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ORIGINAL ARTICLE

Conflicting trends in fall-related injury hospitalisations among older people: variations by injury type

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Abstract
Summary Despite advances in prevention, fall-related hospitalisation rates among older people are still increasing. Rates between 1998/1999 and 2008/2009 for non-facture-related injuries increased by 6.1% while fracture injuries declined by −0.4%. Varying trends in rates of different injury types makes it difficult to provide a definitive explanation for these changes.
Introduction Despite advances in fall prevention research and practice, the rate of fall-related hospitalisations continues to increase. However, hip fracture rates appear to be declining. An examination of trends in types of injuries that contribute to the overall fall injury rate is required to establish which injuries are driving the falls admission rate. The aim of this paper is to examine trends in fall-related injury hospital admissions by injury type in New South Wales (NSW), Australia.
Methods A retrospective review of fall-related injury hospitalisations in NSW among individuals aged 65+years, by injury type, was conducted from 1 July 1998 to 30 June 2009. Direct age-standardised admission rates were calculated. Negative binomial regression was used to examine the statistical significance of changes in trend over time of different hospitalised fall-related injuries.
Results The fall-related hospitalisation rate increased by 1.7% each year ($p<0.0001$; 95% confidence interval (CI), 1.3–2.1%). However, the rate of fracture declined by −0.4% ($p<0.03$; 95% CI, −0.8–0.0%); whereas, the non-fracture rate increased by 6.1% ($p<0.0001$; 95% CI, 5.5–6.7%) annually. Rates for severe head injuries, rib and pelvic fracture increased while those for hip and forearm fracture declined.
Conclusions It appears that while fall prevention efforts in NSW are not yet affecting the overall rate of injury hospitalisation, there has been a significant decline in the rates of some fractures. Opposing trends in the rates of other fracture admissions and a significant increase in the rate of non-fracture injuries associated with falls makes a definitive explanation for these changes difficult.

Keywords Fall injury · Fractures · Injury epidemiology · Non-fracture injury · Older persons

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Introduction

Fall injury in older persons is a significant public health issue worldwide, particularly in high income countries [1]. Around 30% of older people living in the community experience one or more falls each year and fall rates among older people living in residential aged care are significantly higher [1]. Injuries resulting from falls have a major impact on older people and their families with outcomes ranging from fear of falling [2], hospitalisation, loss of independence [3], admission to residential care [4] and sometimes death. Fall-related injuries among older people also place a considerable burden on the wider community as they result in significant costs to the health care system [5–7].

Despite significant advances in fall injury prevention research and practice, the number of fall-related hospitalised injuries continues to increase. While this is due

mainly to the ageing of the population in Australia [8] and other countries [9], it is compounded by a continuing increase in the age-standardised rate of fall-related injury hospitalisations.

Hip fractures are one of the most common injuries resulting in hospitalisation following a fall [1]. After decades of increasing hospitalisation rates for hip fracture, recent research suggests that the rate of fall-related hip fractures in older people is now declining. This trend has been reported in some small area [10–14] and national studies in countries such as New Zealand [15], Austria [16], the Netherlands [9], Canada [17] and the United States [18]. In Australia, hip fracture rates, which have been increasing over much of the last century, have also begun to decline in the past decade, yet the overall fall injury hospitalisation rate is still increasing [8]. Similar trends have been observed in New South Wales (NSW) [19].

In light of the opposing trends in the Australian and NSW fall-related injury and hip fracture only hospitalisation rates, an examination of the types of injuries that are contributing to the increase in the rate of fall-related hospitalised injury is warranted. An understanding of these trends may assist in effectively targeting fall injury prevention strategies. The aim of this study was to examine the trend in fall-related injury admissions among older people in NSW and to investigate the contribution of the various injury diagnoses to the overall trend.

Method

A retrospective review of fall-related injury hospitalisations in individuals aged 65 years and over was conducted using information recorded in the NSW Admitted Patients Data Collection (APDC), from 1 July 1998 to 30 June 2009.

