

Effectiveness of Safety Vests in Pediatric Horseback Riding

Die Effektivität von Schutzwesten im Reitsport bei Kindern und Jugendlichen

Authors

C. Hessler¹, V. Eckert², E. Vettorazzi³, N. Meenen⁴, C. Jürgens⁵, M. Schult⁶, C. Flamme⁷, H.-J. Herberhold⁸, J. Madert⁹, A. Ekkernkamp¹⁰, U. Lockemann², K. Püschel², P. Pohlentz¹¹

Affiliations

Affiliation addresses are listed at the end of the article

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Bibliography

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Correspondence

Dr. Christian Hessler
 Neurosurgery
 University Medical Center
 Hamburg-Eppendorf
 Martinistraße 52
 20246 Hamburg
 Germany
 Tel.: +49/40/7410 50115
 Fax: +49/40/7410 48121
 chessler@uke.uni-hamburg.de

Abstract

Background: Despite the benefit of safety vests to the reduction of torso injuries in children and adolescents is unclear, its' use is recommended. The aim of the present study is to determine the effectiveness of safety vests actually used in pediatric equestrian activities.

Patients and Method: In this case-control-study, we analyzed the accidents of 92 riders aged 18 or younger who fell off a horse onto his/her torso during a period of 18 months. Data were gathered from the clinical records. Additionally, a questionnaire was administered on the day of trauma by the patients and/or their parents.

Results: The cases comprised 31 patients who sustained torso injuries. The controls were 61 riders with injuries of other body parts than to the torso. Safety vest use was not associated with a lower risk of torso injuries (OR=1.18, 95% CI (0.50, 2.81), p=0.707). Post hoc power analysis revealed that within such a setting an odds ratio of 0.266 could be found with a power of 80%.

Conclusion: This study is not able to show an association between wearing a torso protector and protection from torso injuries, probably due to confounding. We did not detect a high effect of safety vest usage in our study population. Whether the development of a new generation of safety vests might be more effective remains unclear. An effective vest should be adapted to the requirements of children and adolescents and should protect the thorax and abdomen, but also the cervical and the lumbar spine.

Introduction

Horseback riding is a popular activity, especially for females under 18 years of age [1–4,8,14,16].

Zusammenfassung

Hintergrund: Obwohl eine Reduktion von Torsoverletzungen durch das Tragen einer Schutzweste bei reitenden Kindern und Jugendlichen unbewiesen ist, wird dessen Nutzung empfohlen. Das Ziel der vorliegenden Studie ist die Untersuchung der Effektivität von Reitschutzwesten bei unter 18-jährigen.

Patienten und Methodik: In dieser Fall-Kontroll-Studie wurden 92 Kinder und Jugendliche analysiert, die von einem Pferd auf den Oberkörper stürzten. Die Daten entstammen der Dokumentation der an dieser Studie teilnehmenden Kliniken sowie einem Fragebogen, der von den Verunfallten bzw. derer Eltern am Unfalltag beantwortet wurde.

Ergebnisse: Die Fallgruppe bestand aus 31 Reitern mit Torsoverletzungen, die Kontrollgruppe aus 61 Reitern, die an anders lokalisierten Verletzungen als am Torso litten. Das Tragen einer Schutzweste war nicht mit einem niedrigeren Risiko einer Torsoverletzung assoziiert (OR = 1,18, 95 % CI (0,50, 2,81), p = 0,707). Mittels einer Post-Hoc-Poweranalyse fanden wir eine Odds Ratio von 0,266 bei einer Power von 80%.

Schlussfolgerung: In dieser Studie zeigte sich kein Zusammenhang zwischen einer Westennutzung und einem Schutz gegenüber Torsoverletzungen, möglicherweise aufgrund von Störfaktoren. Eine effektive Reitschutzweste sollte den Bedürfnissen von Kindern und Jugendlichen angepasst sein und sollte neben dem Oberkörper und Abdomen auch die Hals- und Lendenwirbelsäule schützen. Ob die Entwicklung neuer Schutzwestentypen effektivere Oberkörperprotektoren hervorbringt, bleibt allerdings unklar.

