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Childhood injuries in Oman: retrospective review of a multicentre trauma registry data

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ABSTRACT

Objectives Injuries are among the top causes of hospital-based mortality for adults in Oman. However, little is known about the distribution and risk of injuries among children. This paper describes the epidemiology and risk factors for childhood injuries (0–15 years of age), in two hospitals of Oman.

Methods Data were collected between November 2014 and April 2015 at Khoula and Nizwa Hospitals. All patients between 0 and 15 years with a diagnosis of injury/trauma admitted to the hospital, and those who had trauma team activation in the emergency department were included in the analysis. Descriptive and multivariable Poisson regression analyses were conducted to generate sociodemographic risk factor profiles associated with the need for surgical management of injuries.

Results Out of 795 cases, 59% were under 5 years of age; 67% were males. Around 50% injuries were fall related, followed by exposure to inanimate mechanical forces and transport injuries. Burn injuries were more prevalent in females than males. Three-fourths of all injuries occurred in private residences. Almost 92% injuries were minor (Injury Severity Score <9). Of children with all types of injuries, 303 (40.9%) received surgical treatment. Patients suffering from head injuries (RR 8.8: 95% CI 4.9 to 15.3) or being involved in a burn injury (RR 1.5: 95% CI 0.3 to 7.5) were at increased risk of undergoing surgical treatment.

Conclusion In this study, >30% of injury admissions were children 0–15 years of age. The high incidence of falls, home injuries and burns highlight the need for age-targeted interventions and injury control programmes. Although infrequent, transport injuries and head injuries put children in need of surgical management and prolonged hospital care.

What is already known on this topic?

- Injuries are the leading cause of hospital-based mortality in individuals 1–44 years of age in the Sultanate of Oman.
- There is a knowledge gap in epidemiology and risk factor profile of injuries among children in the same population.

What this study hopes to add?

- Among all hospital admissions due to an injury, 30% were children under 15 years of age; falls, mechanical forces and road traffic accidents were leading causes of injury.
- Hospital-based trauma registries can be useful in providing a constant surveillance of the injury burden across all population demographics.
- Trauma Registriess (TRs) are a useful resource in risk-adjusted comparison of resource utilisation and outcome of paediatric patients admitted with injuries.

INTRODUCTION

Globally, around 5 million deaths reported in 2015 were due to injuries, contributing to almost 9% of all deaths and more than 10% of all disability-adjusted life years (DALY) lost.[1] Unintentional injuries such as drowning, road traffic injuries (RTIs), falls and burns are the leading causes of injury deaths among those aged 0–15 years.[2 3] More than 90% of child injury deaths occur in low-income and middle-income countries (LMICs) with injury death rates being 3–4 times higher in LMICs than in high-income countries (HICs).[4]

Rapidly developing HICs such as those in the Gulf Cooperation Council (GCC) have also observed a significant rise in the injury burden in recent years.[4–6] Urbanisation, increased motorisation, migration for job opportunities and lack of integrated trauma systems are cited as some of the reasons for this ascending trend.[7 8] While other LMICs in the Middle Eastern region are still focusing on maternal and child health, and communicable diseases, these rich gulf countries have made substantial gains in infant and child mortality only to be offset by the burden of injuries and non-communicable diseases.[9–12] More than 20% of all deaths in the GCC were attributed to injuries and account for approximately 15% of all DALYs lost.[13]

The Sultanate of Oman, one of the six countries comprising the GCC, is located in the Southeast coast of the Arabian Peninsula. Almost 50% of the population lives in the urban areas, that is, parts of Muscat and the Batinah coastal plain. Oman is a HIC with a total population of 4.8 million, where 13.9% and 33.7% of the population are under 5 years and under-15 years, respectively.[14 15] In this country of mostly young individuals, injuries are the leading cause of hospital-based mortality in individuals 1–44 years of age.[1] Despite an overall decrease in mortality from unintentional injuries by 38.9% since 1990, there has been a 50% increase reported in RTIs for the same time frame, mainly affecting individuals 26–50 years of age.[16] With relatively under developed emergency medical services (EMSs) in rural areas and only a handful of dedicated trauma centres, many injury victims use private transport and receive initial assessment and care in smaller hospitals, before being transferred to urban trauma centres for definitive care.[16] Additionally, trauma information systems are not widely implemented, and therefore, scarce information is available about the distribution and risk of injuries among children in Oman to make informed decisions about targeted age-specific policies and programmes on child injury prevention.[17]

