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ORIGINAL ARTICLE

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Analyses of injuries to equestrians in a Swedish district over a 16-year period

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Abstract

Horse riding is a popular, yet dangerous, sport, and as such, horse-related injuries contribute considerably to the total number of people hospitalized every year. While some investigations have explored this public health issue, many have focused only on hospital registrations or insurance information, while neglecting the cases where the rider may have not required hospitalization. This study investigated the pattern of equestrian injuries in Sweden and examined factors for predicting hospitalized injuries, using visits to hospital, local medical centers, and public dental services. Data were gathered over a 16-year period at all medical facilities within Skaraborg, Sweden, and retrospectively reviewed. There were 7815 horse-related injury events during the study period. The sample of horse-related injuries were largely represented by females (88%) and those aged between 10 and 20 years old. Injuries commonly took place during private/leisure time (90.8%) and in the afternoon. Logistic regression analysis found that older riders were significantly more likely to be admitted to hospital (OR = 1.013), while female riders were less likely to be admitted than males (OR = 0.739). The numbers of people registering at medical facilities due to horse-related injuries are increasing. Therefore, improved intervention measures must be further investigated.

KEYWORDS

epidemiology, horse, riding, sports

1 | INTRODUCTION

Horse riding is a popular sport all around the globe. In Sweden, horses are an important animal associated with sports and leisure activities, as well as therapeutic activities for disabled people. The overall horse population in Sweden in 2016 was reportedly over 350 000.¹ About one million Swedes² have regular contact with horses, compared with 2.7 in Britain³ and 8 million in the United States.⁴ While popular, horse riding and related activities have also recognized as a dangerous sport, work, and recreational activity and have even been reported to be more dangerous than motorcycle racing.⁵ Horse-related

injuries have also been found to be over-represented in injury events on farms⁶ and injuries caused by any animal, including dogs, bulls, and stingrays.⁷ While decreasing trends in hospitalization rates for other sports have been observed, equestrian injury events have been reported to have remained relatively constant and even increased in some countries.^{8,9}

Despite the dangers of horse riding, horse-riding injuries have received little attention. Due to the limited information available on horse-related injuries, it is necessary to obtain an up-to-date picture of the nature of these injury events and how they compare to global statistics of horse-related injuries. Additionally, there has been limited investigation into the risk

factors associated with hospitalized injuries for all patients involved in any horse-related activity inclusive of those performing maintenance of the horse environment. It is important to understand what factors are associated with severe injuries to work on appropriate prevention measures.

This study aimed to, firstly, highlight the main rider and injury event characteristics in horse-related injuries in Sweden and, secondly, to identify the main risk factors associated with hospitalized injuries in a broad range of horse-related activities.

2 | METHOD

2.1 | Data source

A continuous, comprehensive registration of acute injuries for both in-patient and out-patient visits at hospitals and local health centers has been conducted since the late 1970s in Skaraborg district in the south-west of Sweden, representing approximately 1.7% of the whole population of Sweden. A full description of the Injury Database (IDB) is available.¹⁰

This study involved a retrospective investigation of IDB over the 16-year period from January 2001 to December 2016. This register included all patient visits to a medical facility due to an injury within the Skaraborg district. Participating medical facilities included emergency departments at all hospitals within the Skaraborg district (2001-2016), emergency departments at healthcare centers in the study area (2001-2011), all local medical centers (2001-2008, 2011) and public dental services (2001-2008, 2011) in the district. Data loss was internally documented and estimated to be 10%.

A horse-related injury was defined as an acute injury which occurred as a direct result of participating in any activity involving either horseback riding, horse care or handling, horse transportation, or maintenance of the horse's environment such as building a paddock or cleaning a stall. Horse-related cases were extracted using relevant search terms, including "horse" and "rider." Free text descriptions of the injury event were then carefully examined to ensure each case included was accurate. Cases were excluded where the patient was injured by a bite from another animal while riding a horse or being in paddock and this was the only injury. Additionally, transport-related accidents were excluded where the patient was in a vehicle that hit a car transporting a horse.

