ORIGINAL ARTICLE

Population based study of hospitalised fall related injuries in older people

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Objective: This study aimed to identify the distribution of fall related injury in older people hospitalised for acute treatment of injury, in order to direct priorities for prevention.
Setting: A follow up study was conducted in the Brisbane Metropolitan Region of Australia during 1998.
Methods: Medical records of patients aged 65 years and over hospitalised with a fall related injury were reviewed. Demographic and injury data were analysed and injury rates calculated using census data as the denominator for the population at risk.
Results: From age 65, hospitalised fall related injury rates increased exponentially for both males and females, with age adjusted incidence rates twice as high in women than men. Fractures accounted for 89% of admissions, with over half being to the hip. Males were significantly more likely than females to have fractured their skull, face, or ribs ($p<0.01$). While females were significantly more likely than males to have fractured their upper or lower limbs ($p<0.01$), the difference between proportions of males and females fracturing their hip was not significant. Males were more likely than females ($p<0.01$) to have fall related head injuries (13% of admissions). Compared with hip fractures, head injuries contributed significantly to the burden of injury in terms of severity, need for intensive care, and excess mortality.
Conclusions: The frequency and impact of hip fractures warrants continued emphasis in falls program interventions for both males and females to prevent this injury. However, interventions that go beyond measures to slow and protect against bone loss are also needed to prevent fall related head injuries.

Injury is recognised as an important contributor to the global burden of disease,[1] and initiatives in injury prevention and control are a public health priority in many countries.[2–4] Specific groups targeted for preventive interventions are those aged 65 and over who suffer injuries, particularly from falls, which cause substantial morbidity, mortality, and health care costs.[5]

Characterisation of the nature and extent of fall related injuries in the older population is needed in order to direct priorities for prevention and evaluate the effectiveness of falls prevention programs in reducing the incidence of serious injury. Fractures of the hip are a common fall related injury documented in a number of epidemiological reviews.[6 7] Intervention programs aimed at preventing such fractures include use of hip protectors, exercise, dietary supplementation, and medications to prevent or treat osteoporosis.[8] Less well documented are other injuries to older people, such as head injuries, which may also contribute significantly to death and disability from falls.[9 10]

Studies have established reliable estimates of the incidence of fall related injury events in population based settings[11–14]; however, detailed analysis of injury by type and body region is not readily available. This study aimed to identify injury distribution by type and body part in older people from a circumscribed population admitted to hospital for acute treatment of a fall related injury.

METHODS

Study design and setting

A follow up study was conducted in Brisbane, a subtropical metropolitan city on the eastern seaboard of Australia, over a 12 month period between 1 January and 31 December 1998.

Ethical considerations

The study was approved by the University of Queensland ethical review committee for research involving human participants and by the hospital ethics committee in accordance with the National Health and Medical Research Council's Guidelines.

Participants

The study population included all people aged 65 years and over resident in the Greater Brisbane Region during the study period. Australian Bureau of Statistics 1998 census data by age, sex, and statistical local area were used to define the population at risk.[15] Study participants included all those from the population at risk who were admitted for more than 24 hours to any of the 14 hospitals in the region for acute treatment of a fall related injury. For the purposes of this study, injury was defined as any condition able to be coded to the *International Classification of Diseases, Clinical Modification* (ICD9-CM) nature of injury (N) codes between 800.0 and 995.0 and a fall was an external cause able to be coded to an ICD9-CM E code between 880 and 888. Patients who died as a result of their injury before 24 hours had elapsed were also included in the dataset.