In this paper, we analysed data from the trauma registry implemented in two Omani hospitals to describe the epidemiology and risk factors for injuries among children, who are defined as 15 years and below in the Omani hospital settings. This paper aims to provide a profile of paediatric injuries including the nature and intent of injuries across age and gender profiles, to better understand this burden in Oman and other GCC countries. It also demonstrates the value of collecting systematic data in hospital settings to inform injury prevention efforts. To our knowledge, this is the first such registry analysis from Oman in this population subset.

METHODS

In order to obtain a profile of injuries in Oman, a mHealth-based trauma registry was developed and pilot tested at two regional hospitals.[18] Data were collected on patient characteristics and sociodemographic details such as age, sex, nationality and education level, injury circumstances recorded as external causes of injuries, prehospital assessment, investigations and treatment in the emergency department (ED), inpatient treatment, operative procedures, complications and discharge details (online supplementary file). The Revised Trauma Score and Injury Severity Scores were calculated for each patient, using ED vital signs and Abbreviated Injury Scale, respectively.[16] The electronic data collection tool was deployed on Android tablets using Open Data Kit as the open-source mHealth platform.[19] Data were collected prospectively between 1 November 2014 and 30 April 2015 by trained nurses who were selected based on their routine involvement in trauma care and familiarity with medical coding systems.[17 20]

Khoula Hospital, a tertiary care referral hospital in Muscat, is a national trauma, burns and plastics surgery referral centre, and the country's leading neurosurgical facility. Nizwa Hospital is a secondary care hospital in the governorate of Ad-Dakhiliyah and serves as a regional trauma referral centre for neighbouring governorates. Both hospitals have highly equipped EDs, multidisciplinary trauma teams and 24/7 availability of emergency surgical services.

All patients who were admitted to the hospital with a diagnosis of injuries, (classified by International Statistical Classification of Diseases and Related Health problems 10th Revision), including those referred or transferred-in, and those who had trauma team activation (figure 1) in the ED were included in the trauma registry. Cases across both gender profiles, all age groups were included if they met the inclusion criteria.[16] For the purpose of this study, only children ≤15 years of age were considered for analysis, as per hospitals' definition of paediatric age group.

Descriptive statistical analysis was conducted to estimate counts, frequencies and 95% CIs of injuries by sociodemographic factors such as age and gender, injury characteristics such as external cause, place of injury, anatomical detail, emergency and definitive care. Care at the scene was defined as care provided on route or in the field by trained or lay providers, and included interventions such as C-spine immobilisation, wound care, bleeding control, fracture immobilisation or other resuscitative measures. Univariable and multivariable Poisson regression models with robust SE were derived to test associations between the injury characteristics and in-hospital treatment, specifically surgical management. Akaike information criterion, Bayesian information criterion and log likelihood ratio tests were used to estimate best model fit in multiple logistic regression analysis.[21] Statistical analyses were completed using Stata V.14 I/C package.[22]

RESULTS

Demographics

Children 15 years of age or under, constituted 30% of the entire sample (n=2629). Around 36% were children 1–5 years of age and 23% were under 1 year of age; two-thirds of all cases were males (table 1).