Ethics approval for this investigation was obtained through the Regional Ethical Review Board in Gothenburg.

2.2 | Study variables

All information was obtained from IDB which includes data from a self-reported questionnaire completed at the time of registration at one of the participating facilities. Data

gathered during the self-reported questionnaire included the date of the injury event (including time), rider details (age, sex), place of the injury event (regrouped into: open field or forest area, road or transport area or riding school, and other sporting facilities), situation (private or leisure time, work, and school), treatment (not treated, treated and sent home, referred to another clinic, admitted), and, if admitted, the number of days in hospital.

Injury type and anatomical regions were also recorded. Injury type was categorized as either soft tissue injury, fracture/dislocation, sprain/distortion/tear, or concussion. Anatomical regions were coded as head, neck, chest, abdomen/lumbar spine/pelvis, upper extremities, and lower extremities. The database allowed for a maximum of three injuries to be coded per patient, with injuries being coded using ICD10 codes in order of severity as judged by a medical professional.

Activity type and primary mechanisms of the injury were recoded from the free text descriptions to be more relevant to horse-related injuries. Activities were coded into the variables: riding the horse, mounting or dismounting, carriage or other horse transport vehicle, handling the horse and the horse caused the injury, other incident due to horse handling, maintenance, and repair where the horse did not cause the injury event. Primary mechanisms were grouped into the categories: fall from or with the horse, fall from carriage or other height, other injury due to contact with horse (including kick, bite, trampled or trodden on, crushed by the horse against a wall or the ground following a fall from horseback, and pushed by or headbutted by horse), and other injury without contact with the horse (trip/slip, road transport accident, crush/cut or impact with sharp or blunt object, pulled by the horse while holding lead or reins, electric shock, foreign object in eye, general sprain). Injuries were attributed to a single primary mechanism, but other mechanisms involved in the injury event were also noted and injury events were coded as having multiple mechanisms involved (yes/no).

2.3 | Analysis

Study variables were initially examined using descriptive statistics. Changes in injury type and location over the study period (only for those who visited a hospital due to changes in sampling) were explored using chi-square tests for significance and univariate logistic regression to examine the effects of being injured in each body region (head, neck, upper extremities, lower extremities, chest, and abdominal region).

Risk factors for hospitalized injuries were then investigated using binary logistic regression. A hospitalized injury was defined as an injury which resulted in hospital admission for 1 day or more. Each of the study variables was first examined in a univariate logistic regression with the outcome being hospital admission. Based on the univariate logistic

regression results, factors which were statistically significantly associated with hospital admission were selected for a multiple logistic regression model. Known risk factors, sex and multiple mechanisms (yes/no), were also included even when not independently significantly associated with hospital admission. Analysis was conducted using IBM SPSS Statistics 24.

3 | RESULTS

Of the 324 297 people who presented for any injury to one of the participating clinics in the study area in the 16-year period, 7815 (2.4%) were due to horse-related causes. Over the study period, the yearly percentage of horse-related injury events increased from 1.6% to 3.6% as a proportion of the total number of people visiting one of the participating centers for that year.

3.1 | Rider characteristics

The mean age of the sample was 27 years with a range of 0 to 84 years. As can be seen in Table 1, females predominated the sample, accounting for 88% of the total number of horse-related injuries. This predominance was particularly discernable in the 10- to 20-year age groups and 20- to 30-year age groups where females accounted for 97% and 93% of the number of horse-related injury events in those age group, respectively. However, after the age of 60, males were the largest group, accounting for 80% of all those over 80, although the overall numbers were small.