Similarly to participants of many other sporting activities, equestrians often expose themselves to injury while pursuing their hobby [7]. In terms of epidemiology, horseback riding injuries are

relatively rare compared with other sport injuries [6]. However, according to the Injury Severity Score (ISS), the severity is often higher than for injuries caused by vehicles [11]. Accidents that affect the torso especially constitute the risk of severe injuries [20]. To prevent the torso against injuries caused by horse-related activities, the use of safety vests is recommended. However, to our knowledge, no working group has ever investigated the effectiveness of safety vests in the reduction of torso injuries in the subgroup of riders under 18.

The objective of the presented 8-center-study is to determine the number and degree of torso injuries caused by falls from a horse during childhood and adolescence. Our special aim was to investigate the effectiveness of safety vests actually used in pediatric equestrian activities.

Material and methods



Data evaluation

3 months before data collection began, all trauma centers in Hamburg (n = 17), Germany, and one trauma center in Berlin, Germany, were invited to participate in the study. Data collection was performed between January 1, 2010–June 30, 2011. Equine-related accidents that occurred during the study period and that were treated in one of the participating trauma centers were evaluated after approval through the local ethics committee. Data on equine-related patterns of injury and the resultant therapies were gathered from the clinical records. Additionally, a questionnaire was administered on the day of trauma by the patients and/or their parents (or legal guardians). The questionnaire covered age, gender, the rider's skill level, as well as the date, location and discipline performed at the time of the accident, the cause and mechanism of injury, and the use of safety equipment at the time of the accident. Data evaluation was performed according to data protection officers' requirements and after informed consent was obtained. In this context, all study participants read an information sheet about the content and purpose of our study before they agreed to participate in the study.

Study design

Using a case-control study design, we compared the effectiveness of safety vests in riders with torso injuries who wore safety vests at the time of the accident with those who did not use a safety vest. The case group comprised 31 riders aged 18 or younger who suffered torso injuries. Torso injuries were defined as injuries of the thorax, the clavicles, the scapulae, the abdomen, the pelvis and the whole spine. The control group consisted of 61 riders who suffered solely from injuries other than to the torso.

Inclusion criteria

Riders aged 18 or younger who fell off of a horse onto his/her torso and who then completed the questionnaire were included in this study. We only included equestrians ages 18 or younger, because findings from working groups who investigated the effectiveness of safety vests in adult riders cannot simply be transferred to children and adolescents. In addition, we only included patients who suffered the same accident mechanism. For example, an investigation of the benefits of a body-protector in cases where a rider suffered a hoof-kick against the leg were deemed irrelevant for the present analysis. Further, safety-vest users were only included in this study if their vest fulfilled the highest security level (level 3) according to the BETA (British Equestrian Trade Association).

The BETA was responsible for introducing standards for body protectors in riding sports. The BETA Body Protector Standard meets all the requirements of the European standard (EN 13158:2000). It encompasses 3 levels; level 3 is the highest security level and is considered appropriate for general riding, competitions including eventing and working with horses.

Study population

During the study period, 439 equestrians were admitted to the emergency department at one of the participating trauma centers. Of those, 92 fulfilled the inclusion criteria of this study. The records of these riders were available for analysis and the results are presented in this work.

Statistics

The relationship between torso injuries and safety vest usage was investigated by chi-square analysis with an alpha level of 5%. We calculated the odds ratio (OR) with a 95% confidence interval (CI) from a contingency table. These analyses were performed using SPSS for Windows (version 19). Power analysis was performed to calculate the minimum sample size required so that one can be reasonably sure, e.g. with a power of 80%, to detect an effect of a given size and to calculate the minimum effect size that is likely to be detected in a study of the given size using a given sample size. We used PASS 2008 for all power analyses. To adjust for age and riding experience as potential confounders, a multivariate logistic regression model was estimated.