Injury characteristics

Transport injuries (51%, 95% CI 47.5% to 54.5%) were the most common external cause of injury among all children under 15 years of age across all gender and age profiles (table 2). Exposure to inanimate mechanical forces (20.2%, 95% CI 17.5% to 23.1%) and fall injuries (11.1%, 95% CI 9.1% to 13.5%) followed as leading causes of injuries. However, among female children, injuries due to contact with heat and hot substances (n=36, 13.6%) were the third leading cause. Almost three-quarters of all injuries occurred in the home. Around 12%

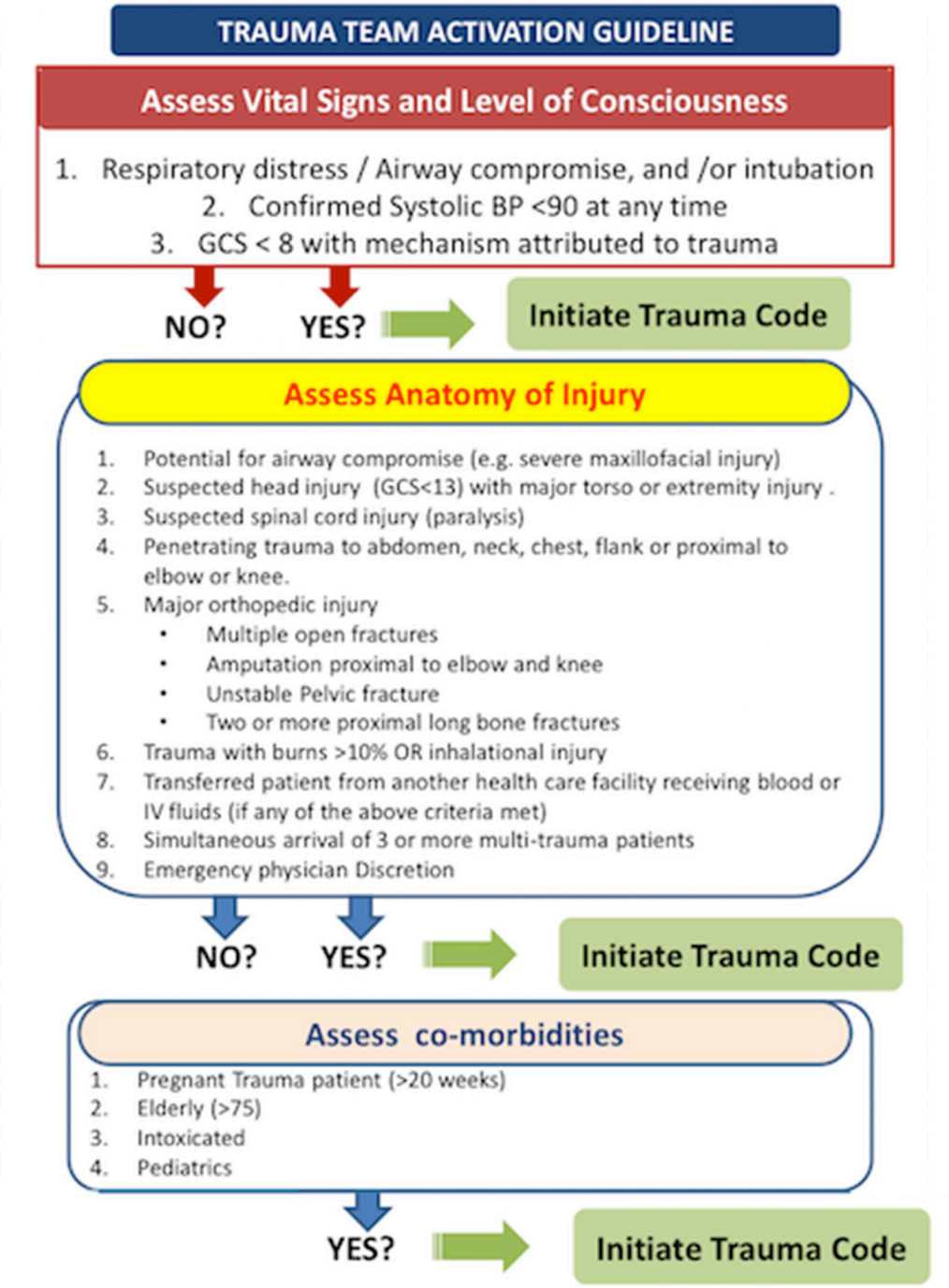

Figure 1 Trauma team activation guideline for Khoula and Nizwa Hospitals. GCS: Glasgow Coma Scale; BP: Systolic Blood Pressure measured in mmHg

