Original Article

Comparison of the epidemiology of elderly trauma between major trauma centres in Riyadh, Saudi Arabia and Melbourne, Australia

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ABSTRACT

الأهداف: مراجعة وبائيات إصابة كبار السن في مدينة الملك سعود الطبية، بالمملكة العربية السعودية، وإجراء تحليلات معدلة حسب المخاطر بمخرجات مستشفى ألفريد بأستراليا، أكبر مركز خاص بالإصابات بأستراليا.

المنهجية: تضمنت هذه الدراسة بأثر رجعي سجلات المرضى المصابين (≥65 عامًا) من سجلات الإصابات بالمستشفى خلال عام 2022م وتم استخراج البيانات الديموغرافية وبيانات الإصابة. وكانت نقاط النهاية المعدلة حسب المخاطر هي وفيات المرضى الداخليين ومدة الإقامة، وتم تحليلها باستخدام الانحدار اللوجستي والمتوسط، على التوالي.

النتائج: تم تسجيل 193 و 1233 حالة لمرضى كبار السن في سجلات مدينة الملك سعود الطبية ومستشفى ألفريد، على التوالي. شهدت مدينة الملك سعود الطبية عدد أقل نسبيا من الإصابات الكبرى (ISS>12) (24.4% مقابل 44.4%، p<0.001) وعدد أقل من المصابين الإناث (31.1% مقابل 44.4%، p<0.001) حازت مجموعة السقوط من مسافات قصيرة على أكبر عدد في المركزين بنسبة (≈60%) وجهة الخروج كانت مختلفة، خاصة بالنسبة للمرضى الذين خرجوا إلى المنزل (86.5% مقابل 56%) أو إلى منشأة إعادة التأهيل (0.5% مقابل 28.2%) وكان تحليل مدة الإقامة المعدلة حسب المخاطر أقل ب 4.5 أيام في مستشفى ألفريد (95% فترة الثقة=[3.25-5.77]، p<0.001) و احتمالات الوفاة داخل المستشفى لم تكن ذات اختلاف كبير بين المركزين (OR=0.72، 95% فترة الثقة=[0.36-1.47]، p=0.37).

الخلاصة: على الرغم من الإعدادات المختلفة، كان السقوط على مستوى منخفض هو السبب الرئيسي للإصابة لدى المرضى الأكبر سنا. تم تحديد مدة إقامة أطول في مستشفى الحالات الحرجة لمدينة الملك سعود الطبية، ومع ذلك، قد يتم تفسير ذلك جزئيًا من خلال ممارسات وجهة الخروج في البلدين.

Objectives: To review the epidemiology of elderly trauma at the Kind Saud Medical City (KSMC), Riyadh, Saudi Arabia, and carry out risk-adjusted analyses to benchmark outcomes with the Alfred Hospital, Melbourne, Australia, the largest Australasian trauma service.

Methods: This retrospective study included records of injured patients (≥65 years) from the hospital trauma registries during 2022. Demographic and injury data were extracted. Risk-adjusted endpoints were: inpatient mortality and length of stay, analysed using logistic and median regression.

Results: A total of 193 elderly patients were registered on the KSMC registry and 1233 elderly patients were registered on the Alfred Hospital registry. Kind Saud Medical City saw proportionally less major trauma (injury severity score of >12, 24.4% vs. 44.2%, p<0.001) and less females (31.1% vs 44.4%, p<0.001). The modal injury group was low level falls in both centres (≈60%). Discharge destination was different, particularly for patients discharged home (86.5% vs. 56%) or to a rehabilitation facility (0.5% vs. 28.2%). The risk-adjusted length of stay was 4.5 days less at the Alfred Hospital (95% CI: [3.25-5.77] days, p<0.001). The odds of in-hospital death were not significantly different (OR=0.72, 95% CI: [0.36-1.47], p=0.37).

Conclusion: Despite the different settings, low level falls were the major cause of injury in older patients. A longer length of stay in the acute hospital was identified for KSMC, however, this may be partly explained by discharge destination practices in the 2 countries.

Keywords: elderly, trauma, registry

Saudi Med J 2024; Vol. 45 (10): 1080-1086
doi: 10.15537/smj.2024.45.10.20240307

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Received 17th April 2024. Accepted 17th September 2024.

