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Epidemiological characteristics of fall injuries and their related outcome in Riyadh, Saudi Arabia: A descriptive study from a Level-I trauma center

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Abstract:

BACKGROUND: Falls are the leading cause of admissions for trauma emergency in Saudi Arabia. However, the scarcity of evidence of what the burden of falls is locally limits the understanding of the underlying risk factors and hinders planning of effective prevention. The objective of this study was to describe patients' characteristics and health outcomes after hospital admissions as a result of a fall injury.

MATERIALS AND METHODS: A retrospective analysis was conducted using a trauma registry from a level-I trauma center in Riyadh. All patients admitted as a result of a fall between 2001 and 2018 were included ($n = 4825$). Variables included were demographics, mechanism of fall, length of hospital stay, surgery, intensive care unit admission, intubation rate, and severity of the injury. For continuous variables, means and standard deviations were calculated, whereas, frequencies and proportions were used to describe categorical variables. Chi-squared tests were used to compare variables across age groups, and F test was used to compare the means of continuous variables.

RESULTS: Majority of the patients (63.6%) were male and about 39% of the sample were children. The most common mechanism of falls was standing (52.6%) followed by slipping (23.0%). Overall, limb fractures were the most common injury (73.3%). While upper limb fractures were more common in children (44.5%; $P < 0.01$), lower limb fractures were more prevalent among the older patients (70.2%; $P < 0.01$). Fall injuries in the elderly were significantly associated with higher mortality (3.5%; $P < 0.01$).

CONCLUSION: This study highlights the significant burden fall injuries impose on population health. Prevention programs may use these findings to guide and tailor interventions for specific age groups. Furthermore, this study underlines the need for a national recording system for injuries to guide policymakers in evidence-based decisions.

Keywords:

Epidemiology, fall, injuries, Saudi Arabia

Introduction

Globally, falls are the second leading cause of unintentional injury deaths.[1] More than 37 million falls require medical attention, and over 17 million disability-adjusted life years are lost as a result of falls every year.[2] The treatment of these injuries is costly and has a negative impact on health-care resources. In 2015, the estimated cost of falls in the United States (U. S) was over $50 billion.[3] The World Health Organization has declared that if the appropriate preventive actions are not implemented, the burden of fall injuries

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would increase by 100% by the year 2030.[4] Evidently, more efforts in research and prevention are needed to reduce the burden of falls on global health and economic resources.

Previous studies identified a wide range of factors that can contribute to fall injuries. These include sociodemographic, environmental factors, alcohol consumption, history of previous falls, acute and chronic health problems, and prescription medications.[5-7] For example, the incidence of falls increases with age and frailty.[8] Globally, the burden of falls is higher in the elderly (>65 years),[5,9] and around 2.8 million elderly patients in the U. S are treated in emergency departments (EDs) for falls every year.[10] Across all age groups, both genders are equally at risk of falls. In some countries, mortality from falls is more likely occur in males, while females suffer from more nonfatal falls.

Fall injuries have several implications for population health and the utilization of health care. Around one-fifth of falls result in serious injuries, the most serious of which are those that affect the brain or cause hip fractures,[11,12] while less severe injuries include bruises, abrasions, lacerations, and sprains, which occur approximately in one-half of fall patients. Moreover, fall-related hospitalizations were found to be 9 days longer than all other causes of hospitalization of the elderly.[13] It has been reported that in China, for each death-related fall, there are 4 cases of permanent disability, 13 cases requiring hospitalization for more than 10 days, and 24 cases who require hospitalization for 1–9 days.[14] Furthermore, fall injuries sometimes have adverse effects on the quality of life. Earlier literature suggests that a fall injury can lead to the fear of future falls. Consequently, patients adopt a sedentary lifestyle, which weakens them and increases the possibilities of subsequent falls.[15]

In Saudi Arabia (SA), unintentional injury is the sixth leading cause of deaths and the seventh leading cause of years lived with disability.[16] Moreover, falls, in particular, are the leading reasons for trauma patients to seek emergency treatment.[17] Despite its importance, very few local studies have examined fall injuries and most have focused on elderly populations or in-hospital falls, which may not cover the full burden.[6,18] A recent study by Al Meqbel *et al*. reported a high burden of fall-related morbidity and disability in the elderly.[6] During the period of 12 months, about half of the elderly had experienced one or more falls. Similarly, another study in Riyadh indicated that 57% of the elderly (>60 years) reported that they had sustained a fall injury.[9]

Fall injuries pose a significant threat to population health in SA. Yet, there is limited knowledge of the characteristics of falls-related injury patients admitted to Saudi hospitals and their outcomes. Describing the demographic and injury characteristics as well as the outcome of falls in our population will add significantly to the body of knowledge of the burden of preventable injuries in SA. It is expected that this analysis would improve the understanding of the underlying risk factors, inform the public and policymakers, and, consequently, guide the effective planning prevention strategies. The objective of this study was to describe the epidemiology and health outcomes of falls in our population.