of all injuries occurred on streets, roads or highways. Only 5% of all injuries occurred on school premises or public administrative areas. Analysis by age revealed that transport injuries were the most common cause of injury for children across all age groups. Males suffered more injuries than females across all external causes of injury. Injuries by contact with heat and hot substances (22.9%) were second most common injury cause for children <1 years of age, across both genders. Burn injuries were also the third leading cause of injury admissions for children 1–5 years of age (online supplementary file 2).

Head injuries (n=344) were the most common anatomical injury among all children brought into the hospital. Most head injuries were associated with falls, followed by transport injuries. The second most common were injuries to the upper extremities, involving hands and wrists. These were seen in children who were exposed to inanimate mechanical forces such as those struck by a falling object; caught or crushed between objects, contact with non-powered tools, sharp objects or household machinery (online supplementary file 3).

Table 1 Age and sex distribution of children under 15 years included in trauma registry

Sociodemographic characteristics	Total (N)	Frequency (%)
Overall	795	
Age		
<1 year	183	23
1–5 years	290	36.5
5–9 years	149	18.7
10–15 years	173	21.7
Gender		
Male	531	66.8
Female	264	33.2

Care of injured children

Only 20.2% (n=147) of all children received care at the scene of injury (table 3). Of the 147 children who received on-scene care, trained prehospital personnel cared for only 3.4%; family/relatives (56.5%) most commonly provided initial care or first aid. Most patients (n=495, 68.1%) were transported to hospital by private car; only 23% of children were transported to the hospital via EMS. About a quarter of patients were transferred or referred from another facility.

Only 8.3% reached the hospital from the scene of injury within 30 min of the injury, while it took more than 6 hours for 124 children (15.6%) to be transported to the hospital. Around 39.5% of RTI patients were transported to the hospital within 1 hour of the crash, while most cases of fall injuries (54.1%) reached the hospital within 2 hours of injury.

On arrival to the hospital, three patients (0.4%) were pronounced dead on initial assessment. Most patients (n=732, 92.1%) had minor injuries; around 75.1% patients were deemed stable enough to wait 30–60 min to receive ED treatment (ED triage code 3). Only 0.5% of patients had severe injuries and had been in a road traffic crash or exposed to smoke, fire or flames.

Characteristics of children requiring surgery

More than 40% (n=303) of the admitted patients required surgery (table 4).

Table 2 Injury characteristics among children as reported in the trauma registry

Injury characteristics	n (n=795)	Proportion (95% CI)
External cause		
Falls	88	11.1 (9.1 to 13.5)
Transport injuries	405	51.1 (47.5 to 54.5)
Exposure to inanimate mechanical forces	160	20.1 (17.5 to 23.1)
Bites/animate mechanical forces	9	1.1 (0.6 to 2.2)
Drowning and submersion	3	0.4 (0.1 to 1.2)
Accidental suffocation and strangulation	4	0.5 (0.2 to 1.3)
Exposure to smoke, fire and flames	17	2.1 (1.3 to 3.4)
Contact with heat and hot substances	73	9.2 (7.4 to 11.4)
Contact with venomous animals/plants	3	0.4 (0.1 to 1.2)
Accidental poisoning/noxious substances	12	1.5 (0.9 to 2.6)
Intentional self-harm	1	0.1 (0.0 to 0.9)
Assault	11	1.4 (0.8 to 2.5)
Others	8	1.0 (0.5 to 2.0)
Place of injury		
Non-institutional (private) residence	586	73.8 (70.6 to 76.7)
Institutional (non-private) residence	7	0.9 (0.4 to 1.8)
School, institution, public administrative area	39	5.0 (3.7 to 6.7)
Sports and athletics area	23	3.0 (1.9 to 4.4)
Street, highway and other paved roadways	98	12.4 (10.3 to 14.9)
Trade and service area	7	0.9 (0.5 to 1.9)
Industrial and construction area	0	0
Farm	5	0.7 (0.3 to 1.5)
Other places	18	2.3 (1.4 to 3.4)
Unspecified place or not applicable	11	1.4 (0.8 to 2.5)