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With an ageing population, elderly trauma presentations are a growing demand on healthcare organisations globally. Older people are more susceptible to injury due to a combination of frailty, comorbidities, and functional changes, which are a normal part of ageing, such as deteriorating vision, hearing, and muscular strength and speed.[1] Older patients are often more impacted by an injury for many of the same reasons. For example, osteoporosis is seen in 23% of women aged over 50 years and predisposes them to fractures from lower-force injuries, such as low-level falls.[2] Healthcare costs associated with the care of older patients may also increase due to an increased length of stay, increased complications of injury, and even increased mortality.[3] Efforts to ameliorate these factors include injury prevention strategies such as falls prevention programmes and efforts to reduce osteoporosis rates.[4,5] However, for patients admitted to hospital, the introduction of dedicated geriatric trauma consultation services has shown promise to reduce in-hospital complications and lengths of stay.[6] Definitions of 'elderly' vary in the literature and will likely change over time as the age of retirement climbs.[7] The Australian Institute of Health and Welfare defines 'older Australians' as those aged 65 years and over.[8]

Variations in healthcare performance can help identify opportunities for improvement, and benchmarking against high-performing centres may highlight where these deficiencies lie. We have previously reported an epidemiology and trauma system-level maturity at King Saud Medical City (KSMC), Riyadh, Saudi Arabia, which is the largest Ministry of Health hospital in Saudi Arabia.[9] The present study aimed to review the last year of data collected by the trauma registry to provide an overview of the epidemiology of elderly trauma at this large public hospital (KSMC) and carry out a risk-adjusted analyses to benchmark outcomes with the largest Australasian major trauma service.

Methods. The Saudi Trauma Registry (STAR), which began data collection in August 2017, is an important component of a quality-improvement initiative focused on the care of injured people in Saudi Arabia. The STAR captures data from KSMC, Riyadh, Saudi Arabia. The STAR was modelled on the Alfred Hospital Trauma Registry (AHTR), which has collected data since July 2021. The Alfred Hospital is one of 2 Level-1 adult trauma centres in the Victorian State Trauma System, located in Melbourne, Australia. It sees over 70,000 emergency department presentations and admits more than 3,800 trauma patient presentations per year, of which 1,600 are classified as major trauma (injury severity score [ISS] of >12). This is the highest number of adult major trauma patients in Australia.

The inclusion criteria for both registries are patients who presented to hospital due to acute physical injuries and either died in the emergency department due to injuries, were admitted for longer than 2 days, were admitted to the intensive care unit, or died from injuries following inpatient admission.

The study was approved by both the Alfred Health research and ethics committee, Melbourne, Australia (180/23) and the institutional review board of KSMC, Riyadh, Saudi Arabia (H1RI-23-Jan22-01).

The overall ISS of each case was derived from the abbreviated injury scale (AIS) codes allocated by trained coders to each diagnosed injury. The severity of each injury is graded 1-6 (1: minor, 2: moderate, 3: serious, 4: severe, 5: critical, and 6: maximal). Any patient with an ISS of greater than 12, or who died because of their injuries, was coded as major trauma, as is now standard across Australian and New Zealand trauma registries since the AIS version update in 2010, to facilitate historical comparisons.[10]

To enable benchmarking, all records with dates of injury from January 2022 to December 2022 inclusive were extracted from the STAR and AHTR databases. The records were cleaned to optimise the quality of the analyses.

The primary outcomes were inpatient mortality and length of stay. Logistic regression was used to analyse the association between site and inpatient mortality. The potential confounding variables assessed were gender, age group, injury cause, Glasgow coma score (GCS) arrival motor score, individual component AIS scores, and ISS group. Starting from the most significant factor identified in the univariable analysis, we used the likelihood ratio test to evaluate whether the inclusion of the next most significant variable helped improve the model fit. This was obtained sequentially until all variables were evaluated. For the length of stay, we used quantile (median) regression to analyse the data since length of stay was significantly positively skewed.

Statistical analysis. The data analysis used Stata V.17 (Stata Corp., College Station, Texas, USA). The level of significance was set at 5%.

Disclosure. Authors have no conflict of interests, and the work was not supported or funded by any drug company.

Results. From the STAR database, a total of 2,261 patient records were registered in 2022, and the definitive care dataset was available for 193 elderly trauma patients (age ≥65 years). From the AHTR database, a total of 4,362 patient records were registred in 2022, with 1,233 eligible elderly patients. Injured older patients made up just 8.5% of the trauma admissions to KSMC, compared with 37.6% of trauma admissions to The Alfred in 2022.