3.2 | Time and place of occurrence

Table 2 displays the environmental characteristics of the injury events involved in this investigation. The highest proportion of injury events occurred in the summer months, with only 18.7% in Winter. The number of injury events occurring on average on the weekend days (Saturday and Sunday) was higher than the number of injury events occurring on average during the week (Monday-Friday), and they were largely in the afternoon between 12-15 PM (25.8%) and 16-19 PM (38.8%). The majority (51.5%) of

the injuries were sustained while in an open field or forest area; however, accidents also frequently took place in riding schools and other dedicated sporting facilities (37.7%).

3.3 | Injury event characteristics

Almost all (90.8%) of injury events took place during private or leisure time and 7.2% occurred during work (Table 2). The most common activity was riding the horse (62.8%) followed by horse handling (28.5%). The most frequently occurring primary mechanisms were fall from or with the horse (58.4%) or other injury due to contact with the horse (19.8%), which mostly involved being kicked by the horse ($n = 817$, 41.4%), trampled or trodden on by the horse ($n = 623$, 31.5%), pushed by or headbutted by the horse ($n = 324$, 16.4%), and bitten by the horse ($n = 106$, 5.4%). A total of 812 (10.3%) of the cases involved more than one mechanism, with this secondary mechanism mostly being either an impact with a blunt stationary object ($n = 259$, 31.9%), being trampled or trodden on by the horse ($n = 178$, 21.9%), being crushed between the horse and the ground ($n = 136$, 16.7%), or the rider getting their foot caught or twisted in the stirrup ($n = 110$, 13.5%).

3.4 | Injuries and outcome

Table 2 displays the injury outcome of the patients involved in this study, including the treatment, injury type, and location of the injury. Most of the patients were treated and sent home (85.1%), while 10.8% were admitted to hospital. For those who were admitted to hospital ($n = 843$), the mean number of days in hospital was 3.5 with a range of 1 to 38 days.

For the 7815 patients included in this study, there were 9400 injuries recorded. Most patients ($n = 6485$, 83%) only suffered one injury, and only 255 (3.3%) patients sustained three or more injuries. The most frequently occurring injuries were soft tissue injuries (55.4%) followed by fractures and dislocations (23.5%) and then sprains, distortions, and tears (12.8%). Predominantly injured body regions included the upper (32.1%) and lower (27.6%) extremities as well as the head (17.9%).

As can be seen in Figure 1, there were slight observable upward trends in the numbers of soft tissue injuries and

TABLE 1 Sex of injured equestrians in Skaraborg between 2001 and 2016 by 10-year age groups ($n=7815$)

	Age group n (%)										Total
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	Unknown	
Male	48 (10)	89 (3)	106 (7)	142 (13)	202 (20)	179 (34)	128 (57)	37 (70)	8 (80)	0	939 (12)
Female	437 (90)	2881 (97)	1342 (93)	939 (87)	809 (80)	351 (66)	97 (43)	16 (30)	2 (20)	1	6875 (88)

^aOne case did not specify sex so is unreported here.

TABLE 2 Injury event and injury details for equestrians injured in Skaraborg between 2001 and 2016 (n = 7815)

Variable (n = 7815)	n (%)
Season	
Winter	1465 (18.7)
Spring	2318 (29.7)
Summer	1945 (24.9)
Autumn	2086 (26.7)
Unknown	1
Day	
Weekday	5064 (64.8)
Weekend	2702 (34.6)
Unknown	49 (0.6)
Time	
04-07 Am	106 (1.4)
08-11 AM	1323 (16.9)
12-15 pm	2015 (25.8)
16-19 PM	3034 (38.8)
20 PM-03 AM	685 (8.8)
Unknown	652 (8.3)
Place	
Open field or forest area	4021 (51.5)
Road or transport area	515 (6.6)
Riding school or other sporting facility	2947 (37.7)
Other and unknown	332 (4.2)
Situation	
Private or leisure time	7099 (90.8)
School	141 (1.8)
Work	562 (7.2)
Unknown	13 (0.2)
Activity	
Riding horse	4904 (62.8)
Horse handling and horse caused injury	2229 (28.5)
Other maintenance, handling or repair	443 (5.7)
Carriage or other transport vehicle	147 (1.9)
Mounting or dismounting	86 (1.1)
Unknown	6 (0.1)
Primary mechanism	
Fall from or with horse	4566 (58.4)
Fall from carriage or other height	127 (1.6)
Other injury due to contact with horse	1975 (25.3)
Other injury with no horse contact	1136 (14.5)
Unknown	11 (0.1)
Multiple mechanism	
Yes	812 (10.4)
No	6992 (89.5)

