

Changes in the epidemiology of fall-related injuries in a high-income developing country

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Abstract

Background: Falls in the Gulf countries are the second most common cause of injuries. The United Arab Emirates government implemented various preventive measures to decrease injuries in the country. We aimed to evaluate the changes that occurred in the epidemiology of fall-related injuries in Al-Ain City that occurred over the last decade.

Methods: Data of hospitalized patients who were presented with fall-related injuries to the Al-Ain Hospital during the two periods of March 2003 to March 2006 and January 2014 to December 2017 were compared. This included patients' demographics, mechanism, location, anatomical distribution and parameters related to injury severity. Non-parametric tests were used for the statistical analysis.

Results: Eight-hundred-eighty-two patients in the first period and 1358 patients in the second period were studied. The incidence of falls decreased by 30.5% over ten years. The number of elderly, female patients and UAE nationals increased, $p < 0.001$, $p = 0.004$, and $p < 0.001$, respectively. Falls from height decreased by 32.5% ($p < 0.001$) while fall on the same level increased by 22.5% ($p < 0.001$). Fall-related injuries at home has increased significantly by 22.6% ($p < 0.001$) while falls in workplaces decreased by 24.4% ($p < 0.001$).

Conclusions: Our study showed that the overall incidence of falls decreased compared to a decade ago. The preventive measures were effective in reducing falls from height and workplace injuries. Current preventive measures should target falls at the same level and at homes.

Background

Fall-related injuries are one of the leading causes of morbidity and mortality in the world. Its global mortality increased from 10.2% in 2000 to 13.5% in 2016 [1, 2]. Young males under the age of 44 years are prone to these injuries. Nevertheless, majority of fall-related deaths occur in the elderly population [1, 2]. Although the preponderance of injuries is in the low- and middle-income countries [3], falls are the third most common cause of injury-related deaths in high-income countries [4].

Falls are the second common cause of injury in the Gulf countries [5]. Construction work is the main contributor to falls from height in these countries [5–8]. Similar to reports from Qatar, Iraq, Oman, and Saudi Arabia, falls is a significant cause of injuries in the United Arab Emirates (UAE) [8–13].

Although fall-related injuries decreased by 20.8% from 1990 to 2013 globally [14], this vary in different countries. The UAE government has implemented various injury preventive measures including policies, regulations and legislations to ensure safety in the work environment [15]. In 2010, Abu Dhabi Emirate established and tasked the Occupational Safety and Health Center with the responsibility of developing and enforcing safety policies in the workplace. [16]. These preventive measures may have changed the severity and pattern of fall-related injuries in the country. We aimed to evaluate the changes in the epidemiology of fall-related injuries in Al-Ain City that occurred over the last decade.

Methods

Ethical approval

Al-Ain Hospital Human Research Ethics Committee, Al Ain, United Arab Emirates approved this study (Approval number AAHEC-03-20-008).

Study Setting and Population

Al-Ain Hospital is the main trauma center in our city and treats 80% of the Al-Ain city's trauma cases. Data of patients who presented with fall-related injuries to Al-Ain Hospital and were admitted for more than 24 hours or died at the Emergency Department during the two periods of March 2003 to March 2006 and January 2014 to December 2017 were extracted from the Al-Ain Hospital Trauma Registry. The population of the Al-Ain City were estimated to be 460 000 during the first period [17], and 766,009 during the second period [18].

Studied variables

Age, gender, nationality (Emirati and non-Emirati), mechanism and anatomical location of the injury, physiological parameters (systolic blood pressure, heart rate), injury severity score (ISS), new injury severity score (NISS), Glasgow Coma Scale (GCS), intensive care unit (ICU) admission, length of hospital stay), and clinical outcome were extracted from the trauma registry.

Statistical analysis

The annual incidence of fall-related injuries during the two studied periods was calculated as follows: $(1.25 \times \text{annual admissions}) / (\text{population} / 100000)$. Categorical data were presented as number (percentage), ordinal data as median (range), and continuous data as mean (standard deviation). To compare categorical data of two independent groups, Pearson's Chi-square or Fisher's Exact test were used as appropriate. To compare continuous or ordinal data, the Mann-Whitney U test was used. Statistical Package for the Social Sciences (IBM-SPSS version 26, Chicago, IL) was used for all analyses, and *the p-value* of less than 0.05 was accepted to be significant.