Data sources

Data from the NSW APDC include information on inpatient separations for individuals from public and private hospitals, private day procedures, and public psychiatric hospitals. It also includes data on episodes of care in hospital, which end with the discharge, transfer, or death of the patient or when the service category for the admitted patient changes. Diagnoses and external causes were coded using the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification* (ICD-10-AM) [20].

To calculate age-standardised rates, age- and sex-specific population estimates for NSW, at 31 December of each of the years under study were obtained from the NSW Health Department. These correspond to the mid-point of each financial year of hospitalisation data and were interpolated from the Australian Bureau of Statistics population estimates at 30 June [21]. The Australian estimated resident population, at 30 June 2001, was used as the standard population [21].

Case selection criteria

Fall-related injury hospitalisations were identified using the following criteria: (1) persons aged 65 years and over; (2) a principal diagnosis of injury, excluding complications of care (ICD-10-AM range: S00-T75 or T79); and (3) a fall-related external cause code (ICD-10-AM range: W00-W19). Hospitalisations relating to transfers between hospitals and changes in the service category (e.g. a change from acute to rehabilitation for a patient during one episode of care in a single facility) were excluded in order to attempt to partly eliminate 'multiple counts' using the referral source variable [22]. Day only admissions (where patients were admitted and discharged on the same date) were also excluded to minimise the influence of changes in admission practice over the 11-year study period.

The NSW APDC also includes hospitalisations of NSW residents that occurred in another state or territory, identified by their state of residence. However, this data for 2007/2008 and 2008/2009 was not available at the time of the analyses and was therefore not included for these years. An estimate of interstate admissions, based on the average of the previous 4 years, suggest that these would have accounted for approximately 1.7% (n=735) of hospitalised fall-related injuries in those 2 years.

Fractures (ICD-10-AM: S02, S12, S22, S32, S42, S52, S62, S72, S82, S92, T02, T08, T10, T12, T14.2) and non-fractures (all other diagnosis codes) were identified separately. Fractures were further disaggregated by body region into fractured skull/face (ICD-10-AM: S02, S06); vertebrae (ICD-10-AM: S12.0, S12.7, S12.9, S22.0, s22.1, s32.0, S32.2, T08, T91.1); rib(s) (ICD-10-AM: S22.3–S22.44), pelvis (ICD-10-AM: S32.3–S32.5, S32.81, S32.83, S32.89); shoulder/upper arm (ICD-10-AM: S42); forearm/elbow (ICD-10-AM: S52); wrist/hand (ICD-10-AM: S62); hip (neck of femur) (ICD-10-AM: S72.0–S72.2), lower leg/knee, including ankle (ICD-10-AM: S82); foot, except ankle (ICD-10-AM: S92) and other femur fracture (ICD-10-AM: S72.3, S72.4, S72.7, S72.8, S72.9). Non-fracture injuries were similarly disaggregated by body region into head, neck, thorax, abdomen/lower back, shoulder/upper arm, forearm/elbow, wrist/hand, hip/thigh, lower leg/knee/ankle, foot and other.

Statistical analyses

Direct age-standardised rates per 100,000 population were calculated, along with annual percentage change in the fall-

related injury hospitalisation rate. Ninety-five percent confidence intervals (95% confidence interval (CI)) were calculated assuming a Poisson distribution [23]. Because of over-dispersion, negative binomial regression was used to examine the statistical significance of changes in the trend over time of hospitalised fall-related injuries [24]. All data extraction and analyses were performed using SAS version 9.1 [25].

Results

Over the 11-year period, the annual number of fall-related injury admissions to acute care hospitals increased by 53% from 14,153 in 1998/1999 to 21,689 in 2008/2009 (Table 1). The number of persons admitted for a fall-related fracture increased by 23% (10,621 to 13,159) while the number admitted for a fall-related non-fracture injury increased by 142% (3,532 to 8,530). Although fractures still represent the majority of admitted fall-related injuries, as a proportion of total fall-related admissions, they decreased from 75% in 1998/1999 to 61% in 2008/2009.