Table 3 Care of injured children in Oman

	Total	Frequency (%)
Care at scene*		
Yes	147	20.2
No	295	40.6
Care provider†		
EMT	5	3.4
Bystander	3	2
Relative	83	56.5
Friend	4	2.7
Others	56	38.1
Care provided in prehospital phase‡		
C-spine immobilisation	15	8.8
Fracture immobilisation	23	13.4
Control of bleeding	23	13.4
Wound care	82	47.9
Intravenous fluids	16	9.4
Intubation	0	0
Needle decompression	0	0
CPR	0	0
Others	58	33.9
Mode of transport§		
Hospital ambulance	112	15.4
EMS	15	2.1
Walk-in, wheelchair	98	13.5
Private car	495	68.1
Others	7	0.9
Transport time to hospital from time of injury§		
0 to 30 min	60	8.3
>30 min to 1 hour	108	14.9
>1 to 2 hours	108	14.9
>2 to 6 hours	124	17.1
>6 to 24 hours	73	10.1
>24 hours	51	7
Unknown	17	2.3
Transferred from another facility	182	25.2
Hospital transfer		
Transferred from another facility	344	43.3
Primary admission	450	56.7
Hospital		
Khoula Hospital	429	53.9
Nizwa Hospital	366	46
ED triage code		
Immediate (1)	10	1.3
10 min (2)	17	2.2
30 min (3)	566	75.1
90 min (4)	158	20.9
120 min (5)	3	0.4
Injury Severity Score		
Minor (≤9)	732	92.1
Moderate (10–15)	35	4.4
Moderate/severe (16–25)	24	3
Severe/critical (>25)	7	0.5
Received surgery		
Yes	303	40.9
No	437	58.9
Surgical procedures		
Khoula Hospital	231	54.4
Nizwa Hospital	72	22.8

*Missing and unknown=353 (44.4%).
†n=147 children who received care at scene.
‡n=147 some children received multiple care.
§Missing=68 (8.5%).
ED: Emergency Department; EMS: Emergency Medical Service; EMT: Emergency Medical Technician; CPR: Cardio-pulmonary resuscitation

In the adjusted Poisson regression analysis, children 1–5 years of age were 1.9 (95% CI 1.01 to 3.6) times at increased risk of undergoing surgery than children 10 years and above. Patients who were either directly admitted to or were transferred from other health facility to a regional referral centre were at 60% reduced risk of undergoing operation than those who were treated at a national referral centre. Additionally, when compared with patients who suffered injuries to the upper or lower extremities, patients with head, face and neck injuries (RR 8.8, 95% CI 4.9 to 15.3), abdomen, back and pelvis injuries (RR 4.01, 95% CI 1.5 to 10.9) and external injuries (RR 5.8, 95% CI 1.1 to 29.9) had increased risk of surgical treatment. Patients with multiple injuries had almost five times increased risk of an operation than those with injuries to the extremities. The difference in the mean length of hospital stay was not significant for patients who underwent an operative procedure versus those who did not (p=0.514).

