Research Article

Accidents in Fall Victims

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Abstract

Background: Accidents are the second leading cause of death following cardiovascular disease in all age groups. Falls account for 40% of deaths worldwide.

Objectives: This study aimed to investigate epidemiologically the victims of falls during a 6-year period by reviewing the medical records of the patients referring to Shahid Rajaee Hospital, Shiraz, Iran.

Methods: This cross-sectional study was conducted by reviewing the medical records of 12,133 patients admitted to the accident department of Shahid Rajaee hospital from 2009 to 2014. Demographic and other important data, such as age, gender, marital status, the severity of injuries, and survival or death, were collected. Then, the data were analyzed using chi-square test and logistic regression analysis.

Results: Medical records of 12133 fall victims were investigated. The mean age of the patients was 44.87 ± 20.91 years. The results of the multiple-regression model showed a significant relationship between death rate and age, injury severity, length of hospital stay, and injured body region in the fall victim (P < 0.05). The multiple-regression model also indicated a significant relationship between fall-related death and gender, injury severity, the injured body region, and the length of hospital stay (P < 0.05).

Conclusions: The highest mortality rate was observed among fall patients aged over 55 years with a high Injury Severity Score (ISS). Therefore, appropriate strategies should be taken for these patients in order to reduce mortality.

Keywords: Fall, Accident, Hospitalization, Death

1. Background

Accidents account for the largest epidemic of the current century (1). They have been reported to be the second leading cause of death after heart disease events in all ages and the first leading cause of years of potential life lost (YPLL) due to premature death (2). In Iran, injuries accounted for 28% of the total burden of diseases (3). Fall accidents account for 40% of deaths worldwide (4). Falls are one of the 15 leading predictors of the burden of disease and injuries in Iran (5) According to the department of forensic medicine, in the first quarter of 2014, 657 individuals (651 males and 6 females) died due to various unintentional accidents. This measure has increased by 4% compared to the same period in the last year. Among these accidents, falling was responsible for most work-related deaths (45%) (6). Overall, crashes and injuries are one of the main challenges for public health that have attracted international attention (7). In 2013, direct medical costs of fall, which was adjusted for inflation, were 34 million dollars (8). It has been estimated that one-third of healthcare costs are devoted to fall events (9). Fall accidents have also been coded in the international classification of diseases, being defined as unintentional and inadvertent falling on the ground, floor, or lower levels (7). Although many factors, including demographic (age, sex, and illness), socioeconomic (education level, income level, housing, public health, and public isolation), behavioral (fear, lifestyle, medication, quitting exercise, and inappropriate clothing), and geographical (buildings, slippery floor, carpet, flooring, and fencing) factors are involved in the incidence of crashes, most falls are caused by the interaction of the features providing the ground for falling (7, 10-12). The rate of death resulting from fall is increased with the increase of age in both sexes and in different races (13). Besides, the risk of non-fatal fall injuries is higher in females than in males (14). Approximately 30% - 35% of falls result in minor soft tissue injuries, while 20% - 30% led to moderate to severe injuries that in turn can reduce mobility and

independence and eventually result in death (15).

Generally, falls are the most important reason for inactivity in older individuals and increased admissions to nursing homes (4, 6). Depending on the type of injury, crashes can lead to hospitalization, disability, and limitation of movement, which considerably reduce the quality of life, especially among the elderly. Thus, more studies are required to identify the prevention methods that can be effective in different cultural backgrounds (7).

2. Objectives

The present study aimed to evaluate the epidemiological aspects of fall accidents in the victims referring to Shahid Rajaee hospital, Shiraz, in 2009 - 2014.

