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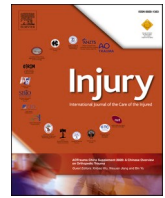
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Patterns of horse and camel- related injuries: A descriptive analysis from a national trauma registry (2007–2021)

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ARTICLE INFO

Keywords:

Horse-related injury
Camel-related injury
Large animal
Trauma

ABSTRACT

Background: The large animal-related injuries are emerging major trauma but remain underestimated public health problem worldwide. We aimed to determine the incidence, clinical characteristics, mechanisms and patterns of horse and camel-related injuries (HCRIs) in a Middle Eastern country.

Methods: A retrospective analysis of all patients who were hospitalized due to HCRIs was conducted. Data included patient's demographics, mechanism of injury, anatomical location and severity of injury, and hospital outcomes.

Results: Between November 2007 and December 2021, there were 273 hospitalized patients with HCRIs representing 1.3 % of the total trauma admissions. Of these, 145 (53.1 %) and 128 (46.9 %) were horse (HRI) and camel-related injuries (CRI) respectively. The most common presenting age group of the cohort was 20–29 years and 88 % were males. Patients with HRIs were younger (27.5 ± 11 years) than CRIs (34 ± 13.5 years). Injuries to the extremities were the most common (62 % vs. 40 %), followed by the head injury (25.5 % vs. 31 %) among the HRIs and CRIs, respectively. The most common mechanism of injury was falling off followed by getting kicked by the HCRIs. Major trauma (ISS ≥ 12) was found in 23 % of HRIs (47.5 %) and CRIs (52.5 %). Only 5 % of patients had shock index >0.90 on admission; two thirds were due to CRIs. There were four fatalities (1.5 %), all attributed to traumatic brain injury, of which three were due to HRIs and one due to CRIs.

Conclusion: This study reveals that HCRIs predominantly affect young adult males and may involve serious injuries, exhibit distinct injury patterns, however, it is associated with low mortality. Preventive measures need to be revisited.

Introduction

Large animal-related injuries (LARIs) are a substantial but neglected, emerging public health problem contributing considerably to high morbidity [1–3]. Large animals such as camels and horses can cause injuries by various mechanisms, including biting, kicking, crushing, goring, stomping, buckling off, falling on, and colliding with a motor vehicle. After LARIs, patients usually suffer blunt and penetrating high-energy transfer trauma to multiple body regions [1,4–5]. The patterns and severity of these injuries vary by region depending on the type, size, and behavior of animals living in that geographical region and the inhabitants' profession, tradition, and sports activities [4]. Moreover, LARIs can be severe and may require initial triage and treatment in the

emergency departments (EDs) and intensive care [6].

The dromedary camel is found throughout the arid regions of Africa, the Middle East, and Western Asia [7]. The United Arab Emirates (UAE), Yemen, Saudi Arabia, Qatar and Oman, have the most significant camel populations in the Arab Middle East [1]. In the Arabian world, camels are mainly employed for sports and recreation, milk/meat sources, as 'pack' animals. Unfortunately, camels can sometimes be aggressive towards humans, causing serious and even fatal injuries [8,9]. Camels remain the most traumatizing animal in the United Arab Emirates (UAE), accounting for 83 % of animal-related trauma and 80 % of animal-related injuries in Saudi Arabia [9,10]. Animal bites, fall from backs, kicks, and collisions with motor vehicles are the main causes of camel-related injuries (CRIs) [1,8–14].

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<https://doi.org/10.1016/j.injury.2023.111093>

Accepted 2 October 2023

Available online 4 October 2023

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Horseback riding is one of Qatar's most popular recreational activities, and the equine-related injuries have increased in the past years [15–17]. However, the overall incidence of these injuries compared to the other sports is described as relatively low [18–20]. The combination of a horse's strength, height, and unpredictability can lead to significant injuries to those who engage in equestrian-related activities [18]. Horse-related injuries (HRI) can be severe, involving fractures, head injuries, and high proportion of patients requires hospitalization. Although falling from horses or being kicked are the most familiar mechanisms of injury, horses can also inflict injuries by biting, pulling, kicking the rider, standing, or rolling on the rider and striking the rider with a sudden movement of the head [18,21]. Furthermore, horses may injure their riders, and caregivers during non-riding activities such as grooming, feeding, handling, and saddling.