Variables and research process

Data collected from the medical records of all study participants included the following variables: date of birth, sex, address; date, mechanism and place of injury; admission date; operations; days in the intensive care unit; discharge destination; injury type and severity, encoded using the abbreviated injury scale (AIS)[16] and the injury severity score.[17]

Abbreviations: AIS, abbreviated injury scale; CI, confidence interval; ICD9-CM, *International Classification of Diseases, Clinical Modification*

Table 1 Age and sex specific rates of fall related injury admissions/1000 population

Age group	No*	Population at risk	Incidence rate	Rate ratio	95% CI
Male					
65–74	109	42013	2.59	1†	
75–84	200	22931	8.72	3.36	2.66 to 4.24
⩾85	120	5198	23.09	8.90	6.88 to 11.51
Female					
65–74	245	48406	5.06	1†	
75–84	562	34425	16.33	3.23	2.78 to 3.75
⩾85	518	12318	42.05	8.31	7.15 to 9.66

*Number of persons admitted with fall related injury.
†Denotes reference group.

Fractures of the hip were identified by AIS codes 851808.3, 851810.3, 851812.3, and 851818.3. Any injury to the cranium, face, or neck (including cervical spine) was categorised as a head injury. A subset of head injuries—intracranial injuries—was defined by AIS codes 113000.6, 115099.9, 115299.9, 140202.5 to 140799.3, and 160202.2 to 161000.2.

Analysis

Age and sex specific injury admission rates were calculated using persons admitted with fall related injury as the numerator and census data as the denominator for population at risk. Frequency distributions examined the range of injuries by place of injury, type of injury, and body region affected. Differences for males and females were examined in univariate analysis. For injuries to the hip and head, differences in outcomes were examined in univariate analysis using χ^2 tests for categorical data and t tests for continuous data, with p values less than 0.05 being taken as the level of statistical significance. The outcome measures used were injury severity, intensive care unit treatment, whether operations were performed, length of stay in hospital, and whether the patient was discharged home, transferred to further care, or died in hospital as a result of injury. The independent effects of age, sex, and injury severity were examined in logistic regression models, using survival/death in hospital as the dependent variable. SPSS Statistical Package was used for data analysis.

RESULTS

The number of injury admissions in 1998 to people aged 15 years and over was 6506, with 2090 (32%) being to people aged 65 years and over. Of the 2090 injury admissions to older people, 1754 (84%) recorded a fall as the mechanism of injury. Age and sex specific rates of fall related injury admissions are shown in table 1. The incidence rate for females compared with males remained consistently higher (between 1.8 and 2.0 times) at each age group.

The case fatality rate was 5.2%, with 91 deaths in hospital as a result of a fall related injury. In a logistic regression model to test the effects of age, sex, and injury severity on death in hospital, increasing age (odds ratio 1.06, 95% confidence interval (CI) 1.02 to 1.09) and higher injury severity scores (odds ratio 1.18, 95% CI 1.13 to 1.23) were significant independent predictors.

Of the 1754 cases (429 males, 1325 females) admitted with a fall related injury, 969 (55.2%) occurred at home while 477 (27.2%) were in a residential institution at the time of injury. As approximately 6% of the Queensland population 65 years and over is in residential care,[18] fall related injuries requiring hospitalisation are disproportionately high for institutionalised residents when compared to community dwellers. While institutionalised fall related injury cases were significantly older than non-institutionalised fallers (mean age of 85.1 years compared with 79.8 years respectively), there was no significant difference in sex distribution between institutional and non-institutional fall related injury admissions.

Table 2 Type of injury and body region affected; values are number (%)

Type of injury	Males* (n=427†)	Females* (n=1323†)	Significance (p value‡)
Fractures			
Skull	11 (2.6)	11 (0.8)	0.005
Face	12 (2.8)	13 (1.0)	0.006
Spine	20 (4.7)	39 (2.9)	NS
Ribs	30 (7.0)	24 (1.8)	0.000
Upper limb	44 (10.3)	218 (16.5)	0.002
Lower limb	281 (65.8)	967 (73.1)	0.004
Hip	192 (45.0)	655 (49.5)	NS
Joint dislocations/sprains			
Spine	5 (1.2)	7 (0.5)	NS
Upper limb	13 (3.0)	23 (1.7)	NS
Lower limb	12 (2.8)	55 (4.2)	NS
Superficial wounds§			
Head	53 (12.4)	130 (9.8)	NS
Trunk	9 (2.1)	9 (0.7)	0.011
Upper limb	46 (10.8)	77 (5.8)	0.000
Lower limb	29 (6.8)	83 (6.3)	NS
Multiple sites	12 (2.8)	27 (2.0)	NS
Head injuries	74 (17.3)	159 (12.0)	0.005
Intracranial	29 (6.8)	49 (3.7)	0.007

