

Review of Fall Injuries and Related Factors in Patients Admitted to a Trauma Referral Hospital in Tehran, Iran

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ABSTRACT

Background: Falls are important causes of mortality and morbidity in urban areas and put a high burden on societies. We investigated patterns of fall traumas and related factors in a referral trauma hospital in Tehran, Iran.

Methods: In this routine-data-based study, all documents of fall cases in Hazrate-Rasool hospital, Tehran, Iran, during October 2014-2015 were investigated. Information on demographic factors of patients, fall conditions and outcomes were collected. Data were analyzed by SPSS 11.5. The statistically significant level was considered ≤ 0.05 .

Results: Of the 307 cases, 70% were male. Median (interquartile range) age was 32 (22-51) years. Of cases, 91% were undergraduates. The mortality rate was 2.6%. Suicide attempts reported in 17 (5.5%) cases and only 2 (12%) of them were successful. Injured body organs in order of frequency were extremities, head and neck, thorax, vertebrae, abdomen and pelvis. Outcome (in terms of injured body organs) was related to age and gender of patients alongside with height and reason of the fall. Falls at workplaces, in suicide attempts and among males happened for significantly higher distances. High distance falls and low GCS at admission were related to higher mortality. Majority of falls on a same level happened at home among old women.

Conclusion: In our region, fall was a problem of people with low socioeconomic status. Our mortality rate is similar to the highest mortality rates in the world. Personal characteristics along with trauma-related factors are both important in the outcomes of fall cases. Safety equipment at high risk jobs is essential to prevent falls.

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► *Implication for health policy/practice/research/medical education:* Fall Injuries and Related Factors

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1. Introduction:

The concept of "vertical deceleration trauma" was formerly noted by Lewis et al, in 1965. They classified falling traumas into "accidental" or "suicidal" and set the word of "jumpers" to imply suicidal attempts (1). Although falls are the 28th leading cause of death (based on 2013 global statistics) (2), they are the second important reason of death due to unintentional injuries globally, after traffic accidents (3). Despite low mortality rates, falls are responsible for 12% of the total burden of injuries in terms of DALYs loss (2). Disadvantages of falls on economy and productivity of societies make these traumas an important field of investigation and intervention (2). Frequency and mortality rates of falls are higher in countries with lower socioeconomic status (2, 3). Based on global statistics, mortality rate of falls is highest in "East Mediterranean Region", which has been estimated to be 2.9 per 100,000 falls (2). Severity of falls in urban areas is higher than rural areas; therefore, in the same country, regional patterns are different (4). Magnitude of falls in the developing world is considerable. For example, regional reports in Nepal and Iran show that falls are the leading cause of injuries, especially in urban places (5, 6). There are different definitions for "fall" in the literature which has led to diversity of reports and statistics. A comprehensive definition according to ICD9, is that: "fall is a sudden occurrence that a person comes down to the ground and can be from a higher level or on a same level"(7). During a fall, "direct impact" results in fractures and promptly "deceleration" happens, which may lead to internal or cranial injuries. Multiple organ traumas are also common in falling injuries (8). Falls may happen accidentally, due to violence or because of intrinsic medical problems like cerebrovascular attacks (7); in addition, they are a common form of suicide attempts and can be a

method for homicide (4). About 40-60% of falls leads to an injury (7), but injuries are usually non-fatal (3). Risk factors for fall accidents include age, gender, substance abuse, underlying diseases and occupations at elevated heights or hazardous conditions (3). Falls can happen at all age groups (2, 3, 9), but outcomes are different based on age: Mortality rate is higher among children and old victims while young adults experience higher morbidity and die at lower rates (3, 4, 10, 11). The mortality rate of falls is higher among male victims and women usually experience non-fatal consequences (3). Height of fall has been counted as another predictor of severity and adverse outcomes (4).

Fall traumas impose a high burden on societies, especially in terms of morbidity and they are preventable. Comprehensive recognition of regional patterns of falls provides key principals for establishment of control programs. Available studies on fall traumas in Iran are limited and most of our knowledge on risk factors and outcomes are obtained from researches in other countries. In this study we describe patterns and outcomes of falls among patients admitted to a trauma referral hospital in Tehran. The aim of this study is to find the risk factors and outcomes of fall traumas in our region.

