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Epidemiology and evaluation of spine injuries in equestrian sports

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Abstract

Introduction and purposes:

Severe injuries are a documented consequence of horse riding accidents. This study aims to explore the prevalence of spine injuries associated with horse riding, identify the most common types of injuries, examine mechanistic underpinnings, analyze typological manifestations, assess implicated spinal regions, investigate demographic risk factors, and examine ensuing neurological sequelae and back pain.

Materials and Methods:

A systematic literature search was conducted using PubMed and Google Scholar. The search employed terms such as 'horse riding,' 'injuries,' 'spine,' 'vertebral,' 'horse-related,' 'equestrian injuries,' 'spinal fractures,' and 'back injuries.' Articles published between 2014 and 2024 were included in the search.

Results:

The primary injury mechanism for horse riders is falling from a moving horse. Studies present conflicting findings on which parts of the spine are most commonly injured. Equestrian activities contribute significantly to sports-related spinal injuries, with spinal injuries ranking as the second most affected body region after head injuries among equestrians. Experienced riders tend to have fewer injuries compared to amateurs. Spine fractures are more prevalent in riders aged over 40 years, and a substantial majority (over 80%) of riders have experienced back pain at some point in their lives.

Conclusion:

In summary, horseback riding poses a substantial risk of spine injuries or pain. A thorough understanding of horse-related spine injury epidemiology is crucial for specific subgroups, enabling the development of preventive strategies across all levels of responsibility.

Keywords: horse riding, spinal injuries, spine fractures, horse-related, equestrian sports

Introduction and purpose

Equestrian pursuits encompass a diverse array of athletic, recreational, and professional activities enjoyed globally by individuals across all age groups. However, the inherent risks associated with such engagements render them prone to a notable incidence of musculoskeletal accidents and injuries. [1,2] Extensive literature underscores the heightened vulnerability of horseback riders to various forms of trauma, particularly emphasizing the prevalence of spinal cord injuries. [3,4] The escalating frequency of severe spinal traumas among riders resonates with the overarching trend of elevated spine injury rates within equestrian circles. [5]

Notably, a comprehensive study revealed that injuries sustained during equestrian sports often necessitated surgical intervention, with 45% of afflicted individuals requiring such measures. Alarmingly, statistical data indicates that one in every five riders will endure a significant injury throughout their lifetime, leading to hospitalization, surgical intervention, or long-term disability, irrespective of their participation in pleasure or competitive equestrian pursuits. [6] Spinal injuries, particularly those affecting the spinal cord, entail profound ramifications for afflicted individuals, often precipitating a loss of functionality and potential onset of chronic disability. Consequently, these injuries exert a deleterious influence on the overall quality of life experienced by affected individuals. [7]

The objective of this review is to provide a comprehensive analysis of the epidemiological landscape surrounding spinal injuries incurred through horse riding, delineating their mechanistic underpinnings, typological manifestations, implicated spinal regions, demographic risk factors, and ensuing neurological sequelae and back pain.

Methods

A systematic literature search was conducted using PubMed and Google Scholar, employing the following search terms: 'horse riding,' 'injuries,' 'spine,' 'vertebral,' 'horse-related,' 'equestrian injuries,' 'spinal fractures,' and 'back injuries.' Articles published between 2014 and 2024 were included in the search. Frequently cited publications published earlier than a

decade ago were also included. The inclusion criteria comprised published papers, case series, and reports focusing on injuries sustained by adults and children during equestrian activities or through contact with horses for various purposes. These injuries could involve the spine to any degree of severity, with or without accompanying neurological damage. Additionally, only publications in English were considered eligible for inclusion.

Mechanisms of injuries.