Results

There were 2573 and 3519 trauma patients in the registry during the first and second periods, respectively. Eight-hundred-eighty-two (34.3%) patients in the first period and 1358 (38.6%) patients in the second period had fall-related injuries. The mechanism included falls from height or fall on the same level. An average of 294 patients with fall injury were admitted to the hospital annually during the first period having an estimated annual incidence of 79.9 per 100.000 population. During the second period, an annual average of 340 patients with fall injury were admitted to the hospital. The estimated annual incidence for the second period was 55.5 per 100.000 population. The incidence of falls in Al-Ain City decreased by 30.5%.

Patients' demographics, mechanism (fall from same level and fall from height), and parameters related to the severity of injury during the two periods are shown in **Table 1**. The patients' age significantly increased overtime ($p = 0.018$). Fall-related injuries in the elderly population also increased by 6.5% ($p < 0.001$). There was a significant difference between genders. Female patients' fall-related injuries increased by 5% ($p = 0.004$). Female falls increased by 10.9% compared to an increase of 4.3% in males in the ≥ 65 age group ($p < 0.001$). There is also a significant increase in UAE nationals' fall-related injuries ($p < 0.001$).

Table 1

Patients' demographics, mechanism and parameters during the first period (2003-2006) and second period (2014-2017)

Variable	Years 2003-2006 (n = 882)	Years 2014-2017 (n = 1358)	p-value
Age*	33 (0.5-100) 32.6 (17.4)	33 (1-105) 36.3 (21.1)	0.018
Age categories			< 0.001
Age ≥ 65	43 (4.9%)	155 (11.4%)	
Age < 65	839 (95.1%)	1203 (88.6)	
Gender			0.004
Male	727 (82.4%)	1051 (77.4%)	
Female	155 (17.6%)	307 (22.6%)	
Nationality			< 0.001
UAE	129 (14.8%)	302 (22.4%)	
Non-UAE	745 (85.2%)	1048 (77.6%)	
Mechanism			< 0.001
Fall from same level	409 (46.4%)	936 (68.9%)	
Fall From Height	473 (53.6%)	422 (21.1%)	
Methods of arrival			< 0.001
Ambulance	70 (7.9%)	332 (30%)	
Other	812 (92.1%)	773 (70%)	
SBP	129 (74-232)	134 (21-265)	< 0.001
Heart rate	87 (50-188)	86 (18-171)	0.142
GCS	15 (3-15)	15 (3-15)	0.189
ISS*	4 (1-34), 5.0 (4.15)	4 (1-36), 6.7 (4.97)	< 0.001
NISS*	4 (1-48), 6.1 (5.72)	4 (1-59), 8.6 (6.63)	< 0.001

Data are presented median (range) or number (%) as appropriate.

*Age, ISS, NISS is also presented in addition as mean (SD) because the median is the same despite presence of statistical significance).

p-value = Fisher's Exact test for categorical data and Mann Whitney U test for ordinal or continuous data

Variable	Years 2003–2006 (n = 882)	Years 2014–2017 (n = 1358)	p-value
ICU admission	30 (3.4%)	53 (3.9%)	0.537
Hospital stay	5 (1-150)	4 (1-121)	< 0.001
Death	2 (0.2%)	5 (0.4%)	0.549
Data are presented median (range) or number (%) as appropriate.			
*Age, ISS, NISS is also presented in addition as mean (SD) because the median is the same despite presence of statistical significance).			
p-value = Fisher's Exact test for categorical data and Mann Whitney U test for ordinal or continuous data			

There is a significant difference in the mechanism of falls between the two periods. Falls from heights decreased by 32.5% and falls from the same level increased by 22.5% ($p < 0.001$)

There was a significant increase in systolic blood pressure in the second period ($p < 0.001$), while heart rate was similar. Both ISS and NISS were higher in the second period ($p < 0.001$). The patients who were admitted in the second period had shorter hospital stay compared with the first period. The median (range) of hospital length of stay were 5 (1-150) compared with 4 (1-121) ($p < 0.001$). There was no difference in mortality between the two periods.

