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Injury History in the Collegiate Equestrian Athlete: Part I: Mechanism of Injury, Demographic Data, and Spinal Injury

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Purpose: Equestrian sports are known to have a high risk and rate of injury. While there is injury data available on acute injuries in the equestrian population, it is of a general nature. Within that data appears to be a lack of information on the collegiate equestrian athlete. Thus, the purpose of the current study and this analysis is to describe the demographics and incidence of spinal injuries found in intercollegiate equestrian athlete. **Method:** A survey was developed with input from each author and implemented in Mach forms. It was sent to 43 equestrian coaches in the Eastern United States who passed it on to their athletes. We estimated 753 athletes would have access to the survey and had a total of 73 respondents. Descriptive statistics were calculated for total number of injuries for each injury category. **Results:** Demographic information, conditioning activity, riding style, pain medication use, total responses (injuries) per body area and injuries to the spine and pelvis are detailed in tables 1-6. Of interesting note is only 73% of respondents reported having access to or utilizing the school's athletic program as part of their participation on the schools equestrian team. **Conclusions and Recommendations:** The current study is amongst the first, if not the first, to report specifically on injury patterns and frequency in US collegiate equestrian athletes. There were several findings that from a sports medicine and athletic perspective are concerning. The lack of overall knowledge and research about the equestrian athlete would appear to put it in the same position as cheerleading was 20 years ago. Significantly more sport specific research is needed to improve the health and safety of the athletes. **Key Words:** *Equestrian Injury, Spine Injury.*

INTRODUCTION

The first domestic interaction between humans and horses is estimated between the 2nd and 3rd millennium B.C.[1] This interaction has evolved from primarily agrarian and war to mostly pleasure and sport. During this time hundreds of expressions and sayings were created that underscore the significance of the dangers associated with this interaction. A typical example is an ancient Arab proverb "The grave yawns for the horse man.[1]

In 1967, the Intercollegiate Horse Show Association (IHSA) was formed to facilitate competition between schools with a student base interested in equestrian competition. Approximately four hundred colleges and universities, across 45 states and Canada, comprising approximately 7000 athletes, currently offer equestrian teams. A large proportion of schools with programs currently follows IHSA guidelines; with a small number organized under the National Collegiate Equestrian Association (NCEA). The National Collegiate Athletic Association (NCAA) currently considers equestrian an emerging sport, as there are not enough programs to officially sanction it. It does, however, classify equestrian as a contact sport.[2,3]

Collegiate equestrian athletes compete in five levels of equitation where no jumping is involved (a.k.a. on the flat) or three levels of jumping over fences up to 3'6". This is unlike traditional non-collegiate equestrian competitions consisting of dressage, which focuses on training and discipline of the horse, stadium jumping and cross-country, which tests horse's courage over obstacles under different settings and with time constraints. Western horsemanship (riding in a western saddle) and reining (similar to dressage) are similar in either setting.[4]

The most common mechanism of injury for equestrian reported in the literature is falling from the horse.[5, 6] According to the United

States Eventing Association (USEA) Safety Committee Cross Country injury report, falls occur during 1 of every 43.6 starts.[7] During equestrian activities the rider is expected to control the horse and his/her center of mass over the horse while managing the forces transmitted to him/her via the movement of the horse. This is accomplished using pressure changes through the seat (saddle), leg (thigh or calf) and/or hands via the rein. "Rider instability" is due to some combination of a lack of a stable place to position one's hands (rein vs. handle bar), a small base of support for the foot (approx. 15% surface area of foot vs. 100% on flat ground) and forces generated by the horse. [8,9] While the literature has yet to define the amount of these forces transmitted directly to the rider, the ultimate outcome of the instability often results in falling from the horse.

Simply hitting the ground is not the only consideration determining final injury. Variables such as being struck by the horse (e.g. being run over, falling on rider, stepped on or kicked), being struck by an object (tree, obstacle in competition or practice such as a fence post), being entangled by reins, and falling technique influencing which body part contacts the ground or object first influence injury.[10,11]

Additionally, riders will give signals to the horse through use of the rein. The rider must be particularly careful with his/her upper extremity due to the sensitivity of the horse's mouth. In fact, they are taught to let the arms move with the horses head to not exceed two-pounds of pull through the reins. Christensen noted "head turning and conflict behavior" occurred with approximate mean rein tensions of 10 N (1 kg).[12] When this limit is exceeded, an offending stimulus is produced that is likely contributing to the horse wanting to throw the rider.