Despite the substantial recreational and occupational activities related to camels and horses in the State of Qatar, there has been no comprehensive national-level study that characterizes the demographics, nature and pattern of injuries inflicted by these large animals. This study aimed to evaluate the incidence, clinical characteristics, mechanisms, and patterns of horse and camel-related injuries requiring hospitalization at the only Level 1 Trauma Center in the country across more than 13 years. Also, we explored factors like gender, age and injury mechanisms that might influence the injury pattern and guide the development of targeted prevention strategies.

Materials and methods

Data source and study population

A retrospective analysis was conducted for data obtained from the Qatar National Trauma Registry (QTR) in Hamad Medical Corporation (HMC), between 01 November 2007 and 31 December 2021. QTR is a mature database that participates in the National Trauma Data Bank of the USA and the Trauma Quality Improvement Program of the Committee on Trauma of the American College of Surgeons (TQIP-ACS). Hamad trauma center (HTC) is the only tertiary care facility and level 1 trauma center in the country which sees and treats moderate to severely injured patients across the country, including referrals from other hospitals. The QTR has internal and external validation on a regular basis [22,23].

A CRI and HRI was defined as a camel and horse-related injury respectively, that occurred as a direct result of participating in any activity involving riding, care and maintenance, transportation, or maintaining the animal environment. Injuries were aggregated into categories based on the anatomic location of the injury. The following parameters were extracted and analyzed: (1) Patient Demographics: Gender, age groups, and nationality. Age groups were stratified into <10 years, 10–19 years, 20–29 years, 30–39 years, 40–49 years, 50–59 years, ≥65 years. (2) etiology and type of animal injury, in addition to the mechanism of injury (kick, fall, other), type of injury (anatomical region involved: head, face, neck, abdomen, spine, arm, leg, and extremities), physiological and anatomical parameters (pulse, respiratory rate, systolic blood pressure, diastolic blood pressure at the scene, and at the ED, Abbreviated Injury Score (AIS), Injury Severity Score (ISS), Glasgow Coma Score (GCS), and Shock Index (SI). The latter scoring tools were described previously [24–25]. Imaging and Interventions included Computed tomography, chest tube insertion, intubation, open reduction internal fixation) and complications.

Outcomes measures

ED disposition, Intensive care unit (ICU) admission, hospital length of stay (HLOS), and in-hospital mortality. Patients with missing or incomplete relevant data were excluded from the analysis.

This manuscript adheres to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The study

was carried out after the approval by the Institutional Review Board of Medical Research Center (MRC), HMC, Doha (IRB# MRC-01-21-700/amendment 02).

Statistical analysis

Data were summarized in the form of proportions and frequency tables for categorical variables. Continuous variables were summarized using means, median, and standard deviation. Chi-square and Student-*t* test were used for comparative analysis for categorical and continuous variables, respectively. In order to quantify the trends over time objectively, we used Poisson regression model for observation time and presented results as incidence rate ratios (IRR) and corresponding 95 % confidence intervals. To assess the robustness of observed temporal trends in the initial analyses, we grouped the study duration into 3 years quartile (2008–2021) and assessed whether the direction and statistical significance of trends were similar to those reported in the main analyses (data from 2007 were removed from this regression model as it entailed 2 months only). A 2-tailed *p* value <0.05 was used for significant statistical differences. Statistical data analysis was done using SPSS software (Statistical Package for the Social Sciences, version 21.0, SPSS Inc., Chicago, Ill, USA) and Microsoft excel. Graphs and figures were created using GraphPad Prism software version 9.0 (La Jolla, CA).

Results

Demographics and injury distribution

During the 13-year study period, patient's data were retrieved from the NTDB using the E-codes related to CRIs and HRIs. A summary of animal related injuries (ARIs) is presented in Fig. 1

A total of 273 patients were admitted and treated for ARIs at the HTC. Of these, 145 (53.1 %) were identified with the HRIs, and 128 (46.9 %) were with CRIs. Overall, most of the patients were males (88.3 %) and were expatriates (73.6 %). The mean age (\pm SD) of the studied population at injury was 30.41 (\pm 15.33). The most common mode of transportation from the scene to the trauma center was ground ambulance (80.6 %, 220/273). The mean ISS was 8.71 ± 6.31 , and the GCS at ED was 14.1 ± 2.9 . Most of the patients sustained mild injuries (50.9 %), followed by moderate (34.6 %) and severe injuries. The median (range) HLOS and ICU stay were 2.5 (1–134) and 2 (1–25) days, respectively (Table 1). Overall, four mortalities (1.5 %) were reported during the study period, attributed primarily to traumatic brain injury (TBI).