There is a significant difference in the locations of fall-related injuries between the two periods (**Table 2**). Fall-related injuries at home and public areas increased by 22.6% ($p < 0.001$) and 7.6% ($p < 0.001$), respectively. However, falls in workplaces, farms, and off-roads decreased by 24.4% ($p < 0.001$), 1% ($p = 0.010$), and 4.3% ($p < 0.001$), respectively. There is a significant increase in abdominal injuries in the second period ($p = 0.041$), while chest injuries decreased significantly ($p = 0.037$). Head, face, and neck, spine, upper and lower extremities did not show any difference (**Table 3**). **Table 4** shows the sub-group analysis of patients by the mechanism. In the falls from the same level category, the patients' age ($p < 0.001$), number of elderly patients ($p = 0.002$), arrivals by ambulance ($p < 0.001$), patients' SBP ($p = 0.011$), ISS ($p < 0.001$) and NISS ($p < 0.001$) increased in the second period. In the same category, patients' heart rate and hospital length of stay were significantly decreased in the second period. Arrival by ambulance of patients who fell from height significantly increased by 30.3% ($p < 0.001$) in the second period. Patient's ISS and NISS were also higher in the second period ($p < 0.001$ both) while the hospital length of stay was shorter ($p = 0.003$).

Location	Years 2003-2006 (n = 882) Number (%)	Years 2014-2017 (n = 1337) Number (%)	<i>p</i> -value
Home	324 (36.7)	793 (59.3)	< 0.001
Street/Highway	12 (1.4)	21 (1.6)	0.687
Workplace	435 (49.3)	333 (24.9)	<0.001
Farm	16 (1.8)	10 (0.7)	0.010
Off-road	56 (6.3)	28 (2.1)	< 0.001
Public area	20 (2.3)	132 (9.9)	<0.001
Others	19 (2.2)	20 (1.5)	0.481
<i>p</i> -value (Fisher's Exact test)			

	Years 2003-2006 (n = 1041 regions)	Years 2014-2017 (n = 1860 regions)	
Region	Number (%)	Number (%)	<i>p</i> -value
Head, face and neck	157 (15.1)	327 (17.6)	0.081
Chest	113 (10.9)	158 (8.5)	0.037
Abdomen	34 (3.3)	90 (4.8)	0.041
Spine	115 (11.1)	237 (12.7)	0.177
Upper extremity	260 (24.9)	437 (23.5)	0.371
Lower extremity	362 (34.8)	611 (32.8)	0.292
<i>p</i> -value (Fisher's Exact test)			

Table 4
Comparison of mechanism of fall-related injuries during the first (2003–2006) and second period (2014–2017).

	Falls from Same Level n = 1345			Falls from Height n = 895		
	2004-2007 n = 409	20014 – 2017 n = 936		2004-2007 n = 473	20014 – 2017 n = 422	
	Median (range)	Median (range)	<i>p</i> - value	Median (range)	Median (range)	<i>p</i> - value
Age	30 (0.5–100)	33 (1-105)	< 0.001	35 (1.8–65)	33 (2–78)	0.786
Age categories			0.002			0.999
Age ≥ 65	41 (10%)	154 (16.5)		2 (0.4%)	1 (0.2%)	
Age < 65	368 (90%)	782 (83.5)		471 (99.6)	421 (99.8%)	
Gender			0.999			0.574
Male	285 (69.7%)	652 (69.7%)		442 (93.4%)	399 (94.5%)	
Female	124 (30.3%)	284 (30.3%)		31 (6.6%)	23 (5.5%)	
Nationality			0.166			0.478
UAE	104 (25.6%)	274 (29.4%)		25 (5.3%)	28 (6.7%)	
Non-UAE	302 (74.4%)	657 (70.6%)		443 (94.7%)	391 (93.3%)	
Methods of arrival			< 0.001			< 0.001
Ambulance	11(2.7%)	188 (24.4%)		59 (12.5%)	144 (42.8%)	
Other	398 (97.3%)	581 (75.6%)		414 (87.5%)	192 (57.1%)	
SBP	128 (90– 232)	134 (21– 265)	0.011	129 (74– 222)	133 (60– 234)	< 0.001
Heart rate	90 (59–188)	86 (18–171)	0.004	85 (50–167)	84 (51–157)	0.499
GCS	15 (3–15)	15 (8–15)	0.656	15 (3–15)	15 (3–15)	0.598
ISS*	4 (1–25) 4.73 (2.89)	4 (1–29) 5.72 (3.69)	< 0.001	4 (1–34)	8 (1–36)	< 0.001
NISS	4 (1–32)	8 (1–51)	< 0.001	4 (1–48)	9 (1–59)	< 0.001
ICU admission	3 (0.7%)	18 (1.9%)	0.316	29 (6.1%)	35 (8.3%)	0.210
Hospital stay	4 (1–150)	3 (2–91)	< 0.001	6 (1–93)	5 (1–121)	0.003
Death	1 (0.2%)	1 (0.1%)	0.563	1 (0.2%)	4 (0.9%)	0.129

Data are presented median (range) or number (%) as appropriate.

