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Horse-Related Injuries: Causes, Preventability, and Where Educational Efforts Should be Focused

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ANIMAL HUSBANDRY & VETERINARY SCIENCE | RESEARCH ARTICLE

Horse-related injuries: Causes, preventability, and where educational efforts should be focused

Fernanda Camargo^{1*}, William R. Gombeski Jr², Polly Barger³, Connie Jehlik⁴, Holly Wiemers⁵, James Mead⁶ and Amy Lawyer⁷

Abstract: A high percentage of equestrians will experience accidents, with different degrees of severity, throughout their riding careers. Horse-related injuries have the highest likelihood of requiring hospitalization based on individuals visiting US emergency departments. Studies have shown that the majority of injured riders said they could have prevented the accident and the injury was due to rider/handler error. Therefore, equestrians reported their injuries, and a panel of experts analyzed these reports to better understand the causes, how to prevent, and where to invest educational resources to generate a reduction in horse-related accidents. The majority of riders reported intermediate riding skills, most accidents occurred in the arena, and most were preventable. The most severe accidents occurred when the weather played a major role, as opposed to the least severe accidents when riders were in the horse's space. Avoidable accidents included when tack broke, as opposed to unavoidable accidents such as horses slipped or fell. Educational Impact Index was calculated with combined results of the cause of injury, avoidability, and severity. Other humans, horse spooked, and tack/equipment problems were the main causes of accidents with the highest educational impact index, and authors believe that educational efforts should be focused on these categories.

Subjects: Agriculture; Environment & Society; Environment & Health; Environmental Policy; Development Studies; Environment, Social Work, Urban Studies; Sports and Leisure; Social Sciences; Tourism, Hospitality and Events; Behavioral Sciences; Education

Keywords: equestrian safety; horseback riding safety; preventable injuries, equestrian helmet, helmet, horse

1. Introduction

Horseback riding is a rewarding and thrilling sport and recreational activity. However, it does not come without risks. A high percentage of riders will experience some sort of injury, with different degrees of severity, throughout their riding careers. It is well known within the equestrian

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PUBLIC INTEREST STATEMENT

Horseback riding is a rewarding and thrilling sport and recreational activity. However, it does not come without risks. A high percentage of riders will experience some sort of injury, with different degrees of severity, throughout their riding careers. The goal of this paper was to evaluate the most common causes of horse-related accidents, their severity, and how to prevent them in order to promote this healthy and wholesome activity.

community that the longer one rides, the greater the likelihood of an accident and injury requiring medical care. Mayberry, Pearson, Wiger, Diggs, and Mullins (2007) noted that 81% of 679 equestrians studied had experienced at least one riding injury in their lifetime requiring medical care. In the pediatric population, as high as 21% of young riders are injured in any year (Havlik, 2010). Injuries caused by horses have the highest likelihood of requiring hospitalization based on individuals visiting US emergency departments with injuries caused by one of the 250 recreational activities tracked. The horse riding injury admission rate to a hospital is 16.6% higher than the next activity—All Terrain Vehicles (ATV)/motorcycle riding at 12.0% (United States Consumer Product Safety Commission, 2014). It has been reported that horseback riding has the highest mortality rate of all sports, with death rate as approximately 1 per million populations per annum in South Africa (Pounder, 1984) and 0.5 per million populations per annum in Sweden (Ingemarson, Grevsten, & Thorean, 1989). Horse-related injuries are reported to occur at a rate less than 1 per 1,000 riding hours (Paix, 1999), and younger females are at a higher risk (Abu-Zidan & Rao, 2003). Several studies have also shown that anywhere from 38–64% of injured riders said they could have prevented the injury and that the injuries were due to horse rider/handler error (Ball, Ball, Mulloy, Datta, & Kirkpatrick, 2009; Ekberg, Timpka, Ramel, & Valter, 2011; Newton & Nielson, 2005). Many respondents also believed that with education and good knowledge of horse behavior, several of these injuries could be prevented (Chitnavis, Gibbons, Hirigoyen, Parry, & Simpson, 1996; Ingemarson et al., 1989).

To help increase awareness of horse-riding safety and to reduce the number and severity of horse related injuries, SaddleUp SAFELY, a coalition of over forty horse and medical organizations based in Lexington Kentucky, was launched in 2009. A complete list of members can be found at saddleup-safely.org.

As part of the launch of SaddleUp SAFELY a website was created where, among other resources, equestrians could report with detail any horse-related accidents and injuries they had experienced. The aim of this study was to analyze the horse-related injuries reported, assess the circumstances surrounding the accidents, evaluate the severity and whether the accident could be prevented; with the goal to better understand where to invest educational resources to reduce the number and severity of horse-related accidents.

2. Materials and methods

From October 2009 until November 2011, 342 riders reported with detail their accidents and injuries they experienced. The saddleupsafely.org injury form (Appendix 1) provided areas for each respondent to explain how the horse-related injury occurred, if they were hospitalized and/or went to the emergency room, saw a doctor or other medical professional, missed school or work or lost employment. Further, respondents were asked to provide a detailed account of the circumstances surrounding their injury, if they thought the accident could have been prevented, as well as advice for how others might avoid a similar injury in the future. Additional information, such as horse-related experience; e.g. how often they ride, whether they raise or keep horses, whether they competed at an amateur or professional level, or if they make their living working with horses. Data regarding gender and age were not collected. However, respondents needed to be over 18 years of age to submit their reports.