References to injuries associated with the sport of equestrian date as far back as Napoleonic times with a specific reference to a Lis Franc injury to the foot. [13] However, it was not until the 1980's that researchers began to more formally document and report injuries associated with participation in equestrian competitions.[14,15] While injuries to the spine, upper and lower extremities are common, the largest percentage of spinal injuries in sport are associated with equestrian events.[16]

The Consumer Product Safety Commission now gathers injury data from The National Electronic Injury Surveillance System (NEISS) based on ICD codes. Despite NEISS data from 1997-2015 showing on average 22% of all equestrian injuries happen in the sports setting, only a trace amount of data could be found for the USEA.[17, 7] We found no database for the IHSA and NCEA. Thus, the purpose of this two-part study and analysis is to describe the demographics of collegiate equestrian athletes, their conditioning patterns, their history of pain medication usage and their incidence of injury. Part I includes the demographic data, conditioning patterns, history of pain medication and incidence of injury to the spine. Part II details the incidence of injury for the upper and lower extremity and the head.

METHODS

Teams were identified from those listed on the NCAA and IHSA website. Head equestrian coaches from 43 eastern United States colleges were sent a form email letter describing the study. If they chose to participate, coaches were instructed to send the link to athletes on his/her respective team. School size ranged from Division I to Division III. All disciplines were represented. The initial request was sent en masse. For email addresses that were deemed "undeliverable," individual coaches were contacted in order to ensure all coaches for the 43 schools received the study information.

Instrumentation

The primary investigators developed the instrument based upon current literature in the field of equestrian. An outside expert in the field of equestrian reviewed the survey instrument for appropriateness of the content, content validity and also provided feedback relative to the format of the questionnaire. An online survey instrument was developed in Mach Forms to gather demographic and injury data from the respondents. The electronic survey was developed and implemented in order to both reduce mailing costs and encourage participation in an uncomplicated manner. The survey requested that respondents choose from one of the following injury history categories: 0 injuries, 1 injury, 2 injuries, or more than 2 injuries. For hours of practice/week and years riding the respondents chose from 1-3, 4-6, 7-10, 11-14, 15-18, 22-25, and 25+. For other demographic data, such as style of riding and conditioning activities, respondents selected the appropriate choice(s). Consent was assumed upon voluntary completion and submission of the survey. Anonymity was assured to all participants. This investigation was approved by The College at Brockport's IRB.

The survey was sent to a total of 43 equestrian teams. A total of 73 athletes completed the survey (women n=71, men=2, age = 20.3 years, weight=62.29kg, height=174.75 cm). It is difficult to arrive at an accurate response rate due to the fact that we did not have an accurate number of athletes on each of the 43 teams and we were unable to determine which coaches actually shared the survey with their team. All participants were identified as being a member of an intercollegiate equestrian team. A residual output analysis was run due to the small sample size. It indicated only three outliers, thus verifying sample robustness (f=4.69756E-05).

Data analysis was performed on Excel version 11.6.6 for Mac. Descriptive statistics were calculated for total number of injuries for each injury category.

RESULTS

Detailed data is presented in the specific charts. Due to the large volume of data, we report only the most common responses here. Athletes were asked, to the best of his/her abilities, to report all the injuries they had sustained in their riding career. Demographic data for hours of practice/week and total number of years riding are presented in **Table 1.** The highest percentage for number of hours of practice/week was 4-6 hours (49.32%) with 7-10 (19.18%) hours the second most common selection. For years riding, the highest selection was 11-14 years (31.51%) with 15-18 years (26.03%) the second highest category.

Table 1: Hours of Practice per Week and Years Riding (% and N)

1-3	**4-6**	**7-10**	**11-14**	**15-18**	**22-25**	**25(+)**
15.07 (12)	49.32 (35)	19.18 (14)	9.59 (7)	2.74 (2)	1.37 (1)	2.74 (2)
12.33 (9)	5.48 (4)	17.81 (13)	31.51 (23)	26.03 (19)	5.48 (4)	1.37 (1)

Data for type of conditioning activity is presented in **Table 2**. Ninety one percent of respondents indicated that they participated in some type of outside conditioning activity. The highest reported activities were running (64.38%), strength training (61.64%) and walking (49.32%). Those who did report participating in conditioning activities averaged 2.26 activities with strength training and running (72.31%) being the most commonly reported combination.