(Continues)

TABLE 2 (Continued)

Variable (n = 7815)	n (%)
Unknown	11 (0.1)
Treatment	
Examined and sent home: no treatment	242 (3.1)
Treated and sent home	6649 (85.1)
Referred to another clinic	15 (0.2)
Admitted to hospital	843 (10.8)
Unspecified treatment	66 (0.8)
Variable (n = 9400)	n (%)
Injury type	
Soft tissue injury	5211 (55.4)
Concussion	563 (6)
Fracture/dislocation	2213 (23.5)
Sprain/distortion/tear	1205 (12.8)
Other and unspecified	298 (2.2)
Injury location	
Head	1679 (17.9)
Neck	511 (5.4)
Chest	576 (6.1)
Abdomen, lumbar spine and pelvis	939 (10)
Upper extremities	3019 (32.1)
Lower extremities	2595 (27.6)

injuries to the lower extremities. Chi-squared tests and univariate logistic regression analysis revealed that these trends were not significant associations between year of injury and type or location of injury.

3.5 | Risk factors for hospital admission

Univariate logistic regression revealed that the variables which had some significant associations with hospitalized injury were age, activity, place, primary mechanism, and time of day. When these variables were entered into a multiple logistic regression model, age, sex, activity, and mechanism displayed significant relationships with hospital admission (Table 3). Older riders were significantly more likely to be admitted to hospital with an increase in odds of 1.3% for every year older (OR = 1.013), while female riders were less likely to be admitted than males (OR = 0.739). Riders who were mounting or dismounting had more than double the odds of being admitted to hospital than riders who were riding the horse at the time of the injury event (OR = 2.586). Contrastingly, riders whose primary mechanism was “other injury with no horse contact” or “other injury due to contact with a horse” had significantly lower likelihood of being admitted to hospital than those who suffered a fall from or with the horse (OR = 0.138 and 0.360, respectively). However,