The increased incidence of injuries in horse riding can be attributed to the unique relationship between the rider and the horse. The rider is positioned 4 meters (13 feet) above the ground on an animal weighing up to 500 kg, which possesses a level of intelligence distinct from humans. Furthermore, the horse can reach speeds of up to 65 km/h (40 mph) and deliver powerful kicks, exerting a force equivalent to 1.8 times its body weight. [8] These unique circumstances contribute to a heightened risk of accidents. According to Buchanan FR study among 6,662 reported cases, the most prevalent injury related to large animals was falling from a horse, accounting for 63% (n=4,168), followed by incidents of being struck by a horse at 16% (n=1,070), and other forms of contact with a horse at 7% (n=493). [9] Injuries can occur not only while riding but also in various non-riding activities, including training, grooming, handling, saddling, shoeing, and feeding of the horse. [10] The primary cause of injury for horse riders often involves falling from a moving horse, typically from a height of 4 meters above the ground. [5,6,7,9,10,11,12,13,14] Injuries tend to be more severe when the rider experiences a fall compared to other injury mechanisms. [15] Of total 222 patients included in retrospective analysis of equestrian-related injuries presenting to a level 1 trauma center mechanisms of injury were fall in 186 cases, kick in 18, stepped on 9, and other also 9. [16] A fall from a horse has the potential to cause spinal fractures due to axial forces applied through the rump and transmitted along the spine. [17] Such injuries are more likely to happen when riders fall from a significant height, particularly when attempting large aerial jumps. [18] In Lethal recreational activities involving horses – A Forensic study eight cases of deaths involving horses were taken into consideration and 7 of them were the result of falling from a horse. [19] Moreover, falls emerged as the predominant mechanism linked to spinal injuries. [5,7,20,21] Out of a total of 1,769 cases, 829 (46.9%) reported spinal and spinal cord injuries, with the majority associated with falls during horse riding. Among these cases, 514 (29%) resulted from horse kicks, 91 (5.1%) from crush incidents, 90 (5%) from trampling, and 23 (1.3%) from bites. [7] In a retrospective data collection encompassing all equine-

related accidents at a German Level I Trauma Centre from 2004 to 2014, 770 patients were enrolled, with 87.9% being females. The primary injury mechanisms were falling off the horse, accounting for 521 cases (67.7%), and being kicked by the horse, comprising 127 cases (16.5%). Of all the patients, 141 (18.3%) experienced spine injuries as part of their overall injuries. [11] In a study investigating horse-related trauma in both children and adults over a two-year period, researchers identified 288 distinct mechanisms of injury. The most prevalent cause was falling off the horse, accounting for 215 cases. Among these, 34 incidents involved additional injury mechanisms accompanying the fall. These secondary mechanisms included instances where the horse fell on the rider (14), stepped on them (9), kicked them (5), and in 6 cases, riders had their foot caught in a stirrup and were subsequently dragged along by the horse. Other riders experienced injuries solely from being kicked (34), stepped on (20), bitten (1), or pushed by the horse (1). Another rider was harmed when the horse abruptly stopped in front of an obstacle, and three were squeezed between the horse and a wall. Additionally, three riders had their fingers caught in the reins and were pulled along by the horse. One adult collided with an obstacle while riding, and five adults were struck by the horse's neck or head. In three instances, the horse fell over the rider. [12] In a study examining Equestrian Injury Presentations at a Regional Trauma Centre in Ireland, a total of 189 injuries were identified, with 24 individuals (12.5%) experiencing spinal damage. Among these cases, only one injury resulted from being trampled by a horse, while the remaining 23 injuries were attributed to falls. [13] In a retrospective analysis of the Morristown Medical Center trauma registry encompassing 440 equestrian injuries, 79 cases (17.95%) involved spinal injuries. Individuals who fell from a horse were found to be more prone to both spinal and torso injuries compared to those injured through other manners. [16] The way in which a horse rider falls plays a crucial role in determining the specific area of the spine that is susceptible to damage. Among 94 patients experiencing spine and spinal cord injuries, the primary cause of the accident for 68 individuals (72.4%) was a fall, followed by hitting a stationary object in 8 cases (8.5%), and jumping in 6 riders (6.4%). [7] The pattern of spinal injury is intricately linked to how the rider lands. [2]

The most commonly injured parts of the spine.

Spinal injuries reportedly account for 2.4% to 14% of all equestrian injuries, with a prevalent involvement of the lumbar or thoracic spine. [21,22] Among 50 cases of riding-related spinal fractures, 51% were lumbar, 32% were thoracic, and 17% occurred in the cervical spine. [23]

