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Equestrian-Related Injuries in Regional Trauma Units: A Prospective Cohort Study from Region Zealand, Denmark

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Equestrian-Related Injuries in regional Trauma Units: A Prospective Cohort Study from Region Zealand, Denmark

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Abstract

Purpose:
Equestrian trauma represents a distinct and understudied trauma mechanism. Understanding injury characteristics and risk patterns is essential to improve prevention and treatment. This study aimed to describe the nature and management of equestrian trauma in a regional context.

Methods:
This sub-population analysis was derived from a larger prospective trauma cohort. All patients with equestrian-related trauma triggering trauma team activation across four trauma units in Region Zealand (1 March 2024 and 28 February 2025) were included. Predefined variables included demographics, injury severity, interventions, and outcomes, analyzed using descriptive statistics.

***Results*:**
A total of 211 patients (13% of the cohort) were included. Patients were predominantly female (97%) with a median age of 21 years (IQR 15-38). Pediatric patients constituted 38% and 67% were ASA 1. The most common injuries involved the thorax (25%) followed by the upper extremity (20%). The mean Injury Severity Score was 2,0 and 91% sustained minor or no injuries (ISS 0-8). Helmet use was reported in 67% and combined helmet and body protector use in 37%. Full trauma CT scan was performed in 70%, while medical interventions were rare. Most patients (62%) were discharged directly from the emergency department. All patients were alive after 90 days.

***Conclusion*:**
Most equestrian patients were young females without comorbidities. Thoracic injuries predominanted and helmet use was common, while body protector use was rare. Despite low injury severity and infrequent interventions, imaging and admission rates were high.

Keywords: equestrian trauma, horse trauma, trauma epidemiology, trauma units, riding, injuries

Statements and declarations

Competing interest

The authors declare no competing interests.

Author contributions

S. King: Conceptualization; Formal analysis; Visualisation; Investigation; Writing – original draft

AE. Thiele-Nygaard: Data curation, Investigation, Writing – review & editing
E.R.Lauritzen, OH.Engelund, E.Ø. Ipsen, I.L. Andersen: Investigation, Writing – review & editing
TP. Møller: Conceptualization; Supervision; Writing – review & editing
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Funding

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Data availability statement

The data that support the findings of this study are available to researchers from third party. Restrictions apply to the availability of these data, which were used under license for this study. The data that support the findings of this study are not publicly available due to legal restrictions on sharing identifiable data from Danish quality assurance projects.

Introduction

Approximately 148,000 citizens participate in horseback riding activities in Denmark, corresponding to approximately 2.5% of the Danish population[1]. This includes around 100,000 adults aged 16 years and older and 48,000 children aged 7–15 years. Horseback riding is considered a high-risk sport due to the rider being placed high above ground, horses often weigh more than 500 kg, can reach speeds of 60-70 km/h, and being less predictable than motor vehicles[2].

Current literature largely originates from the US while European studies are sparse[3,4]. It shows that the majority of equestrian injuries result from falls or kicks, and that most injured riders are adult females participating in recreational riding[3,4]. Injury severity and the odds of fatality increases with age, and approximately one in four injured riders seen in the emergency department requires hospital admission. Head, neck, and upper extremity injuries are common and may result in permanent impairment[5–7].

Although mortality following equestrian trauma is low, patients are often young and without significant pre-existing comorbidities[3,4]. Consequently, incapacity for work following equestrian trauma may have a substantial socioeconomic impact. To reduce the risk of injury, The Danish Riding Association, the main riding organization in Denmark, has established safety guidelines for its 450 affiliated riding clubs. These guidelines include wearing a helmet when riding and wearing a body protector if the rider is under 18 years old and participates in jumping activities[8].

Despite the popularity of horseback riding in Denmark, studies describing equestrian-related injuries in a Danish setting remain limited. To prevent future accidents and optimize the management of equestrian-related trauma, the injuries and risk factors must first be identified and characterized. The aim of this study was to characterize equestrian related injuries requiring hospital assessment in Region Zealand, Denmark. The secondary aim was to describe the management and outcomes of the traumas, identify risk patterns and suggest future improvements for management of equestrian-related trauma.

METHOD

This study was a subpopulation analysis of a larger prospective regional trauma cohort study conducted across four regional hospitals with integrated trauma units in Region Zealand[9]. Data were collected prospectively over a one-year period from 1 March 2024 to 28 February 2025. The study results are reported in accordance with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement checklist[10].