2. Materials and Methods:

In this routine-data-based study, we investigated available records of patients who admitted to the emergency ward of Hazrate -Rasool Hospital, Tehran, Iran, because of fall trauma during October 2014 - October 2015. This hospital is a referral center for traumatic patients. All available records of patients and paraclinic findings including graphies, sonographies, CT scans and MRIs were reviewed and data were extracted and entered into checklists. Height of fall was available in hospital records in some cases, although they might be an estimate made by the emergency physician. In some cases hospital records lacked height of fall and we estimated it based on available reports of method and place of falls, having in mind that each floor is considered to be about 3 meters high and ladders are

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considered to be 2 meters high. In death cases height of fall was reported by forensic reports and in falls at workplace, height of fall was estimated by experts of "Labor Office". Data analysis was done by SPSS version 11.5. Descriptive statistics were presented in the form of Mean (\pm SD) or Median with Interquartile Range (IQR) and

tables. Chi-Square, Mann-Whitney and Kruskal-Wallis tests were used to investigate associations between different types of variables. Significant level was considered ≤ 0.05 in this study.

3. Results:

Study participants were 307 cases of fall

Table 1: Sites, Types and frequencies of injuries among patients referred to Hazrate-Rasool Hospital, Tehran, Iran, during October 2014-2015.

Site of trauma N (%)	Type of injury	N (%)
Head 77 (25)	Superficial laceration	52 (67.5)
	Cerebral hemorrhage	15 (19)
	Skull fracture	8 (10)
	Cerebral contusion	2 (3)
Neck 2 (0.6)	Penetrating trauma of neck	2 (100)
spinal Region 31 (10)	Fracture of lumbar vertebra	21 (69)
	Fracture of thoracic vertebra	5 (16)
	Fracture of neck vertebra	4 (12.5)
	Spinal cord injury	1 (2.5)
Thorax 44 (14)	Rib fracture	26 (59)
	pneumothorax*	7 (16)
	lung contusion**	6 (14)
Abdomen 29 (9.4)	hemothorax***	5 (11)
	Splenic injury	13 (45)
	hepatic injury	9 (31)
	Small intestine injury	5 (17)
Extremities 118 (38)	colon	2 (7)
	Lower limb fractures	68 (57)
	Upper limb fractures	35 (30)
Pelvis 10 (3)	Both	15 (13)
	Pelvic fracture	10 (100)

*4 were accompanied with rib fractures and one was accompanied with hemothorax

**all were accompanied with lung contusion

***4 were accompanied with rib fractures and one was accompanied with pneumothorax

Table 2: Distribution of injured body organs according to gender, location and reason of fall among fall patients referred to Hazrate-Rasool Hospital, Tehran, Iran, during October 2014-2015.

	Head trauma	Spinal trauma	Chest trauma	Pelvic trauma	Limb trauma	Abdominal trauma	p-value
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	
Gender :							0.02
Male	58 (75)	24 (77)	37 (84)	3 (30)	82 (69)	21 (72)	
Female	19 (25)	7 (23)	7 (16)	7 (70)	36 (31)	8 (28)	
Fall location:							0.06
House	36 (47)	10 (32)	13 (30)	9 (90)	53 (45)	9 (31)	
Work place	31 (40)	18 (58)	23 (52)	1 (10)	50 (42)	16 (55)	
Other places	10 (13)	3 (10)	8 (18)	0 (0)	15 (13)	4 (14)	
Fall reason:							<0.001
Accidental	66 (86)	12 (71)	38 (86)	9 (90)	109 (92)	4 (86)	
Suicidal	11 (14)	5 (29)	6 (14)	1 (10)	9 (8)	25 (14)	

patients with median (IQR) age of 32 (22-51) years, ranged from 5 months to 94 years. Of victims 216 (70%) were male. Patients at the age of 20-40 years old consisted 131 (43%) of cases and 53 (17%) of cases were 60 years or older. Median (IQR) age of female cases was significantly higher than male ones: 42 (23-68) and 31.5 (22-45) years, respectively (p-value=0.008). Only 28 (9%) of patients were college or university graduates and 279 (91%) were

undergraduates. Based on the reason of fall we classified cases in two categories: accidental falls vs. suicidal falls. Category of accidental falls included all unintentional falls and also falls due to underlying medical problems. Among our cases, 17 (5.5%) were suicidal falls while 290 (94.5%) were accidental falls. There was not statistically significant relationship between level of education and reason to fall in this study (p-value=0.67). Underlying medical problems

Table 3: Association between injured organs and victim's age and height of fall among fall patients referred to Hazrate-Rasool Hospital, Tehran, Iran, during October 2014-2015.