Materials and Methods

A retrospective cross-sectional descriptive study was conducted to describe the characteristics and outcomes of fall injuries of patients admitted to King Abdulaziz Medical City (KAMC) in Riyadh. KAMC is a tertiary care center with a capacity of 1,500 beds and is considered one of the few hospitals that provide advanced trauma care in the country.[19] KAMC has many surgical and critical care units that perform a variety of complex medical and surgical procedures.

This study included patients from trauma registry admitted between the years 2001 and 2018. This registry was initiated in 2001 and includes all admitted trauma patients. A dedicated coordinator is responsible for the identification of all admitted trauma patients and the entering of their information in an electronic database using Microsoft Access. A patient is included in the registry if he or she was admitted to the hospital through the ED, referred for surgery via the ED, or died either before or after arrival to the ED. Those who receive treatment and are then discharged without admission are not included in the registry.

All fall admissions were included in the analysis. Variables included were age gender, weight, type of transport (ambulance, private transport, and others), mechanism of fall (classified into fall from a standing position, a slip, and fall from height), length of stay (LOS), admission to the intensive care unit (ICU), and intubation status. Additional measures included injury severity scales including the Glasgow Coma Scale (GCS), which is a widely used standardized assessment of the level of impairment of consciousness in response to stimuli.[20] Another measure is the Injury Severity Score (ISS), which is an anatomical measure of severity taking a value from 0 to 75 depending on the extent of injury to regions of the body.[21] Finally, the Revised Trauma Score is a physiological scale applied to all trauma patients when first examined and it includes GCS, blood pressure, and respiratory rate.[22]

The outcome variables for this study are the presence and location of fractures (classified into extremities, skull, ribs, spine, and pelvis) and survival to discharge.

STATA version 15 for Mac (STATA Corp., College Station, TX, USA) was used for all statistical analyses.[23] A comparison of patients' outcome and characteristics of the different age groups was made (≤18, 19–49, ≥50 years). Patients aged 18 years or younger formed the pediatric group, those aged 19–49 were classified as young adults, while patients 50 years or older as the "older population."[24] Data were presented as means and standard deviations for continuous variables, while proportions were used to describe categorical variables. Chi-squared tests were used to compare variables across age groups, and F-statistics were used to compare continuous variables. Comparisons included demographics, health-care utilization, and outcomes. $P \leq 0.05$ was considered a cutoff for statistical significance. Ethical approval with a waiver of informed written consent was obtained from King Abdullah International Medical Research Institutional Review Board.

Results

During the study period, 4825 falls cases fulfilled the inclusion criteria and were included in the analysis. Of the overall sample, 63.6% were male and around two-third were adults (>18). The average LOS was 9.7 days (standard deviation = 25.4; range = 0–821), and the most common mechanism of injury was "fall from standing" (52.6%). A majority of the patients arrived by private vehicles (84%).

Patient characteristics and outcomes differed by age groups. We found that patients aged ≥50 years were less likely to be males than other age groups (49.1 vs. 71.6, 72.4; $P < 0.01$). Older patients were less likely to be males than other age groups (49.1 vs. 71.6, 72.4; $P < 0.01$). Older and younger adult patients (≥50 years of age and 19–49) had more severe injuries than pediatric patients [ISS = 7.6, 6.7 vs. 4.6; $P < 0.01$; Table 1]. While pediatric patients were more likely to sustain injuries from "falls from standing," older patients were significantly more likely to sustain injuries by "slipping." In addition, older patients were more likely to be admitted to the ICU compared to the other age groups (9.3%, vs. 8.5%, 6.8%, $P = 0.02$).

Limb fractures were the most common injury of patients [73.3%, Table 2]. Moreover, lower limb fractures were more common than upper limb fractures (42.4% and 31.9%, respectively). Upper limb fractures constituted the majority of fractures of the pediatric patients (44.5%). On the other hand, lower limb fractures were more prevalent in older adults (70.2%, $P < 0.01$).

Pediatric patients were more likely to sustain skull fractures than other age groups (13.2% vs. 8.7%, 1.6%, $P < 0.01$) In contrast, the proportion of spine fractures was more in adults (age 19–49 years = 8.9%, $P < 0.01$) than other age groups. Over 13% of the study population had undergone surgery. About 2.2% of those who sustained a fall had died though this outcome was less prevalent in pediatric patients than the other age groups (0.6% vs. 2.5%, 3.5%; $P < 0.01$).