Table 1 shows the description of patient and injury characteristics by the type of animal (Horse and Camel) during the study period in Qatar (2007–2021). Fig. 2 breaks down the estimated numbers of Horse and camel-related emergency department-treated injuries from January 2008 to December 2021. Table 2 depicts the results of a Poisson regression analysis examining trends in animal-related injuries in Qatar from 2008 to 2021. The analysis focuses on overall animal-related injuries and breaks down the results into HRIs and CRIs. Overall, the results showed significant temporal trends in animal-related injuries, with substantial increases in overall injuries and HRIs in the later years (2017–2019 and 2020–2021) compared to the reference period (2008–2010). CRIs also increased significantly in the years 2020–2021. These findings suggest a need for further investigation and potential interventions to address the rising trend in animal-related injuries in Qatar.

The CRIs exhibited an increasing trend compared to HRIs between 2007 and 2016. However, the injury estimates for HRIs showed a continuously increasing trend from 2016 to 2021, and during the same period, presentations related to CRIs consistently declined

The mean age of patients with HRIs was 27.5 years ($SD \pm 10.7$), and 33.69 years. ($SD \pm 13.5$) in patients with CRI. Most patients with the HRIs (80.7 %) and CRIs (97 %) were males. The peak age incidence of HRIs and CRIs was in the 20–29 years age group accounting for 55 % and

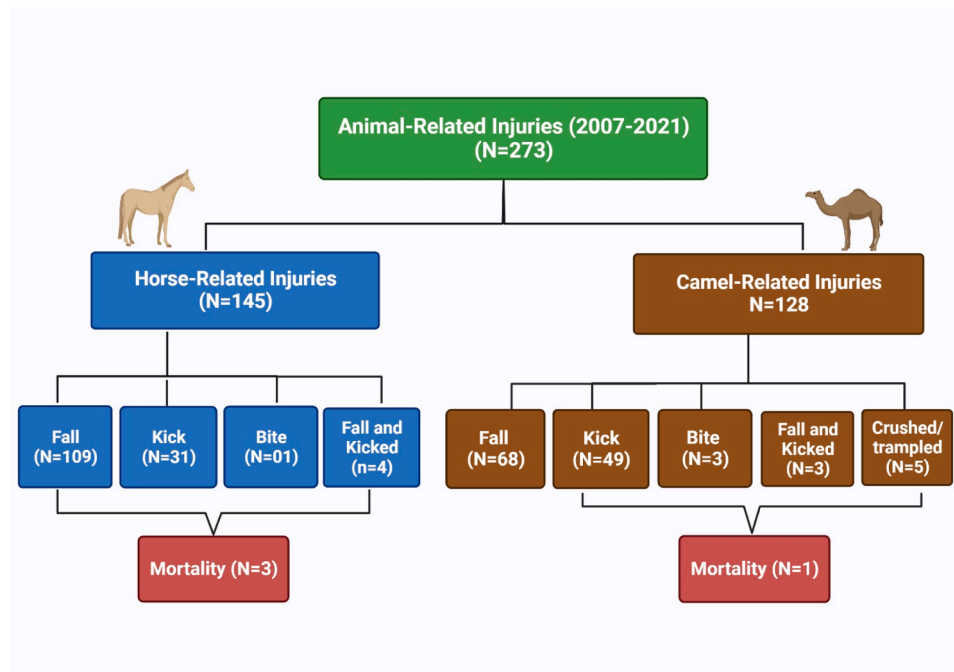


Fig. 1. Summary of animal related injuries (Horse and Camel).

40 % of patients, respectively (Fig. 3a–c). There was a bimodal distribution of peaks for CRIs, with most injuries occurring in the 3rd (20–29 years) and 4th age groups (30–39 years). An overall male predominance was observed with the highest peak in the 20–29 age group. With respect to HRIs, there was a trimodal peak with most injuries occurring in 2nd (10–19 years), 3rd (20–29 years), and 4th (30–39 years) decades of age, respectively (Fig. 3a). Notably, we observed a trend towards an increased proportion of females involved in HRIs, with the highest peak being in the 20–29 years age category compared to CRIs.