The age-standardised fall-related hospitalisation rate for this age group increased significantly by an average of 1.7% each year ($p<0.0001$; 95% CI, 1.3–2.1%) (Table 2). The percentage annual change (PAC) for males was 2.6% ($p<0.0001$; 95% CI, 2.0–3.1%) which was higher than the PAC for females at 1.0% ($p<0.0001$; 95% CI, 0.6–1.4%) (Fig. 1).

The increase in the overall rate of fall-related admissions was driven by the significant increase in the rate of hospitalised non-fracture injuries. The rate for these injuries increased by an average of 6.1% each year ($p<0.0001$; 95% CI, 5.5–6.7%) (Fig. 1). Non-fracture injuries in males (PAC, 6.6%; $p<0.0001$; 95% CI, 5.8–7.3%) and females (PAC, 6.0%; $p<0.0001$; 95% CI, 5.4–6.6%) followed a similar pattern (Fig. 2). Hospitalised non-fracture injury rates increased significantly for all body regions (Table 2).

In contrast, the fall-related fracture hospitalisation rates decreased over the same period by an average of 0.4% per year ($p<0.03$; 95% CI, −0.8–0.0%). As there was no significant change in the fracture rate in males (PAC=0.0%; $p=0.89$; 95% CI, −0.6–0.5%), the decline over this period is mainly due to a significant fall in the female fracture rate (PAC=−0.7%; $p=0.0004$; 95% CI, −1.0% to –0.3%). There was a significant decrease in the hospitalisation rate for the two most common fall-related fractures: hip (PAC=−2.1%; $p<0.0001$; 95% CI, −2.5% to −1.7%) and forearm/elbow (PAC, −1.2%; $p<0.001$; 95% CI, −1.8% to −0.6%). However, there were significant increases in many of the less numerous fracture injuries: skull/face, vertebrae and pelvis ($p<0.0001$) and wrist/hand, ankle/foot and ribs ($p<0.01$).

Discussion

Fall-related injuries among older individuals are increasing in Australia with the ageing of the population [8]. In the current study, both the number and the age-standardised rate of fall-related injury hospitalisations, among older people in NSW, have increased substantially over the 11-year period from 1998/1999 to 2008/2009. Over the study period, the number of fall injury hospitalisations increased by 53% compared to a 20% increase in the population aged 65 years and older (i.e. 819,454 to 986,906) [21]. The continuing increase in the rate of fall-related injury, reported in this study, is consistent with the overall Australian trend [8] and the trend reported in the Netherlands [9]. However, a recent population-level study in the United States suggests a stabilisation in the rate of fall-related hospitalisations there [26].

As these rates are age-standardised, it is unlikely that changes in the age distribution of the older population have influenced the overall rate of fall hospitalisations. It is interesting to note, however, that the greatest increase in the overall falls admission rate, among older people in NSW, occurs in those aged 85 years and older (unpublished data). On the other hand, there has been no significant change in the overall rate of self-reported falls among community-dwelling older people in NSW, between 1999 and 2009, or in the oldest old age group (85 years +) [27, 28]. Further analysis of the hospitalisation data is needed to establish where these falls are occurring and how this may relate to relevant social changes. For example, the tendency to support older people to remain in their own homes longer may result in exposing them to a greater risk of sustaining a fall-related injury which is more likely to result in hospitalisation. There have been few population-level studies published that provide comparative admission rates for different fall injuries over time. Kannus et al. [27] reported an increasing rate of hospitalised low-trauma fractures among older people in Finland, between 1970 and 1999, and found some evidence for differences in hospitalisation rates for differing fracture types and some non-fracture injuries (i.e. severe bruising and contusions and severe joint distortions and dislocations) [29].

The increase in the rate of fall-related injury admissions in the current study is being driven by the significant increase in the rate of hospitalised non-fracture injuries. While the rate of non-fracture injury admissions in all body regions increased significantly, forearm and elbow injuries and head injuries had the highest PACs. However, head injuries had the greatest impact on the absolute number of fall injury admissions of all the non-fracture injuries increasing threefold over the 11-year study period.

