Iran J Public Health, Vol. 53, No.6, Jun 2024, pp.1427-1436

Original Article

Trend Analysis of Unintentional Fall Mortality and Years of Life Lost in the Fars Province of Iran, 2004-2019

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(Received 11 Feb 2023; accepted 18 Apr 2023)

Abstract

Background: Unintentional falls are one of the main causes of death and a significant burden on victims, families, and communities. This study aimed to determine the trend analysis of mortality rate and years of life lost (YLL) due to unintentional falls in Fars Province, Iran.

Methods: All deaths due to unintentional fall in Fars Province, central Iran from the electronic population-based death registration system (EDRS) were obtained. Crude and age-standardized mortality rate, YLL and YLL rate data were calculated and to examine the trend, joinpoint regression was used.

Results: During the 16-year study period (2004-2019), 1816 deaths due to falls occurred in Fars Province. Crude mortality rate had stable trend in men and increasing trend in women. The total years of life lost due to falls, were 25,437 in men and 5,720 in women. According to the joinpoint regression analysis, the 16-year trend of YLL rate due to premature mortality was decreasing in males. The annual percent change (APC) was -2.8% (95% CI -4.5 to -1.0, *P*=0.005). However, there were stable trends for females, APC was 3.5% (95% CI -1.8 to 9.1, *P*=0.181).

Conclusion: Due to the increase in mortality caused by falls in women and stable trend in men, there is an urgent need to plan and implement preventive strategies to reduce the incidence of injuries caused by falls. Home and behavioral modifications such as increasing home lighting, providing handrails on stairs and bathrooms, and educating the people may play an important role in reducing fall deaths.

Keywords: Unintentional fall; Trend; Years of life lost; Joinpoint regression; Iran

Introduction

Unintentional falls are one of the main causes of death and a significant burden on victims, families, and communities (1). Falls are the second leading cause of death from unintentional injuries and the 13th leading cause of global years lived with disability (YLD) (2). Population growth and

aging are major factors in global deaths from falls, which increased by about 21% between 2005 and 2015 (3). Falls among the elderly are a major public health problem, with about one-third of older adults aged 65 yr or older experiencing at least one fall per year (4). Falls are more common in young men under the age of 44 compared to older people. However, the majority of fall-related deaths occur in the elderly population (5). Global fall mortality increased from 10.2% in 2000 to 13.5% in 2016 (6). Fall injuries rank among the top 20 most expensive diseases. For example, in 2015, medical costs related to falls were $31 billion (7).

The global burden and mortality rate of most unintentional injuries have decreased over time, but an increase in the burden and mortality from falls has been observed worldwide (8). More than 420,000 people die each year from falls, making it the second leading cause of injury-related death worldwide (9). The worldwide incidence rate of falls is 5.6 per 100,000 population and 2.1 per 100,000 in the Eastern Mediterranean region (9). According to the WHO, deaths from injuries worldwide increased from 4.3 million in 1990 to 4.8 million in 2013. However, the age-standardized mortality decreased by 21% during the same period (10). Injuries are the second leading cause of death in Iran (11). Unintentional injuries are a growing concern in several countries, including Iran. According to the Iranian Forensic Medicine Organization, one out of every ten deaths among the Iranian population is due to unintentional injuries (12). A systematic study on the epidemiology of injuries in Iran found that falls (22.3%) ranked as the second leading cause of damages. Around one-third of healthcare costs of accidents are related to falls, and two-thirds of its direct cost is related to hospitalization (13).

Years of life lost are an important criterion for ranking the health status of society and observing their challenges. According to WHO report, the value of one year of life is three times more than the Gross Domestic Product (GDP) per capita of any country (14). Considering that no study has been conducted to determine the years of life lost due to falls in Fars Province, this study was conducted to determine the mortality rate and years of life lost due to unintentional falls in Fars Province.

Methods

This cross-sectional study was conducted in Fars Province, central Iran during the years 2004-2019. We extracted all fall-related deaths from the population-based Electronic Death Registration System (EDRS) by age, sex, and year of death. According to International classification of disease (ICD-10); the codes used in this study were W00-W19. In the population-based electronic death registration system, all available sources have been used to detect, record, and collect information about death, inclusion criteria include being a resident of Fars Province, then deaths that were repeated, and also cases of death caused by intentional falls were excluded from the study.

The total estimated population of Fars Province has been estimated using the basic data of health centers and the population and housing census from 1996 to 2016, taking into account the annual growth of the population. The standard population of 2013, for countries with low and moderate-income, was used for standardization (15).