In another study encompassing 851 spine injuries, a substantial portion of 126 (14.8%) was related to the thoracic spine, 171 (20%) to the thoracic spine and chest, and 3 (0.4%) to the thoracolumbar junction. Other recorded injuries included 182 (21.4%) in the cervical spine and neck, 81 (9.6%) in the lumbar spine, 58 (6.8%) in the back and lower spine, 45 (5.3%) in lumbosacral, and 171 (20%) in lumbar and pelvis. In 13 cases (1.6%), the injured area of the spine was not recorded, and in 1 case (0.1%), a normal spinal examination was documented. [7] Another study indicated that spinal injuries were predominantly distortions, notably in the cervical spine, and fractures, primarily at the thoracolumbar junction. [11] In a review by Scott B. Davidson, a total of 90 patients were admitted for equine-related injuries over a 10-year study period. Spine injuries (14.1%) ranked as the second most frequently affected body region after the head and chest. Cervical spine injuries were observed in 5 (3.7%) cases, thoracic spine in 4 (3.0%), and lumbosacral spine, as the most frequently injured part, in 10 (7.4%) patients. Surgical procedures were performed on 8 patients. [5] In the trauma referral center for the Midlands region of Ireland, six patients were admitted with horse-related spinal fractures. Among them, 3 had stable fractures at the thoracolumbar junction, and 2 had stable upper thoracic spine fractures. One patient had an unstable lower cervical spine fracture with neurological deficits, necessitating transfer to the Irish National Spinal Injuries Unit for acute spinal stabilization. [13]

Comparison of spine injuries in horse riding to injuries in other sports.

Cheng et al. investigated the incidence of traumatic lumbar spine injuries over a 10-year period. The study identified the five most prevalent sports-associated causes of these injuries, based on annual weighted estimates, as horseback riding (255.1), snowboarding (164.3), weightlifting (148.9), skiing (140.0), and football (63.6). Horseback riding emerged as the sport most frequently associated with traumatic lumbar spine injuries, with an estimated 255.1 injuries per year. The weighted estimates were further analyzed by sport and gender. For female patients, the highest number of lumbar injuries each year occurred during horseback riding (estimated 211.9 injuries), followed by skiing (estimated 41.8 injuries) and roller skating (estimated 27.1 injuries). In contrast, the primary causes of injuries in male patients each year were snowboarding (estimated 127.4 injuries), weightlifting (estimated 113.8 injuries), and football (estimated 63.6 injuries). Notably, horseback riding accounted for 17% of total lumbar spine injuries across all sports, a significantly higher rate than other sports. The study also observed that cervical spine injuries were more common in men cycling and

women horseback riding. Despite cycling not being a major contributor to lumbar spine injuries, the research highlighted a similarly high incidence of lumbar spine injuries in female patients engaged in horseback riding. [18] Results summarized in Table 1. In a study involving 122 patients with sports-related spinal fractures, resulting in a total of 230 fractures, horse riding (n 55), cycling (n 36), and boating (n 10) were identified as the sports most commonly associated with spinal fractures. Results summarized in Table 2. [24] Lin et al. conducted a 35-year review of spinal cord injuries sustained during horseback riding, revealing a significantly higher number of injuries in female patients compared to diving, motorcycle riding, and gymnastics. [3] Another study, using the National Spinal Cord Injury Statistical Center database, reported that approximately half of all spinal cord injuries in female patients were attributed to horseback riding. [25] A multicenter retrospective comparative study focused on radial neck fractures in children under 15 years old, considering 39 cases. Among them, 18 fractures were associated with a fall from a horse, while 21 were linked to other circumstances, including falls from body height (n = 15), falls from a height less than 2 meters from bed or climbing (n = 3 and n = 2, respectively), and a fall from a roller board scooter (n = 1). The study found that radial neck fractures related to horse riding in children were more severe than those caused by other factors. [26] Furthermore, Boran et al. reported on all patients admitted to The National Spinal Injuries Centre unit with sports-related spinal injuries from 1993 to 2003, totaling 196 cases. Equestrian injuries (82 patients, 41.8%) accounted for the highest number of sports-related spinal injuries in Ireland over a 10-year period. [2]

Sport	Total Injuries (per year)	Female Injuries (per year)	Male Injuries (per year)
Horseback Riding	255.1	211.9	no data available
Snowboarding	164.3	no data available	127.4
Weightlifting	148.9	no data available	113.8
Skiing	140.0	41.8	no data available

Football	63.6	no data available	63.6
Roller Skating	no data available	27.1	no data available

Table 1

Sport	Total Fractures
Horseback Riding	55
Cycling	36
Boating	10

Table 2

Comparison of spine injuries to injuries of other parts of the body.