Head injuries are a common consequence of falls [30], and traumatic brain injury [31, 32] in particular, in older

Table 1 Number of fall-related injury hospitalisations among persons aged 65 years and older, NSW, Australia, 1998/1999 to 2008/2009

Injury type	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	Total
Total	14,153	14,887	14,740	15,223	15,100	16,632	16,972	18,871	20,251	20,789	21,689	189,307
Males	3,585	3,977	3,826	4,040	4,131	4,596	4,813	5,543	5,999	6,225	6,383	53,118
Females	10,568	10,910	10,914	11,183	10,969	12,036	12,159	13,328	14,252	14,564	15,306	136,189
All fracture injuries	10,621	11,019	10,675	10,905	10,534	11,565	11,588	12,218	12,702	12,999	13,159	127,985
Fracture location												
Hip	4,294	4,490	4,286	4,336	4,078	4,489	4,492	4,617	4,732	4,720	4,706	49,240
Forearm/elbow	1,599	1,540	1,494	1,533	1,492	1,599	1,534	1,547	1,647	1,611	1,702	17,298
Shoulder/upper arm	1,054	1,149	1,079	1,050	1,121	1,159	1,187	1,258	1,313	1,337	1,360	13,067
Pelvis	1,008	1,013	973	953	884	981	1,001	1,071	1,038	1,104	1,128	11,154
Lower leg/knee	497	563	574	630	593	696	720	835	868	942	962	7,880
Vertebrae	846	909	969	1,061	994	1,054	1,112	1,162	1,252	1,330	1,345	12,034
Ribs	550	565	536	563	562	687	651	727	777	811	822	7,251
Femur	337	364	338	336	334	413	364	407	383	407	465	4,148
Skull/face	182	182	161	196	185	230	250	259	340	343	333	2,661
Wrist/hand	79	103	108	102	130	102	108	144	159	155	136	1,326
Ankle/foot	107	93	96	98	115	100	111	127	138	164	149	1,298
Other	68	48	61	47	46	55	58	64	55	75	51	628
All non-fracture injuries	3,532	3,868	4,065	4,318	4,566	5,067	5,384	6,653	7,549	7,790	8,530	61,322
Non-fracture location												
Head	1,193	1,378	1,540	1,599	1,675	1,880	2,157	2,698	3,138	3,283	3,612	24,153
Hip/thigh	528	606	580	628	679	759	734	820	972	1,028	1,081	8,415
Lower leg/knee	528	564	580	596	598	626	594	831	933	893	951	7,694
Abdomen/lower back	303	348	324	347	381	422	489	544	615	658	746	5,177
Shoulder/upper arm	305	329	338	370	366	444	413	507	538	566	561	4,737
Forearm/elbow	122	132	167	165	168	194	226	315	363	342	412	2,606
Thorax	191	164	171	222	198	235	249	337	296	328	381	2,772
Other	122	117	137	131	192	206	213	217	243	240	321	2,139
Wrist/hand	101	115	98	120	142	135	128	185	218	227	213	1,682
Ankle/foot	93	82	87	94	109	93	116	129	143	136	144	1,226
Neck	46	33	43	46	58	73	65	70	90	89	108	721

Table 2 Age-standardised rates of fall-related injury hospitalisations among persons aged 65 years and older, NSW, Australia, 1998/1999 to 2008/2009