Statistical analysis

First, crude and standardized fall mortality rates (ASR) were calculated during the study years according to sex and year of death. To calculate standardized mortality rates, direct standardization method was used. The direct method of standardization involves the application of age-specific rates in a Population of interest to a standard age distribution in order to eliminate differences in observed rates that result from differences in population composition (16).

Then, to calculate YLL, using the standard life table and determining the life expectancy for different age and sex groups, as well as the number of deaths due to falls, in each age and sex group,

and based on the following relationship, the calculation was carried out(17).

$$YLL = N\,Ce^{(ra)} / (\beta+r)^2\,[e^{-(\beta+r)(L+a)}[-(\beta+r)(L+a)-1] - e^{-(\beta+r)a}[-(\beta+r)a-1]]$$

Where

N= the number of deaths is at a certain age and gender.

L= the standard of living of the deceased is the same age and gender.

r= Discounting Rate is equal to 0.03.

β = the contract rate in calculating the age value is equal to 0.04.

C = A modified constant value equal to 0.1658

a= the age at which death occurred

e is fixed and equivalent to 2.71.

First, the years of life lost were calculated according to 18 age groups: 0-4, 5-9, 10-14, etc. up to 85 yr old, and then shown on a figure based on age groups 0-4, 5-14, 15-29, 30-44, 45-59, 60-69, 70-79 and over 80 yr old.

The analysis of the number of years of life lost due to premature death due to falls was done using the YLL template of 2015, WHO, in Excel version 2016 spreadsheet software.

To examine the trend of crude and standardized mortality rate and YLL rate 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 decreases 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). We used constant variance (heteroscedasticity) and Uncorrelated in our analysis. Joinpoint Regression Program 4.9.1.0 carried out the analysis for the trend.

The protocol of this study was reviewed and approved by the Ethics Committee of Shiraz University of Medical Sciences. (Code: IR.SUMS.REC.1399.772). All aspects of the study were conducted according to the university's code of ethics.

Results

General fall mortality rate and trend

During the 16-year study period (2004-2019), 1816 deaths due to falls occurred in Fars Province. Of this number, 70.0% (1381 cases) were in men, and 23.0% (418 cases) were in the age group above 80 yr.

As seen in Table 1, the crude mortality rate due to falls in men decreased from 3.4 (per 100,000 population) in 2004 to 1.4 per 100,000 population in 2019 (p for trend= 0.771) AAPC=-0.3%. In women it increased from 1.2 (per 100000population) in 2004 to 2.5 (per 100000 population) in 2019 (p for trend=0.020) AAPC=5.1%. And the standardized mortality rate in men decreased from 4.8 per 100,000 in 2004 to 3.7 per 100,000 in 2019. (P for trend=0.148) AAPC=-1.5%; and in women, it increased from 1.4 per 100000population in 2004 to 2.1 per 100000in 2019 (AAPC=2.4% (P for trend= 0.255 (Table 1).

The highest and lowest number of deaths in men were in the age groups of 15-29 yr and 5-14 yr, respectively, and in women in the age groups above 80 yr and 5-14 yr, respectively (Fig. 1).

Table 1: Crude and standardized mortality (per 100,000 population) and years of life lost due to falls by sex and year in Fars Province during 2004-2019

Year	*No. death*		*Crude mortality rate*		*ASR (95%CI)*		*YLL*			
							No.		(per 1000)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
2004	80	21	4.3	1.2	4.8 (3.8-5.8)	1.4 (0.9-1.9)	1678	435	0.9	0.2
2005	91	20	4.9	1.1	5.4 (4.4-6.4)	1.6 (1.1-2.1)	1966	217	1.1	0.1
2006	74	16	4.0	0.9	3.9 (2.9-4.9)	1.0 (0.5-1.5)	1519	231	0.8	0.1
2007	76	21	4.1	1.1	4.2 (3.3-5.1)	1.4 (0.9-1.9)	1508	405	0.8	0.2
2008	73	15	3.9	0.8	3.8 (2.9-4.7)	1.0 (0.6-1.4)	1612	208	0.9	0.1
2009	88	17	4.6	0.9	4.6 (3.6-5.6)	0.9 (0.5-1.3)	1712	265	0.9	0.1
2010	93	12	4.8	0.6	4.7 (3.7-5.7)	0.6 (0.3-0.9)	1871	174	1.0	0.1
2011	96	24	4.9	1.2	4.6 (3.6-5.6)	1.2 (0.7-1.7)	1727	251	0.9	0.1
2012	101	56	5.1	2.9	4.8 (3.8-5.8)	3.0 (2.2-3.8)	1864	799	0.9	0.4
2013	108	33	5.4	1.7	5.1 (4.1-6.1)	1.5 (0.9-2.1)	1898	452	1.0	0.2
2014	67	20	3.3	1.0	2.9 (2.1-3.7)	1.0 (0.5-1.5)	1133	289	0.6	0.1
2015	67	33	3.3	1.6	3.1 (2.3-3.9)	1.6 (1.1-2.1)	1191	451	0.6	0.2
2016	77	34	3.7	1.7	3.2 (2.4-4.2)	1.6 (1.0-2.2)	1345	392	0.6	0.2
2017	89	29	4.3	1.4	4.0 (3.2-4.8)	1.3 (0.8-1.8)	1366	266	0.7	0.1
2018	114	33	5.5	1.6	5.1 (4.1-6.1)	1.4 (0.8-2.0)	1708	339	0.8	0.2
2019	87	51	4.1	2.5	3.7 (2.9-4.5)	2.1 (1.4-2.8)	1339	546	0.6	0.3
Total	1381	435	4.4	1.4	4.3 (4.1-4.5)	1.4 (1.3-1.5)	25437	5720	0.8	0.2
P value	-	-	0.771	0.020	0.148	0.255	-	-	0.005	0.181