3. Methods

This cross-sectional study was conducted on 12,133 fall victims referring to the emergency department of Shahid Rajaee trauma hospital in Shiraz, southwest Iran. All patients referring to the hospital due to fall accidents including mild injuries were included. The data were collected using a checklist including demographic information, such as age, gender, and marital status, affected organ (head or neck, chest, abdomen, hands, or feet), severity of injury (1 - 3, 4 - 8, 9 - 15, 16 - 24, > 25), length of stay (< 2 or > 2 days), and survival or death. Data related to the height of fall was not recorded in medical profiles of the patients. The accuracy of the collected data was verified using Excel software, 2013. Then, the data were analyzed using SPSS version 19 statistical software. The mean and standard deviation and relative and absolute frequency were used to analyze quantitative and qualitative variables, respectively. Additionally, the chi-square test was used to examine the relationship between the variables. A logistic regression model was also employed for further data analysis. $P < 0.05$ was considered statistically significant.

3.1. Measurements and Data Collection

Whenever a patient refers to Shahid Rajaee hospital, a unique 8-digit code called 'serial code' is generated by the hospital admission unit. Upon admission, information regarding baseline demographics, including identifications, serial code, age, gender, marital status, admission date, and injury mechanism, is routinely recorded electronically by the admission unit. When a patient is discharged, the hard copy records are transferred to the medical records unit where trained staff routinely extracts information regarding external causes of the injury, injury

diagnosis, surgical interventions, and the outcome of hospitalization. The information is then coded using the ICD-10 coding system and entered into an electronic database. Upon initiation of data validation, the trauma registry was accessed in Shiraz Trauma Research Center and the information retrieved from three hospital databases were merged (based on serial codes) to generate one combination.

3.2. Injury Description, Injury Severity Score and Injured Body Regions

An algorithm was designed to convert each ICD-10 rubric (injury diagnosis code) to its relevant abbreviated injury scale (AIS)-98 score if possible. The algorithm was developed using the Microsoft Excel software text functions, which entails transforming text strings into numbers. In the ICD-10 lexicon, each injury is described by a code ranging from S.00 to T79.7 and a code description. We excluded the ICD-10 diagnostic codes related to foreign bodies (T15.0-T19.9), burns and corrosion injuries (T20.0-T32.9), environmental exposures (T33.0-T35.7, T66-T75.8), and poisonings (T36.0-T65.9). Complications of medical care and late effects of injuries (T80-T98) were also excluded, leaving a total number of 47295 patients to be included for calculation of Injury Severity Score (ISS).

In consultation with a member of the Trauma Research Center, each injury-related ICD-10 code was assigned to an appropriate AIS-98 severity code (number) where applicable. Conservatively, we transformed the ICD-10 codes to the lowest AIS-98 severity score. In cases where the ICD-10 codes could not be transformed to accurate AIS, that particular injury was not used in calculating the ISS. Specifically, in cases where the ICD-10 described injuries to multiple, unidentified, or unspecified body regions, a 99 (missing) code was used (e.g. S09.7 multiple injuries to the head). It should be noted that the injured body region for each patient corresponded to the most severely injured body region based on the AIS.

3.3. Length of Stay and Mortality Timing

Length of stay and the interval between admission and death were calculated by subtracting the discharge/death date from the admission date. The resulting variable measured the length of stay on a one-day (24-hour) scale.

4. Results

4.1. Descriptive Analysis

This study was conducted on the clinical history of 12,133 patients suffering from a traumatic fall. The mean ± SD of the patients' age was 44.87 ± 20.91 years (ranging

from 15 to 106 years). The highest rate of fall was reported in people aged 25 - 34 year, followed by older people aged 65 years or higher (Figure 1).
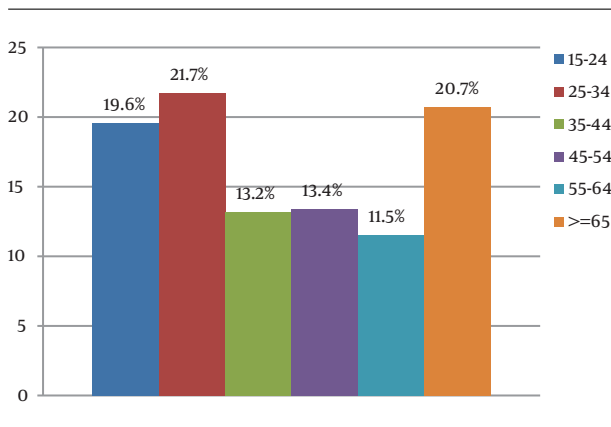

Figure 1. Frequency of Fall by Age Groups

In addition, 63.2% of the patients were male, 43% were above 55 years of age, and 73.4% were married. Moreover, the most injured body regions (42.5%) were lower extremities with an ISS of 9 - 15. The length of hospital stay was also less than 2 days in 77.8% of the cases and only 1% of the patients had a history of hospitalization in ICU.