Regarding the anatomical location, injuries to the extremity region were the most common injured site accounting for 90 (62.1 %) patients in HRIs and 51 (39.8 %) patients in CRIs.

The head injury occurred in 37 patients (25.5 %) in the horse and 40 (31.3 %) in camel-related injuries. Twenty-eight individuals (19.3 %) had horse inflicted chest injuries, whereas 34 (26.6 %) patients sustained camel inflicted head injuries (Suppl Fig. 1). Facial (12.4 %) and leg injuries (12.4 %) were the least common, followed by abdominal (13.8 %) and arm injuries (17.2 %) in patients with HRIs. Similarly, in patients with CRIs, facial (10.2 %), abdominal (13.3 %), arm (13.3 %), and leg injuries (15.6 %) were less common.

The anatomical regions were different among age groups studied in HRIs and CRIs (Suppl Fig. 2). Injuries to extremities, chest/abdomen, and head were more likely to result in hospitalization than injuries to other anatomic sites. Extremities, head/face, chest and spinal injuries exhibited a peak age incidence in the 20–29, followed by 30–39 and 10–19 age groups for HRIs. For the CRIs, extremities, head and face, chest and abdominal injuries were observed mainly in the 20–29 age group, followed by the 30–39 and 40–49 age categories. Notably, the younger (10–19 years) individuals had a greater likelihood of hospitalization due to HRIs than CRIs. Patients >50 years old were most likely to sustain CRIs.

Severe neurological impairment classified as a GCS score of ≤ 8 on presentation was observed in 11 (7.6 %) and 07 (5.6 %) patients with HRIs and CRIs, respectively. Moderate impairment (GCS score 9–12) occurred in only 1 (0.4 %) patient with HRIs and 07 (5.6 %) patients with CRIs. In the cohort, 133 (91.7 %) patients with HRIs and 115 (92.0 %) patients with CRIs were presented with a GCS score between 13 and 15. The severity of injuries assessed by ISS showed patients' scores

mainly falling in the mild or moderate ISS subgroups (55.9 % mild and 30.1 % moderate, respectively) for HRIs and (46 % mild and 39.7 % moderate, respectively) for CRIs. Fourteen percent (14 %) of patients with HRIs and 13.3 % of patients with CRIs were ranked in the severe ISS category. The Injury severity for different anatomical regions assessed by AIS showed the head region having higher mean AIS in HRIs than CRIs (3.6 vs. 2.9).

Mechanism of injury

The most common mechanisms of HRIs were falling off (39.9 %) and getting kicked (11.4 %) [Fig. 1]. Four (1.5 %) patients had fallen and were kicked from the Horse, and only one patient had a bite injury (0.4 %). The most common mechanisms in the CRIs were falls (25.3 %), followed by Kick (17.9 %). Five (1.8 %) patients sustained injuries after being crushed or trampled on by the Camel. Three (1.1 %) patients fell and were kicked by the Camel and suffered bite injuries.

In hospital characteristics and mortality

The distribution of ED disposition of injuries indicated that patients who had sustained a HRI were more likely to be discharged home (15.9 % vs. 7.0 %) and, at the same time, more likely to succumb to injuries as compared to patients who sustained CRIs. An almost equal proportion of patients needed admission to trauma ICU (15.2 % vs. 15.6 %) and surgical procedure (5.5 %) in both groups. The mean HLOS for patients injured by Horse was 4.47 days (SD \pm 5.58) and 6.23 days (SD \pm 12.82) for the Camel. Patients spent an average of 4.42 days (SD \pm 5.40) in the ICU and a mean of 3 days (SD \pm 2.9) on a ventilator for HRIs. The median (range) length of the hospital and ICU stay were 2.5 (1–134) and 02 (1–25) days, respectively. Overall, four deaths (1.5 %) were reported during the study period. All fatalities were primarily due to traumatic brain injury (TBI). Out of four patients, 03 died due to injury inflicted by the horse (fall from the Horse), and one died due to injuries sustained by camel (kicked by the camel). All deceased were male, young (20–29 years) and had sustained severe head and face injuries.

Table 1

Demographics, Injury characteristics, physiological parameters, interventions, severity and outcome of Horse and Camel related injuries (2007–2021).