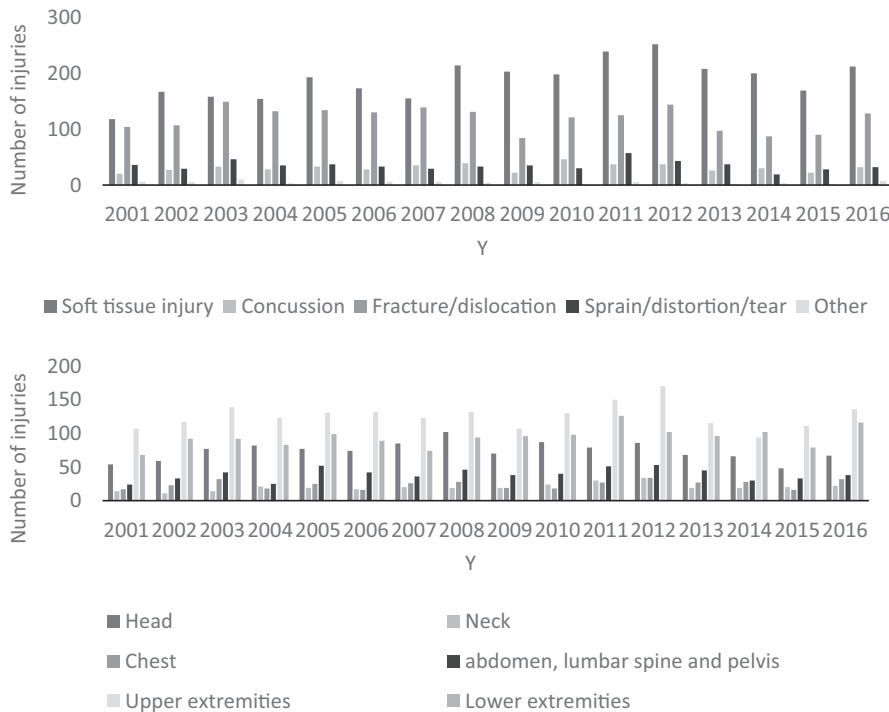


FIGURE 1 Injury type and location over the 16-year period for those patients who presented to the emergency department of one of the participating hospitals

there was no significant difference in the likelihood of admission between riders who fell from a carriage or other height to those who fell from or with the horse. No relationship was found between place of injury event and whether the injury involved multiple mechanisms with hospital admission.

4 | DISCUSSION

Over the study period, there were no observed improvements in the number or type of injuries to equestrians. This highlights the importance of addressing this public health issue and further examining how to prevent these injuries. In this study, the most frequently observed injury event scenario involved a female rider aged between 10 and 20 years, who was riding on the weekend or in the late afternoon during the warmer months of the year. Most injury events involved a fall from or with a horse, while riding the horse during private or leisure time in an open field or forested area. This injury scenario matches closely with previous reports, with several studies suggesting that injuries most frequently occur outdoors in an open field, on dirt or uncultivated land,^{11,12} in the summer months¹¹⁻¹⁵ and in the afternoon with mild weather conditions.^{11,12,16}

Females have frequently been observed to dominate those who are involved in horse-related injuries^{17,18} which matches closely with the findings in this investigation. This may be representative of a predominance of females participating in the sport, with females found to represent 74% of the riding population in Britain in 2015.³

Aside from the dominance of females in the 10- to 20-year age group, after the age of 60, males began to represent the majority of the injuries. A similar pattern has been discovered previously by Papachristos et al¹⁹ who presented a report on a retrospective review of hospital data on adult horse-related injuries and found that males dominated in the over 54-year-old age group. Similarly, Northey et al²⁰ found that, while females accounted for 35% of injuries in the 10- to 19-year-old age group, males were more frequently presenting to hospital for horse-related injuries than females for those patients aged over 50 years old. Thomas et al²¹ found that, in a sample of 102,904 people injured as a result of horse-related injury events in the USA, female injury rates peaked at 10 to 14 years, being three times the injury rate of males in this age group. However, males had higher injury rates than females in the over 55-year-old age group. This pattern has been suggested to reflect a larger proportion of occupational horse-related injuries in the older age groups²² with which males are more frequently engaged.²³

What the results of this study also found was that males and older riders were more likely to suffer a hospitalized injury than younger females. However, reports on the increased likelihood of males to sustain any injury or a more severe injury have been conflicting. Loder et al²⁴ analyzed the predictors of hospitalized injury in those patients who presented to hospital in the United States following a horse-related injury event. This study did not report any correlation between sex and whether the patient was admitted to hospital, finding only correlations between age >18, having a fracture or

TABLE 3 Multiple logistic regression results examining association with admission to hospital

Variable	Odds ratio	p-value	95% CI
Age	1.013	0.00002 ^a	1.007-1.018
Activity			
Mounting or dismounting	2.586	0.009 ^a	1.265-5.280
Carriage or other transport vehicle	2.265	0.164	0.717-7.158
Other maintenance, handling or repair	1.659	0.207	0.755-3.644
Horse handling and horse caused injury	1.563	0.107	0.907-2.691
Riding horse	Reference	-	-
Mechanism			
Other injury with no horse contact	0.138	<0.00005 ^a	0.074-0.257
Other injury due to contact with horse	0.360	0.0001 ^a	0.213-0.608
Fall from carriage or other height	0.388	0.112	0.121-1.264
Fall from or with horse	Reference	-	-
Place			
Other	0.817	0.418	0.500-1.334
Riding school or other sporting facility	1.002	0.986	0.842-1.191
Road or transport area	1.234	0.163	0.918-1.658
Open field or forest area	Reference	-	-
Time			
20-07 AM	1.033	0.803	0.802-1.330
08-11 AM	0.799	0.051	0.638-1.001
12-15 PM	0.959	0.658	0.797-1.154
16-19 PM	Reference	-	-
Gender			
Female	0.739	0.019	0.574-0.952
Male	Reference	-	-
Multiple mechanisms			
Yes	1.068	0.587	0.841-1.356
No	Reference	-	-