Results



Participating hospitals

Overall, 8 level 1 trauma centers agreed to participate: the BG Trauma Hospital in Hamburg (31 patients), the Altona Childrens Hospital in Hamburg (17 patients), the BG Trauma Hospital in Berlin (16 patients), the Asklepios Hospital Nord, Hamburg (13 patients), the University Medical Center in Hamburg (8 patients), the Asklepios Hospital Harburg in Hamburg (4 patients), Asklepios Hospital Rissen in Hamburg (2 patients) and the Asklepios Hospital St. Georg in Hamburg (1 patient).

Equestrians

There were 86 female (93.5%) and 6 male riders (6.5%). At the time of the accident the average age of the injured riders was 11.8 (range 3–17) years. 42 (45.7%) riders were wearing a safety vest at the time of the accident while 50 (54.3%) equestrians had not used a safety vest. 58 riders (63.2%) had more than 6 months of riding experience, whereas 34 riders (36.8%) had less than 6 months experience in riding activities. 28 riders (30.4%) had already participated in safety education programs. The most common places horse-related injuries occurred were in indoor riding rings (n = 37; 40.2%) followed by outdoor riding rings (n = 30; 32.6%) and on outdoor courses/trails (n = 25; 27.2%). 45 injuries (48.9%) occurred during leisure riding, 42 (46.7%) while training and 5 (4.4%) during horse shows.

Injuries

A total of 120 injuries were diagnosed in 92 riders. 30 riders (32.6%) sustained multiple injuries. Of those, 20 riders (16.7%) suffered injuries to multiple body parts. Most riders suffered from injuries of the upper extremities (n = 41, 44.6%), followed by torso injuries (n = 31, 33.7%) and head injuries (n = 23, 25%).

Treatment

35 riders (38%) required hospitalization while 57 (62%) were treated as outpatients. The mean hospitalization period was 4 days (range 1–37 d). 4 riders (4.3%) were treated in an intensive care unit. The mean intensive care length of stay was 8.3 days (range 2–21 d). 13 riders (14.1%) underwent surgical treatment, while in 79 cases (85.9%) conservative therapy was sufficient.

Cases (riders with torso injuries)

31 riders (33.7%; 29 female, 2 male) suffered from a total of 39 torso injuries (Table 1) and 14 injuries of other body parts. At the time of the accident the average age of the injured riders was 12 years (range 5–17 y). 15 (48.4%) riders wore a safety vest at the time of the accident while 16 (51.6%) equestrians did not use a safety vest. 19 riders (61.3%) had more than 6 months of riding experience, while 12 riders (38.7%) had less than 6 months experience in riding activities. The number and type of torso injuries as well as the type of treatment in the case group are shown in Table 2.

Controls (riders with injuries other than to the torso)

61 riders (66.3%; 57 female, 4 male) suffered from a total of 67 injuries other than to the torso. The most frequent affected body

parts were the upper extremities (n=37) followed by the head (n=20) and the lower extremities (n=10). At the time of the accident the average age of the injured riders was 11.7 years (range 3–17y). 27 (44.3%) of 61 riders of the control group wore a safety vest at the time of the accident while 34 (55.7%) equestrians did not use a safety vest. 39 riders (63.9%) had more than 6 months of riding experience, while 22 riders (36.1%) had less than 6 months experience in riding activities. The number and type of torso injuries as well as the type of treatment in the control group are shown in Table 2.

Statistics

Safety vest use was not associated with a lower risk of torso injuries (OR=1.18, 95% CI (0.50, 2.81), p=0.707) (Table 3). A post-hoc power analysis revealed that within a case-control design with 31 cases and 61 controls, an odds ratio of 0.266 (OR=0.266) can be found with a power of 80% using an alpha=5%. To detect a risk reduction by 0.5, 0.25, or 0.1 (the safety vest reduces the risk of sustaining a torso injury by 50%, 75%, or 90%), we found a power of 34.6%, 83%, or 99.2%. Therefore, the population investigated was large enough to detect a moderate protective effect of the vest, namely a reduction in the risk of sustaining a torso injury of 75%. When adjusted for age and riding experience, the OR increased slightly 1.34 (95% CI (0.53–3.35, p=0.536). We found no significant effects of age (OR=0.93, p=0.416) or riding experience (OR=1.71, p=0.431) on the type of injury (Table 3).

