Equestrian Trauma: Injury Patterns Vary among Age Groups

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Patients with equestrian injuries were identified in the trauma registry from 2004 to 2007. We *a priori* divided patients into three groups: 0 to 18 years, 19 to 49 years, and 50 years old or older. There were 284 patients identified with equestrian-related trauma. Injury Severity Score for the three major age categories 0 to 18 years, 19 to 49 years, and 50 years or older, were 3.47, 5.09, and 6.27, respectively. The most common body region injured among all patients was the head (26.1%). The most common injuries by age group were: 0 to 18 years, upper extremity fractures; 19 to 49 year olds, concussions; and 50 years or older, rib fractures. Significant differences were observed among the three age groups in terms of percent of patients with rib fractures: percent of patients with rib fractures was 2, 8, and 22 per cent in age groups 0 to 18, 19 to 49, and 50 years or older, respectively. We found different patterns of injuries associated with equestrian accidents by age. Head injuries were commonly seen among participants in equestrian activities and helmet use should be promoted to minimize the severity of closed head injuries. Injury patterns also seem to vary among the various age groups that ride horses. This information could be used to better target injury prevention efforts among these patients.

HORSEBACK RIDING IS a popular recreational activity in the United States, involving approximately four million horses.[1] Per the American Horse Council Statistics, there are approximately 83,000 horses in New Jersey, over 80 per cent of which are involved in showing and recreation.[1] Horseback riding has several risk factors associated with it. It involves a large animal (average weight 1000 lbs.) that can travel at relatively high speeds (25 to 30 mph) and which has the potential to act both independently and unpredictably. The rider also sits in an elevated position, further increasing the potential for injury.[2–5] The Centers for Disease Control and Prevention has estimated the risk of equestrian related injuries at 18.7 injuries per 100,000 events.[6] The risk of injury during equestrian activity has been notoriously difficult to quantify accurately, but in a recent survey, 81 per cent of horse enthusiasts reported at least one injury during their riding career (one in five of which were characterized as serious).[7] It was also shown the incidence of injury was dramatically higher in the novice as compared with more experienced riders.[7]

Morristown Medical Center is an American College of Surgeons-verified Level I and New Jersey State Level II suburban trauma center in a county that has a large amount of recreational horseback riding. We present what we believe is the largest single-center experience of equestrian trauma in North America in the literature: 284 patients in a 4-year period. The purpose of this study was to better characterize the type and severity of equestrian injuries seen at our trauma center and to compare it with reported experiences elsewhere.

Patients and Methods

A retrospective review of the Morristown Medical Center trauma registry was conducted. All patients evaluated between January 1, 2004, and December 31, 2007, with an equestrian-related trauma injury were identified. Formal review of the collected data was approved by the Institutional Review Board of Morristown Medical Center and judged to be exempt from informed consent.

Study patients were identified retrospectively in the trauma registry as sustaining trauma related to horses.

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Patients were also identified using E-codes from the hospital database (STAR by McKesson). Independent variables collected included patient and injury characteristics (gender, age, date of injury, Injury Severity Score [ISS], type of transport to the hospital, arrival Glasgow Coma Score [GCS], type of injuries). Rider information gathered included use of helmets.

We *a priori* arbitrarily chose to compare patients in three age groups: 0 to 18 years, 19 to 49 years, and 50 years old or older. We compared mode of transport to the hospital and ISS scores, helmet use and ISS and intracranial injury, and admission rates, and ISS and type of injury for the three age groups.

To test for statistical significance, we used χ^2 and Fisher's exact tests for nominal data, Mann-Whitney and Kruskal-Wallis tests for ordinal data, and Student's *t* test for continuous data with α set at 0.05. We used the Bonferroni correction when making multiple comparisons.

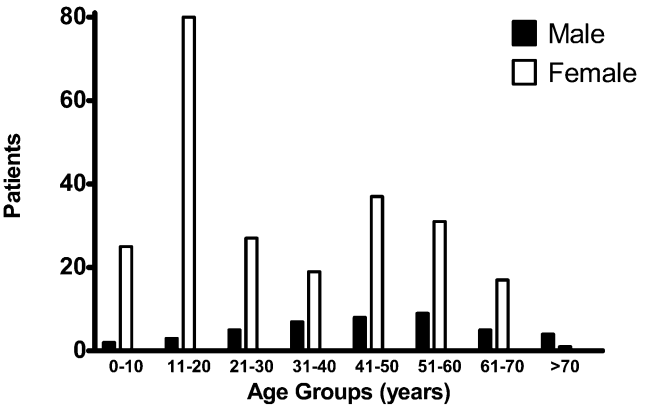

FIG. 1. Distribution of patients per each age group. Females (which accounted for 84% of the total) outnumbered males across all age groups, except in the age group older than 70 years. There were 80 females (28.1%) in the 10- to 20-year age group.

