5.71	5.07
30–44	2.33	2.09	2.31	1.80	1.91	3.01	2.97	3.15	3.16	2.72
45–59	1.45	1.41	1.25	1.07	1.17	1.30	1.43	1.73	1.72	1.51
60–69	0.87	0.69	0.74	0.62	0.65	0.70	0.84	0.83	0.99	0.94
70–79	0.53	0.59	0.47	0.44	0.36	0.50	0.60	0.55	0.66	0.60
+ 80	0.35	0.24	0.35	0.26	0.19	0.32	0.32	0.50	0.46	0.35
Total	2.31	2.14	2.17	1.75	1.87	2.63	2.65	2.83	2.82	2.46
ASR[a]	1.95	1.82	1.86	1.51	1.62	2.28	2.33	2.53	2.57	2.26

[a]Adjusted YLL rate using the WHO world standard population

groups, the largest burden was attributed to people aged 15–29 and 30–44 years in both genders. In addition, trends of both YLL due to suicide are increasing in males, females and both genders although only males showed statistically significant. The reason for this result is age and gender differences in patterns and attitudes about suicide. Studies show that lethal suicide attempts with the different pattern for suicide and maladaptive attitudes about suicide are more common in males and are generally more among individuals 15–29 years (Gould et al. 2004; Hamilton and Klimes-Dougan 2015; WHO 2014).

Although Iran has one of the lowest death rates due to suicide (WHO 2015a), it is still one of the main psychosocial and public health problem as younger population (15–44 years old) contribute largely to both number and rates for mortality and YLL. Based on Institute for Health Metric and Evaluation (IHME) results, about 1.31% of total estimated DALYs in Iran (2016) were related to self-harm (IHME 2016). In addition, in regard to DALYs, the rank of self-harm among injuries increased from 10 to 3 during 1990–2016 in Iran (IHME 2016). This means that suicide has a major effect on national productivity and demographic change in future if the public health system does not implement an effective intervention to decrease the current trends (Curtin et al. 2016). While according to the report from WHO, the global average of suicide mortality rate in 2015 was 10.7/100,000, the lowest rate was in Eastern Mediterranean region (3.8/100,000) and the highest observed in European region (14.1/100,000). In fact, the rate among different countries has a larger variation than WHO regions: from 35.3/100,000 in Sri Lanka (South-East Asia) to 0.4/100,000 in Barbados (American region) [World Health Organization (WHO) 2015a]. Over the period of study, male-to-female ratio varied between 2.0 to

Table 5 Years of life lost (YLL) count and rate per 1000 persons and its trend by external causes of death (methods) of suicide and gender, Iran, 2006–2015

External causes of death	YLL (years)			YLL rate (per 1000 persons)			Coefficient for YLL trend*		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hanging (X70)	790,517	185,816	976,333	21.01	4.31	12.09	0.01	0.08	0.02
Self-immolation (X76-77)	74,190	170,642	244,832	1.97	3.96	3.03	− 0.01	− 0.06	− 0.05
Medication (X60-64)	94,639	72,554	167,194	2.52	1.68	2.07	0.06	0.05	0.06
Chemical (X68-69)	149,668	113,056	262,724	3.98	2.62	3.25	0.10	0.06	0.08
Firearm (X72-74)	129,447	15,433	144,880	3.44	0.36	1.79	− 0.003	0.06	0.003
Sharp, blunt object (X78-79)	11,418	1753	13,171	0.30	0.04	0.16	− 0.20	− 0.08	− 0.18
Drowning (X71)	6206	4575	10,781	0.16	0.11	0.13	− 0.03	0.02	− 0.006
Fall (X80-81)	24,331	17,354	41,686	0.65	0.40	0.52	0.08	0.10	0.09
Explosive (X75)	304	0	304	0.01	0	0.004	0.48	–	0.48
Cold weapon	10,559	1526	12,085	0.28	0.04	0.15	0.47	0.48	0.47
Electrocution	619	79	698	0.02	0.002	0.01	0.37	0.39	0.37
Other (X83)	5192	2257	7448	0.14	0.05	0.09	0.53	0.58	0.55
Unknown	3170	1631	4801	0.08	0.04	0.06	− 0.15	− 0.09	− 0.13

*Based on Poisson regression (p value for all coefficients is < 0.001)