Injury type	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	Annual % change (95% CIs)
Total	1,799.2	1,832.1	1,751.2	1,745.1	1,678.4	1,795.5	1,781.5	1,929.5	2,011.1	2,011.4	2,036.7	1.7* (1.3; 2.1)
Males	1,166.7	1,251.8	1,170.7	1,177.4	1,166.7	1,255.0	1,275.6	1,427.8	1,500.7	1,508.1	1,493.3	2.6* (2.0; 3.1)
Females	2,195.5	2,192.8	2,119.9	2,104.0	2,014.1	2,151.7	2,125.1	2,269.8	2,364.3	2,363.6	2,418.1	1.0* (0.6; 1.4)
All fracture injuries	1,349.2	1,355.5	1,267.9	1,250.2	1,171.0	1,249.2	1,216.9	1,250.6	1,265.4	1,261.5	1,239.7	−0.4** (−0.8; 0.0)
Fracture location												
Hip	552.7	556.6	510.6	496.6	450.6	480.5	466.2	465.6	462.2	448.7	432.1	−2.1* (−2.5; −1.7)
Forearm/elbow	199.2	187.4	176.6	176.1	167.4	175.3	163.7	162.1	169.7	161.1	167.4	−1.2* (−1.8; −0.6)
Shoulder/upper arm	133.2	140.7	128.0	120.4	125.0	126.0	125.6	129.8	132.4	131.9	129.9	0.1 (−0.5; 0.7)
Pelvis	109.1	112.9	115.4	121.4	109.8	112.8	115.6	116.8	122.6	125.9	123.2	1.4* (0.8; 2.0)
Lower leg/knee	124.4	122.5	114.9	109.6	99.7	107.7	107.8	113.2	107.4	111.8	112.2	−0.5 (−1.2; 0.2)
Vertebrae	63.1	69.3	68.1	72.2	65.7	75.1	75.5	85.6	85.9	90.8	90.2	3.8* (2.9; 4.6)
Ribs	69.9	69.4	63.6	64.6	62.5	74.2	68.6	74.3	76.7	78.8	76.7	1.5*** (0.3; 2.6)
Other femur	42.9	44.8	40.2	38.4	37.1	44.5	38.4	41.5	38.3	39.8	43.8	0.0 (−1.0; 1.0)
Skull/face	22.9	22.4	19.1	22.5	20.6	25.0	26.3	26.9	34.6	33.5	31.8	5.5* (4.1; 7.0)
Wrist/hand	9.9	12.6	12.8	11.7	14.5	11.2	11.5	14.9	16.1	15.4	12.8	2.9*** (0.9; 4.9)
Ankle/foot	13.3	11.2	11.4	11.3	13.0	11.0	11.8	13.3	14.1	16.6	14.8	2.7*** (0.6; 4.8)
All non-fracture injuries	450.0	476.6	483.3	494.9	507.4	546.4	564.6	679.0	745.7	749.9	797.0	6.1* (5.5; 6.7)
Non-fracture location												
Head	152.2	169.8	183.1	183.3	186.1	202.7	226.0	275.4	309.6	315.4	337.5	8.3* (7.4; 9.1)
Hip/thigh	67.9	75.0	69.1	71.9	75.3	81.5	76.6	83.0	95.7	98.0	100.4	4.2* (3.3; 5.0)
Lower leg/knee	67.3	69.6	69.0	68.3	66.4	67.3	62.1	85.2	92.1	86.6	88.9	3.7* (2.6 : 4.8)
Abdomen/lower back	38.6	42.9	38.5	39.8	42.3	45.5	51.5	55.3	60.8	63.8	69.6	6.8* (5.8; 7.8)
Shoulder/upper arm	38.5	40.3	40.1	42.5	41.0	48.2	43.9	51.8	53.9	54.8	53.3	4.0* (2.9; 5.1)
Forearm/elbow	15.5	16.4	19.9	18.9	18.6	20.8	23.5	31.8	35.3	32.7	37.7	9.8* (8.2; 11.4)
Thorax	24.3	20.1	20.3	25.5	22.0	25.5	26.2	34.7	29.6	31.8	35.3	5.2* (3.6; 6.7)
Wrist/hand	12.7	14.1	11.6	13.8	15.8	14.7	13.4	19.1	21.5	21.9	20.1	6.1* (4.5; 7.8)
Ankle/foot	11.7	10.0	10.4	10.8	12.2	10.2	12.2	13.4	14.4	13.1	13.9	3.7* (2.2; 5.3)
Neck	5.8	4.0	5.1	5.3	6.5	7.9	7.0	7.1	9.1	8.7	10.4	7.7* (5.1; 7.3)