*ISS is also presented in addition as mean (SD) because the median is the same despite presence of statistical significance).

p-value = Fisher's Exact test for categorical data and Mann Whitney U test for ordinal or continuous data

Discussion

Our study has shown that the incidence of fall-related injuries decreased in our setting. Fall-related injuries increased in the elderly, female population, and UAE nationals. Although falls from the same level, in-homes, and public places increased; falls from height and workplaces decreased. The severity of injuries was higher, but hospital length of stay decreased overtime. The mortality did not change.

Some countries in our region, such as Iraq, has reported an increased incidence of accidental falls [10]. In contrast, fall-related injuries reduced overtime in our city which is similar to the global decrease [14]. However, the Gulf region countries showed the lowest decrease ($\leq 10\%$) in the incidence of fall-related injuries and shared this category with South Asian and African countries [14]. One of the significant determinants of fall-related injuries is its location. Workplace-related falls from height are still common in our setting because of the construction demands [19]. We think that the decrease in fall from height in the current study reflects the successful implementation of safety regulations at workplace in our setting [20].

Fall-related injuries in our study were mainly in males. In contrast, other studies showed higher incidence in females [21, 22]. This can be attributed to the high percentage of male expatriate manual laborers working in construction in our city. Nevertheless, and like others, fall-related injuries in females, which are mainly on the same level, has increased in our study [23, 24].

Geriatric falls is a serious public health problem [25]. Living alone, effect of medications, movement disorders, weak sensory power, reduced mobility, and arthritis are risk factors for falls in the elderly population even if physically active [26-28]. UAE has a fast aging population compared with the other Gulf countries [29]. Similar to others, our study has shown that geriatric falls increased overtime which was more in females [30]. Injury prevention and developments in the trauma system in our city reduced injuries by 38.2% and mortality by 56% in hospitalized trauma patients [31].

Despite the increased severity of injuries of hospitalized fall-related patients in the second period, hospital stay, and mortality were less. This can be attributed to developments in the trauma system which includes better pre-hospital field medical management, faster transfer to the hospital and better in-hospital trauma care including the emergency department, surgical interventions, and critical care.

Fall prevention programs should be properly implemented [8, 32]. Despite the significant decrease in work-related fall-related injuries and fall from height in the current study, there is an urgent need to reduce falls at public areas and homes.

Limitations

There are several limitations in our study. *First*, the data studied were from a single hospital in our city which cannot be generalized to the whole country. Nevertheless, we think that observing the preventive interventions and evaluating their effects gives a strong example to follow within our region. *Second*, we studied injured patients who were hospitalized for more than 24 hours or who died at the Emergency Department. Therefore, this group does not represent the whole fall-related injuries in our city as it excludes who did not present to the hospital. *Third*, it would have been better to have a continuous data registry through those years without interruption. This occurred because of financial restraints which is a common problem facing trauma registries. Fourth, we do not have more details on the injury incidents and their contributing factors which can give us a more in depth planning for the next prevention strategies.

Conclusions

Our study has shown that the overall incidence of falls decreased overtime. This was mainly in fall from height at work places. Falls at the same level, at home and in the geriatrics increased indicating that preventive measures should target falls at the same level at homes.

List Of Abbreviations

GCS: Glasgow Coma Scale

ICU: Intensive Care Unit

ISS: Injury Severity Score

NISS: New Injury Severity Score

UAE: United Arab Emirates

Declarations

Ethics approval and consent to participate: Ethical approval for this study was obtained from the Human Research Ethics Committee of the Al-Ain Hospital, Al Ain, United Arab Emirates (AAHEC-03-20-008). Written informed consents were taken from the patients or their caregivers to use patients' data in this research study.

Consent for publication: Not applicable

Availability of data and material: There is no additional data available to share with the readers. Data can be shared with the Editor of the Journal if requested.

Competing interests: The authors declare that they have no competing interests.

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Author's Contribution:

AAC, DOA, HOE, MG, and FAZ contributed to the study conception and design. DOA, HOE, and FAZ contributed to the acquisition and coding of data. AAC and FAZ analyzed the data and wrote the results section. AAC and FAZ drafted the manuscript. DOA, HOE, MG, and FAZ critically read the manuscript. All authors read and approved the final manuscript.

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