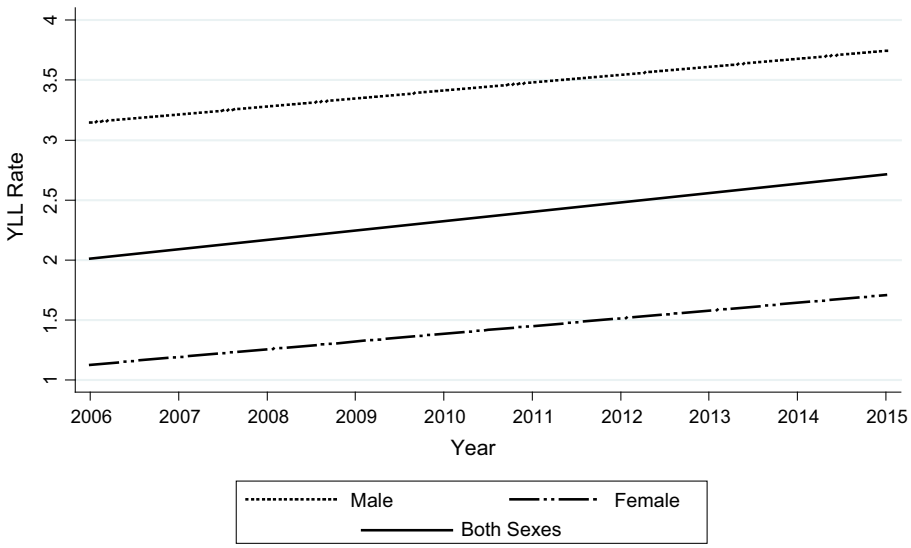

Fig. 1 Ten-year trend of years of life lost (YLL) rate due to suicide in male, female and both genders, Iran, 2006–2015

4.2 with no significant trend. With continuing increase in the incidence of suicide mortality rate in men and no improvement in women, someone expects to see more gaps between male suicide mortality rate and female suicide mortality rate within next years. Our finding regarding the male predominance of suicide mortality rate is in accordance with other studies elsewhere (Patel et al. 2012; Skinner et al. 2016).

The current study showed an increase in YLL rate/1000. Such increase should be described by three possible reasons: increase in suicide mortality rate, increase in number and rates of suicide mortality among younger age-groups or a combination of these two factors. While in most developed countries, trends for YLL are decreasing such finding might be of most interest for public health. As it has been mentioned before, the large proportion of YLL is contributed to younger and most productive age-groups 15–44 years old. ASR for YLL in Austria as a country with higher suicide mortality rate compared to other average value in a European country showed a decreasing trend from 2000 to 2010 in men and women, 3.88/1000 and 1.14/1000, respectively. The corresponding value for the same

year in Iran was 3.11/1000 and 0.75/1000 for men and women, respectively (Etzersdorfer et al. 2015). Such similarity in ASR for YLL and big differences in suicide mortality rate is mainly due to the disparity in epidemiological pattern of suicide in two countries. While in Austria, a large proportion of people are those aged > 50 years, the suicide increases with aging. In Iran with a young age structure, suicide mortality rate is high among people aged 15–44 years and therefore this leads to a higher ASR.

This study is the largest of its type; a national observational study using administrative data from legal medicine investigating trends in YLL and death rate from suicide in Iran, and the most important added value of this article is providing the YLL of suicide in Iran in 10 consecutive years calculated by real data. While all deaths due to suicide must be reported to legal medicine in Iran, similar to studies elsewhere, such studies suffer from underreporting deaths from suicide (Tollefsen et al. 2012). One probable reason for underestimation of a number of suicide deaths is due to the low validity of such reports to differentiate the intent of death (Shepherd and Klein-Schwarts 1998). Although it has been estimated that such failure can lead to 10% underreport of death by suicide (Donaldson et al. 2006), it is most likely that the value in Iran is larger than 10%. In fact, there is a strong stigma regarding the suicide in Iranian culture, and therefore, it is more likely to have a non-differential underreporting of suicide over the period of study with no effect on our interpretation of trends. In data for 2012–2015, there were two variables registered in the name of the year recorded for suicide and exact date of suicide that, in the present study, based on the date of suicide, the year recorded for suicide was modified, but this was not done for the 2006–2011 due to the lack of an exact date for suicide. Also, garbage codes for injuries include ICD-10 codes: Y10-Y34 and Y87.2 and must be redistributed. In this study, the death registered with garbage codes was not considered due to unavailability. In our data, 512 deaths had no recorded intention and therefore were excluded from the study.

Implications for public health policy

Health policy makers need to have a holistic approach in order to decrease the burden of suicide within the next years, and this issue needs a strong health organizational and social commitment. They can use the results of present study to better planning and interventions with respect to specific target groups including lower age-groups and males.

Conclusion

The results revealed that male shows an increasing trend in YLL specifically among youth and adult, while there is no improvement in females. Taking into account this point that most of such deaths are preventable, there is a national need to implement an effective health policy intervention in order to save the burden of suicide in Iran.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving data extracted from existing information were in accordance with the ethical standards of the forensic medicine organization and Kermanshah University of Medical Sciences research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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