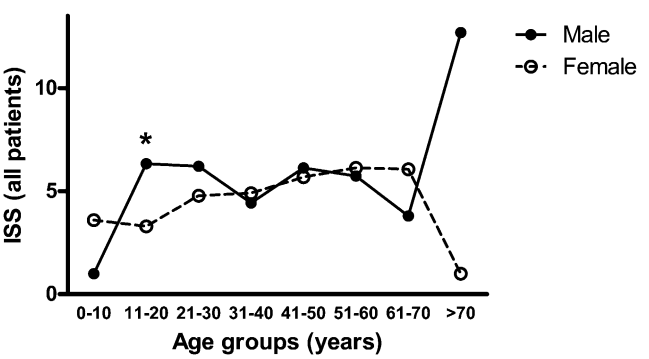

FIG. 2. Injury Severity Score (ISS) *versus* age groups (male and female). There was only a statistically significant difference in the 11- to 20-year age group, where the ISS for males was 6.33 *versus* 3.28 for the females (*$P < 0.05$).

Results

During the 4-year period (January 1, 2004, to December 31, 2007), there were 271,967 emergency department visits, 5,381 trauma activations/consults, and 4,002 trauma admissions at Morristown Medical Center. There were 284 patients identified with equestrian-related trauma, representing 0.10 per cent of all emergency department visits. The majority of patients (69%) were discharged home. Twenty-eight per cent were admitted to the hospital: 21 per cent to the floor, 4 per cent to the intensive care unit, and 3 per cent went directly to the operating room. The admitted patients represented 2.2 per cent of trauma admissions. There was one mortality (0.35% of total). The median age of these patients was 30 years (interquartile range, 14 to 50 years). We noted that there was a bimodal distribution with peaks at 6 to 10 years of age and at 45 years of age (Fig. 1). Overall, there was a predominance of female patients, which represented 84 per cent of the total. Females outnumbered males across all age groups, except in the age group older than 70 years (Fig. 1). Of the patients, 80 per cent had an ISS of 5 or less. Incidence of severe ISS (greater than 11) was 10.5 per cent (30 patients). We compared mean ISS for males *versus* females across all age groups. We found that there was only a statistically significant difference in the 11- to 20-year age group, where the ISS for males was 6.33 *versus* 3.28 in the females. (Mann-Whitney test, $P < 0.05$) (Fig. 2).

Regarding mode of transport, walk-ins represented the highest number of patients, whereas air transport was responsible for the least amount. The method of arrival was ambulatory in 51 per cent of cases; however, only 7.4 per cent of patients who presented as walk-ins were admitted (148 patients; 11 were admitted). Thirty-three per cent of the patients arrived by ambulance and 13 per cent came by helicopter. Higher percentages of these patients arriving by ambulance and helicopter were admitted, 55 per cent (91 patients; 50 were admitted) and 91.4 per cent (35 patients; 32 admitted), respectively. ISS was highest in the group of patients transported by helicopter. ISS between each mode of transport reached statistical significance (Fig. 3). We looked at the subset of admitted patients and compared the ISS *versus* mode of transport. The ISS was found to be the highest among those who arrived by helicopter (11.72) as compared with 8.32 in the ambulance group and 5.45 in the walk-in group. This reached statistical significance ($P < 0.0047$) based on the Kruskal-Wallis test (Fig. 3).

We looked at the seasonal variation of equestrian trauma. Across all seasons, female patients outnumbered males. The number of male patients remained relatively constant across all seasons; however, there were fewer absolute patients in the winter months. In the female

subset of patients, there was a statistically significant decrease of patients during the winter months. We feel that the difference observed here is reflected by the predominantly recreational nature of the ridership population, especially among female riders. Although ISS was lower in the winter months, the seasonal variation in ISS was not statistically significant (Spring-ISS = 4.77; Winter-ISS = 4.86; Fall-ISS = 5.10; Winter-ISS = 3.84).