	Head trauma	Spinal trauma	Chest trauma	Pelvic trauma	Limb trauma	Abdominal trauma	p-value
Age(years):							<0.001
Median	32	31	32.5	67	35	32	
(IQR)	(22.5-46)	(19-74)	(23.5-40)	(45-85)	(26-61)	(23-46)	
Height of fall(meters):							<0.001
Median	3	4.5	4	2.45	2	4.25	
(IQR)	(1.5-5)	(3-7)	(2.6-5.8)	(0-5)	(0.5-4)	(3-6.25)	

Table 4: Association between the reason of fall and gender and age of victims and height of fall among fall patients referred to Hazrate-Rasool Hospital, Tehran, Iran, during October 2014-2015.

Reason of fall	Gender:		Age(year):	Height of fall(meters):
	Male	Female	Median (IQR)	Median (IQR)
	N (%)	N (%)		
Suicidal	5 (2)	12 (13)	31 (26-34.5)	5 (4-6)
Accidental	211 (98)	79 (87)	32.5 (22-52)	2 (1-3)
p-value	0.001		0.44	<0.001

were only reported in 8 (2.6%) cases: cardiovascular diseases in 5 and diabetes in 3 cases. Positive history of psychiatric disorders was reported in 8 (2.6%) patients: 4 were addicts and 4 had depression. Death occurred in 8 (2.6%) cases and 2 (25%) of them were suicide cases. Location of the incident was home in 147 (48%), work place in 119 (39%) and outdoors in 41 (13%) of cases. Median (IQR) height of fall was 2 (1-3) meters with maximum of 25 meters and minimum of zero for cases who fell on a same level. Height of fall was significantly higher among male cases: median (IQR) of 2.5 (1.5-4) meters for males and 1 (0-2) meter(s) for females (p-value=0.001). Median (IQR) height of fall was 3 (2-5) meters for workplace events while it was 1 (0-2) meter(s) for falls at home (P value=0.001). Falling from scaffolding and ladders composed the majority of occupational falls. In this study, 56 (18%) cases fell on a same level with the median (IQR) age of 66 (49-81) years old and 37 (66%) of them were female; in addition 51 (91%) of falls on a same level happened at home and the other 5 (9%) happened outdoors. In fact, 35% of falls at home happened on a same level. The majority of non-par level falls at home happened from stairs or footstools. Falling from the mountain, escalators or in the street were the leading methods of outdoor falls. The reason of death was head trauma in 7 (87.5%) victims and internal hemorrhage in 1 (12.5%) case. Sites, Types and frequencies of injuries in our study population are summarized in Table-1. Table-2 and Table-3

summarize the distribution of injured body organs according to gender of victims, location of event (workplace, home or outdoors), reason of the fall (suicidal vs. accidental), age of victims and height of fall. There was statistically significant relationship between injured body organs and gender (P value=0.02) and age of patients (P value<0.001). There was also a statistically significant relationship between injured body organs and reason and height of fall (both with P value<0.001), but there was not a statistically significant relationship between injured body organ and location of the fall (P=0.06). Table-4 shows the relationship between reason of the fall (suicidal vs. accidental) and age and gender of victims and height of fall. Median (IQR) height of fall was 7 (4-14.25) meters for dead cases, while it was 2 (1-3) meters for survivors (P value=0.002). Height of fall was associated with the location of fall (P value<0.001): Median (IQR) height was 1 (0-2) meter(s) for falls at home, 3 (2-5) meters for falls at work place and 2 (1-2.75) meters for falls that happened outdoors. Median (IQR) of GCS at admission was 7.5 (6.25-10) in patients who died while it was 15 (14-15) among survivors (p-value<0.001).

4. Discussion:

In this study, we reviewed records of 307 fall patients who referred to the Hazrate-Rasool Hospital, Tehran, Iran. This hospital is a referral center for traumatic patients; therefore fall cases in this hospital can be representative of severe fall cases in Tehran.