Variables	Overall (N = 273)	Horse (N = 145)	Camel (n = 128)
Age, (mean \pm SD)	30.41 \pm 12.49	27.50 \pm 10.75	33.69 \pm 13.49
Gender			
Male	241 (88.3 %)	117 (80.7 %)	124 (96.9 %)
Female	32 (11.7 %)	28 (19.3 %)	4 (3.1 %)
Injuries by anatomical regions			
Head injury	77 (28.2 %)	37 (25.5 %)	40 (31.3 %)
Chest injury	62(22.7 %)	28 (19.3 %)	34 (26.6 %)
Face injury	31(11.4 %)	18 (12.4 %)	13 (10.2 %)
Abdomen injury	37(13.6 %)	20 (13.8 %)	17 (13.3 %)
Spine injury	57(20.9 %)	28 (19.3 %)	29 (22.7 %)
Arm injury	42(15.4 %)	25 (17.2 %)	17 (13.3 %)
Leg injury	38(13.9 %)	18 (12.4 %)	20 (15.6 %)
External injury	141(51.6 %)	90 (62.1 %)	51 (39.8 %)
GCS at ED, (median, IQR)	15(15–15)	15 (15–15)	15 (15–15)
Severe (≤ 8)	18(6.7 %)	11 (7.6 %)	7 (5.6 %)
Moderate (9–12)	4(1.5 %)	1(0.7 %)	3 (2.4 %)
Mild (≥ 13)	248(91.9 %)	133 (91.7 %)	115 (92.0 %)
Injury severity score, (median, IQR)		5 (4–10)	9 (4–13)
Mild (1–8)	139 (50.9 %)	80 (55.9 %)	59 (46.8 %)
Moderate (9–15)	93(34.6 %)	43 (30.1 %)	50 (39.7 %)
Severe (≥ 16)	37(13.8 %)	20 (14.0 %)	17 (13.5 %)
Head AIS (median, IQR)	3(3–4)	3(3–4)	3(2–3)
Chest AIS (median, IQR)	3(2–3)	3(2–3)	3(2–3)
Face AIS (median, IQR)	2(1–2)	2(1–2)	2(1–2)
Abdomen AIS (median, IQR)	2(2–3)	2(2–3)	2(2–3)
Spine AIS (median, IQR)	2(2–2)	2(2–2)	2(2–2)
Arm AIS (median, IQR)	2(2–2)	2(2–2)	2(2–2)
Leg AIS (median, IQR)	2(2–3)	2(2–3)	2(2–3)
External AIS (median, IQR)	1(1–1)	1(1–1)	1(1–1)
Interventions			
Chest tube insertion	10(3.7 %)	3 (2.1 %)	7(5.5 %)
Intubation	21(7.7 %)	12(8.3 %)	9(7.0 %)
ORIF	21(7.7 %)	10 (6.9 %)	11(8.6 %)
ICU Admission	51(18.7 %)	25(19.5 %)	26(17.9 %)
Hospital length of stay, median (range)	2.5 (1–134)	3(1–134)	2(1–38)
ICU length of stay (n = 51)	2 (1–25)	2(1–11)	3(1–25)
In hospital mortality	4 (1.5 %)	1(0.8 %)	3(2.1 %)

AIS, abbreviated injury score; SD, standard deviation; GCS, Glasgow coma score; ED, emergency department; ICU, intensive care unit; TBI, traumatic brain injury; CT, computed tomography; ORIF, open reduction and internal fixation.

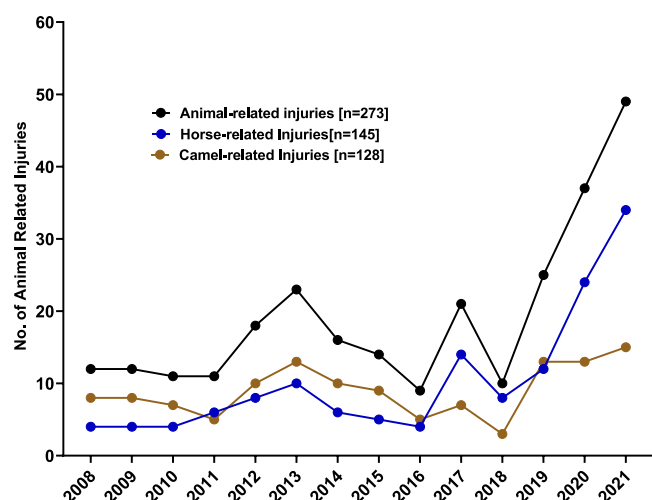


Fig. 2. The annual number and incidence rate ratio of emergency room presentations for Horse and camel-related injuries (Data presented from 1/1/2008 to 31/12/2021).