Table 2: Conditioning Activities (% and N)

Pilates/ Yoga	Walking	Running	Strength Training	Swimming	None
24.66 (18)	49.32 (36)	64.38 (47)	61.64 (45)	5.48 (4)	9.59 (7)

Results from riding style are presented in **Table 3**. The highest reported riding styles were English (41.10%) and Hunt Seat (38.36%). The slight difference between the two is likely due to the introductory skills class not present in the English discipline.

Table 3: Riding Style (% and N)

English	Western (2 disciplines)	Eventing (3 Disciplines	Hunt	Dressage
41.10 (30)	15.07 (11)	4.11 (3)	38.36 (28)	1.37 (1)

Pain medication use is presented in **Table 4**. Regular use of pain medication was reported by 16.44% of the respondents. Ibuprofen was the most commonly reported pain medication used. Interestingly, a higher percentage (20.55%) of athletes responded to what medication they used, vs. using pain medication on a regular basis.

Table 4: Pain and Medication Use (N and % of total injuries)

Medication Use on Regular Basis (Y/N %)	Medication (Aleve/ Ibuprofen/ Tylenol)
12 (16.44)/ 60 (82.19)	3/10/1 (20.55)*

Athletes were asked to report, to the best of his/her abilities, all the injuries they had sustained in their riding career. Total Responses (Injuries) per Body Area is reported in **Table 5**. The total number of injury responses reported was 507. The lower extremity as a whole had the most injuries, followed by the spine, upper extremity, head, and axial skeleton. With regard to the spine, the highest number of responses was to the lumbar (34) and thoracic spine (29).

Table 5: Total Responses per Body Area (N and % of total injuries)

Head	Spine	SI/ Pelvis/ Ribs	Upper Extremity	Lower Extremity
22 (4.33)	83 (16.37)	15 (2.95)	81 (15.97)	306 (60.35)

Table 6 provides detailed data on reported injuries to the spine and pelvis. In the cervical spine, 6.85% of the respondents reported one and 10.96% reported two or more episodes of pain/arthritis. In the thoracic spine, 8.22% of respondents reported one and 19.18% reported two or more episodes of pain/arthritis. In the lumbar spine, 6.85% of respondents reported a fracture, while 15.07% reported one or greater than two episodes of pain/arthritis respectively.

Table 6: Spine and Pelvis (Reported number of incidences; 1, 2, >2)

C-Spine	% Pop	T-Spine	% Pop	L-Spine	% Pop	Pelvis	% Pop
Fracture		**Fracture**		**Fracture**		**L.Surgery**	
1= 0		1= 1	1.37	1= 5	6.85	1= 0	
2= 0		2= 0		2= 0		2= 0	
>2= 1	1.37	>2= 0		>2= 0		>2= 0	
Pain/Arthritis			**Pain/Arthritis**			**L. Fracture**	
1= **5**	6.85	1= 6	8.22	1= 11	15.07	1= 1	1.37
2= 0		2= 1	1.37	2= 2	2.74	2= 0	
>2= **8**	10.96	>2=14	19.18	>2=11	15.07	>2= 0	
Disc Injury		**Disc Injury**		**Disc Injury**		**R. Surgery**	
1 = 2	1.37	1 = 1	1.37	1 = 2	2.74	1 = 0	
2 = 0		2 = 1	1.37	2 = 1	1.37	2 = 0	
>2 = 0		>2 = 1	1.37	>2 = 1	1.37	>2 = 1	1.37
Sprain		**Surgery**		**Spondylo.**		**R. Fracture**	
1 = 3	4.11	1 = 1	1.37	1 = 1	1.37	1 = 1	1.37
2 = 0		2 = 0		2 = 0		2 = 0	
>2 = 1	1.37	>2 = 0		>2 = 0		>2 = 0	1.37
Surgery						**SI Sprain**	
1 = 2	1.37					1 = 3	4.11
2 = 0						2 = 1	1.37
>2 = 0						>2 = 3	4.11

Lastly, 73% of respondents reported having access to or utilizing the school's athletic training program as part of their participation on the school's equestrian team.