Information regarding use of helmets was not documented in 142 cases (49.8%). Among the riders, whose use of helmets was documented, 119 (83.2%) were wearing helmets at the time of injury. In this group, only 24 patients (16.8%) were not wearing helmets. We then looked at this subgroup of patients in whom helmet use was documented. The mean ISS in patients wearing a helmet was 4.86 as compared with 10.26 in the nonhelmet group. Using the unpaired *t* test, this difference reached significant level ($P < 0.001$) (Fig. 4A). We also found the incidence of intracranial injury among these patients to be different. In patients wearing helmets, the incidence of intracranial injury was only 7.7 per cent as compared with 20.8 per cent in patients not wearing helmets (Fig. 4B).

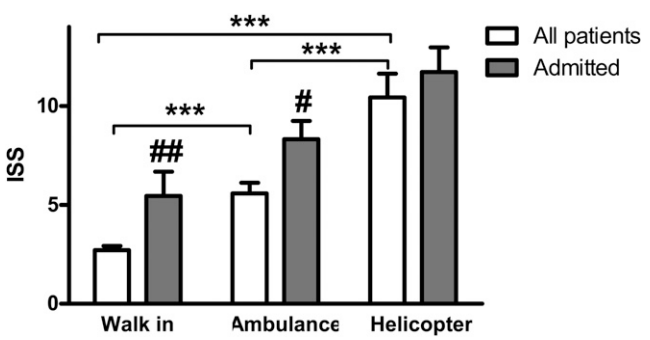

FIG. 3. Injury Severity Score (ISS) *versus* mode of transport. The mean ISS was highest for the patients brought in by helicopter (10.4 ± 1.2). The mean ISS was the lowest for the walk-ins (2.7 ± 0.21) Statistical analysis revealed a significant difference between the ISS of all groups: walk-in group *versus* the ambulance group, $***P < 0.0001$; the walk-in group *versus* the helicopter group, $***P < 0.0001$; ambulance *versus* helicopter, $***P < 0.0001$ (using unpaired *t* test). ISS of admitted patients *versus* mode of transport. The ISS of the admitted patients brought in by helicopter was significantly higher as compared with the walk-in and ambulance groups. There was a statistical significance between the ISS of the admitted walk-in patients and the admitted helicopter patients, $##P = 0.008$ (unpaired *t* test). There was also a statistical difference between the ISS of the admitted ambulance patients and the admitted helicopter patients, $#P = 0.02$ (unpaired *t* test). No statistical significance was found between the admitted walk-ins and admitted ambulance patients.

We decided to divide the patients, arbitrarily, into three major age categories: 0 to 18 years, 19 to 49 years, and 50 years or older (to roughly represent children, adults and the elderly) There were 99 patients in the 0- to 18-year-old group, 115 patients in the 19- to 49-year-old group, and 71 patients in the 50 years and older group. There was no statistically significant difference between the total number of patients in each group. Admission rates for the 0- to 18-year-old group was 19 per cent as compared with 37 per cent in the 19- to 49-year-old group and 49 per cent in the age 50 years or older group. ISS for the age categories were 3.47, 5.09, and 6.27, respectively. This was found to have statistical significance using the Kruskal-Wallis test ($P < 0.04$). However, statistical significance was only achieved in the 0- to 18-year age group as compared with the other groups (Fig. 5). Not unexpectedly the ISS for admitted patients was found to be higher in all three groups: 7.39 (0- to 18-year age group), 8.93 (19- to 49-year age group), and 10.11 (50 years or older). There was no statistical difference among these groups using the Kruskal-Wallis test (Fig. 5).

The most common body region injured among all patients was the head (26.1%) followed by the upper extremity and the thorax (Table 1). The patients were then subdivided by age groups and the body regions were subdivided to look at more specific injuries (Table 2). When this was done, each age group was found to have a unique distribution of the most common body region injured (Table 3). In the 0 to 18 year olds, upper extremity fractures were the most common injury. Among the 19 to 49 year olds, concussions were the most common. In the oldest group (50 years of age or older), rib fractures accounted for 12.1 per cent of injuries, making it the most common injury in this age group (Table 3).