Discussion

This was a descriptive study of the epidemiological characteristics and the outcome of the fall injuries in Riyadh. Our study found that a significant proportion of patients had sustained fractures following fall injuries. These findings concur with previous literature highlighting the burden of falls on health-care settings.[6,9,25] The present analysis underlines the importance of addressing this preventable threat to population health.

Surprisingly, the results showed a higher involvement of patients 18 years or younger in fall injuries than older adults. This finding could be attributed to the demographic composition of SA, as those aged ≤19 years represent nearly 40% of the population.[26] These findings are consistent with other studies which also show that falls occur more frequently among younger children.[27,28] Even if falls among younger patients are not fatal, they may lead to permanent disabilities. Therefore, the value of prevention in this group is paramount for the improvement of the outcome and reduction of health-care utilization.

However, other studies have reported a higher burden of fall injuries in the elderly. Several studies indicated that increased age was positively associated with fall injuries.[29-31] This might be explained by changes in the biological process of aging, which involves functional and structural changes, for example, decreased lower extremity muscle strength and changed the nervous system. Such changes compromise postural control and balance and consequently increase the risk of falls.[32] Slipping injuries, many of which occur in the bathroom,[33] were more common in this group than in younger patients. A prevention program should design specific interventions to reduce the incidence and recidivism in these patients.

The current study indicates that falls were more common in males than females. A higher incidence in men has also been reported in various studies conducted in the region.[25,34,35] We posited that the difference in the likelihood of injuries between males and females could be the cultural role of males, as they are more likely to do manual labor or be in high-risk jobs and thus become more susceptible to falls. However, a different trend reported in some developed countries suggests that the risk of falls was higher for females.[36,37] Further studies

Table 1: Descriptive characteristics of fall patients admitted to King Abdulaziz Medical City (years 2001-2018)

Variables	Age group			Total (*n*=4825) *N* (%)	*P*-Value
	0-18 years (*n*=1866) *N* (%)	19-49 years (*n*=1184) *N* (%)	≥ 50 years (*n*=1775) *N* (%)		
Gender*					
Male	1351 (72.4)	848 (71.6)	872 (49.1)	3071 (63.6)	<0.01
Female	515 (27.6)	336 (28.4)	903 (50.9)	1754 (36.4)	
Weight (kg) Mean±SD (median)	25.8±19.1, (20.0)	76.2+17.9, (75.0)	73.9+17.7, (73.0)	52+30.6, (56)	<0.01
Mode of transport*					
Ambulance	186 (9.97)	227 (19.1)	337 (18.9)	750 (15.5)	<0.01
Private vehicle	1672 (89.6)	954 (80.6)	1428 (80.4)	4054 (84.0)	
Others	8 (0.4)	3 (0.25)	10 (0.56)	21 (0.4)	
Mechanism of fall*					
Fall from standing position	39 (72.2)	85 (46.9)	178 (52.5)	302 (52.6)	<0.01
Slip	0 (0.0)	23 (12.2)	109 (32.1)	132 (23)	
Fall from a height	15 (27.8)	73 (40.3)	52 (15.3)	140 (24.4)	
Length of stay Mean±SD (median)	4.1±20.0, (2)	10.3±30.6, (5)	14.6±25.6, (10)	9.7±25.4, (5)	<0.01
RTS Mean±SD (median)	10.9±2.97, (12)	11.7±1.2, (12)	11.9±0.5, (12)	11.5±2.0, (12)	<0.01
ISS Mean±SD (median)	24.6±4.3, (4)	mean±SD format, (4)	7.6±3.9, (9)	6.2±5.6, (4)	<0.01
GCS Mean±SD (median)	14.5±1.9, (15)	14.4±2.1, (15)	14.6±1.7, (15)	14.6±1.7, (15)	<0.01

*Chi-square test. SD=Standard deviation, RTS triage=Revised trauma scale, ISS=Injury severity score (higher reveals worst injuries), GCS=Glasgow Coma Scale