*Significantly associated with hospital admission.

traumatic brain injury, or occurrence on other public property and hospital admission. Another study by Hasler et al²⁵ found female participants to be predictive of any injury in a case-control survey conducted in Switzerland on 61 patients in 2008. Our study found only a weak association between sex and hospitalized injury and may be more a reflection of the relationship between age and sex, particularly as sex was not independently associated with admission to hospital. It could also be indicative of intrinsic differences in the sample where the study by Loder et al²⁴ involved only those patients who presented to the emergency department of one of the investigated hospitals.

Reports on the correlation between age and either any injury or severity of injury, however, have been more consistent, with older age being reported in both of these investigations to be a predictor of injury, independent of sex.^{24,25}

The number of mechanisms has also been reported to be significantly associated with length of stay in hospital.²⁶ This was not observed in our results; however, it was found that the primary mechanisms type was significantly associated with hospital admission. Injuries which were primarily caused through contact with the horse or “other injury without horse contact” were significantly less likely to result in hospitalization than those riders who fell off or with the horse

while riding. Other injury without horse contact involved a wide range of activities such as fetching food and water, building the horse stall, or shoeing the horse and appears to involve less severe injuries than when riding the horse which may be tied to the higher energy impacts when falling off a horse. These injuries are connected to the occupational or facility safety features and regard other strategies than rider protection. Mounting and dismounting from the horse was also found to be significantly associated with hospital admission when compared to riding the horse.

Another factor which has been reported in literature to be a predictor of horse-related injuries is riding proficiency or level of experience, although these results have been conflicting.^{25,27,28} Dekker et al²⁷ found long-term disabilities were associated with advanced riders, while Hasler et al²⁵ reported that those with diploma in horse riding were less likely to be involved in a horse-related injury event. Similarly, Hitchens et al²⁸ discovered that injurious falls related to apprentices. These studies, however, considered differing horse-riding populations from children,²⁷ to jockeys riding in jumping competitions.²⁸ It was not possible to investigate this in our study as we had no measure of the level of proficiency of the rider available in our retrospective data but could be of interest in future work in determining best methods for appropriately educating horse riders.

We were also limited in this investigation using self-reported, retrospective data, with a database which was not specifically designed for obtaining information on horse-related injuries. We were therefore unable to obtain detailed information on the use of protection by the riders in this investigation and as such did not investigate how different types of protection changed over the study period. Another weakness was the lack of national data or details on exposure to horse-related injury in Sweden; meaning that it is unknown whether the predominance of young women and incidents in the warmer months and afternoon was due to increased exposure or a higher risk of injury. However, this was strengthened by the use of not only hospital data, but out-patient visits to medical centers and public dental services, providing a widespread view of all injuries due to horse-related activities. We were therefore able to obtain an idea of both minor and major horse-related injury which was particularly important due to low numbers of injury-related deaths and severe injuries in the study period.²⁹

The most common injury types found in this investigation were soft tissue injuries, which appeared to increase slightly over the study period, followed by fractures. These injuries occurred most frequently to the upper extremities followed by the lower extremities and the head. This closely mimics what has been reported in other investigations.⁹ This injury pattern did not change substantially over the 16-year time period, although the percentage of patient registrations at a participating medical facility due to a horse-related injury

increased with respect to all other registrations. Despite the lack of exposure data, we can still conclude that there are at least no improvements in the numbers of patients presenting to medical facilities with horse-related injuries and this is supported by the previous reports.^{8,9}