DISCUSSION

Having only two males reporting is not unusual as female athletes dominate equestrianism in the US. The physical characteristics of our population compare favorably with both Meyers' populations (23.6 yo/64.9kg/161.8cm and 23.6yo/62.4kg/165.3cm). [18,19]

Years Riding

Interestingly, the current study indicated that over 72% of equestrian athletes that participate in activities other than riding participated in a combination of weight training and running. While Meyers' didn't report on outside activities, over the last 10 years there has been a shift in the thinking from "time on the horse is the way to get better" to "I am as much an athlete as any other athlete and need to start treating myself as such." This would certainly explain the high percentage of athletes involved in conditioning activities such as weight training and running.

The most common response for years riding was 11-14 years, with 15-18 as the second most common response. Considering the mean age of the respondents is 20.3 years, it indicates that these riders began at a very early age. While the United States Pony Club recommends waiting until age 9 to begin equestrian, it is not uncommon for a family with a child or children showing interest in horses and riding to start the child "on horse" at 5 years of age.[20] The size of the horse is a matter of parental preference and can range from true ponies (approximately 58" or shorter at the shoulder) to a full size horse. The emotional make up of the horse is often weighed more heavily than horse size when the child first starts riding. A common suggestion is to choose a horse 9 years of age or older and/or more experienced with children to reduce the risk of injury. The horse is then matched with the skills demonstrated by the child as he or she ages.

Pain Medication Usage

The NCAA found "nearly one-quarter of student-athletes reported using prescription pain medication."[21] While dose and frequency are important when taking medication, using the word "regular", defined medically as occurring at fixed intervals, would provide a general idea of use.[22] In our sample, 16.44% of respondents reported using some type of pain medication on a regular basis. The most commonly reported pain medicine used by athletes was Ibuprofen (13.69%). Interestingly, a higher percentage (20.55%) responded to what medication they used, vs. using pain medication on a regular basis. While not addictive in the way opiates are, the athlete may become dependent on these lower level pain medications to manage his/her daily pains.

Athletic Training Program Access

It is not surprising only 73% of athletes (53/73) reported having access to or being able to utilize the schools athletic training program. Although organized under IHSA and NCEA, lack of NCAA sanctioning relegates these teams to "club" status. As such, athletes may not be aware they can utilize the school's athletic training services. Coaches may not be aware of this, nor ask. Practice facilities are often off campus and if there is a conflict between the athletes academic and practice schedule, the athlete may choose practice over seeking care. This is also concerning due to the high number of injuries and the potential for disability that would be expected to occur.

Injury Data

The average athlete reported 6.9 responses (total number of injuries). While there is no way to utilize NEISS data to determine number of injuries per athlete in a similar age group (0-24), the data indicate that from 2002-2014, 40.85% of all injuries happen in this age group.[17] Injury data compiled from non-collegiate related cross country events is "sourced from external, non-verified sources" (these data coming from technical delegates when present) so it is extremely vague. From 2009-2014, the reported rate of a "non-serious injury" for each jump is 1 in 8757.[7] No definition was provided, in the report, for "non-serious".

Spine

Spinal injuries are not uncommon. Boron found sports related spinal injuries accounted for 11% of all spinal injuries.[16] Equestrian events contributed the largest percentage (41.8%), accounting for 4.5% of all spinal injuries. In our study, spinal injuries comprised 16.37 % of the total injuries reported. Kraft found 88% of elite show-jumping athletes with a history of low back pain.[23]

Spinal injuries can be categorized as either traumatic (fall) or atraumatic (no fall involved). With falling, the rider can land on his/her back, feet, and/or tailbone, with or without contacting an obstacle, (e.g. fence post) generating a flexion or extension mechanism. Flexion is the most common mechanism producing a lumbar or thoracic spinal body and/or rib fracture.[24] The cervical spine can be injured when upper extremity strength is insufficient to protect the head and neck during a fall or in cases where the rider's head strikes the ground.