DISCUSSION

This study highlights the high burden of paediatric injuries in Oman; >30% of all injury admissions of the two trauma centres in Oman comprised children under 15 years of age. A similar study from a primary health centre reported 41% of all injury-related visits were among children ≤12 years.[23] These injuries cover approximately 46% of the total DALY lost among children younger than 15 years of age in Oman.[23] Taken together, these statistics

Table 4 Multivariable Poisson regression analysis of injuries requiring surgical treatment

	Unadjusted		Adjusted*	
Characteristics	**RR**	**95% CI**	**RR**	**95% CI**
Age (n=741)				
10 years and more	Reference		Reference	
<1 year	1.9	1.6 to 2.3	1.1	0.3 to 1.9
1–5 years	2.3	1.1 to 4.9	1.9	1.0 to 3.6
6–9 years	1.2	0.9 to 1.6	1.3	0.2 to 1.7
Gender (n=741)				
Male	Reference		Reference	
Female	0.9	0.5 to 1.5	0.7	0.5 to 1.1
External cause (n=740)				
Falls	Reference		Reference	
Transport injuries	1.3	0.7 to 2.4	0.6	0.3 to 1.1
Exposure to inanimate mechanical forces	0.5	0.4 to 0.9	0.5	0.2 to 0.9
Exposure to smoke, fire, flames, heat/hot substances	1.3	1.1 to 1.6	1.5	0.3 to 7.5
Others*	0.9	0.6 to 1.2	0.6	0.3 to 1.5
Mode of transfer (n=680)				
Private car	Reference		Reference	
Hospital ambulance	0.9	0.6 to 1.6	0.64	0.28 to 1.46
Royal Omani Police (ROP) ambulance	0.4	0.2 to 1.7	0.27	0.07 to 1.05
Walk-in, wheelchair	0.5	0.3 to 1.2	0.76	0.45 to 1.25
Others	0.9	0.4 to 1.8	0.73	0.52 to 4.06
Hospital admission type (n=740)				
Primary admission	Reference	–	Reference	–
Transferred	1.2	0.6 to 2.1	1.4	0.8 to 2.6
Hospital				
National referral centre (Khoula)	Reference		Reference	
Regional referral centre (Nizwa)	1.1	0.6 to 2.1	0.4	0.2 to 0.8
Emergency Room triage code (n=700)				
Immediate	Reference		Reference	
10 min	2.8	0.5 to 15.5	0.3	0.04 to 3.2
30 min	3.3	0.6 to 19.3	0.4	0.1 to 5.1
90 min	1.8	0.3 to 9.9	0.4	0.1 to 2.1
240 min*	2.7	0.4 to 17.3	–	–
Body part (n=721)				
Extremities	Reference		Reference	
Head, face and neck	6.2	3.4 to 11.5	8.8	4.9 to 15.3
Thorax	3.5	2.2 to 5.7	0.7	0.1 to 3.3
Abdomen, back and pelvis	3.7	2.7 to 5.2	4.01	1.5 to 10.1
Multiple injuries*	2.7	1.4 to 5.2	4.9	1.5 to 16.3
External*	4.6	3.4 to 6.2	5.8	1.1 to 29.9
Others	4.4	3.4 to 5.8	3.3	0.6 to 16.6
Injury Severity Score (n=741)				
>25	Reference		Reference	
<10	2.4	0.4 to 12.9	0.3	0.03 to 2.3

Continued

Table 4 Continued

Characteristics	Unadjusted RR	Unadjusted 95% CI	Adjusted* RR	Adjusted* 95% CI
10–15	14.4	1.4 to 148.4	4.2	0.4 to 42.5
15–25	1.9	0.4 to 11.5	0.5	0.1 to 4.6
Revised Trauma Score (n=297)	1.2	0.5 to 2.7	2.9	0.9 to 9.5

*Bites or exposure to animate mechanical forces, drowning and submersion, accidental suffocation and strangulation, contact with venomous animals and plants, accidental poisoning and exposure to noxious substance, intentional self-harm, assault.

highlight a remarkably high burden of injuries among young children and early adolescent population. This burden is at par with some HICs such as the USA, despite differences in social and cultural environments.[1]