The results in Table 2 showed a significant difference among the three age groups in terms of per cent of

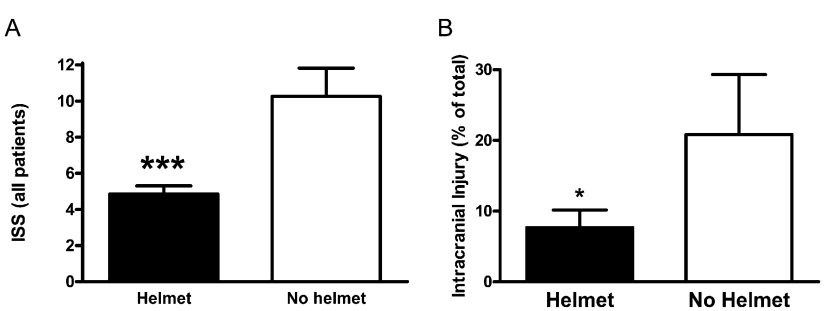

FIG. 4. (*A*) Comparison of Injury Severity Score (ISS) between helmeted riders and those not wearing helmets. The mean ISS in patients wearing a helmet was 4.86 as compared with 10.26 in the nonhelmet group ($***P < 0.001$, unpaired *t* test). (*B*) Incidence of intracranial injury (helmeted *vs* no helmet). Helmeted riders had a lower incidence of intracranial injury ($P = 0.0504$).

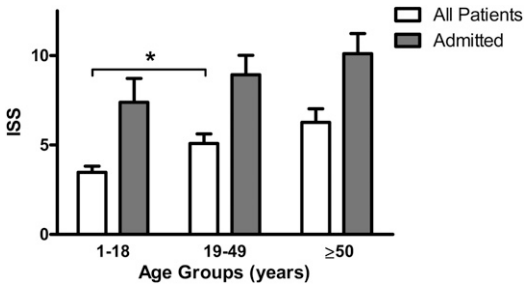

FIG. 5. Comparison of Injury Severity Score (ISS) across age categories. ISS for the age categories were 3.47, 5.09, and 6.27, respectively. Statistical significance was only achieved in the 0- to 18-year age group as compared with the other groups using the Kruskal-Wallis test ($P < 0.04$). Comparison of ISS of admitted patients across age categories. No statistical difference was noted between the groups of admitted patients using the unpaired *t* test.

TABLE 1. Incidence of Injuries among Body Regions

Injury Classification	Total
Head	115 (26.14%)
C-spine	22 (5.00%)
Thorax	67 (15.23%)
Abdomen/pelvis	51 (11.59%)
Spine	57 (12.95%)
Upper extremity	83 (18.86%)
Lower extremity	45 (10.23%)
Total	440 (100%)

patients with rib fractures (2, 8, and 22% of patients in age groups 0 to 18, 19 to 49, and 50 years or older, respectively; $P < 0.001$ based on the χ^2 test). No statistically significant differences were observed among the three age groups in terms of any of the other injury classifications listed in the table. Several trends were also noted. Pneumothoraces occurred more often in the two older groups. Thoracolumbar and sacral (TLS) spine contusions occurred more often in the two younger groups. TLS spine fractures occurred more commonly in the oldest group as compared with the 19- to 49-year-old group. Upper extremity fractures occurred more commonly in the youngest group when compared with the two older groups. Lower extremity soft tissue injuries were more prevalent in the 19- to 49-year-old group (Table 2).

An attempt was made to collect data regarding style of riding, place of injury, and activity during injury to better characterize the circumstances surrounding the injury. However, in most cases, this information was unable to be abstracted from the charts. There was one mortality in the series. This was a 55-year-old woman, who by report was a helmeted rider who was thrown over her horse's head after the animal became "spooked." She reportedly landed on her head. She was noted to be initially conscious, stated that she did not feel well, and subsequently lost consciousness. On emergency medical services arrival, she was noted to be in cardiac arrest and cardiopulmonary resuscitation (CPR) was initiated. The patient presented to the trauma center intubated with CPR in progress. Her pupils were fixed and dilated and her GCS was a 3T. The Advanced Trauma Life Support protocol was initially continued with no response and the patient was subsequently pronounced. A postmortem lateral C-spine radiograph demonstrated a posterior C1 fracture.