Of the 342 respondents, 42 provided safety tips only and 35 of the injury forms had significant missing data leaving a useable sample of 266 cases for analysis. The same accident could have led to multiple injuries, and these were accounted for.

The forms submitted were jointly reviewed, discussed and quantitatively coded by a team of four expert equestrian professionals associated with the Kentucky 4-H Horse Program, The United States Pony Clubs, the Certified Horsemanship Association, and the University of Kentucky Equine Programs. The experts assessed each accident and assigned the causative reason for each resulting accident. The reasons and explanations are depicted on Table 1. All coding discrepancies were debated and solved by reviewer consensus. Finally, the coded data was imported into a Statistical Package for the

Table 1. Causative reasons for accidents and their explanation

| | |
|--|---|
| Buddy/Barn Sour Behavior | Horse refused to move away from barn because it was missing its friend, or vehemently wanted to return to the barn, causing the accident |
| Error, Other horse | Another horse, which may or may not have a rider, was the cause of the accident |
| Error, Other human | Someone else, who is not directly related with the rider, was instrumental in causing the accident |
| Fresh Horse | Horse was not warmed up and supple enough for the task, or horse was full of energy from the get go |
| Green Horse | The horse is in the beginning of training, or new to learning a specific task |
| Hit Horse's Neck/Body/Head | Accident was the result of the rider, as he/she was falling, hitting the horse on the neck, on the body, or on the head |
| Holes in Ground/Obstacle | Accident was the result of holes in the ground or right before an obstacle |
| Horse Ill, Sore Back | Horse was showing signs of disease, or had back pain |
| Horse Keeping/Maintenance | Accident happened while handler was either feeding or grooming the horse |
| Horse Not Tied/Tying | Accident happened when handler was trying to tie the horse, or handler thought the horse was tied, and it was not |
| Horse Refused | Horse refused to perform designated task, which may include jumping, crossing water, or any other maneuver the horse is vehemently refusing to perform |
| Horse Slipped | Horse slipped, which could have been the result of a number of situations, for example, metal horseshoes on pavement |
| Horse Spooked | Horse reacted in fear of something, unseating the rider |
| Horse Tripped and Fell | Something out of the control of the rider caused the horse to stumble and also fall |
| Horse Tripped | Horse tripped, but did not fall |
| Human Medical Problems | The rider had a medical problem, such as diabetes or heart condition, or any other medical problem |
| Ill-Mannered Horse | The horse crowded, was pushy, acted aggressively, or otherwise refused to heed the commands of the rider or handler |
| In Horse's Space | Handler did not respect the horse's space, and did not pick up on horse's cues when the horse was indicating something was wrong or bothering him |
| Incorrect Leading | The handler was not following proper safety procedures for leading a horse |
| Incorrect Lunging | Handler was incorrectly trying to lunge the horse (for example, lunge line was wrapped around the hand, or was dragging and handler tripped) when accident occurred |
| Incorrect Riding Apparel | The rider did not wear proper clothing and footwear to protect against common riding incidents |
| Jumping | The accident occurred while the rider and horse were intentionally jumping or preparing to jump an obstacle |
| Loose Horse in Pasture/Gate | The accident happened when handler was turning horse out, or catching horse from pasture |
| Mount/Dismount | Accident occurred either during mounting or dismounting |
| Mud/Rain/Ice/Slick | Accident was the result of terrain |
| New Horse | Horse is new to the rider, regardless of any or level of training |
| No Safety Check | Rider or whoever tacked the horse, did not perform a pre-riding safety check of the tack to ensure it was intact and safe |
| Other/Not Clear | The reviewers were not able to identify the specific cause of the accident |
| Rider Fell/Handler Fell | No other explanation was given for what resulted in the fall |
| Runaway Horse | The rider lost control of the horse, which resulted in the horse running off |
| Saddle Slipped | The saddle, for whatever reason, moved out of proper position causing either unbalance for the rider or discomfort for the horse, which resulted in the accident |
| Tack Broke | The correct tack was used but something caused it to tear or break resulting in the rider falling or losing control of the horse |
| Tack/Equipment Problem: or the purpose of the ride | The tack and or equipment was ill-fitting for the horse or rider, or the incorrect tack was used for the training level of horse |
| Unsafe Speed | Horse was going too fast for the task it was about to perform |
| Weather (Heat/Cold) | The weather is windy, too hot, there is a storm approaching, or any sudden change in weather patterns |

Social Science (IBM SPSS Statistics, version 21) file for analysis. Means and Z-scores were calculated for each cause of accident to assess severity, avoidability, and educational impact index.

To calculate the severity of the injury, the consequence of the reported injury was used. The severity of the injury was coded depending on whether a rider did not seek medical care (the least serious outcome, with a coded value of 1), sought medical care but did not visit an emergency department (a less serious outcome, with a coded value of 2), just visited the emergency department (a serious outcome, with a coded value of 3) or was hospitalized as a result of the injury (the most serious outcome, with a coded value of 4). To allow for more intuitive comparisons of injury severity by causes, the injury severity data was transformed into Z-scores (calculated by subtracting the raw score for each rider from the mean seriousness of injury score within the data, divided by the standard deviation of the population). As such, Z-score values represent the degree to which an original data value is above or below the mean injury severity within the data-set, as expressed in units of standard deviation from the mean value. Therefore, the higher the Z-score value the more severe the injury, from a relative standpoint.