Fatalities resulting from horse-related incidents often involve severe injuries, with the head being the most commonly affected area at 80% (n=33). [9] In certain extreme circumstances, injuries sustained in horse-related accidents can lead to the death of the rider. [27,28,29,30] primarily due to severe head injuries. [31,32,33] Lethal head injuries frequently occur in the aftermath of falls and kicks. [19] The prevalent injuries identified at autopsy following falls, as demonstrated in the current study, are multiple rib fractures, basilar skull fractures, lumbar spine fractures, clavicle fractures, pulmonary contusions, pneumothoraces, cervical spine fractures, thoracic spine fractures, and subarachnoid haemorrhage, listed in decreasing order of occurrence. [34] Among non-lethal injuries, soft tissue injuries like contusions and abrasions are the most common, followed by fractures. [35,36] Previous studies consistently indicate that the most frequent injuries in horse-related incidents include head injuries and fractures of the long bones. [37] According to Moss PS, the most frequently injured areas were the extremities, head, and neck. Notably, head and neck injuries were more prevalent among children (n = 33) compared to adults (n = 11). [38] At the Emergency Department of

MRH Tullamore, one hundred and forty-nine equestrian-related presentations were recorded, revealing a total of 189 injuries. Radiological abnormalities included upper limb fractures (32%), clavicular fractures (19%), lower limb fractures (15.5%), spinal fractures (12.5%), dislocations (11%), and pelvic fractures (4%). [13] According to J.W. Bilaniuk's review of injuries distributed among body regions, out of a total of 440 injuries, the head was the most commonly affected part, accounting for 115 cases (26.14%). Following this, the cervical spine experienced 22 injuries (5.00%), the thorax had 67 injuries (15.23%), the abdomen/pelvis region sustained 51 injuries (11.59%), and other parts of the spine incurred 57 injuries (12.95%). The upper extremity was injured in 83 cases (18.86%), while the lower extremity was affected in 45 cases (10.23%). [39] Another analysis of 770 individuals revealed that the most common injury patterns occurred in the head, face, and throat, with 251 cases (32.6%), followed by the trunk with 188 cases (24.4%), and the spine with 141 cases (18.3%). In this group, the upper limb experienced injuries in 170 cases (22.1%), while the lower limb was affected in 175 cases (22.7%). [11] In the study conducted by Scott B. Davidson et al., it was found that thirty-eight percent of patients had injuries in more than one body area. The chest was the most commonly injured area, accounting for 23%, followed by the brain/head at 21.5%. Injuries to the spine represented the next most frequently affected body region, comprising 14.1% of the cases. [5] In a retrospective review evaluated by K. Guyton involving two hundred thirty-one injured equestrians, the findings revealed that 41% of patients, or ninety-six individuals, had head injuries. Among these, 82% (79 patients) had significant intracranial injuries. Other observed injuries included chest injuries in 25% (fifty-eight patients), thoracolumbar spine injuries in 13% (thirty patients), abdominal injuries in 13% (thirty patients), pelvic injuries in 11% (twenty-six patients), extremity injuries in 11% (twenty-six patients), and neck injuries in 8% (twenty patients). Additionally, fifty patients (21%) had injuries in multiple body regions. [40] According to M. F. Hofmann, injured upper extremities accounted for 52.5%, followed by spinal and pelvic injuries at 23.2%. [14] The most common injuries were contusions/lacerations, ranging from 30% to 50%. Extremity fractures/dislocations followed at 20% to 30%, while brain injuries were reported at 10% to 20%. Injuries to the spine, pelvic fractures, facial fractures, and thoracoabdominal internal injuries each constituted 2% or less of the total injuries. [41,42] In a comprehensive study that categorized injuries by type rather than simple location, orthopedic injuries were found to be the most frequent at 31%, in contrast to 20% for brain and spinal cord injuries. Injuries to the trunk or torso were also common, occurring not only during falls from the horse, especially in

jumping scenarios but also during ground-level horse handling. These injuries encompass not only back injuries but also pulmonary and abdominal injuries. Consistently across the literature reviewed, there is a notable trend of a relatively low incidence of lower extremity injuries. [17,42,43,44] Smartt and Chalmers conducted an investigation of 716 horse-related accidents in New Zealand, revealing that over half of the falls resulted in fractures and dislocations of limb and girdle bones (171 cases, 58%) or the skull, spine, and pelvic bones (123 cases, 42%). In cases where a fall was combined with a secondary mechanism, most injuries occurred in the limbs and girdles (45% of 31 cases). An additional 23% of falls resulted in internal injuries, including intracranial injury (82 cases, 76%), injury to the spleen (15 cases, 12%), injury to the kidney (8 cases, 7%), traumatic pneumothorax (11 cases, 8%), and injury to the cranial and spinal nerves (3 cases, 2%). [45] Though specific categorizations may vary by study, the most frequently injured body parts, generally in order, included the thorax, upper extremities, lower extremities, spinal column, head, face, and abdomen. [9,46,47]

Groups at risk of spine injuries.