The study results showed that the mortality rate (5.5%) and the length of hospital stay (> 2 days) (3.6%) were higher in the patients with head and neck injuries, the patients with ISS = 16-24 (8.4% and 4.9%), and those with a history of hospitalization in ICU (65.4% and 73.1%) (Table 1).

4.2. Regression Analysis

The results of the crude analysis for the factors associated with mortality and the length of hospital stay are presented in Table 2. Based on the results, age, gender, marital status, the injured body region, and ISS were significantly related to mortality and the length of hospital stay.

4.3. Mortality Rate

The results showed that the mortality rate was lower in male patients in comparison with females [OR = 0.62, 95% CI (0.43 - 0.87)], in married patients in comparison with single ones [OR = 0.65, 95% CI (0.44 - 0.97)], and in patients with the length of hospital stay > 2 days in comparison with those with the length of hospital stay < 2 days [OR = 0.16, 95% CI (0.12 - 0.22)]. On the other hand, mortality rate was higher in the patients aged above 55 years in comparison with those below 24 years of age [OR = 4.02, 95% CI (2.73 - 5.93)], the patients who suffered from injuries in extremities in comparison with those with head and neck injuries [OR=5.22, 95% CI (3.27 - 8.34)], and in those with ISS > 15 [OR = 5.30, 95% CI (1.41 - 19.88)].

4.4. Length of Hospital Stay

The results showed that the length of hospital stay was higher in male patients in comparison with females [OR = 1.86, 95% CI (1.69 - 2.05)], in the patients aged above 55 years in comparison with those below 24 years of age [OR = 0.66, 95% CI (0.59 - 0.73)], in married patients in comparison with single ones [OR = 1.31, 95% CI (1.18 - 1.45)], in the patients suffering from lower extremities injuries in comparison with those with head and neck injuries [OR = 1.70, 95% CI (1.48 - 1.95)], and in the patients with ISS = 4 - 8 in comparison with those with ISS < 4 [OR = 1.50, 95% CI (1.13 - 1.99)].

The results of multivariate logistic regression analysis for the factors associated with mortality and length of hospital stay are presented in Table 3. Accordingly, age, marital status, the injured body region, and ISS were significantly associated with mortality rate. Moreover, gender, the injured body region, and ISS had significant relationships with the length of hospital stay in multivariate modeling.

The results of multivariate logistic regression analysis showed that the mortality rate was higher in the patients aged above 55 years in comparison with the younger age groups [OR = 4.39, 95% CI (2.64 - 7.30)], in the patients suffering from injuries in extremities compared to those with head and neck injuries [OR = 7.89, 95% CI (4.15 - 14.97)], and in the patients with ISS > 25 in comparison with those with ISS < 4 [OR = 3.80, 95% CI (0.81 - 17.72)]. On the other hand, the mortality rate was lower among patients with a length of hospital stay > 2 days in comparison with those with the length of hospital stay < 2 days [OR = 0.61, 95% CI (0.40 - 0.94)] (Table 3). The results of multivariate analysis also indicated that the length of hospital stay (> 2 days) was lower in male patients in comparison with females [OR = 0.69, 95% CI (0.60 - 0.79)] and in the patients with ISS > 25 in comparison with those with ISS < 4 [OR = 0.07, 95% CI (0.05 - 0.10)]. However, the length of hospital stay was higher in the patients who suffered from injuries in lower extremities compared to those with head and neck injuries [OR = 1.81, 95% CI (1.48 - 2.26)] (Table 3).