Study setting

Region Zealand is one of five geographical regions in Denmark with a population of approximately 850,000 citizens[11]. It is comprised of four trauma units with no major trauma center (MTC). The trauma units are integrated parts of the emergency departments in the regional hospitals. Trauma patients, including those with equestrian injuries, who are suspected of having severe injuries are transported directly to a MTC in a neighboring region. Other equestrian trauma patients who meet the criteria for trauma team activation are assessed by a multidisciplinary team of 9-17 healthcare professionals in one of the four trauma units in Region Zealand. Equestrian-related accident is considered high energy trauma, constituting one of the two criteria required to trigger trauma team activation. Trauma team activation criteria in Region Zealand are outlined in Appendix 1. A patient can be brought in by ambulance from the injury site to trauma team care as a primary trauma patient or be converted to trauma team care as a secondary trauma patient after being assessed by a physician in the emergency department. The trauma team will provide appropriate resuscitation and if the patient turns out to be severely injured may choose to transfer to a MTC for secondary survey.

Ethical considerations

No formal ethical approval is required for quality approvement studies according to the regional scientific ethical committee in Region Zealand. Approval for performance of the study and storage of data was given by the relevant quality departments covering the four included hospitals (Project registration numbers: **EMN-2020-35306**, **EMN-2025-00153**, and **EMN-2022-00863**). According to Danish law, no further approvals are necessary for quality assurance projects.

Data collection and management

Data for the present study were derived from the main prospective regional trauma cohort and supplemented with additional data extracted specifically for this subpopulation analysis. The main cohort included all patients undergoing trauma team activation in one of the four trauma units in Region Zealand during a one-year period from 1 March 2024 to 28 February 2025. All equestrian trauma cases were identified and extracted from the main cohort. No exclusion criteria were applied. In the main study, data were prospectively recorded in a predefined REDCap (Research Electronic Data Capture, Vanderbilt University, Nashville, USA) database by the anesthesiologist, who usually served as the trauma team leader. Electronic medical records providing assessment notes or scan results were accessed using the patients' unique identification numbers. Trauma logs were compared to the medical records to identify potential missing entries in REDCap and missing data were added retrospectively appraising available data in electronic medical journals.

Abbreviated Injury Scale (AIS), Injury Severity Score (ISS) and New Injury Severity Score (NISS) were calculated based on the electronic medical journal information including radiology records. AIS-assessment was performed by AAAM-certified research personnel in accordance with AIS Version 2015[12].

The following variables were registered during the data collection period: trauma team activation (primary or secondary), demographics (age, sex), vital signs on arrival, interventions (such as airway management, chest drain placement, blood product administration), imaging (eFAST, CT scan), destination after trauma, AIS codes and 90-day mortality. Systolic blood pressure <90 mm Hg was considered threshold for hypotension for patients ≥11 years old. For patients between 1–10 years old, the hypotension threshold is defined as SBP < 70 + (2 × age in years) mmHg[13]. Pre-injury ASA classification was assigned using the medical records based on information on disease and lifestyle factors. Following the data collection period, all equestrian trauma patients have been contacted telephonically to specify the riding context at the time of trauma (hobby, work-related or competition), the mechanism of trauma (fall, kick, bite or other) and use of protection gear (use of helmet and/or protective vest). If the patient failed to answer the phone call, the medical journal was used to retrieve the information where possible.