A retrospective analysis of data collected from all equine-related accidents at a German Level I Trauma Centre between 2004 and 2014 revealed interesting trends. Up to the age of 20, the odds of requiring inpatient treatment and surgery for horse riding injuries decreased, but these odds increased after that age. The study further highlighted that in equestrian sports, men are at a higher risk of major injuries, and with increasing age, the risk for major injuries also rises. [11] In a cohort prospective study, it was found that children engaged in horse-riding faced approximately a 40 times higher risk of sustaining a traumatic back injury compared to the risk associated with non-organized leisure time physical activity. The primary cause of these back injuries was identified as falls from horses. When exposure for physical activity was factored in, horse riding exhibited the highest incidence rates of back injuries compared to other sports. Previous research has also indicated an injury peak for riders in the age group of 10–14 years. [48] In the study conducted by R. Chang et al., it was observed that injuries among horseback riders were predominantly concentrated in the 41- to 65-year-old age group, constituting 56% of the total injuries within the sport. Specifically, within this demographic, horseback riders aged between 41 and 65 years were found to be the most likely to experience a traumatic lumbar sports-related injury. An estimated 255.1 annual lumbar spine injuries were sustained in female patients while horseback riding, which is notably higher compared

to approximately 125 annual cervical spine fractures in the same age group. [18] According to Bilaniuk et al., thoracolumbar and sacral spine contusions were more prevalent in the younger age groups. Specifically, in the group under 18 years old, there were 20 (13.8%) spinal injuries, 22 (12.9%) in the group aged 19 to 49, and 7 (5.6%) in riders older than 49 years. However, spine fractures were more common in the oldest group, accounting for 9.7%, as compared to the 19- to 49-year-old group, which had a slightly lower incidence at 9.4%. [39] In a retrospective electronic medical record review conducted for patients presenting to a level 1 trauma center for horse-related injuries, it was observed that patient age greater than 54 years and the mechanism of injury were strong predictors of the Injury Severity Score, injury localization, healthcare expenditure, and mean hospital stay. Specifically, over 40% of spinal injuries were observed in the group above 55 years old. [16] According to M. F. Hofmann, patients with spinal or pelvic injuries tended to be older (38.5 vs. 34.4 years), although this difference was not statistically significant ($p=0.280$). [14] It is suggested to use injury prevention strategies targeted towards older people exposed to horses, including the possible use of protective body equipment, since patients in this group sustained more spine and torso injuries. [49]

Comparison of spine injuries and back pain in amateur and professional riding

Injured equestrians are often found to be amateurs or less experienced riders, potentially riding horses with less training experience. [50] An analysis of falls on race day for jockeys indicated that apprentice or amateur jockeys had a higher likelihood of experiencing a fall. [51] Experience is considered a protective factor for equestrians, [52] and human error has been identified as a contributing factor in over a third of equestrian accidents. [53] Studies suggest that professionals are more prone to severe injuries, possibly due to their younger age, inexperience, the difficulty of the horses they are training, competition level, and higher hours spent in the saddle and handling horses per week. [6] Adjusting injury rates by hours spent in the saddle, one study found that experienced equestrians were less commonly injured than amateurs. [53] While professional equestrians may face an increased risk of severe injuries due to their occupational exposure load, amateurs are more likely to sustain injuries associated with a lack of experience or risky behaviors, such as riding without establishing the proper fundamentals necessary to cue a horse safely. [54] Recreational riders tend to sit with their head held high in an upright posture and do not assume the forward-leaning position of a jockey. Falls from the upright position are more likely to impact the pelvis, thoracic, and

lumbar spine to a greater degree than the cervical spine. [4] In I. Deckers study 16 professional and 16 amateur riders (25 ± 7 years) participated in two questionnaires (a sport-specific questionnaire and the Oswestry Disability Index questionnaire) and were examined via the physical functional movement screening (FMS) and Luomajoki's motor control screening. Riding level was defined as per Williams and Tabor (2017): professionals were those whose career was related to their competitive profile and amateurs were those competing at affiliated level at regional competitions. Professional riders revealed significantly higher prevalence of back pain in the last month before assessment ($P=0.014$) than amateur riders. 88% of professional riders had experienced BP at some time in their life and 56% in the last month, which was higher compared to 73% ($\chi^2=0.963$; $P>0.05$) and 13% ($\chi^2=6.028$; $P=0.014$) in the amateur riders. [55]

Type of injuries and treatment.