Table 2: The outcome of fall injury stratified by age group

Variable Outcome	Age group			Total *N* (%)	*P*-Value
	0-18 years *N* (%)	19-49 years *N* (%)	≥ 50 years *N* (%)		
Any limb fracture	1154 (61.8)	879 (74.2)	1503 (84.7)	3536 (73.3)	<0.01
Upper limb fracture	830 (44.5)	428 (36.2)	280 (15.8)	1538 (31.9)	<0.01
Lower limb fracture	332 (17.8)	467 (39.5)	1247 (70.2)	2046 (42.4)	<0.01
Skull fracture	246 (13.2)	103 (8.7)	29 (1.6)	378 (7.8)	<0.01
Rib fracture	3 (0.16)	32 (2.70)	38 (2.1)	73 (1.5)	<0.01
Any spine fracture	32 (1.7)	106 (8.9)	60 (3.4)	198 (4.1)	<0.01
C-spine fracture	20 (1.1)	28 (2.4)	15 (0.8)	63 (1.3)	<0.01
T-spine fracture	5 (0.3)	27 (2.3)	15 (0.8)	47 (0.97)	<0.01
L-spine fracture	10 (0.5)	61 (5.1)	35 (1.97)	106 (2.2)	<0.01
Pelvis fracture	7 (0.4)	64 (5.4)	96 (5.4)	167 (3.4)	<0.01
Underwent surgery	376 (20.1)	166 (14.0)	90 (5.0)	632 (13.1)	<0.01
Admitted to the ICU	128 (6.8)	101 (8.5)	165 (9.3)	394 (8.1)	0.021
Intubation	111 (5.9)	85 (7.1)	72 (4.0)	268 (5.5)	<0.01
Death	11 (0.6)	30 (2.5)	63 (3.5)	104 (2.2)	<0.01

ICU=Intensive care unit

using population-based samples are needed to provide a more comprehensive finding.

Falls while standing or walking, although infrequent among young adults, were common in children. This finding could be explained by the active lifestyle that children have and their increased likelihood to indulge in risky behaviors. Moreover, Saudi families tend to have many children who play unsupervised or with little experience in safety precautions. This underscores the importance of creating injury prevention programs to ensure safe and secure play environments for young children, raising the public awareness of measures of fall prevention.

Falls are the leading cause of injuries that require hospitalization,[6,38] leading to increased health utilization such as hospital LOS. We found that fall patients stayed 9.7 days on average. This estimate was longer than the duration reported in previous studies in the United Arab of Emirates and Iran.[25,35] The fact that our patients stayed longer in KAMC might be related to the difference in clinical practice or differences in the severity of patients. KAMC is known to specialize in treating trauma patients and therefore is more likely to receive severe injuries. Furthermore, older patients make up the majority of the extended-stay hospitalizations. A previous study suggested that the average LOS for

fall injuries in old people is 9 days longer than all causes of hospitalization.[18]

Similar to previous studies within the Gulf region, the most common sites of injury were the extremities,[25] followed by the head.[34] Compared to other age groups, skull fractures were more common in children whose injuries tend to occur during recreational or sporting activities. Safety precautions such as the use of helmets, gloves, and safety boots could reduce injuries.

Mortality is the most severe consequence of fall injuries. In this study, mortality among fall patients was higher than the rate reported in a previous study in the region.[25] It is possible that because this study only included admitted patients, which were likely to be more severe than those treated in outpatient settings. Mortality is associated with the severity and the age of the patients. A study by Sterling *et al*. reported that death for the same level falls was ten times more prevalent in the elderly than the younger group.[39]

Public health programs could use the study to raise awareness of the impact falls on population health and gain further support from policymakers to invest in prevention. Moreover, the results may facilitate the tailoring of prevention programs to different age groups and the evaluation of the effectiveness of current prevention and control measures to improve population health.

This study has several limitations that need mentioning in light of these findings. First, the study used data from one hospital only; therefore, the findings cannot be generalized nationwide. Second, it was limited to admitted patients. Thus, a significant number of patients with minor fall injuries were not included. Third, it focused on falls sustained outside health-care facilities. These limitations may underestimate the burden of fall injuries on population health. Hence, future population-based studies are required to provide a more comprehensive view of the epidemiology and the outcomes of fall-related injuries nationwide. In addition to motor vehicle injuries, falls represent a significant cause of preventable injury in SA. There is a significant need to initiate a nationwide trauma surveillance program to mitigate their impact on population health.

Conclusion

This is the first descriptive study of the characteristics and outcomes of fall patients in a major trauma center in SA. Fall injuries, a major public health issue worldwide, result in a heavy burden on individuals, society, and the health-care system. Most fall injuries are preventable. Therefore, besides other preventive measures, providing safe environments at home and the workplace for vulnerable groups and training families on how to prevent falls can be helpful. Moreover, further investment in injury surveillance is required to guide policymakers in taking evidence-based decisions.

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Conflicts of interest
There are no conflicts of interest.

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