Discussion

Our series represents a more homogenous population of recreational riders as compared with others' experiences with rodeo workers[8] or farmers.[9] As such, our cohort is more heavily represented by young female riders when compared with other groups.[4–6, 8, 9] The supposition that these are recreational riders is further supported by the dropoff of female riders during the winter months. Even among these different groups of riders, similarities exist. The bimodal distribution of the age ranges as well as the females' predominance across the age ranges until the later decades of life was described in the National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP) database study by Thomas et al.[5] As mentioned previously, there is a predominance of female patients, which is an unusual phenomenon in trauma and has been described by others.[2, 4, 7, 10–14] The overall admission rate of 28 per cent was similar to previously reported results, which ranged from 10.4 to 30 per cent.[5, 9–13] Our rate of seriously injured patients (10.5% of patients with ISS greater than 11) was also concordant with rates seen in studies from Greece (10.6% with ISS greater than 8)[9] and Wisconsin (16% with ISS greater than 10)[15] but much higher than seen in a Canadian review[3] (2% of patients with an ISS greater than 12).

Mayberry et al.[7] in 2007 reported that novice riders seemed more at risk for injury during their initial rider hours. However, they also recognized that supervised training (which usually mandates helmet use), not just ridership hours, was important in diminishing the risk.[7] Our data strongly suggest that helmets also play an important role in diminishing the risk of injury. In our study, patients who were wearing helmets had a statistically significant lower ISS as well as a lower incidence of intracranial injury (Fig. 4A–B). There have been numerous studies that address the different injury patterns among rodeo events, bull riding, and horseback riding.[8, 16] We disagree with the implications by Ketai, that because head injuries are less common in nonequestrian events, helmet use is not warranted.[8] We believe that because the potential for a severe preventable head injury exists, helmet use should be recommended during all these activities. Chitnavis et al.[17] in

TABLE 2. Statistical Analysis of the Distribution of Injuries in three Different Age Groups

Injury Classification	0–18 Years	Age Groups 19–49 Years	50 Years or Older
Head	11 (7.6%)	9 (5.3%)	7 (5.6%)
Head and face soft tissue injury			
Concussion	22 (15.2%)	23 (13.5%)	11 (8.9%)
Skull/facial fracture	3 (2.1%)	6 (3.5%)	1 (0.8%)
Intracranial injury	6 (4.1%)	12 (7.0%)	4 (3.2%)
Cervical spine	8 (5.5%)	6 (3.5%)	4 (3.2%)
Cervical sprain			
Cervical fracture	0 (0%)	2 (1.2%)	1 (0.8%)
Central cord syndrome	0 (0%)	1 (0.6%)	0 (0%)
Thorax	6 (4.1%)	4 (2.3%)	9 (7.3%)
Thoracic soft tissue injury			
*Rib fracture	2 (1.4%)	10 (5.8%)	15 (12.1%)
Pneumothorax	0 (0%)	7 (4.1%)	5 (4.0%)
Hemothorax	0 (0%)	1 (0.6%)	2 (1.6%)
Pulmonary contusion	1 (0.7%)	2 (1.2%)	3 (2.4%)
Abdomen/pelvis	11 (7.6%)	8 (4.7%)	9 (7.3%)
Abdominal/pelvic soft tissue injury			
Pelvic fracture	2 (1.4%)	4 (2.3%)	7 (5.6%)
Liver injury	0 (0%)	1 (0.6%)	1 (0.8%)
Spleen injury	1 (0.7%)	1 (0.6%)	2 (1.6%)
Renal injury	1 (0.7%)	1 (0.6%)	0 (0%)
Hematuria/ureteral injury	0 (0%)	1 (0.6%)	1 (0.8%)
Spine	12 (8.3%)	16 (9.4%)	3 (2.4%)
Thorax/lumbar/sacral/coccygeal contusion			
Thorax/lumbar/sacral/coccygeal fracture	7 (4.8%)	7 (4.1%)	12 (9.7%)
Upper extremity	15 (10.3%)	15 (8.8%)	7 (5.6%)
Upper extremity soft tissue injury			
Upper extremity fracture	24 (16.6%)	12 (7.0%)	10 (8.1%)
Lower extremity	12 (8.3%)	17 (9.9%)	4 (3.2%)
Lower extremity soft tissue injury			
Lower extremity fracture	1 (0.7%)	5 (2.9%)	6 (4.8%)
Total	145	171	124

* denotes statistical significance among the three age groups (P<0.001).