Accidents like falls from horses result in high-energy injuries that exert significant pressure on the spine, potentially leading to severe injuries. The special architecture of the thoracic spine, characterized by reduced blood supply and a narrow spinal canal, has been theorized to be associated with paraplegia in 80% of cases. [56] Researchers in medical radiology have investigated the biomechanical modifications and traumatic alterations of the spine in equestrian sports, revealing valuable insights. This includes the classification of trauma types, modifications in angles and physiological curves of the spine, alterations in interbody discs, changes in the ligamentous apparatus of the spine, and disruptions in somatic components. Notably, the average reduction of interbody discs in the spines of horse riders is found to be 33.6%. [57] Siebegna et al. conducted an investigation into horse-related spinal injuries, revealing that among the 32 cases studied, 22% of patients experienced permanent occupational disabilities. [58] In a separate study by Lin et al., which focused on a sample of 121 equestrians who sustained spinal cord injuries from horseback riding accidents, the injuries most frequently led to incomplete tetraplegia (41%), followed by complete paraplegia (24%). [3] Triantafyllopoulos et al. reported three cases of spinal injuries resulting from horse-riding accidents. In all three cases, the patients suffered fractures at the levels of T5–T8. While one patient achieved full recovery after surgery, the remaining two patients remained paraplegic despite receiving early surgical treatment and undergoing prolonged rehabilitation therapy. [8] Patients with spinal or pelvic injuries exhibited a higher injury severity according to the Abbreviated Injury Scale (2.48 vs. 2.03, respectively; $p=0.046$) and underwent

significantly longer hospital treatment (25 days) compared to other injuries ($p=0.019$). This difference was influenced by two patients who experienced complete and incomplete tetraplegia following trauma to the cervical spine and initiated early spinal rehabilitation. [14] These findings align with the conclusion by Lin et al. that spinal cord injuries in horseback riders represent a substantial contributor to long-term morbidity. [3] In another comprehensive review, out of a total of 222 recorded injuries to the spine and spinal cord, 154 (69.4%) were fractures, 26 (11.7%) were dislocations-fractures, 27 (12.1%) were soft tissue injuries, and 15 (6.8%) involved spinal cord and nerve injuries. Examining the neurological impact on the participants, of the 233 horse riders whose neurological status was documented after the injury, 94 (40.3%) suffered an incomplete lesion, 56 (24%) experienced a complete lesion, 74 (31.8%) did not sustain any neurological impairment, while the extent of the damage wasn't recorded in 9 cases (3.9%). Looking specifically at the type of neurological damage, 62 (53.5%) suffered tetraplegia, and 54 (46.5%) experienced paraplegia. [7] This review underscores that spine and spinal cord injuries, particularly when accompanied by neurological impairment, predominantly lead to quadriplegia and, in some instances, paraplegia. These unstable injuries often necessitate surgery involving potential discectomy, spinal cord decompression, and spinal fusion, with or without implants, to restore the normal architecture of the spine, preserve neurological function, and ensure ambulation, autonomous mobility, and the return of the patient to normal daily activities. [8,56,59] Retrospective data collected from all equine-related accidents at a German Level I Trauma Centre between 2004 and 2014 included 770 horse-related injuries, with 141 of them being spinal injuries. Distortions, primarily at the cervical spine, and fractures, predominantly at the thoracolumbar junction, were the prevailing types of spinal injuries. Notably, there was only one patient with a spinal cord injury, and two patients experienced lesions of the brachial or lumbosacral plexus. Primary surgical procedures were required in 9 cases. [11] In a study by Papachristos et al., a questionnaire was administered to 172 patients with horse-related injuries, revealing a total of 152 spinal injuries in 78 (45%) patients. The majority (69%) of these patients suffered vertebral column fractures. Among those with cervical spine injuries, five had spinal cord contusions, including one patient with a complete cord syndrome at C3. Surgical treatment was administered to thirteen (17%) patients with spine injuries. Additionally, thirty-nine (23%) patients sustained thoracic injuries, with 77% of them having serious thoracic injuries. The cohort of patients with thoracic injuries required a median hospital stay of 9 (1-31) days. Furthermore, 44% of patients with thoracic injuries needed care for a median time of 45 (8-26