In the present study, 70% of fall patients were male and 91% were undergraduates (didn't have a university degree). We used an education level of patients as an indicator of their socioeconomic status; therefore 91% of participants were in low socioeconomic level. Consistent with our findings, previous studies have also reported predominance of men in fall injuries (2, 4, 5, 9, 12-18). Although comparing the results of the current study with other studies is imprecise because study populations, their inclusion criteria, trauma locations and mechanisms are different. The most affected age groups were young adults in the range of 20-40 years old (42.7%) followed by patients older than 60 years (17.3%). Related articles usually focus on falls in children or elderly because of higher mortality rates (9). Although old people (over 60 years) and young children (usually under 5 years old) are high risk groups for accidental falls and its morbidity and mortality (3, 4, 10, 11); but according to different reports, the rate of fall injuries is also high among young people (3, 9, 11). For example, similar to our study, Ramos *et al*, in a series of fall patients in a hospital in Bronx, USA, during 1977-1982, reported that 44% of the falls were among people in 20-40 years old (19). Fayyaz *et al*, in a study on fall patients at a hospital in Pakistan found that 70% of them were young adults between 15-44 years old (2). Gupta *et al*, evaluated all fall injuries in Nepal during 2014 and found that most fall cases (45.1%) were young adults in the range of 25-45 years old (5). Contrary to our study, in the report of Talbot *et al*, among 1497 Americans with high education level, falls were more frequent among old people (9). Based on available evidence we conclude that falls of young adults is higher in populations with low socioeconomic level. One reason could be that young people in these populations usually work in physical low rank jobs like construction, industrial or service works. These jobs are not usually equipped with appropriate safety equipment and subject workers to high probability of accidental falls (20, 21). In this study death rate was 2.6%. Consistent with this rate, Behcet *et al*, reported death rate of 2.2% for

accidental falls in emergency department of a hospital in Batman, Turkey in 2007 (11). The death rate in the study of Fayyaz *et al*, in Pakistan was 1.9% (2). Yagmur *et al*, reviewed flat roof falls in a 4 year period in Turkey and with the mean height of 4.5 meters, mortality rate was 5.8% (8). Liu *et al*, reported mortality rate of 22.7% among the population of Taipei who fell from more than 6 meters height (13). Totally, by increasing the height of fall, mortality rates also rise (10, 13). Again, the differences between the mortality rate of the current study with previous studies can be due to different study population and fall-related conditions. Our mortality rate is comparable to the rate of "East Mediterranean Region", which has the highest mortality rates in the world (2). Death rates of fall traumas are usually lower in developed countries (16, 22). Generally, young adults fall from higher points and experience more intensive falling traumas. Although their death rates are lower than elderly, but they endure high morbidity and put a high burden in terms of DALYs loss and low productivity on the societies (3, 4). Setting safety measures, especially for young workers in hazardous jobs seem essential to prevent job-related falls. To obtain a more accurate estimate of the prognosis of fall traumas, death rate alone is not sufficient and further assessments on morbidity are needed. Our suicide rate was 5.5%. This rate was about 11% in Goren's study, in Turkey (10) and 29.7% in Fayyaz' study in Pakistan (2). The lower rate of suicide in this study can be due to concealment of reporting. In fact, because of the social stigma of suicide in Iranian society, victims and their relatives don't state it. Suicide in this study was more prevalent among females, substance abusers and people with psychological problems; analogous findings have been addressed in previous reports (10, 19). Distance of fall was significantly higher in suicidal falls which is consistent with findings of different studies (4, 10, 18). Distance of fall is an important predictor of the severity of trauma (8); therefore we expect to observe more intensive injuries among suicide cases. Our findings show that 25% of deaths due to fall

was among suicide cases, this rate was 56% in the study of Atanasijevic *et al*, in Belgrade (18). While comparing these rates, again underreporting of suicide attempts in Iran should be in mind. Our study findings show that the majority (91%) of fall traumas happen among undergraduates with low socioeconomic status. Similar to our findings, Gupta *et al*, in Nepal, reported that fall traumas were more frequent among undergraduates (5). Employment of undergraduates in hazardous jobs will subject them to fall accidents and can be a reason for such a high rate of falls among them. Injured body organs in the present study in order of frequency were extremities, head and neck, chest, spinal region and abdomen. In the studies of Fayyaz *et al* (2), and Gupta *et al* (5), frequencies of trauma in body regions in fall cases were comparable to our findings. In different researches on fall traumas, extremities have been the most frequent injured organs (15, 16, 22-24). Traumas and fractures of extremities are not fatal, but may cause morbidity and absence from work which may result in losing jobs and lots of direct and indirect costs (17). Low rate of neck trauma (0.6%) in our study is similar to the study of Partridge *et al*, which reported one superficial neck trauma among 59 adults that fell from ladder (22). In most studies, like the present study, the leading cause of death in fall injuries is head trauma (4, 8, 10, 13, 22). Liu *et al*, confirmed that head trauma is an independent prognostic factor for death in fall patients after adjusting for age, GCS and traumas of other organs (13). Different researches have reported the frequency of head trauma from 8% to 25% in fall injuries (23), which is also 25% in our study. Pelvic trauma in our study was significantly higher among female patients and 90% of pelvic trauma cases fell at home. Falling at home and on same level is a characteristic of old people and happens usually among women with osteoporosis and lack of postural balance; and they are also at high risk of pelvic trauma (9, 25-27). Pelvic traumas are an important cause of disabilities, especially in old patients and lead to a higher hospitalization period, compared to traumas