Statistical analysis

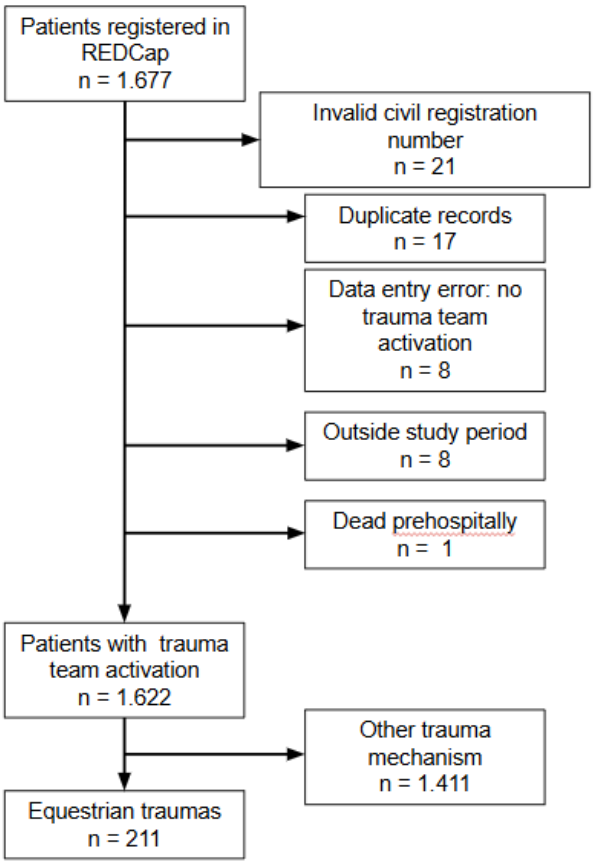
Descriptive data analysis is presented with numbers and percentages and continuous variables as medians with interquartile ranges (IQR). The chosen level of statistical significance of a p-value was set at $p < 0.05$ in the current study. All data management and statistical analysis were performed in the statistical software for data science, Stata v.19.

Results

Patient characteristics

The total trauma cohort consisted of 1622 patients of which 211 (13%) were equestrian related and included in the study (Figure 1).

Fig 1 Flow diagram of the case inclusion process



Patients were predominantly female (97%) with a median age of 21 years (IQR 15-38). Pediatric patients (<18 years) constituted 38% of the cohort. Majority of the patients, 142 (67%) were classified as ASA 1. Most common mechanism of injury was fall from horse, 150 (71%), followed by mixed mechanism, 33 (16%) and most injuries happened while recreationally riding 129 (61%) (Table 1).

Table 1 Characteristics of equestrian trauma patients

Sample characteristics	**Number of equestrian trauma patients (N=211)**
Sex, female, n (%)	204 (97)
Age; median [Q1, Q3]; (min, max)	21; [15, 38]; (6, 78)
ASA 1, n (%)	142 (67)
Trauma context, n (%)	
Leisure related trauma	129 (61)
Competition related trauma	5 (2)
Occupation related trauma	13 (6)
Unknown	64 (30)
Mechanism of injury, n (%)	
Fall from horse	150 (71)
Kick	12 (6)
Other	16 (8)
Mixed mechanism	33 (16)
Injury Severity Score (ISS), mean **New Injury Severity Score (NISS),** mean	2.0 2.4
ISS groups, n (%)	
ISS ≤ 8	193 (91)
ISS 9–15	13 (6)
ISS ≥16	5 (2)
Anatomical injury site[a], n (%)	
Head; Face; Neck	7 (4); 30 (19); 0 (0)
Thorax	39 (25)
Abdominal	14 (9)
Spine	14 (9)
Extremity: upper; lower	31 (20); 23 (15)

Abbreviations: ASA, American Society of Anesthesiologists physical status classification; ISS, Injury Severity Score; NISS, New Injury Severity Score; Q1, lower quartile; Q3, upper quartile; SD, Standard deviation
[a] Derived from AIS codes, total number of AIS injuries.

Both helmet and body protector were worn in 80 (38%) cases, only helmet in 65 (31%), no protective gear in 25 (12%) and 41 (19%) of cases are unknown. Median age for riders using both helmet and body protector was 15 years, increasing to 29 years for the group only using helmet and 43 years for the group not using protective equipment (Table 2).

Table 2 Use of protective gear and injury site in equestrian trauma patients

	Helmet + body protector (N=80, 38%)	**Only helmet (N=65, 31%)**	**No protective gear (N=25, 12%)**	**Unknown (N=41, 19%)**
Age, median [Q1,Q3]	15 [13,18]	29 [20,50]	43 [32,49]	19 [21.5,31.5]
ISS, mean ±SD	0.9 ± 0.5	2.7 ± 1.1	4.3 ± 2.2	1.9±1.1
Injury site, n (%)[a]				
Head / Face / Neck	5	6	7	9
Thorax	<5	10	<5	6