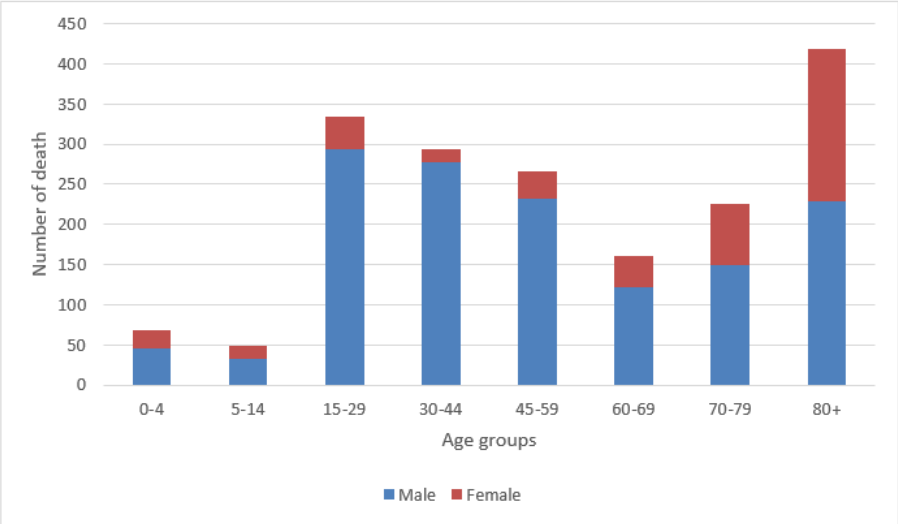

Fig. 1: Number of deaths due to falls by gender and age groups

Temporal trends of fall mortality by age groups

In the 0–44 age group, there were decreasing trends in men (AAPC= –4.2%, *P*=0.001) and stable trends in women (AAPC= –2.6%, *P*=0.480).

In the 45–59 age group, there were stable trends in men (AAPC= -2.0%, *P*=0.111) and women (AAPC=30.9%, *P*=0.069).

In the 60–74 age group, there were stable trends in men (AAPC=1.8%, *P*=0.312) and women (AAPC=3.0%, *P*=0.801).

In the +75-age group, there were increasing trends in men (AAPC=4.2%, *P*=0.018) and women (AAPC=7.0%, *P*=0.019).

Temporal trends of fall YLL rate

The total years of life lost due to falls during the 16-year study period were 25,437 (0.8 per 1,000 people) in men, 5,720 (0.2 per 1,000 people) in women, and 31,157 (0.5 per 1,000 people) in both sexes. (Male/female sex ratio, 4.4) (Table 1). The highest YLL in both sexes was in the age group of 15-29 yr and the lowest YLL in men was in the age group of 5-14 yr, and women in the age group of 30-44 yr (Fig. 2).