A comparison of the baseline characteristics for the elderly trauma patients presenting to each trauma centre during 2022 is shown in Table 1. Women comprised 31.1% of admissions in the KSMC cohort and 44.4% of admissions in the Alfred cohort. In both centres, most injury events were 'blunt', with only 0.5% of cases recorded as penetrating trauma and approximately 2% being burns. The modal mechanism of injury in this age group was low falls, occurring in approximately 60% of cases in both centres. No cyclists were in the KSMC cohort for 2022, whereas this aetiology made up over 4% of the Alfred trauma presentations. Injured patients presenting to the Alfred had a higher ISS with 44.2% defined as major trauma (ISS>12) compared with 24.4% at KSMC (p<0.001).

The risk-adjusted length of stay (Table 2) at the Alfred Hospital was 4.5 days less (95% CI: [3.25-5.77] days, p<0.001) than at KSMC after adjusting for arrival GCS, age, injury severity, and mechanism of injury.

The crude case fatality rate for 2022 was not significantly different between the 2 centres (8.11% at Alfred vs. 10.36% KSMC, p=0.29). The odds of in-hospital death from trauma (Table 3) at the Alfred were not significantly different from KSMC after adjusting for GCS on arrival, age, injury severity, and mechanism of injury (OR=0.72, 95% CI: [0.36-1.47], p=0.37).

Discussion. This registry-based study examined elderly trauma patients cared for during 2022 by 2 major trauma centres from different continents and

Table 1 - Characteristics of the Saudi Trauma Registry and the Alfred Hospital Trauma Registry cohort.

Characteristics	KSMC (n=193)	Alfred (n=1233)	*P*-values
Gender			
Female	60 (31.1)	547 (44.4)	<0.001
Male	133 (68.9)	686 (55.6)	
Age in years at event, mean±SD	76.1±8.6	78.8±8.4	<0.001
Cause of injury			
Falls-low (<1m)	116 (60.1)	751 (60.9)	
Falls-high (>1m)	11 (5.7)	155 (12.6)	
Burns-all types	4 (2.1)	19 (1.5)	
Cutting, piercing object	1 (0.5)	6 (0.5)	
Motor vehicle occupants	38 (19.7)	150 (12.2)	
Motorcyclists	0 (0.0)	14 (1.1)	<0.001
Other specified external cause	1 (0.5)	31 (2.5)	
Pedal cyclist	0 (0.0)	50 (4.1)	
Pedestrian	17 (8.8)	38 (3.1)	
Struck by object or person	4 (2.1)	18 (1.5)	
Unspecified external cause	1 (0.5)	1 (0.1)	
Injury severity score range			
<12	142 (73.6)	672 (54.5)	
12–25	43 (22.3)	467 (37.9)	<0.001
26–40	7 (3.6)	88 (7.1)	
>40	1 (0.5)	6 (0.5)	
Crude outcome measures			
Discharge destination			
Death	20 (10.4)	100 (8.1)	
Home	167 (86.5)	690 (56.0)	
Nursing home	0 (0.0)	93 (7.5)	<0.001
Other	0 (0.0)	2 (0.2)	
Transferred to another hospital for ongoing acute care	5 (2.6)	0 (0.0)	
Transferred to another hospital for rehabilitation or convalescence	1 (0.5)	348 (28.2)	
Deceased at discharge			
No	173 (89.6)	1133 (91.9)	0.29
Yes	20 (10.4)	100 (8.1)	
Length of stay, median (IQR)	10.0 (7.0-17.0)	6.8 (3.5-11.8)	<0.001

Values are presented as numbers and percentages (%). KSMC: King Saud Medical City, SD: standard deviation, IQR: interquartile range

Table 2 - Risk-adjusted length of stay (N=1426).