Table 2

Poisson regression analysis of the trend in animal related injuries, 2008–2021 in Qatar.

Year	Animal related injury IRR (95 % CI)	Horse related Injury IRR (95 % CI)	Camel related injury IRR (95 % CI)
2008–2010	1(Reference)	1(Reference)	1(Reference)
2011–2013	2.088(1.360–3.205)*	2.811(1.406–5.621)*	1.711 (0.986–2.970)
2014–2016	1.283(0.813–2.025)	1.439(0.674–3.074)	1.201 (0.678–2.128)
2017–2019	1.786(1.781–2.725)*	3.163(1.638–6.108)*	1.068 (0.589–1.916)
2020–2021	4.085(2.759–6.048)*	7.943 (4.266–14.789)*	2.072 (1.199–3.582)*

CI, confidence interval; IRR, incidence rate ratio; *p value <0.05.

Year 2007 was removed as it included only two months data.

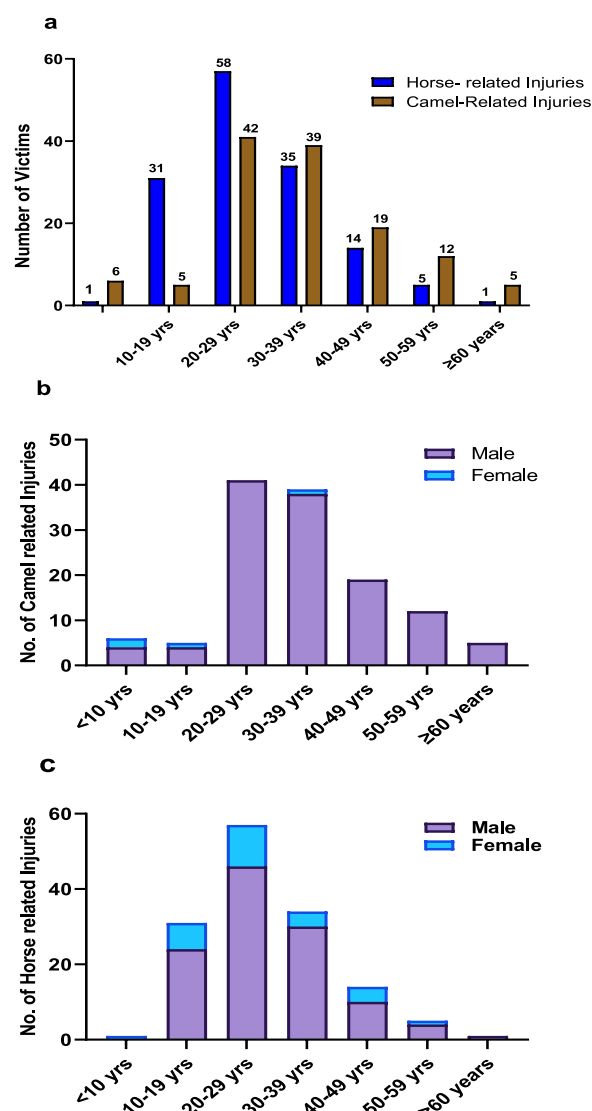


Fig. 3. Horse and camel related injury by age (a); Camel-related injuries stratified by Gender (b); Horse -related injuries stratified by Gender (c).

Discussion

This is a 13-year descriptive analysis of all the hospitalized patients who sustained HRIs or CRIs in a rapidly developing Middle Eastern country. Animal-related injuries vary worldwide depending on the type

of animal co-existing in the community, the animal behavior, and the human activities toward these animals [1–3]. Due to a lack of awareness and national regulations and surveys, horse and camel-related injuries are underreported public health issues. In the current study, we addressed the recent epidemiology and outcome of HRIs and CRIs based on gender, age group, mechanism of injury sites and patterns of injury in one of the rapidly developing country in the Middle East.