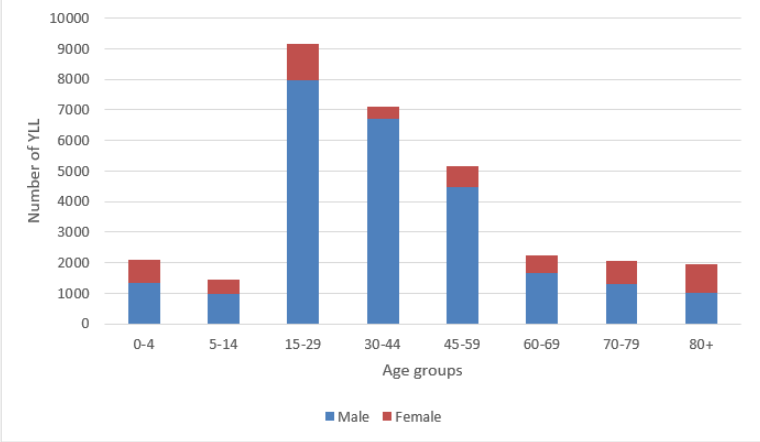

Fig. 2: Years of life lost due to falls by gender and age groups

According to the joinpoint regression analysis, the 16-year trend of YLL rate due to premature mortality was decreasing in males. The annual percent change (APC) was -2.8% (95% CI -4.5 to -1.0, *P*=0.005). But there were stable trends for females, APC was 3.5% (95% CI -1.8 to 9.1, *P*=0.181). The model did not show any joinpoint; hence, the AAPC (Average Annual Percent Change) is the same as APC (Figs. 3, 4).

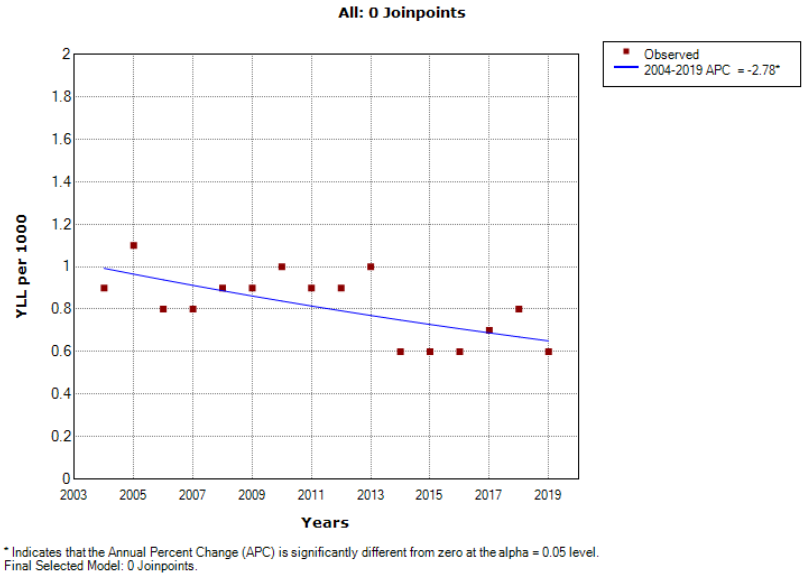

Fig. 3: Trends in the number of years of life lost due to falls in men during the years 2004-2019

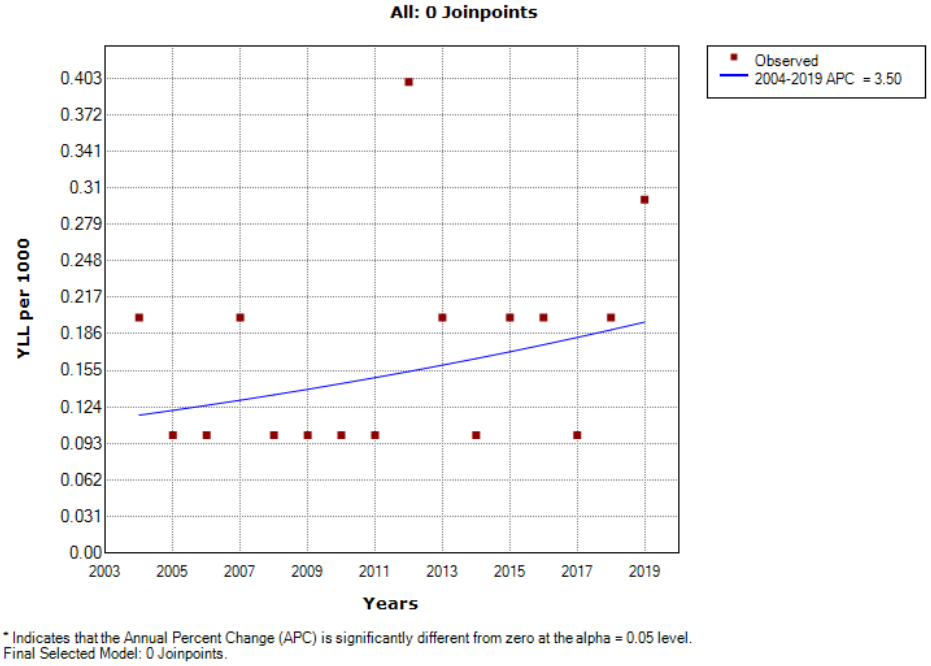

Fig. 4: Trend in the number of years of life lost due to falls in women during the years 2004-2019

Discussion

We investigated mortality and YLL due to falls in both genders and in all age groups over 16 yr to show a better view of this event among the Iranian population. Since this issue is less noticed and less studies have been done on it, these findings can be very important for health officials and can be used to develop and implement measures to reduce the burden of falls.