*$p \leq 0.0001$; **$0.01 < p < 0.05$; ***$0.0001 < p \leq 0.01$, significance levels

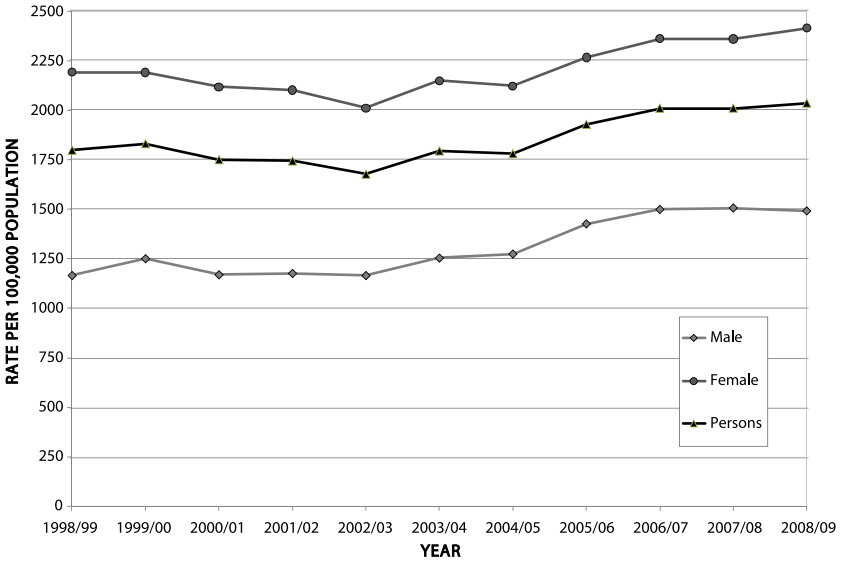

Fig. 1 Age-standardised fall-related injury admission rates by gender and year, persons aged 65 years and older, NSW, 1998/1999–2008/2009

adults. The current study showed a significant increase in the rates for both non-fracture and fracture injuries of the head between 1998/1999 and 2008/2009. This is consistent with trends reported in Australia overall [30] and internationally [33]. It has yet to be established whether these trends reflect a real increase in the incidence of head injuries or whether they reflect improvements in diagnosis.

Because older patients have an increased risk of significant intracranial injury, routine CT scanning has been mandated for all falls presentations in Emergency Departments (EDs) in NSW unless the person is totally asymptomatic with no other risk factors [34]. Although this policy was only mandated in early 2008, the increasing availability of CT scanning equipment in NSW hospitals over the study period, and increased awareness among clinicians of head injury outcome following a fall in an older person may have contributed to significant increases in confirmed diagnoses of head injury and subsequent hospitalisation. If the increasing rate of head injuries is related to improvements in diagnosis, a stabilisation of these rates should occur in future.

Whether or not this proves to be the case, the dramatically increasing rate of traumatic brain injury due to falls in older people is cause for considerable concern. Urgent consideration should be given to the design of fall prevention interventions that explicitly address head injuries. While further examination of the causes of these types of injury is necessary, interventions that specifically target high risk groups such as the oldest old, who are less able to break their fall, and falls from heights among males, in particular, are warranted.