The avoidability of the injury was created based on whether the accident or injury was avoidable, based on the expert coders' assessment of the description and circumstances surrounding the injury event (rated on a six point scale where 1 = not at all avoidable and 6 = completely avoidable). This data was also transformed into Z-scores. The higher the Z-score, the more avoidable the injury is.

The educational impact index was calculated using information on percent of injury by cause, avoidability, and severity of resulting injury. This value was used to create an educational impact index, which allows us to see the greatest opportunities to educate humans with the goal of reducing injury. Note, since the avoidability and seriousness of resulting injury are each presented as Z-score values, our index of the opportunity to reduce injuries gives equal weight to avoidability and severity, though other weighting schemes are certainly possible. The educational impact index provides a relative measure that shows which causes of severe injuries could be reduced the most thorough education/prevention efforts.

3. Results

An overview of the participant population can be found in Table 2. "Level of riding experience" was primarily intermediate (52.5%) with similar proportions of novice/beginner (24.2%) or advanced/professional (23.4%).

Table 3 provides an overview of the injury results. Thirty-eight percent ($n = 101$) of the injuries occurred "at home", while 23.3% ($n = 62$) happened when the horse was "away from home". We were unclear about the location for 38.7% ($n = 103$) of the accidents. Over half of the injuries took place in the "arena" (22.3%), on the "trail" (20.8%) or in the "pasture" (11.7%). Most of the injuries took place while "mounted" (95.1%) as opposed to "on the ground" (4.9%). Overall 55.8% had an injury serious enough to be "hospitalized" (26.0%) or to go to an "emergency department" (29.8%). About 66% of the injured riders said their injury was avoidable and the study experts who reviewed the injury/accident narrative indicated that they strongly agreed or agreed that 60.8% of the injuries were preventable.

Table 2. Study population description of their riding experience

| Riding experience | <i>n</i> | % |
|-------------------|----------|-------|
| Novice | 10 | 3.8 |
| Beginner | 54 | 20.4 |
| Intermediate | 139 | 52.5 |
| Advanced | 48 | 18.1 |
| Professional | 14 | 5.3 |
| Total | 265 | 100.1 |

Table 3. Injury information

| | n | % |
|---|----------|----------|
| Location where injury occurred | | |
| Arena | 59 | 22.3 |
| Trail | 55 | 20.8 |
| Pasture | 31 | 11.7 |
| Barn | 20 | 7.5 |
| Trailer | 10 | 3.8 |
| Round pen | 2 | 0.8 |
| Other/Not clear | 88 | 33.2 |
| Injury occurred mounted or dismounted | | |
| Mounted | 253 | 95.1 |
| Dismounted | 13 | 4.9 |
| Location when injury happened | | |
| Home | 101 | 38.0 |
| Away | 62 | 23.3 |
| Unclear or missing data | 103 | 38.7 |
| Injury consequence | | |
| Hospitalized | 69 | 26.0 |
| Emergency Room visit but not hospitalized | 79 | 29.8 |
| Sought medical attention not Emergency Room | 44 | 16.6 |
| Did not seek medical attention | 73 | 27.5 |
| Injured equestrian indicated: Accident/Injury preventable | | |
| Yes | 175 | 66.2 |
| No | 90 | 33.8 |
| Expert panel rated: Accident/Injury preventable | | |
| Preventable | 161 | 60.6 |
| Neutral | 54 | 20.3 |
| Not preventable | 40 | 15.0 |
| Unclear (needed more explanation) | 11 | 4.1 |

Table 4 shows the cause of injury in descending order with the more frequent events at the top. A “spooked horse” was the leading cause responsible in 27% of the cases followed by “error caused by other humans” 16%, “green horse” 11%, “new horse” 11% and “error caused by other horse” 9%.

Table 5 depicts the severity of the injuries, with the most severe injuries having a higher Z-score. “Weather”, such as sudden weather changes while riding, and “human medical problems”, such as diabetes, while consisting of low number of respondents, had the highest severity of injury scores at 1.920 and 1.476 respectively. The top five causes of injuries with number of respondents over 18 resulting in the most serious injuries were “runaway horse” (1.371), “error caused by other human” (1.360), followed by “jumping” (1.107), “new horse” (1.092) and “green horse” (1.072), “tack and equipment problem” (1.033) and “error by other horse” (1.033).

Table 6 depicts the avoidability of injuries based on their Z-scores. The top three most avoidable causes were tack related: “tack broke” (1.937), “saddle slipped” (1.859) and “no safety check” (1.859). Four of the first six causes that were most avoidable were tack-related.

Table 4. Causes of injury (multiple causes were allowed)