5. Discussion

The findings of the present study showed that fall patterns in Shiraz complied with other studies in terms of age, gender, and marital status. In total, 12,133 medical records of fall victims were reviewed in this study. Evaluation of fall accidents distribution revealed that nearly 63.2% of fall victims were male. Generally, men are more likely to experience fall accidents because of reasons including there are a larger number of male workers, women are more alert and

Table 1. Description of the Socio-Demographic Features of the Fall Victims in Fars Province, Iran[a]

		Mortality		Length of Hospital Stay, d	
	Total (n = 12133)	Non-Survived (n = 165)	Survived (n = 11968)	< 2 (n = 9443)	> 2 (n = 2690)
Gender					
Female	4465 (36.8)	44 (1.0)	4421 (99.0)	4443 (99.5)	22 (0.5)
Male	7668 (63.2)	121 (1.6)	7547 (98.4)	7595 (99.0)	73 (1.0)
Age, y (n=12133)					
< 35	3737 (30.8)	99 (2.6)	3638 (97.4)	3686 (98.6)	51 (1.4)
35 - 55	3179 (26.2)	31 (1.0)	3148 (99.0)	3159 (99.4)	20 (0.6)
55 >	5217 (43.0)	35 (.7)	5182 (99.3)	5193 (99.5)	24 (0.5)
Marital status					
Single	3232 (26.6)	32 (1.0)	3200 (99.0)	3216 (99.5)	16 (0.5)
Married	8901 (73.4)	133 (1.5)	8768 (98.5)	8822 (99.1)	79 (0.9)
Injured body region (n = 5092)					
Head and neck	1298 (25.5)	72 (5.5)	1226 (94.5)	1251 (96.4)	47 (3.6)
Face	97 (1.9)	0 (0)	97 (100)	97 (100)	0 (0)
Chest	679 (13.3)	8 (1.2)	671 (98.8)	673 (99.1)	6 (.9)
Abdomen	857 (16.8)	12 (1.4)	845 (98.6)	850 (99.2)	7 (.8)
Extremities	2161 (42.5)	24 (1.1)	2137 (98.9)	2148 (99.4)	13 (.6)
Injury severity score (n = 6067)					
1 - 3	1171 (19.3)	4 (0.3)	1167 (99.7)	1168 (99.7)	3 (.3)
4 - 8	1930 (31.8)	8 (0.4)	1922 (99.6)	1924 (99.7)	6 (.3)
9 - 15	2055 (33.9)	52 (2.5)	2003 (97.5)	2025 (98.5)	30 (1.5)
16 - 24	631 (10.4)	53 (8.4)	578 (91.6)	600 (95.1)	31 (4.9)
> 25	280 (4.6)	5 (1.8)	275 (98.2)	273 (97.5)	7 (2.5)
ICU admission					
Yes	130 (1.1)	85 (65.4)	45 (34.6)	35 (26.9)	95 (73.1)
No	12003 (98.9)	80 (0.7)	11923 (99.3)	12003 (100.0)	0 (0)
Length of hospital stay, d					
< 2	9443 (77.8)	102 (.8)	11936 (99.2)	-	-
> 2	2690 (22.2)	63 (66.3)	32 (33.7)	-	-

[a] Values are expressed as No.(%).

cautious compared to men, and men take harder and more hazardous tasks compared to women. Many studies have also reported a higher prevalence of fall accidents among men (16).

Nearly, 25.65% of the injured patients referring to Shahid Rajaee hospital were due to fall accidents. The incidence rate of all fall injuries was 59 (95% CI: 45 - 72) per 1000 person-year in Tehran, Iran (17). Given the lack of studies focusing on fall injuries, the current results show a higher frequency of fall accidents in Iran compared to other countries. This difference may result from the lack of protective measures and equipment used among Iranian people.

In the current study, the mean age of the victims was 44.16 ± 21.4 years (ranging from 14 to 106 years), which is consistent with other studies (18-20). This may be attributed to workers' immaturity and high workload.