TABLE 3. The Most Common Injuries in Each Age Group

0–18 Years	Age Groups 19–49 Years	50 Years or older
Upper extremity Fracture (16.6%)	Concussion (13.5%)	Rib fracture (12.1%)
Concussion (15.2%)	Lower extremity soft Tissue injury (9.9%)	TLS spine fracture (9.7%)
Upper extremity soft Tissue injury (10.3%)	TLS spine contusion (9.4%)	Concussion (8.9%)
TLS spine soft Tissue injury (8.3%)	Upper extremity soft Tissue injury (8.8%)	Upper extremity fracture (8.1%)
Lower extremity soft Tissue injury (8.3%)	Intracranial injury and Upper extremity fracture (7.0%)	Abdominal/pelvic soft tissue and thoracic soft tissue injury (7.3%)

TLS, thoracolumbar and sacral.

1996 demonstrated a decrease in the incidence of head injury, in the United Kingdom, through the implementation of injury prevention measures (which included helmet use).

A wide spectrum of commonly injured body regions is cited in the literature: brain/craniofacial,[16] head,[2, 5] chest,[3, 4] upper extremity,[12–14] lower extremity,[11, 18] and soft tissue.[10] Among our patients, the most commonly injured body region was the head followed by upper extremity and the thorax (Table 1). However, the distribution of injuries varied in the respective age groups. In the youngest group, upper extremity fractures and concussions were most prevalent. In this age group, their reflexes are presumably the quickest and because they try to protect themselves during their fall, the upper extremity is the most vulnerable to injury. In the oldest group, fractures accounted for three of the top five injuries and 41.9 per cent of all their total injuries (as opposed to 27% of injuries in the youngest group and 26.8% in the 19- to 49-year-old group). These older patients' most common injuries tend to involve the core structures and fractures. Physiologically, these patients are more susceptible to fractures as a result of weaker bone structure. Overall, the middle age group represents patients who have a higher muscle mass and their injuries reflect this. The most common injuries, in this age group, involve the soft tissue structures (Table 3).

In our cohort, the youngest patients (age 0 to 18 years) presented with the lowest ISS as compared with the two older subsets (Fig. 5). This is probably the result of a bias to more cautious riding with this population. This group is mostly comprised of adolescent females who are frequently in a supervised setting. As such, they are more likely to be wearing helmets and their activity is better controlled. Being in this setting also incurs liability issues, in which medical attention is more strongly encouraged, even for minor injuries. These participants are more likely to be referred for medical evaluation despite not presenting with an overt injury and therefore a higher percentage of these patients are treated and released from the emergency department. The admission rate in this age group is 19 per cent as compared with the 37 and 49 per cent admission rates in the corresponding older subsets.

Like in many other aspects of trauma, injury prevention evolves as an important adjunct to patient care. As noted in several previous studies, the recidivism rate for participants in equestrian activities is high (36 to 47%) and many riders are young.[3, 19] As such, injury prevention efforts have the potential to have a significant impact throughout the lifetime of the rider. Chitnavis'[17] study, in 1996, nicely demonstrated the impact of decreasing the incidence of head injury, in the United Kingdom, through the implementation of injury prevention measures. In their study, there was a fivefold decrease in head injuries among patients in 1991 as compared with 1971. This was attributed to improved headgear as well as a higher rate of helmet usage (73 *vs* 43%).[17]

In this country, the annual national estimate of emergency visits for head injury secondary to equestrian activities, as estimated by the National Electronic Injury Surveillance System, has remained constant,[12] suggesting that a better job can be done in preventing these injuries. In our study, concussions were a prevalent injury among all age groups. This, combined with the recent concerns about concussions (among high school and professional athletes), should serve as important corroborative evidence to help educate riders in the importance of helmet use. Although there are standards for helmets set by the American Society for Testing and Materials, perhaps these need to be reevaluated and adjusted to provide more protection. Although helmets are probably the mainstay for injury prevention efforts, they clearly cannot prevent many of the other injuries sustained by riders. Prevention efforts must be multifaceted to achieve higher success rates. Better riding education, instruction in falling technique, and guidelines for the use of proper equipment and appropriate clothing can also play an important role. Several studies have also discussed the use of personal protective equipment in general terms to help prevent injury to other parts of the body.[3–5] Loder,[12] Moss,[13] and Northy[14] recognized the potential of attempting to prevent their most prevalent injury (upper extremity injury) by suggesting use of wrist guards. The use of wrist guards has been shown to be successful in reducing wrist injuries in snowboarding.[20] By separating the patients by age and analyzing their injury patterns, our study demonstrated that not all populations are at risk for the same injuries. Perhaps, this better understanding of injury patterns can lead to the development of more appropriately targeted protective equipment; for example, wrist guards for the younger riders or protective vests to be worn by older riders.