We found in current study there were 1,816 deaths due to falls in all age groups over 16 yr but this number was more (72,234) in Brazil between 2008 and 2016 in elderlies because they examined larger population (18). In another study in Taiwan, 3555 people died from fall injuries during 2005–2007 (19).

In this study there was a -2.8% decrease in YLL of falls in men and stable trend in YLL of fall in women while Alamgir reported during 2003 to 2007, there was a 20.2% increase in the death rate for men and a 22.5% increase for women of all ages (20). Globally, the YLL of falls from 1990 to 2017 was reported to be 16,688,088 (21). In our study, YLL due to falls during the 16-year study period was 31,157, which was higher in men because men are at greater risk of mortality (19). One explanation is that men are more physically active or more prone to risky behaviors (20). In addition, men suffer more comorbidities than women of the same age and are more likely to die from falls (22). On the other hand, in Iran, most of the families are male earners, and adult women stay at home, and this may be the reason for more deaths due to falling among men.

The age-standardized death rate (ASDR) of falls in Iran until 2015 decreased in women (1.32%) and increased in men (2.93%) (12). A population-based study found that the death rate from falls was four times higher in men than in women as well (23) but we observed a decreasing trend in mortality rate due to falls (crude and standardized) in men and an increasing trend in women over the period 2004 to 2019. Similar finding were achieved from another studies (24, 25). There was an increasing trend of deaths due to falls in southern Sweden from 1998 to 2014 (26). Moreover, a population-based study in China found that the annual fall mortality rate was as high as 0.49 per 100,000 people (23). Moreover, Burns et al demonstrated a significant increase in the ASDR between 2007 and 2016 in the United States whereas Olij's study did not observe a significant change during 1997-2016 (27).

Unlike the present study, which includes 16-year-old data and all age groups, most previous studies have been conducted in specific population groups (28-30). Therefore, the comparison of mortality rates with these types of studies may be biased and therefore different from our study. Even the incidence of fall injuries in similar population groups seems to vary between countries. This is due to the unique lifestyle of the people and the environmental characteristics of the region (10).

Additionally, the highest number of deaths in men was in the age group of 15-29 yr and women in the age group of over 80 yr. In this regard, increasing age is a risk factor for falls and related deaths (31, 32). The increasing trend in mortality from falls in the elderly may be due to the increased physical and cognitive functions and the increased risk of several chronic diseases (e.g., diabetes, arthritis, and vision and hearing disorders, Parkinson's disease) and the drugs used to treat them increase the risk of falling (33-35). In Iran, the highest number of YLL is in the age group of 60-69 and 15-29 yr (36) which is similar to our findings. People under the age of 75 are prone to falling outside the home due to their activities, which leads to more severe injuries (37). The external cause of injuries due to several factors, including the increase in urbanization and construction, Iran's location on the earthquake belt, will be the main source of the burden of injuries and losses of construction workers and a challenge for Iran's health system in the coming years (36). However, contrary to the results of our study, falls are the most common cause of unintentional injuries among pediatric populations in the United States and some European

countries (38, 39). Besides, more than one million children and adolescents visit emergency departments in the United States because of falls (40). Falls are the third leading cause of death from unintentional injuries in children under 9 years of age in Europe (41).

A limitation of the present study was that YLL was not evaluated throughout the whole of Iran due to the unavailability of the necessary data. Therefore, it is suggested to use national and large-scale data to improve generalizability and investigate possible causes of death from falls. Besides, we did not have information on the health status of those who experienced a fall, which significantly affects the final health outcome of the fall. The strength of this study was the high quality of the data and the large sample size and the extensive time period and age group.

Conclusion

Due to the increase in mortality, morbidity, and disability caused by falls, there is an urgent need to plan and implement preventive strategies to reduce the incidence of injuries caused by falls. Improvements in various aspects of health care, including the development of emergency and trauma care systems, home and behavioral modifications such as increasing home lighting, providing handrails on stairs and bathrooms, and educating the people may play an important role in reducing fall deaths.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

We would like to acknowledge the Health Vice-chancellor, Shiraz University of medical sciences.

Conflict of interest

The authors declare that there is no conflict of interests.

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