The results of both multiple and simple analyses in our study indicated that age, the injured body region, ISS, and the length of hospital stay were significantly associated with mortality. Accordingly, mortality increased with age and most of the fatalities were related to the cases above 55 years of age, which is consistent with the results of other

Table 2. Crude Odds Ratio (OR) Estimating the Factors Associated With Mortality and Length of Hospital Stay in Fall Victims

	Mortality		Length of Stay (LOS) in Hospital	
	OR (95% CI)	P Value	OR (95% CI)	P Value
Sex				
Female	Reference	Reference	Reference	Reference
Male	0.62 (0.43 - 0.87)	0.007 *	1.86 (1.69 - 2.05)	0.001 *
Age, y (n = 12133)				
< 35	Reference	Reference	Reference	Reference
35 - 55	2.76 (1.84 - 4.14)	0.001*	0.78 (0.70 - 0.87)	0.001 *
55 >	4.02 (2.73 - 5.93)	0.001*	0.66 (0.59 - 0.73)	0.001 *
Marital Status				
Single	Reference	Reference	Reference	Reference
Married	0.65 (0.44 - 0.97)	0.035 *	1.31 (1.18 - 1.45)	0.001*
Injured body region (n = 5092)				
Head and neck	Reference	Reference	Reference	Reference
Face and chest	4.92 (2.35 - 10.28)	0.001 *	1.09 (0.90 - 1.32)	0.337
Abdomen	4.13 (2.23 - 7.66)	0.001 *	1.34 (1.12 - 1.59)	0.001*
Extremities	5.22 (3.27 - 8.34)	0.001 *	1.70 (1.48 - 1.95)	0.001*
Injury Severity Score (n = 6067)				
1 - 3	Reference	Reference	Reference	Reference
4 - 8	0.19 (0.07 - 0.50)	0.001*	1.50 (1.13 - 1.99)	0.005*
9 - 15	0.70 (0.27 - 1.79)	0.451	1.44 (1.12 - 1.85)	0.004*
16 - 24	4.36 (1.14 - 13.44)	0.010*	0.86 (0.67 - 1.11)	0.270
> 25	5.30 (1.41 - 19.88)	0.013*	0.17 (0.13 - 0.23)	0.001*
Length of hospital stay, d				
< 2	Reference	Reference	Reference	Reference
> 2	0.16 (0.12 - 0.22)	0.001 *	-	-

studies (17, 21-24).

Previous studies also revealed different injury patterns by age groups. As such, older people reported a higher level of injury severity compared to younger people (21). Moreover, older people reported higher rates of death after controlling for chronic disease border and injury severity (ISS) (22).

Reduced physical activity, reduced effective cognitive capacity, and comorbidity with other chronic diseases could be the reasons for the higher rate of mortality in older ages. Besides, since aging is accompanied by lower body fat tissue and higher skeletal tissue, the probability of injury is higher among older patients (25). Varied anatomical and physiological status in the elderly and young cases could play a role, as well.

The present study findings demonstrated that the injured body region was associated with mortality. Accordingly, the mortality rate was higher in the patients who had injuries in their lower extremities compared to those with injuries in their other body regions.

Many studies have shown that head injury is the most common injury in young adults, and hip and hip joint injuries are most common among the elderly. This difference may be due to different injury mechanisms between these two individuals. As such, head injury in young adults is usually because of road traffic accidents and assaults, whereas hip and hip joint injuries usually result from fall accidents in older people (26, 27).

Generally, fall-related injuries are usually associated with multi-organ, especially skeletal, muscles (28).

Higher rates of fall-related trauma and injuries in regions such as elbows, forearms, and hip in elderly women show the lack of screening and preventive care services provided for the elderly (27).