| Cause | n | % |
|-----------------------------|----------|----------|
| Horse Spooked | 71 | 26.69 |
| Error, Other human | 41 | 15.47 |
| Green Horse | 29 | 10.90 |
| New Horse | 28 | 10.53 |
| Other/Not Clear | 26 | 9.77 |
| Error, Other horse | 25 | 9.43 |
| Tack/Equipment Problem | 25 | 9.40 |
| Jumping | 24 | 9.02 |
| Horse Tripped and Fell | 20 | 7.52 |
| Runaway Horse | 18 | 6.77 |
| Horse Refused | 17 | 6.39 |
| Ill-Mannered Horse | 16 | 6.02 |
| Hit Horse's Neck/Body/Head | 15 | 5.64 |
| Mount/Dismount | 13 | 4.89 |
| Mud/Rain/Ice/Slick | 13 | 4.89 |
| Holes in Ground/Obstacle | 12 | 4.51 |
| Saddle Slipped | 11 | 4.14 |
| No Safety Check | 11 | 4.14 |
| Horse Keeping/Maintenance | 11 | 4.14 |
| Unsafe Speed | 10 | 3.76 |
| Fresh Horse | 10 | 3.76 |
| Horse Tripped | 10 | 3.76 |
| Loose Horse in Pasture/Gate | 9 | 3.38 |
| Rider Fell/Handler Fell | 8 | 3.01 |
| Incorrect Leading | 7 | 2.63 |
| Incorrect Riding Apparel | 7 | 2.63 |
| Horse Not Tied/Tying | 7 | 2.63 |
| Horse Slipped | 7 | 2.63 |
| Tack Broke | 6 | 2.26 |
| In Horse's Space | 6 | 2.26 |
| Weather (Heat/Cold) | 5 | 1.88 |
| Buddy/Barn Sour Behavior | 5 | 1.88 |
| Horse Ill, Sore Back | 4 | 1.50 |
| Human Medical Problems | 2 | 0.75 |
| Incorrect Lunging | 1 | 0.38 |

Being able to ascertain the educational impact index of an injury was a key component to this study. Table 7 depicts the educational impact index. Using the method described above, this study suggests that additional education would have the greatest impact on injuries caused by other humans, which had the highest index. The 0.222 index score indicates that, relative to other injury causes, “other human” involved injuries are a multiplicative combination of very common,

Table 5. Severity of injury by cause

| Cause | n | Z-Score |
|-----------------------------|----------|----------------|
| Weather (Heat/Cold) | 5 | 1.920 |
| Human Medical Problems | 2 | 1.476 |
| Runaway Horse | 18 | 1.371 |
| Tack Broke | 6 | 1.371 |
| Error, Other Human | 41 | 1.360 |
| Incorrect Leading | 7 | 1.341 |
| Horse Ill, Sore Back | 4 | 1.318 |
| Mount/Dismount | 13 | 1.306 |
| Horse Refused | 17 | 1.122 |
| Jumping | 24 | 1.107 |
| New Horse | 28 | 1.092 |
| Green Horse | 29 | 1.072 |
| Tack/Equipment Problem | 25 | 1.033 |
| Error, Other Horse | 25 | 1.033 |
| Fresh Horse | 10 | 1.033 |
| Incorrect Lunging | 1 | 1.002 |
| Horse Spooked | 71 | 0.999 |
| Loose Horse in Pasture/Gate | 9 | 0.948 |
| Holes in Ground/Obstacle | 12 | 0.948 |
| Horse Tripped and Fell | 20 | 0.938 |
| Saddle Slipped | 11 | 0.929 |
| Other/Not Clear | 26 | 0.916 |
| Unsafe Speed | 10 | 0.906 |
| Horse Slipped | 7 | 0.888 |
| Horse Keeping/ Maintenance | 11 | 0.872 |
| Hit Horse's Neck/Body/Head | 15 | 0.864 |
| Horse Tripped | 10 | 0.843 |
| No Safety Check | 11 | 0.814 |
| Incorrect Riding Apparel | 7 | 0.798 |
| Horse Not Tied/Tying | 7 | 0.798 |
| Ill-Mannered Horse | 16 | 0.764 |
| Rider Fell/Handler Fell | 8 | 0.684 |
| Mud/Rain/Ice/Slick | 13 | 0.672 |
| Buddy/Barn Sour Behavior | 5 | 0.146 |
| In Horse's Space | 6 | 0.104 |

comparably severe, and generally avoidable injuries, such that educational efforts directed to their prevention would likely result in a more meaningful reduction of the most harmful injury events, relative to causes with lower index scores. “Spooked horse” was the second area with the most potential for reduction in injury consequences (0.212) followed by “tack and equipment problem”

Table 6. Avoidability by cause of injury

| Cause | n | Z-Score |
|-----------------------------|----------|----------------|
| Tack Broke | 6 | 1.937 |
| Saddle Slipped | 11 | 1.859 |
| No Safety Check | 11 | 1.859 |
| Incorrect Leading | 7 | 1.849 |
| In Horse's Space | 6 | 1.814 |
| Tack/Equipment Problem | 25 | 1.706 |
| Incorrect Riding Apparel | 7 | 1.534 |
| Buddy/Barn Sour Behavior | 5 | 1.471 |
| Runaway Horse | 18 | 1.446 |
| Mount/Dismount | 13 | 1.437 |
| Horse Not Tied/Tying | 7 | 1.429 |
| Unsafe Speed | 10 | 1.397 |
| Horse Keeping/ Maintenance | 11 | 1.391 |
| Green Horse | 29 | 1.374 |
| Human Medical Problems | 2 | 1.324 |
| Horse Refused | 17 | 1.280 |
| Loose Horse in Pasture/Gate | 9 | 1.242 |
| Horse Slipped | 7 | 1.113 |
| Error, Other Human | 41 | 1.054 |
| Other/Not Clear | 26 | 1.040 |
| Fresh Horse | 10 | 1.029 |
| Ill-Mannered Horse | 16 | 1.002 |
| Incorrect Lunging | 1 | 1.000 |
| New Horse | 28 | 0.982 |
| Hit Horse's Neck/Body/Head | 15 | 0.980 |
| Rider Fell/Handler Fell | 8 | 0.956 |
| Mud/Rain/Ice/Slick | 13 | 0.927 |
| Error, Other Horse | 25 | 0.882 |
| Horse Tripped | 10 | 0.882 |
| Horse Spooked | 71 | 0.795 |
| Holes in Ground/Obstacle | 12 | 0.772 |
| Horse Ill, Sore Back | 4 | 0.772 |
| Weather (Heat/Cold) | 5 | 0.735 |
| Jumping | 24 | 0.680 |
| Horse Tripped and Fell | 20 | 0.367 |