Discussion

In order to prevent injuries during sport activities, the use of protective clothing seems to be a reasonable method. Especially the effectiveness of helmets has been thoroughly investigated and confirmed. Several studies have indicated that wearing a helmet may reduce the risk of head injury by 60–85%, depending on the sport investigated [15,21–24]. For example, Thomas et al. reported a 2.7-fold (CI 95% 1.5–4.9) higher risk of sustaining bicycling-related injuries to the upper head among unhelmeted children compared to helmeted children. For loss of consciousness, the risk was 7.3-fold higher (2.6–20.4) among unhelmeted children compared to helmeted children. This translates into a risk reduction among helmet wearers of 63% (CI 0.2–0.66) for

Table 1 Type of torso injury in the case-group.

Type of Torso Injury	Cases (n=31)	
	Safety Vest Users (n=15)	Safety Vest Non-users (n=16)
	Number of Injuries (n)	Number of Injuries (n)
thoracic vertebra fracture*	4	3
blunt abdominal trauma*	3	4
rump contusion	3	3
rib contusion*	2	2
lumbar vertebra fracture*		3
clavicle fracture*	2	1
pelvis contusion	2	
rip fracture*	2	
whiplash injury		2
scapula fracture*	1	
pneumothorax*	1	
shoulder contusion		1
Total	20	19

* Injuries of body parts localized under the vest

Table 2 Number and type of torso injury as well as the type of treatment in the case-/control-group.

	Cases (n=31)		Controls (n=61)		Total (n=91)	
	Safety Vest Users (n=15, 48.4%)	Safety Vest Non-users (n=16, 51.6%)	Safety Vest Users (n=27, 44.3%)	Safety Vest Non-users (n=34, 55.7%)	Safety Vest Users (n=42, 46.2%)	Safety Vest Non-users (n=50, 53.8%)
Torso injuries (n)	20	19	–	–	20	19
other injuries than Torso (n)	6	8	29	38	35	46
hospital therapy (n*/ %)	7 ^{2*} 46.7	7 ^{3*} 43.8	9 ^{4*} 33.3	12 ^{5*} 35.3	16 ^{6*} 38.1	19 ^{7*} 38
surgical therapy (n*/ %)	1 6.7	1 6.3	5 18.5	6 17.6	6 14.3	7 14
intensive care (n*/ %)	1 6.7	–	1 3.7	2 5.9	2 4.8	2 4

* Number of riders

^{2*} Mean duration of hospital stay: 3.7 days (range: 1-15d)

^{3*} Mean duration of hospital stay: 2.6 days (range: 1-10d)

^{4*} Mean duration of hospital stay: 4.6 days (range: 1-14d)

^{5*} Mean duration of hospital stay: 4.7 days (range: 1-37d)

^{6*} Mean duration of hospital stay: 4.7 days (range: 1-37d)

^{7*} Mean duration of hospital stay: 4.7 days (range: 1-37d)

upper head injuries and 86% (CI 0.05–0.38) for loss of consciousness [22]. In our study, we found an insignificant increase in the risk of sustaining a torso injury associated with wearing a safety vest, OR = 1.18; the corresponding 95% confidence interval (0.50–2.81) indicates that our result is consistent with a true rate of risk reduction associated with vest usage of 50% at best.

Assuming that the 14- to 18-year-old riders can be treated as adults, we performed a sensitivity analysis for the subgroup of riders ages 13 or younger and found that safety vest use in this age group also was not associated with a lower risk of torso injuries (OR = 1.11, 95% CI (0.37–3.32), $p=0.850$). When adjusted for age and riding experience, the OR increased slightly 1.225 (95% CI (0.38–3.9), $p=0.733$).