Table 3. Adjusted Odds Ratio (OR) Estimating the Factors Associated with Mortality and Length of Hospital Stay in Fall Victims

	Mortality		Length of Stay (LOS) in Hospital	
	OR (95% CI)	P Value	OR (95% CI)	P Value
Sex				
Female	Reference	Reference	Reference	Reference
Male	-	-	0.69 (0.60 - 0.79)	0.001
Age, y (n = 12133)				
< 35	Reference	Reference	Reference	Reference
35 - 55	2.67 (1.60 - 4.44)	0.001	-	-
55 >	4.39 (2.64 - 7.30)	0.001	-	-
Injured body region (n = 5092)				
Head and neck	Reference	Reference	Reference	Reference
Face and chest	4.06 (1.75 - 9.40)	0.001	1.74 (1.36 - 2.22)	0.001
Abdomen	2.68 (1.24 - 5.79)	0.012	1.71 (1.34 - 2.18)	0.001
Extremities	7.89 (4.15 - 14.97)	0.001	1.81 (1.48 - 2.26)	0.001
Injury severity score (n = 6067)				
1 - 3	Reference	Reference	Reference	Reference
4 - 8	0.18 (0.06 - 0.53)	0.002	1.07 (0.75 - 1.54)	0.685
9 - 15	0.24 (0.08 - 0.74)	0.013	0.59 (0.41 - 0.84)	0.004
16 - 24	1.81 (0.45 - 7.14)	0.396	0.29 (0.20 - 0.41)	0.001
> 25	3.80 (0.81 - 17.72)	0.089	0.07 (0.05 - 0.10)	0.001
Length of hospital stay, d				
< 2	Reference	Reference	Reference	Reference
> 2	0.61 (0.40 - 0.94)	0.027	-	-

Additionally, the risk of death is influenced by the height of fall, parts of the body hitting the ground, and the type of the land at the site of the crash (29).

ISS was also associated with mortality in the current study. Based on the results, the mortality rate was higher in the patients with ISS > 25, which is in agreement with the results of other studies (22, 30). In general, the severity of injuries is affected by the height of the fall (31), type of fall, and patient's overall health status (32, 33). Hence, an appropriate treatment protocol is recommended to reduce mortality and morbidity in patients with multiple trauma (34, 35).

The results also revealed that mortality was lower in the patients whose length of hospital stay was more than two days. In fact, the patients who suffered from severe injuries lost their lives within the early hours and, as a result, the average duration of hospitalization was lower in these patients.

Based on the results of both multiple and simple analyses, male gender, the injured body region, and ISS were significantly related to the length of hospital stay. Accord-ingly, the length of hospital stay was lower in males in comparison with females, which is consistent with the results of the research by Johnson et al. In that study, women's higher survival after falling down and hospitalization was expressed as the reason for this difference (36).

Moreover, ISS and injured body region had significant relationships with the length of hospital stay. Based on the results, the length of hospital stay was higher in the patients with injuries in their lower extremities. Besides, the higher the ISS, the lower the duration of hospitalization would be.

Overall, considering the highest mortality rate among the older cases (above 55 years old) with high ISS, strategies should be proposed to reduce injury and death in this group.

5.1. Conclusions

The current study results showed that an increase in ISS was accompanied by a decrease in the length of hospital stay among fall victims. Moreover, gender, marital status, injury severity, and death or recovery outcomes were

associated with the length of hospital stay. Early detection of the determinants of the existing outcomes (death and the length of hospital stay) is important in trauma centers. Thus, it is recommended to design and implement fall control and prevention programs.

5.2. Limitations, Strengths, and Future Directions

One of the major limitations of the present study was misclassification of some study variables, including injury severity and the injured body region, which could have affected the determination of two major outcomes, including mortality and the length of hospital stay. Thus, the accuracy of the final analyses of these variables was not verified. Besides, fatalities reported here were not representative of all fall-related deaths.

5.3. Recommendation

Generally, fall phenomenon requires three different levels of prevention, the first of which being prevention of the onset of diseases and reduction of mortality rate, length of hospital stay, costs, complications, and morbidity. Unfortunately, today even the simplest preventive methods, such as occupational safety tools, are not applied in our country, which is apparently due to inappropriate regulations and executive rules. Second, prevention in our country does not involve a well-designed national trauma surveillance system. Therefore, equipped trauma centers must be established. Another major dimension of secondary prevention is regular data collection related to the fall patients, which can be applied to the treatment process and further research. Finally, the third stage involves following up the fall patients after discharge from hospital to make sure about their occupational skills and physical/mental health. Additional review of the effectiveness of injury severity scoring methods is necessary, as well.

Acknowledgments

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