The annual number of HRIs fluctuated from 2007 to 2015. From the year 2016 to 2021, we observed an increase in the HRIs. During the same period, it was striking to note that HRIs in patients 10–30 years of age substantially increased 12 folds. This finding is in accordance with a previous observation, suggesting a possible relationship between injuries and the increasing popularity of horse-related activities [6]. With respect to CRIs, legislation was enacted in 2003 in which minors under the age of 18 years were prohibited from participating in camel racing. Following this, the number of Camel race-related injuries declined after 2003, especially among children in the region [26]. However, we noted an approximately three-fold increase in patients with CRIs and a 3-fold increase in 10–29 years of age during the period of 2017–2021, which remains a matter of concern.

The current study has shown that the majority of CRIs were among nationalities of the Indian subcontinent (Bangladeshi (32 %; Indian 11.7 %), and East Africa and Sudanese (26.5 %). There was a disproportionate representation of males (97 %) and females (3 %) regarding CRIs. This could be because, in the Middle Eastern countries, camel related activities are culturally dependent, and males are frequently employed for these activities which include caregivers involved in livestock mustering and racing [10]. Regarding HRIs, most of the injuries were observed in Qatari's nationals, followed by Indian (19.3 %) and Bangladeshi (11.7 %). In Qatar, horse-related sports activities, mainly racing, are an increasingly popular pastime for residents, and most of them sustain injuries related to recreational /leisure activity. Also, people from the Indian subcontinent are employed in this industry as caregivers and performing activities related to breeding thoroughbreds and caregiving.

The distribution of injured patients across age groups is depicted in Fig. 3. In agreement with other studies [27–29], 75 % of the total population with LARIs were found to be most common in the 3rd decade of life (20–29 years), indicating that the victims of injuries were the mostly young proportion of the population. Our study also uncovered the demographic data, which suggested that from the age perspective, patients with HRIs were relatively younger than patients with CRIs (27 vs. 34). Males were more affected than females in our study, which is consistent with earlier findings. The male preponderance in the current study is most likely due to their higher exposure to horse and camel related activities. Also, we observed an over-representation of females with respect to HRIs compared to CRIs (19.3 % vs. 3.1 %). The relatively high proportion of the females in the HRIs compared to CRIs can be linked to an increasing popularity and exposure of young women for the horse related recreational activities in Qatar. This contrasts with the findings of previously published studies showing that females are injured more often in horse-related activities [4,15]. The identification of risk-taking behavior among trauma patients depending on gender may have implications for injury prevention.

The result of the current study suggested that the injury type and injured body region were not independent of age. The injuries of the younger riders frequently involved extremities, followed by head/face and chest/abdomen, whereas older riders more frequently experienced torso and internal organ injuries. Inconsistent with previous studies, injuries to the extremities were the most frequently injured region in HRIs and CRIs [8,9,15,20,30]. The higher proportion of the extremities in younger patients can be attributed to the quick reflexes during a fall [30]. Similar to previous studies [9,31,32], the head was the second most frequently injured body region for the injured and was mainly associated with mortality. This finding coincides with previous data indicating greater mortality from head injuries in LARIs [33]. In

addition, head injuries were most frequently observed in the younger age patients (≤ 29 years) [30]. It is unclear, why there was a tendency for younger patients to suffer head more head injuries. Helmet and protective vest usage information was not available for the datasets examined in this study which have been shown to be effective in reducing serious injuries [30,31]. It seems that hospital admission risk from horse riding or horse-related injuries has been found to carry a greater risk than football, car, motorbike racing, and Skiing [31]. Therefore, implementing the consistent use of protective gears will provide added safety to the riders and, together with an awareness of injury patterns, will significantly reduce the number of severe injuries.

The interaction with large animals like horses and camels sometimes involves unpredictable behavior and may lead to injuries that are usually blunt [29]. The most prevailing mechanism of injury was a fall from horse (39.9 %), followed by a kick by a horse (11.4 %). These findings are consistent with some previous studies [6,15,32,34,35]. Like other reports [36], our study showed that fall from camel as the most common mechanism of camel related head, chest, spine, and extremities injuries, followed by camel kicks and bites. However, studies from UAE and Saudi Arabia have shown camel kicks as the most common cause of these injuries [8,9,37]. The victims are often camel handlers or caregivers. However, most of the engagement with camel is limited to recreational activities (i.e., racing) in Qatar. Many victims were camel jockeys who had sustained injuries due to fall from the camel. In addition, kicking, and biting, camel trampling or squatting on people were also observed. This can further exacerbate the injury sustained by the rider and may result in significant organ and tissue damage [38].