374) hours. Notably, patients who sustained spinal injuries were significantly more likely to continue experiencing moderate/severe pain compared to those who did not. [60] M. F. Hofmann et al. reported that eleven (47.8%) out of 23 patients with injuries to the spine and pelvis underwent surgery. [14] Concerning surgical interventions, the posterior approach appears to be more commonly employed than the anterior one. Stable spinal injuries can be effectively managed through early or late functional rehabilitation or brace application. [7] It's worth noting that more severe injuries, such as fractures, dislocations, and head and neck injuries, are likely to be prominently featured in the literature, while less serious soft tissue injuries may be underreported. [61] Physical rehabilitation plays a crucial role in managing such cases, both postoperatively for the ongoing protection of the patient and on a longer-term basis, as chronic physical difficulties often accompany these injuries. [7] Physical therapy is instrumental in loosening muscles and joints, facilitating movement, and reducing pain. This muscle relaxation not only effectively alleviates pain but also diminishes stress hormones and symptoms associated with low back pain. [62] Additionally, Pilates has demonstrated the ability to enhance muscular endurance, improve flexibility, and enhance balance. [63] Training programs that include Pilates have proven to be more effective in improving function and reducing lower back pain compared to core strengthening programs. [64]

Back pain among horse riders.

Equestrian-related injuries exhibit a relatively higher severity when compared to injuries in other widely practiced sports. [65] A notable portion of these injuries is acute, and there is evidence suggesting that they can lead to long-term chronic dysfunction. [66] Chronic pain can result from physical overloading, [67,68,69] and in eventing riders, overuse injuries contribute to almost half of the injuries. [53] Back pain is a prevalent issue in the equestrian population, with a reported prevalence ranging from 71% to 100%, notably higher than the 33% reported in non-riders. [67,68] The potential origins of spinal discomfort in horse riders span various factors, including the repetitive nature of riding, acute traumas, postural defects, asymmetry, [71,72] insufficient recovery periods following falls, inadequate rehabilitation of previous injuries, and monotonous training routines. [53] In a study examining the characteristics of back pain in 32 horse riders, it was found that 81% of riders had experienced back pain at some point in their lives, and 35% had experienced back pain in the last month before the assessment. The intensity of the pain, as measured by the Visual Analog Scale (VAS), ranged from no pain to moderate pain (min. VAS=0.00/10; max. VAS=5.70/10;

$\mu=1.91\pm 1.67$). Among the 32 riders with spinal discomfort, 83% reported the discomfort in the lumbar spine, 26% in the thoracic spine, and 9% in the cervical spine. [55] In another analysis involving 2185 respondents, 85.4% of riders reported experiencing pain, with lower back pain being the most common location (51.9% of participants), especially prevalent in riders over 35 compared to other rider populations. Among those experiencing pain, 54% had suffered for over 6 years, 16% for four to five years, 21% for two to three years, and 8% for one year or less. Additionally, 7.8% of individuals reporting pain had experienced severe pain. A preliminary study examining the prevalence of pain in elite dressage riders during competition in the United Kingdom found that 74% of riders (37/50) reported competing with back pain, and 27 riders (54%) reported having sustained a severe injury (fracture or dislocation) in their career. [69] Lumbar disc degeneration, specifically, could potentially serve as a risk factor for back pain in adults. [73] Lower back pain in certain riders may also have a functional origin, associated with muscular imbalances. In some instances, there was no definitive MRI evidence indicating that lower back pain in riders was caused by disc degeneration, spondylolysis, spondylolisthesis, or pathological changes to the paraspinal muscles of the lumbar spine. [74,75] Papachristos et al. observed a notable increase in persistent pain and an extended recovery period among patients with spine injuries resulting from equestrian incidents. [60] Stable duties and riding impose stress on the musculoskeletal system through twisting and lifting, a factor identified by many riders as a contributor to their pain. Riders noted that weather conditions, prolonged sitting, and the horse's movement exacerbated their discomfort. The majority of riders reported enduring pain for over 6 years and acknowledged that it impacted their performance by causing fatigue, restricting movement, reducing the range of motion, and inducing postural asymmetry. These symptoms align with common manifestations of lower back pain resulting from the physical demands associated with riding and engaging in stable tasks. [76] The age group most susceptible to pain comprised individuals aged 36-45 years; however, Jordan et al. identified that the highest age group in the general population experiencing lower back pain was the 45-64 year age group. Consequently, horse riders tend to experience pain at an earlier age than non-riders. [70,77]

Injury prevention.