Children under 5 were more likely to present with injuries than their older counterparts. Potential reasons could include the exploratory and curious nature of younger children, which when coupled with the lack of dexterity and coordination puts them at a higher risk of sustaining injuries.[24] In some settings, heavy reliance on child care predisposes to inadequate direct parental attention, thereby putting children at risk of injuries.[25] This study also found that male children were more prone to all causes of injuries, except for burn injuries where females had a proportionately higher burden.[26] Similar findings have been noted previously, where young girls and women involved in the kitchen for daily cooking chores, had higher incidence of burn injuries.[27]

Large burden of falls, home injuries and burns demonstrate the need for age-targeted interventions. Engagement of primary caregivers in injury control programmes and 'child-safe homes' are vital in ensuring a safe environment for toddlers and young children.[28 29] This includes infrastructure modifications, which coupled with parental supervision, may help reduce household injuries.[30] That unintentional injuries are the predominant cause among children ≤15 years in Oman is similar to previous findings from the region.[31 32] Urbanisation and increased motorisation in GCC countries have made RTIs a major concern, even for children and adolescents.[23 33 34] Some researchers have documented risky behaviour among boys as young as 14 years, such as driving without a licence, performing stunts and lack of understanding of traffic rules, that increases the likelihood of traffic crashes and injuries.[34 35] Programmes and policies, such as graduated drivers' licence, are needed to control traffic-related injury events in this population.[35]

Even though childhood injuries are a frequent cause of injury admissions, the most cases in this study presented with minor injuries and were transported to the hospital by private cars after receiving initial care from relatives. A sizeable proportion of the patients were transferred from other hospitals for further assessment or treatment; this subgroup also had statistically non-significant higher odds of surgical treatment. This illustrates that despite having a good distribution of primary health centres and smaller hospitals that provide initial assessment and stabilisation, lack of definitive treatment and major surgical facilities is the main reason for a high number of transfers and referrals, especially for paediatric population.[16 34]

Among patients who required surgical procedures, the number of surgeries performed at Khoula Hospital was significantly higher than those performed at Nizwa Hospital. This is probably due to it being the national trauma and burns referral centre, making it more capable to provide definitive care to complex paediatric trauma patients. As Nizwa Hospital is geographically more central, closer to major highways and is the only referral hospital in the region, they usually receive more seriously injured cases especially from RTIs.

Since most patients in the trauma registry had minor injuries, ED triage code did not have any association with the need for surgical treatment. However, injuries to the head, face and neck had higher odds of being surgically treated than injury to any other body part. Injuries to the head and neck region, irrespective of their severity, pose risks of concussions, haematomas and skull fractures requiring close observation, additional radiological monitoring and neurosurgical procedures.[36] Facial injuries may require expert opinion from plastics and reconstructive surgeons. Although our study does not cover long-term functional outcomes, studies have suggested increased risks of psychosocial and cognitive problems among children with minor head injuries, thus calling for efforts to prevent traumatic brain injuries.[37] The data show that children who were exposed to fire, flame or smoke also had a higher likelihood of receiving surgery including surgical debridement and subsequent skin grafting. Notwithstanding that most of patients in this category had less than 10% body surface area involved, burn injuries are often associated with the high probability of long-term consequences in the paediatric population.[38] The occurrence of transport injuries and head injuries also put children in need of surgical management and potential long-term disabilities[36]. This finding has also been highlighted in another paper focusing on Omani adolescents.[33]

This study is based on the data collected during the pilot phase of trauma registry implementation. Since follow-up period of patients in this trauma registry is limited to hospital discharge, we do not have information on short-term or long-term consequences of head injuries, postdischarge complications and school attendance or performance of children after injuries.

CONCLUSION

Hospital-based trauma registry data demonstrate a high burden of injuries among children in Oman. The high incidence of falls, home injuries and burns illustrate the need for age-targeted interventions, programmes and policies changes to reduce injury events in this population.

Contributors AM conceptualised and designed the trauma registry as well as led the analysis and writing of the article. PA analysed the data and developed subsequent drafts of the manuscript. All authors contributed to writing of the article and provided technical feedback during preparation of the article.

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