The ISS has been shown to correlate with mortality, morbidity and hospital stay. The distribution of the ISS scores in our study was similar to previous studies evaluating HRIs, with 14 % of patients rated as severely injured (ISS > 16) and 60 % of patients were classified as mildly injured [2,30]. The HLOS in the present study showed victims of CRIs had a higher mean of HLOS than those with HRIs suggesting the different and distinct biomechanics involved with these animals.

We recognized some lacunae in the documentation with respect to recognized risk factors associated with severe trauma, including details of the background of the occupation of the injured person and whether protective equipment had been used. Personal protective equipments (i.e., helmets, gloves, body protectors, boots) has been shown to significantly reduce the severity of head and extremities injuries [30,31]. Standardized documentation may further improve injured patients' early diagnosis and clinical management.

Lastly, the mechanism of LARIs involving horses and camels are complex and diverse. Therefore, a multi-faceted approach to injury prevention is required. Understanding animal anatomy, behavior, mechanism of injury and training workers on dealing with animals might help refine our strategies and inform potential injury prevention approaches that can reduce the severity of injury. Further prospective studies are required regarding the role of protective gears and risk factors for severity of injury.

Limitations

This retrospective analysis included only injured patients in horse and camel related trauma presented and admitted to our trauma center. The data did not include the patients who died before reaching the emergency department. Also, it is possible that patients' minor injuries received definitive treatment at a local primary health care center. Therefore, the number of cases may be conservative. The seasonal variation in the pattern, mechanism and severity of injury were not addressed in this analysis. Furthermore, we do not have enough information on the protective equipment usage, so any recommendation was based on a combination of trends seen in our data and identified in the existing literature. Because the hospital is not a designated pediatric trauma center, the number of pediatric patients may be underestimated. Also, we did not have data on whether the injuries were due to work-

related or recreational activities. Despite these limitations, the current study is based on a nationally representative sample over a 13-year study period. Camel and horse racing are popular sports in Qatar, with potential for injuries during training and competitions. In 2004, Qatar had implemented pioneering legislation to restrict camel racing to adults, prohibiting minors under 18 from participation, and introduced robotic camel riders to prevent injuries, resulting in a decline in CRIs, especially among child camel racers [26,39]. In the case of horse-racing, Qatar has invested heavily in excellent equestrian facilities and hosts various events throughout the year, attracting both local and international competitors. However, HRIs are a significant but often overlooked public health concern. To address this information gap we have tried to investigate the incidence and magnitude of HRIs which carries a higher risk of hospitalization compared to other sports like football, motor racing, or skiing [39]. Protective gear is not consistently used, and therefore, Qatar needs more preventive legislation to address these injuries. The severe injuries in this category demand significant hospital resources and are associated with high morbidity, and permanent disability. In the current study, we have shown that HRIs are more common and often involve serious injuries in this region predominantly and affect young adult males in their economically productive age group. Therefore, a pressing issue requires further attention and potential regulatory action to enhance safety in the sport.

Conclusions

Horse and camel related injuries may involve serious injuries that predominantly affect young adult males. Non-compliance to the proper use of protective equipment may further exacerbate the extent of these injuries. The study shows which body regions are mostly at risk and how specific injury patterns may be more prevalent in certain age groups. Moreover, the disproportionate pattern of injuries among various age groups necessitates an evidence-based public health strategy to address the risk factors, implement preventative strategies. Trauma team should be familiar with the spectrum of different mechanisms of HRIs and CRIs.

Funding

This research received no external funding.

Institutional review board statement

This study was approved by the Research Ethics Committee, at Medical Research Center, Hamad Medical Corporation (HMC), Doha, Qatar (MRC-01-21-700/Amendment 02). No direct contact with participants and data were collected anonymously and retrospectively.

Informed consent statement

Not applicable.

Data availability statement

All data were presented in the manuscript and tables.

CRedit authorship contribution statement

Ayman El-Menyar: Conceptualization, Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Naushad A. Khan:** Formal analysis, Writing – original draft. **Syed G.A. Naqvi:** Data curation, Writing – review & editing. **Hassan Al-Thani:** Conceptualization, Data curation, Methodology, Supervision.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

Acknowledgments

We Thank the Qatar national trauma registry staff and healthcare provider at the Hamad trauma center. We acknowledge "Open Access funding provided by the Qatar National Library".

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.injury.2023.111093](https://doi.org/10.1016/j.injury.2023.111093).

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