problems (0.166). The next four categories; “green horse” (0.161), “runaway horse” (0.134), “new horse” (0.113) and “horse refused” (0.092) are similar in that there is a horse behavior theme involved, and relate to injuries that could possibly be prevented with improved horse training.

Table 7. Greatest opportunities to reduce injury: Educational impact index

| Cause of injury | Percent of injury x | Avoidability x | Severity = | Educational impact index |
|---------------------------------|---------------------|----------------|------------|--------------------------|
| | % | Z-Score | Z-Score | Index |
| Error/Other Human(s) | 15.47 | 1.054 | 1.360 | 0.222 |
| Horse Spooked | 26.69 | 0.795 | 0.999 | 0.212 |
| Tack/Equipment Problem | 9.40 | 1.706 | 1.033 | 0.166 |
| Green Horse | 10.90 | 1.374 | 1.072 | 0.161 |
| Runaway Horse | 6.77 | 1.446 | 1.371 | 0.134 |
| New Horse | 10.53 | 0.982 | 1.092 | 0.113 |
| Horse Refused | 6.39 | 1.280 | 1.122 | 0.092 |
| Mount/Dismount | 4.89 | 1.437 | 1.306 | 0.092 |
| Other Horse(s) | 9.43 | 0.882 | 1.033 | 0.086 |
| Saddle Slipped | 4.14 | 1.859 | 0.929 | 0.071 |
| Jumping | 9.02 | 0.680 | 1.107 | 0.068 |
| Other/Not Clear | 9.77 | 1.040 | 0.916 | 0.066 |
| Incorrect Leading | 2.63 | 1.849 | 1.341 | 0.065 |
| No Safety Check | 4.14 | 1.859 | 0.814 | 0.063 |
| Tack Broke | 2.26 | 1.937 | 1.371 | 0.060 |
| Horse Keeping/ Maintenance | 4.14 | 1.391 | 0.872 | 0.050 |
| Hit Horse's Neck/Body/ Head | 5.64 | 0.980 | 0.864 | 0.048 |
| Unsafe Speed | 3.76 | 1.397 | 0.906 | 0.048 |
| Ill-Mannered Horse | 6.02 | 1.002 | 0.764 | 0.046 |
| Fresh Horse | 3.76 | 1.029 | 1.033 | 0.040 |
| Loose Horse in Pasture/ Gate | 3.38 | 1.242 | 0.948 | 0.040 |
| Holes in Ground/Obstacle | 4.51 | 0.772 | 0.948 | 0.033 |
| Incorrect Riding Apparel | 2.63 | 1.534 | 0.798 | 0.032 |
| Mud/Rain/Ice/Slick | 4.89 | 0.927 | 0.672 | 0.030 |
| Horse Not Tied/Tying | 2.63 | 1.429 | 0.798 | 0.030 |
| Horse Tripped | 3.76 | 0.882 | 0.843 | 0.028 |
| Weather (Heat/Cold) | 1.88 | 0.735 | 1.920 | 0.027 |
| Horse Slipped | 2.63 | 1.113 | 0.888 | 0.026 |
| Horse Tripped and Fell | 7.52 | 0.367 | 0.938 | 0.026 |
| Rider Fell/Handler Fell | 3.01 | 0.956 | 0.684 | 0.020 |
| Horse Ill, Sore Back | 1.50 | 0.772 | 1.318 | 0.015 |
| Human Medical Problems | 0.75 | 1.324 | 1.476 | 0.015 |
| In Horse's Space | 2.26 | 1.814 | 0.104 | 0.004 |
| Buddy/Barn Sour Behavior | 1.88 | 1.471 | 0.146 | 0.004 |
| Incorrect Lunging | 0.38 | 1.000 | 1.002 | 0.004 |

4. Discussion

It is well known that equestrians can be injured many ways. Many studies have identified horseback riding as a higher risk-activity than car racing, motorcycle riding, football and skiing (Buckley, Chalmers, & Langley, 1993; Macnab & Cadman, 1996; Norwood et al., 2000; Sorli, 2005). Our data

shows a wide variety of causes with varying degrees of preventability. It is unfortunate that reported head injuries can be as high as 48% in some study populations (Ball, Ball, Kirkpatrick, & Mulloy, 2007), being that the use of proper riding helmets has significantly reduced the number of severe and fatal head injuries (Chitnavis et al., 1996; Ingemarson et al., 1989).

The knowledge, through education, of risk factors associated with horse-related injuries, and horse behavior can be invaluable in preventing many horse-related injuries. It is noteworthy that the minority of the population in this study reported to compete professionally, or to make their living working with horses. This implies that the majority of this study's population either compete as amateurs, or ride recreationally, and the authors of this study anticipate that this population will be receptive to horse-related education.