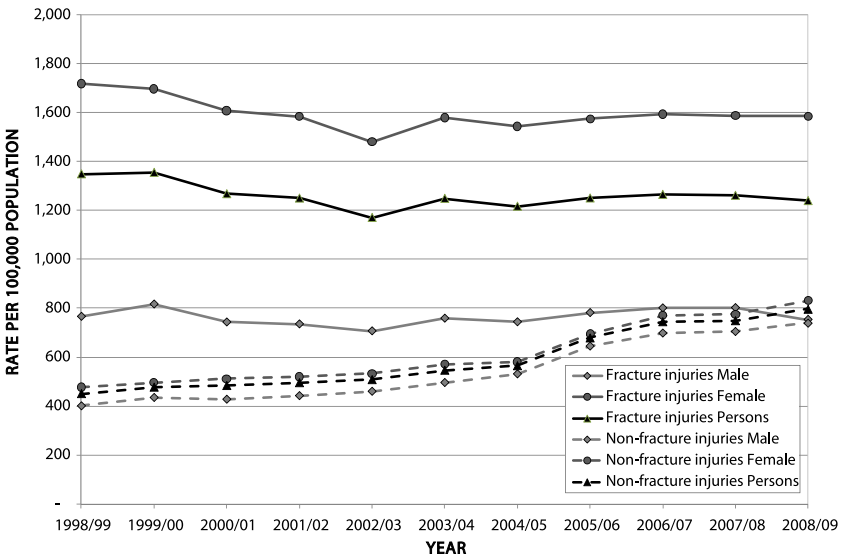

Fig. 2 Age-standardised fall-related injury admission rates by fracture status, gender and year, persons aged 65 years and older, NSW, 1998/1999–2008/2009

In the current study, the most significant decrease in admission rates for fall-related injuries occurred for hip fractures (PAC, −2.1%) which, combined with the increase in the ageing population, resulted in an increase in absolute numbers of 10% (n=412) over the 11-year study period. Hip fracture is one of the most serious injuries associated with falls and is responsible for significant costs, considerable disability and increased mortality [35]. Hip fractures tend to occur in older, frailer persons, with low body mass and low bone mineral density (BMD), who are unable to protect themselves by breaking their fall [36]. The significant decline in the rate of hip fracture admissions identified in this study is consistent with recent trends observed in Australia [8] and in other developed countries [9, 15–18, 37, 38].

A number of suggestions have been made as to the reason for the decline in hip fracture hospitalisation rates, although no clear evidence for the cause of the decrease has yet emerged. For example, correlations have been reported between the decline in hip fracture rates and the increased uptake of anti-osteoporotic drugs [10] although this does not explain the reductions seen in men who have not been the target for osteoporosis screening and treatment [17]. Improved health and fitness of later population cohorts [15] and the increasing weight of the older population [17] have also been identified.

Unlike hip fracture, which almost always warrants hospitalisation, the admission rates for other fracture types can be affected by other factors, such as hospital policies and practices and bed availability. Consequently, few studies have examined trends in hospital admission rates for other types of fall-related fracture injuries. However, a significant increase in the hospitalisation rate of low-trauma vertebral fractures [36] and fractures of the foot [39], a decrease in the incidence of knee fractures [36] in individuals 50+ years in Finland and a stabilisation in shoulder fractures in older women (60 years plus) [40] broadly correspond to trends observed in the current study, while a slightly decreasing rate of ankle fractures [41] are in contrast to the findings of the current study. While it is difficult to make definitive comparisons between these Finnish studies and the current study due to differences in the categorisation of injuries, the age and gender of the study populations and timeframes, it is clear that there are broad similarities in the trends observed, which would perhaps be more apparent with standardisation of classifications.

The current study confirms the continuation of a rising trend in hospitalisations due to pelvic [42] and wrist fractures [43]. The admission rate for forearm/elbow fractures decreased significantly over the study period. Distal forearm fractures tend to occur in relatively healthy older people, with low BMD, from a fall onto an outstretched hand. Positive associations have been shown between this type of fracture and increased levels of physical activity and with brisk and frequent walking [36]. A healthy cohort effect, one of the explanatory factors proposed for a reduction in hip fracture rates, might be expected to result in an increase in the rate of lower arm fractures. However, although we attempted to control for changes in admission policy by excluding day only cases, it may also be that the decreasing admission rates observed for forearm/elbow fractures simply reflect an increasing tendency to favour ambulatory over inpatient care, rather than a real change in the rate of these injuries. A study which quantifies the rates of fracture injuries presenting to EDs, is necessary to clarify this issue.

There have been no population-level studies that examine the contribution of non-fracture injuries to the overall rate of change in fall-related injury hospitalisations among older people. This is perhaps not surprising as the hospitalisation rate for non-fracture injures may be more subject to factors unrelated to injury severity such as changes in admission practices. Again, we have attempted to control for this possibility by excluding day only admissions.