An older investigation by Chitnavis et al³⁰ investigated changes in horse-related injuries, comparing patients admitted to hospital in 1971-72 to those in 1991. There was reported to be a five-fold decrease in the number of patients admitted to hospital with head injuries. The authors suggested that this could be linked to helmet use, with helmet usage rates increasing from an estimated 42%-72% to 73%, corresponding to the reduction in head injuries. In 2013, Abu-Kishk et al⁹ also investigated the changes in injuries observed in horse-related injury involved patients who were admitted to the study hospital in Israel between 1984 and 2008. Here, however, an overall increase in the number of patients with horse-related injuries was observed from two in 1984 to 13 in 2008. Additionally, the incidence of hospitalization for more than 3 days increased significantly during the study period. As with the results reported in this investigation, an increase in horse-related injuries was observed in the data presented here.

Improvements in the numbers of horse-related injuries have not been observed since the initial improvement when the helmet was introduced. The lack of improvement in horse-related injury occurrence and severity in recent years is suggestive that there has been limited improvement in the safety measures and protective devices available for horse riders since the introduction of horse-riding helmets. Even with helmets available, head injury rates are still high³¹ and it has been suggested that perhaps helmets are not designed appropriately for the equestrian impact conditions.^{32,33} As such, there is a need to establish tangible change in protection for horse riders. Our results suggest that target groups are young females who are involved in riding for leisure in open fields and have suffered a fall from horseback. Contrastingly, based on risk of hospitalized injury, older riders who have fallen from horseback, particularly males, should also be targeted. The injuries to provide protection for are soft tissue injuries and fractures to the extremities and head. Protective devices should be designed to help prevent injuries to these body regions. We were limited in this investigation as a maximum of three injuries per rider were coded in the database; however, only a small proportion of riders reported having suffered three or more injuries, and injuries were coded in order of severity, so our database does contain those injuries most necessary to prevent. However, we can expect the number of soft tissue injuries to be even higher than what is presented here.

This investigation did not examine the risk factors for different injury types and locations in order to devise targeted protection for each body region. Abu-Kishk et al⁹ did find a significant association between age and injury type, with

adult patients (≥ 17) more likely to suffer from neck injuries than pediatric patients (< 17). Additionally, it has been shown that injuries to the head and face occur as frequently to those riders who are unmounted as those who are mounted.³⁴ Eckert et al³⁵ reported a high number of hoof kick injuries to the face during horse care, and as helmets are not typically used by unmounted equestrians, there could be large proportion of head injuries occurring while riders are unmounted. Thorough investigation of the relationships between injury location with rider and injury characteristics would be highly beneficial in assisting in development of current and new protective measures.

4.1 | Perspective

This study presented an overview of horse-related injuries in Sweden, involving not only those presenting to hospitals but also those as out-patients in medical facilities. The findings of this study suggest this public health issue is not improving and, as such, deserves attention. There were on average 7815 equestrians injured every year in the Skaraborg region, which, as found in previous studies, predominantly involved females between the ages of 10 and 20.^{17,18} This study, however, went beyond previous reports and investigated factors associated with hospitalized injuries. The findings indicated that males and older riders were more likely to suffer a hospitalized injury. Further work should focus on differences between males and females in terms of the activities undertaken and injuries sustained following a horse-related incident. It may be appropriate to provide different knowledge and protection for riders of different sexes and ages.

5 | CONCLUSION

This study presented an overview of horse-related injuries in Sweden, involving not only those presenting to hospitals but also those as out-patients in medical facilities. Those most frequently involved in horse-related injury events in the Skaraborg district, Sweden, were females between the ages of 10 and 20, matching closely with most reports from around the globe. However, those most likely to suffer a hospitalized injury were males and older riders. There was not seen to be any change or improvements in horse-related injuries over the 16-year period, and hence, protection and prevention of horse-related injuries are of great importance.

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