Variables	Coefficient	95% CI		*P*-values
		Upper	Lower	
KSMC	1.00			Reference
Alfred	-4.51	-5.77	-3.25	<0.001
Glasgow coma score motor (arrival)				
Obeys commands	1.00			Reference
Localises pain	-0.78	-3.31	1.74	0.54
Withdraws to pain	6.46	-0.22	13.14	0.06
Flexion to pain	-4.17	-9.67	1.34	0.14
Extension to pain	-7.57	-21.98	6.83	0.30
None	0.33	-1.76	2.42	0.76
Not stated	-0.52	-5.06	4.02	0.82
Injury severity score range				
<12	1.00			Reference
12-25	0.72	-0.48	1.92	0.24
26-40	1.20	-1.63	4.04	0.41
>40	-3.31	-10.73	4.10	0.38
Age at injury event (years)				
65-74	1.00			Reference
75-84	0.33	-0.58	1.24	0.48
85-94	0.52	-0.59	1.64	0.36
95+	1.84	-0.42	4.10	0.11
Chest injury severity				
No chest injury	1.00			Reference
Minor	0.29	-1.73	2.31	0.78
Moderate	0.03	-1.58	1.63	0.97
Serious	1.07	-0.04	2.18	0.06
Severe	7.52	4.52	10.52	<0.001
Critical	-2.33	-9.65	4.99	0.53
Abdominal injury severity				
No abdominal injury	1.00			Reference
Minor	0.59	-6.01	7.19	0.86
Moderate	1.40	-0.63	3.44	0.18
Serious	2.29	-1.63	6.22	0.25
Severe	6.16	1.41	10.92	0.01
Critical	3.30	-7.15	13.75	0.54
Spinal injury severity				
No spinal injury	1.00			Reference
Minor	2.19	-1.84	6.22	0.29
Moderate	1.90	0.97	2.84	<0.001
Serious	1.81	0.32	3.31	0.02
Severe	5.23	0.68	9.78	0.02
Critical	-1.05	-9.50	7.41	0.81
Upper-limb injury severity				
No upper-limb injury	1.00			Reference
Minor	0.35	-2.94	3.63	0.84
Moderate	0.16	-0.91	1.23	0.77
Serious	-1.06	-11.31	9.20	0.84
Lower-limb injury severity				
No lower-limb injury	1.00			Reference
Minor	0.36	-7.92	8.64	0.93
Moderate	2.11	0.64	3.59	0.01
Serious	3.91	2.53	5.30	<0.001
Severe	4.86	0.96	8.75	0.02
Critical	-0.60	-8.99	7.79	0.89

KSMC: King Saud Medical City, CI: confidence interval

follows on from prior work describing the development of the STAR and initial benchmarking in 2018.[9] The published literature on outcomes of injury in older patients has predominantly focused on populations from North America, Australia, and Europe.[4-6] This study was designed to investigate the management,

Table 2 - Risk-adjusted length of stay (N=1426). Continue

Variables	Coefficient	95% CI		*P*-values
		Upper	Lower	
Other injury or burn severity				
No other or burn injury	1.00			Reference
Minor	-0.45	-1.31	0.41	0.31
Moderate	-0.90	-3.00	1.21	0.41
Serious	-2.26	-7.17	2.65	0.37
Severe	5.20	-4.32	14.72	0.28
Critical	-21.57	-29.13	-14.02	<0.001
Head injury severity				
No head injury	1.00			Reference
Moderate	0.70	-1.20	2.60	0.47
Serious	1.34	-0.13	2.80	0.07
Severe	3.34	1.06	5.62	<0.001
Critical	2.49	-0.36	5.34	0.09
Mechanism of injury				
Falls-low (<1m)	1.00			Reference
Falls-high (>1m)	-1.30	-2.60	0.00	0.05
Burns-all types	17.10	12.65	21.54	<0.001
Cutting, piercing object	2.57	-2.94	8.07	0.36
Motor vehicle occupants	0.05	-1.22	1.32	0.94
Motorcyclists	-1.32	-5.29	2.64	0.51
Other specified external cause	-1.37	-4.00	1.27	0.31
Pedal cyclist	-2.83	-4.97	-0.69	0.01
Pedestrian	-2.15	-4.24	-0.07	0.04
Struck by object or person	-2.79	-5.97	0.39	0.09
Unspecified external cause	0.78	-9.34	10.91	0.88

KSMC: King Saud Medical City, CI: confidence interval

and associated outcomes for these patients, in an established major trauma centre in Saudi Arabia, to inform local clinicians caring for these patients. As the busiest mature trauma centre in Australasia, the Alfred Hospital provides a suitable benchmark for this analysis and leverages the pre-existing registry establishment relationship described by Alsenani et al.[9]

Trauma centres with higher volume tend to have improved outcomes.[11] In this focused assessment of elderly patients, the Alfred Hospital cared for over 6 times as many elderly patients as KSMC in 2022, with a greater proportion of cases defined as major trauma (ISS>12). Outcomes such as length of stay and discharge destination also varied between the 2 trauma centres. Variations in these outcomes may be influenced by differences in local practice. For example, the shorter length of stay at the Alfred Hospital may reflect discharge destination practices. Patients admitted to the Alfred Hospital were more likely to be discharged to a rehabilitation facility (28.2% vs. 0.5%), which potentially reduced the relative length of stay in the acute hospital. Rehabilitation facilities in Saudi Arabia are limited, and patients may have a longer acute hospital length of stay when compared with Australian and North American centres.[12] Therefore, less opportunity may exist for elderly patients to receive early subacute care. Furthermore, there may be cultural expectations for families to care for elderly relatives in Saudi Arabia, and thus a prolonged length of stay may be necessary to optimise the patient's condition before they can return home.