One study (Abu-Zidan & Rao, 2003) reported that the majority of injuries admitted in their hospital was caused by fall from a horse (67%), followed by being kicked by a horse (16%), and most accidents occurred in public places (55%). Our results support their findings, in that the great majority of accidents happened after the rider fell from the horse (83.4%, which includes "fell off horse", "bucked off", "knocked down", "horse fell on rider", "horse fell with rider", "dragged"), whereas being "kicked" or "stepped on" by a horse reportedly happened 19.5% of the time. However, our results show that the majority of the reported injuries happened "at home" ($n = 101$) whether in an "arena", "trail" or "pasture", as opposed to "away from the horse's home" ($n = 62$), which differs from Abu-Zidan's report.

This current study finding of 66% of riders reporting their injuries were preventable is very similar to Mayberry et al.'s (2007) and Ball et al. (2007) findings (both report 64%) and supports the potential value of increased safety awareness and education.

The primary cause reported by the respondents in this current study is that their "horse spooked" ($n = 71$), followed by "error of another human" ($n = 41$), "green horse" ($n = 29$), "new horse" ($n = 28$), "tack and equipment problem" ($n = 25$) and "error of another horse" ($n = 25$). Horses, being prey animals, are known to be unpredictable and spook at numerous things. However, it is also known that the more a horse is trained, the likelihood of it randomly spooking is much lower when compared to green, less trained, horses (McGreevy & McLean, 2010). Therefore, the authors believe that having a horse-related accident as a result of a horse that spooks can be prevented by riding horses that are better trained. This can be achieved by sending the horse off to professional trainers, or through training and education of the owners/riders.

Regarding injuries caused by "green horse" and "new horse", they can also be somewhat prevented by education or safer practices. Many times equestrians think they are more proficient than they actually are, and that notion will make a person ride a green or new horse when they probably do not have the necessary skill set and ability to ride such horses. Although it is reported that professional equestrians suffer more serious accidents than the non-professionals (Mayberry et al., 2007), their accidents happen less often, and are generally due to more complex causes, such as the increased level of difficulty of their activity, as compared to a "green horse". The authors highly recommend that people ride horses that are adequately trained for the rider's level of expertise. Horse and rider suitability is a main area where coaches and instructors may assist in the prevention of injuries. A "green horse" should never be paired with a rider that is less than advanced. Green horses can be unpredictable, maybe not intentionally, but this unpredictability is somewhat predicted and expected by advanced riders, who have enough training and skill to not have an accident or injury. It is up to coaches and instructors to identify gaps in horse and rider suitability and be able to adjust accordingly, pairing up the appropriate horses with the riders' proficiency level.

Increasing levels of difficulty of riding results in increased levels of risk. In disciplines where speed, jumps, or rough terrain are a factor in competition, caution must be taken when considering footing, environment, materials and construction of obstacles, and level of training of the horse and rider.

These factors should be evaluated not only by the rider and instructor, but also the show or facilities manager. Proper safety equipment, which includes an approved helmet, is recommended. Helmets have the potential to diminish the chances of serious head injury, but will not protect the spine and other parts of the body, or even prevent all head injuries.

What was surprising to the authors, who are lifelong equestrians, is that the second highest reported cause of accidents was the “error of another human”. This includes people that honk their horn or rev their engine as they drive by, spectators at shows and competitions that display inappropriate behavior around horses, such as flailing of the arms, shaking loud plastic bags, opening umbrellas, running toward a horse, or even riders and new horse owners who do not know proper show ring/trail ride riding etiquette. Although this is a group of people that may be difficult to reach since they are not necessarily an audience that would seek information on horse behavior, it is imperative that horse organizations make an effort to educate the general public on equine behavior and safety. As our society becomes more modernized and moves away from an agrarian upbringing, it is expected that people may know less about horse behavior than previous generations, and, therefore, do not know how to behave near a horse. Consequently, to ensure the safety of equestrians, equine organizations need to address this issue. Educational materials, signs, increased personnel to help and inform individuals of proper behavior are all ways to help minimize this element as a factor in horse-related injuries.

The severity of injuries that resulted from unexpected weather patterns was somewhat unforeseen. However, the conclusion the authors derive from changes in weather is that a horse being a prey animal may feel more fear with the smells and sounds that accompany an incoming thunderstorm and other inclement weather. It is the recommendation of the authors, that unless the rider absolutely has to ride during those types of weather, to just wait for the weather pattern to calm down. When the weather issue is created by extreme heat, it is recommended that the rider take measures to elevate the hydration status and glycemic index for both themselves and their horse. This will help to prevent overheating and fainting both of the rider and the horse, which can be catastrophic.

When the injuries caused by “tack and equipment problems”, “tack broke”, “saddle slipping”, and “failure to perform a safety check”, were combined, the second largest category of accidents (second to “spooked horse”) was generated, with varying degrees of severity. This category also includes but is not limited to, saddle, stirrup, bridle, or girth breaking during the ride, saddle slipping, incorrect bit or other equipment, as well as poorly fitting tack. With a total of 53 accident reports (19%) related to tack and equipment, the authors believe that more educational efforts need to be geared toward this subject. Pre-ride tack check is paramount for a safe ride. This will include, making sure the tack fits properly (both to the horse and rider), leather that is not frail (tack that is in adequate working order), intact stitching, a girth that is tight enough (girth will tend to get loose a few minutes after the horse is tacked and starts to move, so it needs to be readjusted), tack that is free of debris (including saddle pads and wraps), and correct bit for the specific horse. It is important to check and adjust the tack as needed especially if someone else tacked the horse for the rider. This becomes more complicated when the instructor tacks the horse for the student for several reasons; (1) the instructor has a leadership role over the student, (2) the instructor allegedly knows more/is more proficient than the student, (3) the horse and tack may belong to the instructor, (4) the instructor has taught the student how to properly tack a horse, (5) student may feel awkward going behind the instructor to adjust the tack, and likely many other reasons. However, the authors believe that for safety and potential liability issues, the instructors should put the responsibility of the final tack check on the student. This way the student may feel more comfortable in doing a final check.