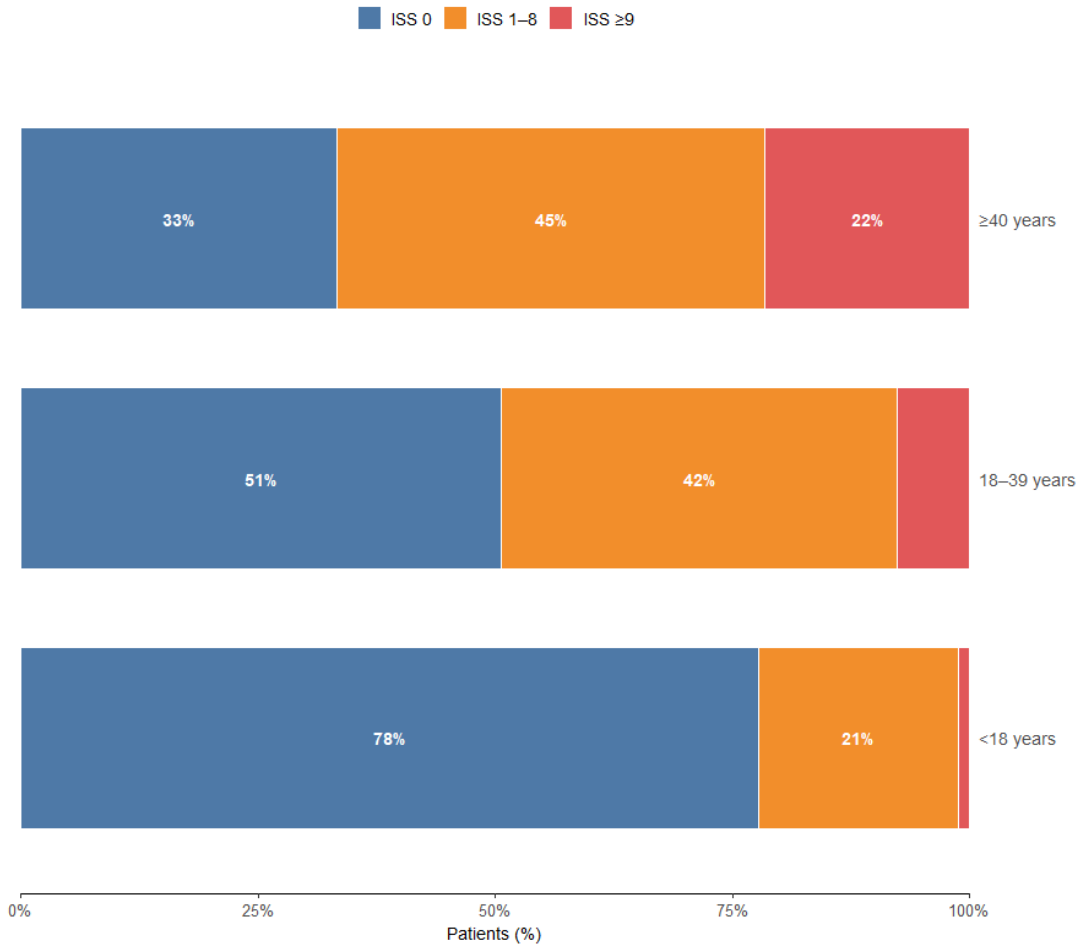
Abbreviations: Q1, lower quartile; Q3, upper quartile; ISS, Injury Severity Score; SD, standard deviation.
[a] Number of patients with one or more injuries in anatomical site.

Injury distribution and severity

Overall, injury severity was low, with 57% of patients having no injuries (ISS = 0). Only 2% sustained severe injuries (ISS ≥16) and the highest registered ISS in the cohort was 22. Among the 91 patients (43%) who sustained at least one AIS-coded injury, a total of 157 injuries were recorded. Thoracic injuries were the most common (25%), followed by upper extremity (20%) and facial injuries (19%) (Table 1).

The mean Injury Severity Score (ISS) for equestrian trauma was 2,0. As shown in figure 2, the proportion of patients with moderate-to-severe injuries (ISS ≥9) was higher among patients in the age group of ≥ 40 years old.