There are several limitations in this study. This was a retrospective review. As such, certain data were unable to be collected or was incomplete, i.e., helmet use, type of riding. When the injuries were subdivided, certain categories had low numbers, therefore limiting their statistical reliability and use.

In summary, head injuries are commonly seen among participants in equestrian activities and helmet use should be promoted to minimize the severity of closed head injury. Injury patterns seem to vary among the various age groups that ride horses. This information could be used to better target more specific injury prevention efforts among these patients.

REFERENCES

1. American Horse Council. National economic impact of the US horse industry. Available at: www.horsecouncil.org/nationaleconomics.php. Accessed June 2010.

2. Sorli JM. Equestrian injuries: a five year review of hospital admissions in British Columbia, Canada. Inj Prev 2000;6:59–61.

3. Ball CG, Ball JE, Kirkpatrick AW, et al. Equestrian injuries: incidence, injury patterns, and risk factors for 10 years of major traumatic injuries. Am J Surg 2007;193:636–40.

4. Carrillo EH, Varnagy D, Bragg SM, et al. Traumatic injuries associated with horseback riding. Scand J Surg 2007;96:79–82.

5. Thomas KE, Annest JL, Gilchrist J, et al. Non-fatal horse related injuries treated in emergency departments in the United States, 2001–2003. Br J Sports Med 2006;40:619–26.

6. Centers for Disease Control and Prevention. Injuries associated with horseback riding: United States 1987–1988. Mortal Morb Wkly Rep 1990;39:329–32.

7. Mayberry JC, Pearson TE, Wiger KJ, et al. Equestrian injury prevention efforts need more attention to novice riders. J Trauma 2007;62:735–9.

8. Ketai LH, Temes RT, Deis JL, et al. Rodeo related large animal injury: is protective head-gear warranted? Injury 2000;31:757–9.

9. Petridou E, Kedikoglou S, Belechri M, et al. The mosaic of equestrian-related injuries in Greece. J Trauma 2004;56:643–7.

10. Hobbs GD, Yealy DM, Rivas J. Equestrian injuries: a five-year review. J Emerg Med 1994;12:143–5.

11. Lim J, Puttaswamy V, Gizzi M, et al. Pattern of equestrian injuries presenting to a Sydney teaching hospital. ANZ J Surg 2003;73:567–71.

12. Loder RT. The demographics of equestrian-related injuries in the United States: injury patterns, orthopedic specific injuries, and avenues for injury prevention. J Trauma 2008;65:447–60.

13. Moss PS, Wan A, Whitlock MR. A changing pattern of horse injuries to horse riders. Med J Emerg. 2002;19:412–4.

14. Northy G. Equestrian injuries in New Zealand, 1993–2001: knowledge and experience. N Z Med J 2003;116:601–9.

15. Busch HM Jr, Cogbill TH, Landercasper J, et al. Blunt bovine and equine trauma. J Trauma 1986;26:559–60.

16. Norwood S, McAuley C, Vallina VL, et al. Mechanisms and patterns of injuries related to large animals. J Trauma 2000;48:740–4.

17. Chitnavis JP, Gibbons CL, Hirigoyen M, et al. Accidents with horses: what has changed in 20 years? Injury 1996;27: 103–5.

18. Griffen M, Boulanger BR, Kearney PA, et al. Injury during contact with horses: recent experience with 75 patients at a level I trauma center. South Med J 2002;95:441–5.

19. Frankel HL, Haskell R, Digiacomo JC, Rotondo M. Recidivism in equestrian trauma. Am Surg 1998;64:151–4.

20. Ronning R, Ronning I, Gerner T, et al. The efficacy of wrist protectors in preventing snowboarding injuries. Am J Sports Med 2001;29:581–5.