of other organs (28). Height of fall is a prognostic factor in the severity of injuries and death (13). In the present study also prognosis of patients was affected by the height of fall: dead cases fell from higher distances and in survivors, a significant relationship existed between the height of the fall and traumatized organs. The higher distance of fall was observed in spinal, abdominal and chest traumas, respectively. Some other studies have also reported the same patterns for affected organs based on the height of fall (8, 10, 18, 29). Most high distance falls in this study happened at work places or outdoors with higher frequency of men; this pattern has been described by Talbot *et al*, in USA (9). Job-related falls among our patients usually happened from ladders or scaffolds. Based on previous reports, falls from ladder and scaffolds at job usually happen at construction works and height of these falls is usually more than 2 meters and therefore causes severe injuries (17). According to different studies, rate of spinal injuries in falling from heights is about 22-45% and spinal cord injuries occur in 2-5% of spinal traumas (23). In this study, the rate of spinal trauma was 10.4% and spinal cord injury was observed in 3% of spinal traumas. The lower rate of spinal injuries in this study can be due to our different population, differences in height of the falls and methods of trauma and also missed diagnoses of spinal injuries in our patients. Among our spinal traumas, lumbar vertebrae were hurt in 69% of cases followed by thoracic vertebrae at 16% and cervical vertebrae in 12.5% of cases; these findings are comparable with the study of Velmahos *et al* (23). They reported that among high falls (10 feet or higher), lumbar, thoracic and cervical spinal regions were injured in 63%, 25% and 12% of spinal traumas (23). Chest trauma in this study was more common among men and this is consistent with the findings of Faergeman *et al* (16). In addition, the most common trauma of the chest among our patients was rib fracture which was also reported by Behcet *et al* (11). Abdominal traumas among in this study happened at higher distance falls and Yagmur *et al*, also showed the similar finding (8). GCS at

admission was related to prognosis of fall victims and it was significantly lower among the victims who died. Yagmur *et al* (8), and Liu *et al* (13), also reported lower GCS in dead victims of fall compared with survivors. It should be noted that head trauma is an independent predictor of mortality and the relationship of GCS score with a mortality of fall injuries is in fact due to its association with head trauma (13).

There are some limitations to this work. We included injured people who were visited at the emergency ward of hospital; severe cases who died before hospital admission and mild injured cases that didn't seek a hospital visit or visited at ambulatory clinics are not included. To make a more precise assessment of fall traumas, besides hospital records, death certificates and questionnaire based surveys may be beneficial. We used self-reported data on some items in this study, which are unquestionably accompanied with errors or biases. Reason of fall is one of the items with high probability of bias. Height of fall is an estimate in many cases and definitely accompanied by error and bias. The only indicator of socioeconomic status in this study was education level of the participants and based on this criterion majority of fall cases were in low socioeconomic level; we need further investigations with complete information on other indicators of socioeconomic status are needed to confirm the relationship between falls and socioeconomic status of victims. The study was retrospective and medical records were not complete in some cases and patients were not available for further evaluations. Many cases were multiple traumas, but as some injuries like head trauma are more worrying among health care personnel, injuries to other organs may be neglected or not recorded and therefore underestimated in this study. In addition, evident traumas like fractures of extremities and head traumas are usually reported while internal organ injuries or spinal fractures are not visible and may be remained undiagnosed; these may result in underestimation of the prevalence of these invisible traumas.

5. Conclusion:

Fall traumas in our region happen at any age, but they are more frequent among young people with the predominance of males. The majority of patients were undergraduates, thus in low socioeconomic status and at low rank and hazardous jobs. Although the mortality rate of fall is low in our region, morbidity is high. Male gender, high distance falls, head trauma, suicide attempts, falling at workplace and low GCS at admission were related to poor prognosis of our fall patients. Suicide events were more prevalent among females and patients with psychiatric disorders, they happened from higher distances and their mortality was higher than accidental falls. The falls at home happened from low distances, but they were responsible for 90% of pelvic traumas. Falling at any age, from any distance and at any location can be serious and needs especial attention. Preventive measures should address all age groups and different circumstances. While safety equipment at high risk jobs seems essential to prevent falls in young workers, houses should also be improved to prevent fall accidents among old people.

6. Conflict of Interest:

The authors of the present work declare no conflict of interest.

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