In agreement with reports previously cited about the severity of horse-related accidents (Guyton, Houchen-Wise, Peck, & Mayberry, 2013), these results show that over 25% of the cases resulted in hospitalization. However, the data-set did not provide information on the duration of hospitalization.

The data used in this retrospective study were derived from information that respondents freely gave. Therefore, without the use of a more complete questionnaire, there are many causes of injuries that could be grouped together. For example, using the educational impact index (Table 6), the top 10 causes could be grouped into four categories: “errors by other humans”, “horse behavior”, “tack and equipment”, and “mounting and dismounting”. The authors recommend that horse-related organizations should discuss how to address these four areas in their safety lectures and materials.

It is also important to note that there is an inherent risk that everyone assumes when handling, riding, or just being around horses. This fact is made evident by approximately 15% of the injuries reported were deemed not preventable by our expert reviewers, with the reviewers being unsure of the preventability of another 20% of the injuries.

There are limitations with the data collected for this study. First it is self-initiated. Participants had to find out about our website and accident-reporting form. Therefore, the group that responded is more likely to have internet access and be comfortable using the internet. It is likely our research participants are more educated and motivated about horse riding and handling safety than the general horse riding population.

Second, the data is self-reported and retrospective. There can be discrepancies between actual and remembered facts. Haegeli, Falk, Brugger, Etter, and Boyd (2011) and Boyd, Haegeli, Abu-Laban, Shuster, and Butt (2009) both indicated that minor injuries are often under reported in those injured by avalanches. Gabbe, Finch, Bennell, and Wajswelner (2013) did note that major elements of an injury are more likely to be recalled a year later as opposed to minor details. Therefore, it is likely that there is some inaccuracy in the data reported in our study as there was no limit on time since injury and it is likely minor injuries were not reported.

However, self-reported data is, sometimes, the only way to acquire medical data. Mitchell, Finch, and Boufous (2010) noted that in a study of 2,414 respondents involved in sports activities, 31% had reported an injury in the previous 12 months. Only 2.8% were hospitalized and 6.1% had visited an Emergency Room. This means over 90% of those injured would not have been identified through use of hospital data alone. This highlights that self-reported data is often the only cost-effective and accessible method to collect information from a targeted population.

A third limitation of our data is that it represents equestrians who had more severe injuries. Using the 2014 National Electronic Injury Surveillance System data, 16.6% of those visiting an Emergency Room due to a horse riding injury were hospitalized. On the other hand, in this present study 43% who visited an Emergency Room were hospitalized.

However, the literature in general shows that self-reported data is valid and an acceptable approach for measuring accident injury recall (Bavarian, Mehrkhanl, Ziaee, Youseti, & Nourian, 2009; Lubeck & Hubert, 2005; Stathokostas, Theou, Vandervoort, & Raina, 2012).

5. Conclusion

The horse riding community has long recognized that injuries are one of the potential consequences of participating in the equestrian sport or recreational activity. This study indicates that some kinds of injuries are more likely to be preventable than others. For example, it is easier to prevent an accident caused by tack breakage than by a horse tripping and falling, which can be near impossible to prevent under certain circumstances. It is imperative that riders learn equine behavior and safety practices around horses to prevent the majority of accidents while on the ground. Safety practices when dismounted include correct leading, turn out in the pasture, approach, grooming, lunging, mounting and dismounting.

This study shows that a constituted effort needs to be made on the part of equine organizations everywhere to educate not only riders but also the general public on horse safety. This study has identified some key areas where injuries are frequent that could easily be avoided by increased knowledge and practice. Educational efforts should be targeted at those causes in hopes to lessen the frequency and severity of injuries that occur around horses. The educational impact index created provides a starting point for considering where to invest education and training resources. It is our hope that more people will be able to enjoy and benefit from horseback riding if many preventable injuries can be reduced.

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Competing interest

The authors declare no competing interest.

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Appendix 1. Online form where riders described their accidents and resulting injuries

We want to know how you avoid riding injuries!

Have you ever had a horse-related accident? Please tell us about it!