*Columns represent no of cases and % of gender group. The unit of analysis is the injury so that a person with multiple injuries may be counted more than once.
†There were four cases (two males, two females) with missing injury data.
‡Differences for nature of injury between males and females were examined using χ^2 tests.
§Superficial wounds include abrasions, contusions, and lacerations to the skin.
NS = not significant at the p<0.05 level.

The 1754 cases presented with 2689 fall related injuries, an average of 1.5 injuries per fall event (injury data were missing for four cases). Main types of injury and body regions affected for males and females are shown in table 2. Fractures occurred in 1566 (89%) of fall related injury admissions. Males were significantly more likely than females to have fractured their skull, face, or ribs (p<0.01). Of hospitalised fall related injuries to the extremities, females were significantly more likely than males to have fractured their upper or lower limbs (p<0.01). However, the difference between proportions of males and females fracturing their hip was not significant.

Of the body regions affected, there were 1558 cases with injury to the extremities and 233 with head injuries, of which 78 were intracranial injury. Males were significantly more likely than females to have suffered head injuries, including intracranial injury (p<0.01).

A comparison of hip fracture and intracranial injury cases is shown in table 3. When adjusting for age and sex, cases from

Table 3 Comparison of hip fracture and intracranial injury*; values are number (%) unless otherwise stated

	Hip fracture (n=847)	Intracranial injury (n=78)	Significance (p value†)
Mean age (years)	82.3	80.4	0.03
Place of injury			
Home	417 (49.2)	44 (56.4)	
Residential institution	320 (37.8)	14 (17.9)	0.0004
Other	84 (9.9)	13 (16.7)	
Unknown	26 (3.1)	7 (9.0)	
Mean injury severity score	9.07	17.79	0.0000
Procedures			
Operations	780 (92.4)‡	21 (26.9)	0.0000
Intensive care unit treatment	21 (2.5)‡	28 (35.9)	0.0000
Outcomes			
Death in hospital	49 (5.8)	19 (24.4)	0.0000
Transferred for further treatment	176 (20.8)	15 (19.2)	
Discharged	621 (73.4)§	44 (56.4)	
Mean length of stay for survivors (days)	17.85	15.14	NS

*There were no cases with both hip fracture and intracranial injury.
†Demographic and injury outcome differences between persons sustaining a hip fracture or intracranial injury were examined using χ^2 tests for categorical data and *t* tests for continuous data.
‡Three cases had data missing.
§One case had data missing.

institutions were 2.6 (2.1–3.3) times more likely to be admitted with a fractured hip than non-institutional cases, but there was no significant association between institutionalisation and admission for a fall related head injury.

In comparison to cases with hip fracture, intracranial injury cases were significantly younger (mean age 80.4 *v* 82.3 years), were more severe (injury severity score mean 17.79 *v* 9.07), and more likely to die in hospital as a result of the injury (24.4% *v* 5.8%). While intracranial injury was more likely to require admission to intensive care (35.9% *v* 2.5%), cases were less likely to require operative procedures (26.9% *v* 92.4%).

DISCUSSION

The rate of fall related injury admissions increased exponentially with age for both males and females, and age adjusted incidence rates were approximately twice as high in women than in men. This is consistent with previous studies,[12 13 19] which have shown similar age and sex associations with fall rates for injury requiring medical attention. Age related increase in frailty and disability is thought to account for the increased fall related injury rates with age and would also account for the disproportionately high rate of fall related injuries in residential care settings,[11 20] despite the increased levels of supervision in institutional care.