Multiple variables must be considered with atraumatic mechanism of injury. First would be the on horse postures taught as part of "accepted riding". Riders are often instructed to have a "following seat" where the low back is "softened" to follow the movement of the horse and minimize pounding on either the horse's or rider's back. This technique results in the rider repetitively flexing and extending the lumbar spine as the horse goes through it's gait cycle. Some schools of teaching advocate pulling the belly button in to decrease lumbar lordosis. Biasing the lumbar spine to start from a more flexed posture could potentially decrease the spine's capacity to follow the horse's movement (smaller ROM to "follow" the horses motion) and affect its capacity to handle the forces generated by the horse. Instructor subjectivity regarding proper sitting posture and how much lordosis is "enough vs. too much," in addition to lack of general knowledge on how physical variables (gender, injury, etc) affect the rider, play into this concept of "accepted riding."

Habituation is described as a situation where the body moves out from under the head precipitating a reflex cascade with the goal to stabilize the head via the neck in order to improve gaze stability.[25] The neck muscles must balance the need to preserve cervical segment stability and minimize pain with maximizing vision so the rider can effectively see the situation during competition and make appropriate adjustments.

Another factor in spinal injury is the saddle and saddle padding. Saddles are often changed between horses by the rider. Padding is used to improve saddle conformation to the horse and minimize the impact of the rider and the horse on each other's spine. Our study reported 11 responses of 1 episode of lumbar spine (LS) pain and 11 responses of 2 or more episodes of lumbar spine pain. Quinn found females to have a higher incidence of low back pain (LBP) than males regardless of saddle type.[26] While our study does not have enough males to compare, this could indicate a gender component where females have less tolerance to the vertical forces generated by the horse.

The vertical forces generated when riding are significant. DeCocq measured dimensionless forces at the saddle/horse interface of between 1.9 and 3x's body weight during sitting and rising trot.[8] Peham measured 2112N at the sitting trot, 2056 N at the rising trot and 1688 N at the two-point seat. One Newton equals approximately .22 ft-lbs, allowing us to estimate that the rider is exposed to approximately 400 ft-lb. of vertical force during each gait cycle.[9] While it is difficult to determine the precise amount of vertical force that is directly transmitted to the riding athlete's spine, if we estimate 20-25 minutes of work in these gaits a day, it is not unreasonable to theorize these forces have some responsibility for the high levels of pain and arthritis reported in our group.

Another potential contributing factor to the spinal injury responses are centuries old methods of taking care of the horse and facilities, which have remained essentially unchanged over time. Lofqvist found "high levels of musculoskeletal disorders in the shoulders, neck, hands/wrists, and low back due to the large volume of repetitive manual labor involved (shoveling, lifting, use of wheel barrow) with the back spent in bent and or twisted positions." [27,28]

LIMITATIONS

The primary limitation with this study is the potential for under-reporting of information. The design of the current study was self-report by the athletes. Although the athletes are self-reporting the injuries, it is possible that not all of the injuries reported were actually diagnosed by a health care professional. In addition, age specific information for use in comparison to our population is limited, and what is available/reported is general in nature. Due to this, it is difficult to compare our sample with other cultures where equestrian sports are more mainstream. That said, the current study provides a vital first step in identifying the types and frequency of injuries seen in equestrian athletes. Also, these athletes are in college and have to balance the needs of school with competition. How this affects injury in comparison to a similarly aged person who has entered the work force or is skilled enough to be sponsored and/or does not have to work is unknown.

CONCLUSIONS

The current study is amongst the first, if not the first, to report specifically on equestrian athlete demographics and spinal injury patterns. Injury and pain in the spinal region appears to be prevalent. Interesting demographics point to the vast majority of athletes engaging in some regular conditioning activity and a comparatively high percentage using OTC pain medication. While a large percentage of athletes have access to the school's athletic training staff, having less than 100% access is cause for concern due to injury potential. Future research should determine why athletes choose certain conditioning activities over others, what conditions limit/prevent access to the schools athletic training staff and what drives OTC pain medication use.

Lastly, given the high potential for disability from spinal pathology, the NCEA and IHSA could potentially use this injury data to facilitate research and programs that would improve the knowledge, health and safety of their athletes. The governing bodies for many sports, such as soccer, utilize epidemiological injury data to institute changes and modifications to rules and training protocols.

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