Given the burden of economic costs and disability associated with all fall-related hospitalised morbidity, the contribution of non-fracture injuries to the overall burden warrants further investigation. At the individual level, a fall can instil a fear of falling [2], raise levels of anxiety and depression [44], result in post-traumatic stress disorder [45] and decrease levels of activity resulting in loss of independence [3]. Any injurious fall can therefore have significant personal and economic consequences for the individual and their family in addition to the overall impact of these injuries on the hospital system. With the rates of fall-related non-fracture injury admissions among older people increasing at the rate of 6.1% per annum, in NSW, further research is urgently required to establish what is driving this change and what can be done to prevent further increases.

There are some limitations of this study. Day only admissions were excluded in an attempt to include only those cases with a level of severity that would always result hospital admission over the study period. However, as discussed earlier, changes in admission policy, and improvements in diagnosis and treatment over this time cannot be ruled out.

The study relied on correctly identified ICD-10-AM classification of the principal injury diagnosis and external cause of injury to calculate accurately the number and rate of hospitalisations. Although the data quality of the NSW APDC is largely unknown, nationally less than 1% of injury and poisoning separations are thought to be missing, representing minimal risk of sampling error [8].

Although attempts have been made to minimise double counting, the methods used to extract incident cases produce estimates only. Readmissions were not excluded as they could not be reliably separated from new injuries. According to the APDC coding guidelines, the 'readmission within 28 days' flag should be used to indicate a readmission for the same problem/condition. However, previous work conducted at the NSW Injury Risk Management Research Centre [46] on methods used to estimate the incidence of falls hospitalisations, suggests that, compared with the incidence obtained using data record linkage (the 'gold standard'), exclusion of readmissions within 28 day results in a decrease in incidence of 5.6%. This suggests that some hospitals/coders may be using this flag even when a previous admission is related to other injuries or health conditions. Consequently, given the risk of subsequent falls in this older age group, these records were included in the enumeration of incident cases as their inclusion more closely approximates the "gold standard' than excluding them.

The study also only identified cases with a principal diagnosis of injury. Consequently, the number and rates presented for the different injury types does not reflect the total number of admissions which sustained each particular injury.

Denominator data (the older population in each year of observation) is an estimate only based on 5-year census data. However, the population estimates produced by the Australian Bureau of Statistics are the standard denominator data for all population-level epidemiological studies undertaken in Australia and form the basis for all national and state-level population estimates. While some smaller countries have a statutory, computer-based population register, which is optimal for this type of epidemiological study, Australia has a very robust and effective system of compulsory vital statistic registration (births, deaths and immigration data) which underpins the annual between-census population estimates.

This study is the first of its kind to examine the contribution of different injuries to the rate of fall-related hospital admissions in older people. The findings of this study suggest that changes in the overall rate of fall-related injury hospitalisations are driven by varying trends in individual injury rates. These variations in the individual trends suggest the impact of independent and/or interacting changes in different injury risk factors and hospital admission policies. However, when overall fall injury trends are examined, changes in the trends of individual injuries are masked and opportunities to identify priorities for injury prevention efforts can be overlooked.

Conclusion

It is clear that the number of fall-related injury hospitalisations among older people in NSW has increased dramatically over the 11-year study period. This is due to the ageing of the population and an increasing rate of fall-related injury hospitalisations. The hospital admission rate for fall-related injury is being driven by an increase in the rate of non-fracture injuries, particularly head injuries. On the other hand, the admission rate for the most common and most debilitating injury, hip fracture, has decreased significantly over the same period, as has the rate of the next most common injury, forearm/elbow fracture. The opposing trends in the hospitalisation rates of other fracture types suggest the impact of varying factors and complicate any proposed explanation of this phenomenon. It is likely that the overall numbers and costs of fall-induced injury hospitalisations will continue to rise due to the ageing of the population, unless further significant gains in fall injury prevention are made.

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Conflicts of interest None.

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