The major fall related injury was a fracture (89% of admissions) with over half (54%) of such cases having a fracture of the hip. Of fall related injury admissions from residential care settings, 67% sustained a hip fracture. In contrast, Luukinen *et al* found that, in institutions, the highest proportion of serious injuries (defined as fractures, dislocations, and soft tissue injuries requiring suturing) were to the head.[11]

The frequency of hip fractures warrants continued emphasis of falls programs to prevent this injury. Hip protectors appear to reduce the risk of sustaining hip fracture within selected high risk populations such as those in residential care.[21] Injuries to the head are also a frequently occurring fall related injury. Intracranial injuries, compared with hip fractures, contribute significantly to the burden of injury in terms of severity, need for intensive care, and excess mortality. While no interventions have been developed to protect against fall related head injury in this population, the primary prevention of falls should remain the first priority.

The difference in nature and site of injury between males and females may be explained by differences in the mechanism and activity being undertaken at the time of the fall and host risk factors such as comorbidities. Despite the lack of such data in this study, the sex differences in injury patterns may assist the focus of injury prevention interventions. For example, the fact that no significant sex differences in hip fracture rates were found in this study, suggests that interventions such as the use of hip protectors and the prevention and treatment of osteoporosis should be aimed at both males and females. The high rate of head injuries particularly among men suggests the need for interventions that go beyond measures to slow and protect against bone loss.

Limitations

This study represents a population based incidence of fall related injury severe enough to warrant hospitalisation. This assumption depends on the accuracy of both numerator and denominator. All hospitals in the area, except one small private hospital, were included in the data collection. Fewer than 5% of the study sample had residential postcodes outside the census district. The assumption for the numerator is that those admitted from outside the area would be balanced by those from the catchment area injured and treated elsewhere. The use of census data for the denominator to calculate rates in defined populations is in accord with methodology used previously.[12]

While the focus of the study was on the nature of injury and body part injured, it would have been of additional interest to describe the distribution of injury characteristics with respect to causal mechanism. Unfortunately, the nature of the data was such that detailed circumstances of the injury event were not available.

The study criteria included all fall related deaths that occurred during prehospital (ambulance) care, emergency department treatment, or hospitalisation. A substudy of reliability of coding in this dataset showed good to excellent inter-rater reliability as measured by κ for all variables discussed in this paper.[22] Cases of deaths from falls where there was no postmortem contact with the hospital system were not included. However, it is thought the numbers would be small and unlikely to affect the conclusions of the study.

CONCLUSIONS

Until more is known about preventing fall related injuries, the focus of interventions continues to be prevention of falls themselves. There is now sufficient evidence that falls prevention programs targeting both intrinsic and environmental risk

Key points

- This study establishes a population based incidence of hospitalised fall related injury in older people.
- The study focus is to describe detailed distribution of fall related injury by body part and nature of injury, and to discriminate sex differences in patterns of injury.
- Hospitalised fall related injury rates for older people increased with age, and rates were twice as high in women than men.
- Fractures, particularly to the hip, were the main injury sustained.
- Admissions for fall related hip fractures were disproportionately high for institutionalised compared with non-institutionalised residents, after adjusting for age and sex.
- Males were more likely than females to be hospitalised with fall related head injuries, which also contributed significantly to the burden of injury in this age group.
- Until there is more evidence for the effective prevention of fall related injuries, the primary prevention of falls should remain the first priority.

factors of individual patients are effective in community based settings.[23] Less is known about effective falls prevention interventions in institutional settings. However, specifically for those who provide care in residential institutions there is a need to raise awareness of the potential for, and sequelae of, fall related injuries in their elderly clients.

This study has contributed to the already extensive falls literature by establishing a population based incidence of fall related injury requiring hospitalisation, describing detailed distribution of injury by body part and nature of injury, and discriminating sex differences in patterns of injury. Given that the sociodemographic characteristics of urban centres throughout Australia are essentially similar,[24] it would be reasonable to assume that the results for Brisbane would be representative of other large urban cities in Australia.

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