The initial step in injury prevention is for each equestrian to acknowledge the personal benefits of wearing helmets and other protective gear. [78] Despite long standing

recommendations by equestrian organizations promoting personal protective equipment, surveys have revealed a prevailing attitude among equestrians that accidents are unlikely to happen to them ("it won't happen to me"). [79] This denial may be attributed to the fact that minor injuries occur four times more frequently than serious ones. [41] Furthermore, ensuring the proper maintenance, regular inspection, and fitting of equipment such as the saddle, bridle, reins, and bit are essential for maintaining control over the horse while optimizing comfort. [79,80] An examination of horse-related injuries necessitating medical attention in southwestern Colorado revealed that equipment issues, coupled with rider inexperience and unpredictable horse behavior, ranked as the top three causes. [81] Preventive measures typically center around either the use of protective equipment or educating athletes to enable the modification of sport-specific risk factors. In the context of equestrian activities, the emphasis on protective equipment has primarily centred on the adoption of suitable helmets for head and neck protection. [27,82] Concerning torso protection, protective vests have been available for some time and are gaining popularity, particularly in competitive settings where their use is often mandated. These vests are most commonly worn during the cross-country jumping phase of Three Day Eventing, as well as in racing and rodeo environments. [44,83] Protective vests, including more recent inflatable designs, have emerged as additional safety devices for horse riders. Designed to absorb impact during a fall, safety vests aim to protect an equestrian's torso. [54] However, the adoption of protective vests has been limited, with only a small fraction of equestrians incorporating them. Presently, safety vest usage remains low among the general equestrian population. A survey of injured equestrians revealed that only 14% reported wearing safety vests at the time of their injuries. [84] In a study by Kiss et al., only four out of 112 accident-involved equestrians interviewed were wearing a vest when their accidents occurred. [15] An examination of FEI data spanning from 2015 to 2017, focusing on falls during international eventing competitions, revealed that riders utilizing an air jacket faced 1.7 times higher odds (95% CI 1.14–2.64) of sustaining a serious or fatal injury in a fall compared to riders not wearing an air jacket. [85] Further research is essential to elucidate injury patterns and the characteristics of riders who utilize safety vests. As of now, safety vests have not demonstrated a significant reduction in the risk or severity of spinal injuries. The cervical spine remains vulnerable in horse-related accidents, as safety vests do not provide protection for the neck. Injuries to the cervical spine are associated with spinal cord injuries. [86] An innovative approach could involve the development of inflatable collars within airbag vests, potentially promoting a more favorable posture for the spine. Vests

featuring an airbag collar or inflatable restraint may prevent hyperextension of the cervical spine, assisting in maintaining a neutral position and potentially averting severe fractures. Given the limited evidence supporting current vests in reducing the risk of severe injuries, cost considerations may influence an equestrian's decision to purchase and wear safety vests. The introduction of safety vests with inflatable collars designed to protect the cervical spine could be a valuable advancement for the equestrian community, contributing to a reduction in such injuries. Presently, no published studies have confirmed whether airbag collars effectively reduce the incidence of cervical spinal cord trauma. [87]

Conclusion

Horseback riders face an elevated risk of traumatic spine injuries, primarily due to falls from height during activities such as mounting, jumping, and being thrown off the horse. The most common injury mechanism for horse riders is the fall from a moving horse, and within all sports, equestrian activities contribute the highest number of sports-related spinal injuries. Spine fractures are more prevalent in riders aged over 40 years. In equestrians, injuries to the spine rank as the second most frequently affected body region after head injuries. A significant majority, over 80%, of riders have experienced back pain at some point in their lives. Overall, horseback riding carries a substantial risk of spine injuries or pain.

From a research perspective, a deeper understanding of horse-related injury epidemiology is essential, particularly for specific subgroups, to develop preventive strategies at all levels of responsibility. While helmets and safety vests are crucial for injury prevention, they may not prevent all injuries sustained by riders. Effective prevention efforts should adopt a multifaceted approach. This could involve improved riding education, instruction in falling techniques, regular exercise, and guidelines for the proper use of equipment and clothing. Such comprehensive measures aim to increase awareness among horse riders, enhance training techniques, modify rules, and design safer protective equipment and athletic facilities. Additionally, the gathered data can guide clinicians in patient maneuvers during transport, reduction and decompression procedures, and the selection of optimal fixation techniques.

Disclosure

Conceptualization, MK, and KC; methodology, MK; software, KK; check, MK, KK and JL; formal analysis, JL; investigation, MK; resources, KK; data curation, JL; writing - rough

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Conflicts of Interest

The authors declare no conflicts of interest.

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