Fig. 2 Injury Severity Score distribution among the age groups in equestrian trauma patients



Although patients younger than 18 years constituted the largest age group, most had no AIS-coded injuries (ISS = 0, 78%). Mean ISS differed according to the use of protective equipment. Patients wearing both a helmet and a body protector had the lowest mean ISS (0.9 ± SD 0.5), compared with those wearing a helmet only (2.7 ±SD 1.1) and those wearing no protective equipment (4.5 ± SD 2.3) (Table 2). The riders wearing a helmet sustained statistically significantly less head / face / neck injuries than those who did not (OR 0.21, $p<0.01$). Likewise, the riders who wore a body protector sustained less thoracic injuries (OR 0.31, $p<0.01$) (Table 2).

Prehospital assessment and management

A total of 85 (40%) patients were primarily transferred to the hospital with priority A - the highest priority in Danish ambulance service. A smaller group of 38 patients (18%) were

transferred with priority B. It was also very common for patients, 76 (36%), to transport themselves to the hospital. A minority of patients presented with hypotension, 11 (9%) with a mean ISS of 2,0 and 8 (6%) patients with Glasgow Coma Scale (GCS) under 15. Use of vacuum mattress was common, 64 (30%), while other prehospital interventions were rare, <5. A total of 124 (59%) had primary trauma team activation with the mean ISS of 2.9 ± SD 0.8 while 87 patients (39%) had secondary trauma team activation with a mean ISS of 0.8 ± SD 0.4

Inhospital management and outcomes

Medical interventions during trauma call were rare and less than 5 patients required immediate surgery. Focused Assessment with Sonography for Trauma (FAST) was performed in 173 (82%) patients with less than 5 having a positive result. A total of 148 (70%) went on to have a full trauma computer tomography (CT).

Most patients (131, 62%) were discharged home after completion of the trauma team assessment and a secondary assessment. A total of 73 patients (35%) were admitted to hospital ward and additionally 7 patients (3%) were admitted to the intensive care unit. The median length of stay from admission to discharge from hospital was 7 hours (IQR 3-22) and 48 (23%) of the patients were admitted >24 hours. There was no mortality after 90 days follow-up in the cohort (Table 3).

Table 3 Inhospital assessment and treatment

Inhospital assessment and treatment	**n (%)**
Intervention during trauma call[a]	11 (5)
Radiology	
Full trauma CT	148 (70)
Selective CT	32 (15)
Positive FAST	<5
Negative FAST	170 (81)
Destination after trauma	
Discharged to home	131 (62)
Secondary transfer to MTC	<5 (1)
Admission to intensive care unit	7 (3)

Inhospital assessment and treatment	n (%)
Admission to a hospital ward	
• Overall	73 (35)
• Adult	37 (28)
• Pediatric	36 (44)

Abbreviations: CT, computed tomography; FAST, Focused Assessment with Sonography for Trauma; MTC, Major Trauma Centre.

[a] Any of the following: intubation, sedation, surgery (directly related to the trauma mechanism and beginning within 6 hours of trauma team activation), pleural drainage/thoracostomy, fluid resuscitation, blood transfusion, pelvic sling, hemostasis (tourniquet or dressing), surgical hemostasis, or vasopressor.

Discussion

The current study demonstrates that equestrian trauma primarily affected young females, who mainly sustained minor injuries. Only 2% of patients sustained severe injuries (ISS ≥16), and no mortality was observed after 90 days. These findings are similar to previously published literature[3,6].

Neville et al. found a mean ISS range between 5 and 11 in a literature review of 39 studies on equestrian trauma[3]. The mean ISS in the current study was 2,0, likely due to the organization of trauma care in Region Zealand, with suspected major trauma being transported directly to a MTC.

A large proportion of the trauma patients (41%) underwent secondary trauma team activation. This subgroup had a lower mean ISS (0.8 ± SD 0.4) versus primary trauma calls (2.9 ± SD 0.8), highlighting that the likelihood of severe trauma is very low when patients self-transport or when ambulance staff decide the incident does not warrant a trauma team activation.

Hypotension, used as a measure of hemodynamic shock, was recorded in 9% of the cohort with a mean ISS of 2,0 in hypotensive patients. Mutore et al found a lower prevalence of hypotension (1.4%) a more severe ISS distribution (44% had ISS 9-15 and 21% had ISS ≥16) and reported the presence of hypotension to be strongly associated with death[14]. Despite limited data, the current study found no association between hypotension and higher ISS. Physiologic

derangement was uncommon in this cohort, limiting our ability to assess its value as a marker of severe injury. Larger studies are needed to clarify this association.