The acute hospital length of stay may also have affected the mortality data since patients had a longer period within which their death would be counted as in-hospital mortality. In the original 2018 comparison study, shortly after the formation of the STAR, the risk-adjusted odds of in-hospital death were significantly lower, and this finding was maintained when restricted to the ≥65 years age group (OR=0.42; 95% CI: [0.19-0.92], p=0.03).[9] Conversely, the 2018 risk-adjusted length of stay was very similar to the 2022 data (4.2 days less at the Alfred, 95% CI: [2.92-5.52], p<0.001, unpublished data).

Despite system differences, the similarities in the causes of injury in the 2 locations are interesting to note, particularly for the modal aetiology group of low-level falls, which occurred in a similar proportion of patients as reported in other centres.[6] This suggests that vulnerability to falls is a universal feature of increasing age and is not dependent on lifestyle or place of residence. Dissimilarities were also found. The absence of cyclists in the KSMC cohort might be attributable

Table 3 - Risk-adjusted mortality (N=1416).

Variables	Odds ratio	95% CI		*P*-values
		Upper	Lower	
KSMC	1.00			Reference
Alfred	0.72	0.36	1.47	0.37
Glasgow coma score motor (arrival)				
Obeys commands	1.00			Reference
Localises pain	8.37	3.71	18.89	<0.001
Withdraws to pain	3.40	0.31	36.97	0.32
Flexion to pain	50.05	8.43	297.27	<0.001
Extension to pain	1.00			
None	22.02	11.07	43.82	<0.001
Not stated	4.49	0.73	27.48	0.10
Injury severity score range				
<12	1.00			Reference
12-25	1.48	0.89	2.45	0.13
26-40	5.03	2.51	10.10	<0.001
>40	15.23	1.93	120.07	0.01
Age at injury event (years)				
65-74	1.00			Reference
75-84	1.58	0.86	2.93	0.14
85-94	5.60	2.90	10.81	<0.001
95+	5.83	1.97	17.27	<0.001
Mechanism of injury				
Falls-low (<1m)	1.00			Reference
Falls-high (>1m)	0.72	0.30	1.70	0.45
Burns-all types	3.94	1.30	11.97	0.02
Cutting, piercing object	1.00			
Motor vehicle occupants	0.68	0.31	1.51	0.34
Motorcyclists	0.91	0.07	12.11	0.94
Other specified external cause	0.69	0.13	3.63	0.67
Pedal cyclist	0.64	0.12	3.34	0.59
Pedestrian	1.77	0.55	5.66	0.33
Struck by object or person	3.80	0.90	16.07	0.07

KSMC: King Saud Medical City, CI: confidence interval

to the climactic conditions in Saudi Arabia, specifically the heat. The top temperature inland regularly exceeds 40°C in summer, which may be a deterrent to cycling at any age, but particularly for older people.[13] Motorcyclists were also absent, possibly similarly due to climactic conditions, but potentially additionally due to differences in the popularity of motorcycling as a recreational activity in the older age group.

The larger proportions of pedestrians and motor vehicle occupants are consistent with the recognised preponderance of road trauma in Saudi Arabia.[14] This study did not specify whether the motor vehicle occupants were drivers or passengers. However, as an adjunct to ongoing efforts to reduce the road toll, exploring this in future research might be useful.

Study limitations. Registry data is entered by trained coders who review each patient's electronic medical record and summarise the information into a purpose built database. The analysis described will therefore be limited by the quality of the data extracted from the registry and may be affected by factors related to this process, for example, miscoding of mechanism of injury or patient diagnoses by the individual coder.

The comparison focused on a single centre in Saudi Arabia which may limit the generalisability to the rest of the region. Similarly, the Alfred is a single centre in Australia and may not be reflective of performance across Australia.

In conclusion, this study expands on the insights gained from previous research into the epidemiology of traumatic injuries in Saudi Arabia. Benchmarking against the busiest major trauma centre in Australasia demonstrated similar aetiologies, with some notable exceptions. However, the odds of in-hospital death were not significantly different from the Alfred Hospital. Although the length of stay was shorter at the Alfred Hospital, this may represent different discharge practices since the availability of rehabilitation centres is lower in the Saudi Arabian setting. As the population ages worldwide, monitoring and benchmarking of outcomes in elderly injured patients will become increasingly important.

Acknowledgment. *The authors gratefully acknowledge Cambridge Proofreading & Editing LLC (https://proofreading.org) for their English language editing.*

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