One cannot thus claim that these results prove that safety vests are unable to reduce the risk of sustaining a torso injury. However, the comparison of our results with those demonstrating the effectiveness of helmets show that safety vests are less effective in the reduction of torso injury rate in accidents occurring during pediatric horseback riding than helmets are in the reduction of head injuries caused by bicycling or skiing.

As expected, the general recommendation is for riders to use a safety vest during all riding activities. In 2008 Kiss et al. published that children are at risk for significant upper body injuries during horseback riding and would therefore potentially benefit from the use of safety vests [12]. However, after reviewing the relevant literature, we were unable to find an article that could demonstrate the effectiveness of body protectors in children and adolescents in reducing the rate of injury in horsebackriding-related accidents. In the past, other working groups have already questioned the effectiveness of body protectors used in activities other than horseback riding. Schmitt et al. doubted the benefit

of safety vests used in snowboarding and criticized that a false feeling of safety may be generated in the wearer of such a protector [17] and De Rome et al. detected the lack of protective effects for back armor in motorcyclists, because most motorcycle accident-related back injuries are caused by bending and torsional forces, not by direct impact to the spine [5].

It is quite obvious that it is not possible to create safety vests for equestrians capable of protecting against severe injuries for all types of accidents. Children and teenagers participating in equestrian activities remain at risk for substantial injury [9]. Particularly the physical differences between horses and children predispose towards severe injury and are compounded by the potential for unpredictable behavior in both species [10]. Consequently, a large percentage of children and adolescents experience severe injuries due to riding-related accidents independently of safety vest usage at the time of the accident [12].

It has to be mentioned that children especially can suffer from undiagnosed comorbidities that can complicate the right interpretation of the supposed sporting accident-related injuries. One example was published by Meinicke et al. in their case report of a 13-year-old male patient with an anterior spinal cord syndrome (ASAS) 1 week after he had suffered a leg strain in a Taekwondo-fight [13]. After completing and analyzing the diagnostic studies, the ASAS was most likely based on a thrombotic risk factor of a previously undiagnosed MTHFR-polymorphism with elevated homocysteine levels and a possible endothelial lesion caused by his fight's injury [13].

However, our findings provide an indication that safety vests do not substantially reduce the number and severity of injuries in children and adolescents who fall off a horse. In our opinion, the ineffectiveness of safety vests has several different reasons. Firstly, safety vests used in equestrian sports offer no protection against injuries to several parts of the torso. One example of a critical area is the cervical spine, which is particularly vulnerable to injury because it builds the mobile element between 2 fixed ends, the skull base and the thoracic spine. An axial force exerted through the crown of the head is transmitted through the skull to the cervical spine and can result in crushing of the vertebrae and extrusion of vertebral body and disc material posteriorly into the spinal canal. In these cases, the danger of severe neurological deficits is very high [19]. Another unprotected part of the torso not covered by a safety vest is the gluteal region. Other study groups have already detected that equestrians usually fall on their backsides when the accident results in spinal

Table 3 Odds Ratio (using a safety vest vs. no vest): unadjusted and adjusted for age and riding experience.

Adjusted Odds Ratio (OR)			
	OR	95% CI for OR	
		Lower	Upper
vest vs. no vest	1.336	0.534	3.347
age	0.928	0.774	1.112
riding experience >6 months vs. ≤6 months	1.713	0.449	6.543
unadjusted Odds Ratio (OR)			
	OR		
vest vs. no vest	1.181	0.496	2.809