The most common anatomical injury site in the current study was the thorax with a prevalence of 25% followed by the upper extremity (20%) and the face (19%). In previous literature, a large review including 39 studies from 2018-2023 found the most frequently injured regions to be the thorax and the upper and lower extremities [3]. Some available studies however contradict that order, finding head and neck injuries to occur most often [6,14]. Such variation may reflect differences in study populations, inclusion criteria or frequency of protective equipment use.

Previous studies have shown a lower incidence of severe injuries to the head and lower ISS if the rider was wearing a helmet [15,16]. Literature regarding the efficacy of vests is sparse, however, Andres et al. has found protective vests to reduce injury frequency and severity in cross country riding, but not flat riding or show jumping [17]. Reported helmet use ranges between 20% and 56% of riders, with vest use is even rarer [18,19]. In our study, riders wore both a helmet and a vest in 38% of cases and helmet alone in 31% of cases. Mean ISS was 0.9 and 2.7 respectively, compared with 4.5 in riders using no protective equipment. Greater use of protective equipment was associated with lower median age, which may explain the correlation between younger age and lower ISS. However, riders using protective equipment may generally be more cautious, potentially falling from lower speeds and heights and sustaining less severe injuries. Furthermore, a subset of injuries in riders without protective equipment resulted from ground-level incidents, such as being kicked, pushed or trapped between the horse and a wall. This warrants the consideration of whether protective equipment should be recommended not only during riding, but also when tending to a horse from ground.

Full trauma CT was performed in 70% of the patients and FAST in 82%. These rates are similar to those of the general trauma patient population in region Zealand, where CT (both full trauma CT and selective CT) is performed in 86% of the cases and FAST in 80% [9]. This finding underlines the high level of priority assigned to equestrian-related trauma within the healthcare system. The concern may originate in the high-energy mechanism of trauma rather than data showing high severity following equestrian related injuries. However our study shows most equestrian patients in Region Zealand to sustain only minor, if any, injuries. That raises the question of whether the extent of CT radiation exposure and the significant hospital resource use

are justified. Given the young age of this population, radiation exposure is of particular concern, why selective imaging or refined triage criteria may warrant consideration. Further studies evaluating decision rules specific to equestrian trauma may help balance patient safety with resource stewardship.

Strengths and limitations

This study has several methodological strengths. The data was prospectively collected across all four trauma units in Region Zealand and subsequently validated using the electronic health records ensures a consistent and comprehensive data set. The use of standardized trauma scoring systems (AIS and ISS/NISS) and certified AIS coders improves reliability and eases comparison to other studies.

Several limitations are applicable in this study. First, AIS coders were not blinded to the patient outcomes, potentially introducing a risk of under- or overestimation of injury severity. Second, the study did not include a follow-up on the functional or patient-reported outcomes. As a result, the long-term consequences of equestrian injuries could not be assessed. This limits the interpretation of injury burden to the acute hospital phase.

Finally, this study was conducted in a region without a MTC and patients with suspected severe injuries were routinely transported directly to a MTC in another region. Furthermore, a substantial proportion of minor equestrian injuries were not captured in this study, as these patients did not meet the criteria for trauma team activation and were instead managed in the emergency department. Consequently, the study does not provide a complete picture of equestrian trauma occurring in the region, potentially underestimating injury severity, intervention rates and mortality of equestrian trauma patients. This means that results may only be generalized to other trauma-team activated equestrian injuries.

Conclusion

This study provides a unique overview of equestrian-related trauma managed in a regional trauma system without a major trauma center. Most patients were young females without significant comorbidities. Injuries predominated in the thorax and upper extremities. Helmets were worn in the majority of cases, while protective vests were used far less consistently, revealing an opportunity for future injury prevention, particularly while ground-level horse

tending. Despite generally low injury severity and few interventions, a large proportion of patients underwent imaging and hospital admission, illustrating a significant mismatch between injury severity and the organizational resources used in equestrian trauma care.

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Figure titles and legends:

Fig. 1 Flow diagram of the case inclusion process

Flow diagram of case inclusion process from obtained data points from the database to the final study population included in the analysis.

Fig. 2 Injury Severity Score distribution among the age groups in equestrian trauma patients

Diagram showing distribution of Injury Severity Scores (ISS) in the following age groups: ≥40 years, 18-39 years and <18 years

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix1.odt