1. What caused the injury?
2. What area of the body was injured and how badly?
3. Were you hospitalized for the injury?
 - a. Yes
 - b. No
4. If you sought medical attention, did you:
 - a. Go to the emergency room
 - b. See a doctor or medical professional
 - c. Miss school or work
 - d. Lose employment/got laid off
5. Do you think your accident could have been prevented?
6. What advice do you have for the other riders of horse handlers for avoiding this kind of accident?
7. Do you have any safety tip?
8. What is your experience with horses?
 - a. I only ride occasionally
 - b. I ride weekly or more often
 - c. I raise or keep horses
 - d. I compete on an amateur level
 - e. I compete on a professional level
 - f. I'm a person who makes their living working with horses

Appendix 2. Injury form developed by committee to code each cause of accident and resulting injury

SUS Injury Form

1. ID #: _ _ _ _

2. Date submitted tip: _ _ - _ _ - _ _ (day, month, year)

3. Cause of Accident:

Initial Cause _____, _____, _____, _____

Resulting Cause

- 01. No safety check
- 02. Tack broke
- 03. Horse slipped
- 04. Horse tripped
- 05. Horse spooked other
- 06. Unknown
- 07. Vehicle
- 08. Animal
- 09. Paper/material
- 10. Noise

- 23. Tack Problem
- 24. Holes in ground
- 25. Horse not tied
- 26. In horse's space
- 27. Mud/rain/ice/slick
- 28. Runaway horse
- 29. Mount/dismount
- 30. Buddy/barn sour behavior
- 31. Incorrect Leading

- 01. Fell off horse
- 02. Bucked off
- 03. Emergency dismount
- 04. Horse fell on rider
- 05. Finger/hand caught
- 06. Pulled muscle
- 07. Stepped on by horse
- 08. Bit by horse
- 09. Dragged
- 10. Slammed/struck tree/fence

- 11. Bees/Wasps/Flies
- 12. Horse ill, sore back
- 13. Loose horse in pasture/gate
- 14. Green horse
- 15. New horse

- 32. Human medical problems
- 33. Alcohol/Drugs
- 34. Horse not lunged
- 35. Unsafe speed
- 36. Ill-mannered horse
- 37. Other/Not Clear

- 11. Kicked
- 12. Other/Not Clear
- 13. Wagon/buggy
- 14. Horse fell with rider

- 16. Weather (Heat, Cold)
- 17. Jumping Problem
- 18. Horse Refused
- 19. Horse Tripped/Fell
- 20. Rider Fell
- 21. Saddle Slipped
- 22. Hit horse's neck/body/head

4. Primary Injury

1=yes 2=no

- Broken Bone _____
- Concussion _____
- Bruises _____
- Bleeding _____
- Internal bleeding _____
- Cuts _____
- Sprains/Strains/tear _____
- Pain _____
- Swelling _____

Joint dislocation _____

5. Secondary injury 1=yes 2=no

- Broken Bone _____
- Concussion _____
- Bruises _____
- Bleeding _____
- Internal bleeding _____
- Cuts _____
- Sprains/Strains/tear _____
- Pain _____
- Swelling _____
- Joint dislocation _____

6. Third Injury 1=yes 2=no

- Broken Bone _____
- Concussion _____
- Bruises _____
- Bleeding _____
- Internal bleeding _____
- Cuts _____
- Sprains/Strains/tear _____
- Pain _____
- Swelling _____
- Joint dislocation _____

Fourth Injury

- Broken Bone _____
- Concussion _____
- Bruises _____
- Bleeding _____
- Internal bleeding _____
- Cuts _____
- Sprains/Strains/tear _____
- Pain _____
- Swelling _____
- Joint dislocation _____

Fifth Injury

- Broken Bone _____
- Concussion _____
- Bruises _____
- Bleeding _____
- Internal bleeding _____
- Cuts _____
- Sprains/Strains/tear _____
- Pain _____
- Swelling _____
- Joint dislocation _____

7. Injured Body Part

Yes = 1 No = 2

1. Head _____
- Chest _____
 - Arm(s) _____
 - Leg(s) _____
 - Hand _____
 - Foot _____
 - Ribs _____
 - Abdomen _____

- Knee _____
- Back _____
- Hip _____
- Shoulder _____
- Elbow _____
- Ankle _____
- Neck _____
- Wrist _____
- Face _____

2. Head _____
- Chest _____
 - Arm(s) _____
 - Leg(s) _____
 - Hand _____
 - Foot _____
 - Ribs _____
 - Abdomen _____

- Knee _____
- Back _____
- Hip _____
- Shoulder _____
- Elbow _____
- Ankle _____
- Neck _____
- Wrist _____
- Face _____

8. Sought Medical Attention : _____ 1=Yes 2=No 3=Not clear 4=NA
A. Immediate _____
B. Delayed _____
9. Went to Emergency Room _____ 1=Yes 2=No 3=Not clear 4=NA
10. Hospitalized _____ 1=Yes 2=No 3=Not clear 4=NA
11. Missed School or work _____ 1=Yes 2=No 3=Not clear 4=NA
12. Lost employment/laid off _____ 1=Yes 2=No 3=Not clear 4=NA

13. Error _____ 1=Human 2=Horse 3=Both 4=Neither 5=Not Clear

14. On or Off _____ 1=Ground 2=On horse

15. Accident happened at

Home (where horse lives) Y/N/NA

Away Y/N/NA (Show, competitions, trail rides, etc)

Barn or Stall _____ Pasture _____ Arena _____ Trail _____ Trailer _____ Round Pen _____ Unclear _____

16. Accident Avoidable _____ 1=Strongly agree 2=Agree 3=Neutral
4=Disagree 5=Strongly Disagree

17. Rider implies accident was preventable Yes _____ No _____

18. Riding level to understand prevention measures

- _____ Novice Level
_____ Beginner Level
_____ Intermediate Level
_____ Advanced Level
_____ Expert/Professional Level

19. Experience: 1=Yes 2=No

- I only ride occasionally ___
- I ride weekly or more often ___
- I raise or keep horses ___
- I compete on an amateur level ___
- I compete on a professional level ___
- I'm a person who makes their living working with horses ___



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