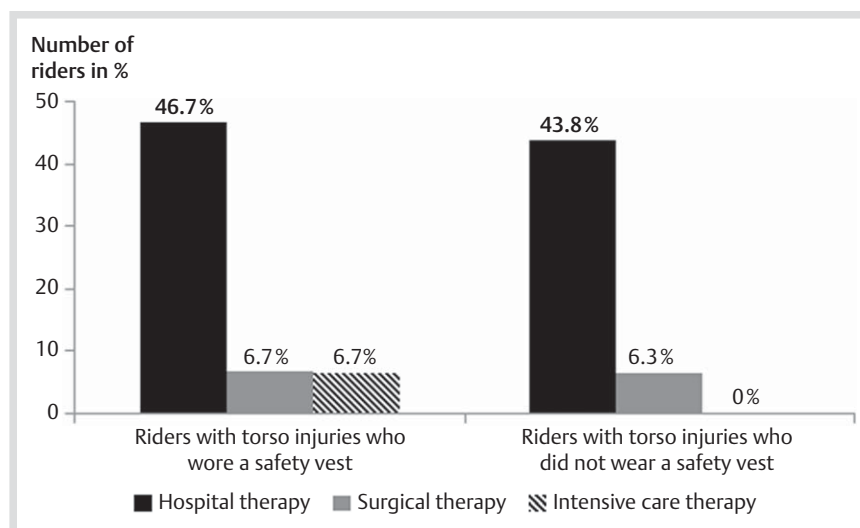


Fig. 1 Torso injury-related therapy dependent on the use of safety vests.

injuries [18]. In these cases the force effect on the thoracolumbar junction is purely axial, leading to fractures between T11 and L2. Secondly, it is questionable if vests really protect body parts localized under the protector when the rider falls from a horse. In our study, riders with torso injuries who used a safety vest suffered from a total of 15 injuries of body parts localized under the vest such as fractures of the thoracolumbar spine (n=4) or rib contusions/fractures (one leading to a pneumothorax) (n=4) (► **Table 1**). Furthermore, our results show no indication that safety vest users are suffering from less severe injuries than safety vest non-users (► **Fig. 1**).

Limitations of the study

In our study, we included all riders who were treated at one of the participating trauma centers over a period of 18 months who fulfilled the inclusion criteria of this study and who agreed to participate in our study. In retrospect, using this study design, we were not able to demonstrate a statistically significant protective effect of the safety vest because of the low number of casualties we investigated in each group. The post hoc power analysis subsequently created is surely of limited reliability. Another limitation is that it is impossible to perform a study including all riders in the area served by the participating trauma centers. Hence, we cannot make any general statements about the incidence of horseback riding-related accidents in children and adolescents.

The over-representation of girls (93.5%, n=86) in our study population is not a limitation and only represents the fact that horseback riding is practiced predominantly by females [1–4, 6, 14, 16].

Conclusions

This study is not able to show an association between wearing a torso protector and protection from torso injuries, probably due to confounding. We did not detect a high effect of safety vest usage in our study population. Whether the development of a new generation of safety vests might be more effective remains unclear. An effective vest should be adapted to the requirements of children and adolescents and should protect the thorax and abdomen, but also the cervical and the lumbar spine. However, at the present time, it is difficult to develop effective safety vests because the knowledge about the mechanisms and patterns of injuries from equine-related accidents is lacking. Therefore, further studies with long-term data collection including large collectives of riders seem necessary to increase the knowledge about these types of injuries and ultimately to develop more effective safety vests for children and teenagers in the future.

Conflict of interest: The authors have no conflict of interest to disclose.

Affiliations

¹Neurosurgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

²Legal Medicine, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

³Medical Biometry and Epidemiology, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

⁴Paediatric Sport Medicine, Altona Childrens Hospital, Hamburg, Germany

⁵Traumatology, BG-Hospital Hamburg-Boberg, Hamburg, Germany

⁶Traumatology, Asklepios Hospital Hamburg Heidberg, Hamburg, Germany

⁷Traumatology, Asklepios Hospital Hamburg Harburg, Hamburg, Germany

⁸Traumatology, Asklepios Hospital Hamburg Rissen, Hamburg, Germany

⁹Traumatology, Asklepios Hospital Hamburg St. Georg, Hamburg, Germany

¹⁰Traumatology, BG-Hospital Berlin Marzahn, Berlin, Germany

¹¹Oral and Maxillofacial Surgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

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