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Effects of body protection vests and experience levels in prevention of equestrian injuries

Sarah A Andres,[1,2] Adrienne M Bushau-Sprinkle,[2,3] Michael E Brier,[1] Yvette R Seger[2,4]

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[1]Department of Medicine, University of Louisville, Louisville, Kentucky, USA
[2]United States Pony Clubs, Lexington, Kentucky, USA
[3]Department of Pharmacology and Toxicology, University of Louisville, Louisville, Kentucky, USA
[4]Office of Public Affairs, Federation of American Societies for Experimental Biology, Bethesda, Maryland, USA

Correspondence to
Sarah A Andres; sarah.andres@louisville.edu

ABSTRACT

Objectives To investigate the risk reduction and benefit of wearing body protection/safety vests in equestrian sports.

Methods A comparison of equestrians wearing body protective vests and those not wearing vests was performed using incident report data of 718 participants in the United States Pony Clubs during 2011–2017. Data obtained included age, gender, certification level of member, type of activity, description of incident, description of injuries, what protective equipment was worn and other possible contributing factors.

Results While wearing body protective vests when riding on the flat or for show jumping was not correlated with a decrease in injuries, wearing vests for cross country was correlated with decrease in reported injuries (p=0.036) and showed a trend towards a lower incident severity level (p=0.062). Wearing body protection during cross country reduced the relative risk of injury by 56%. While the volume of incidents varied with a rider's experience level, the number of serious injuries did not appear to correlate with lesser equestrian experience.

Conclusions While equestrian sports are considered to have a certain degree of risk associated with them, there are ways to make them safer. Wearing safety equipment, such as helmets and body protection, and obtaining education and experience can lessen the chance of incurring serious injuries.

What are the new findings?

- An analysis was performed that illustrates a statistically significant decrease in equestrian injuries when body protection is worn during cross country activities, but not other types of riding.
- A trend towards less severe injuries was observed when body protection was worn for cross country riding.
- While the amount of incidents varied with a riders experience level, the amount of serious injuries did not appear to be correlated with lesser equestrian experience.

INTRODUCTION

Previous studies regarding the safety of equestrians have focused on the high incidence of head injuries, especially compared with other sports.[1 2] These studies discussed the lack of helmet use in equestrian sports as a primary reason for the increased incidence of concussion.[1–5] While studies have reported that head injuries account for between 13% and 48% of equestrian-related injuries,[6–11] injuries to the chest or back have been reported in 11%–54% of equestrian cases.[5–12]

The United States Equestrian Federation (USEF) and the United States Eventing Association (USEA) first recommended the use of body protecting vests for the cross country phase in the sport of eventing in 1994, and later made their use mandatory in 1996.[8] While the USEA/USEF do not currently require the use of an American Society for Testing and Materials (ASTM)-approved body protection vest for cross country jumping, British Eventing currently requires use of a body protector with at least British Equestrian Trade Organization (BETA) Level 3 certification. This is the highest level of protection recognised by BETA and is considered appropriate for general riding and competitions. BETA states that Level 3 body protectors should prevent minor bruising that would have produced stiffness and pain, reduce soft tissue injuries and prevent a limited number of rib fractures, while Level 2 offers lower than normal protection and Level 1 offers the least protection, but is designed to meet the weight restrictions that apply to jockeys when racing.

While numerous studies have demonstrated that wearing helmets dramatically reduces the risk of head injury, few studies have investigated the risk reduction of wearing other safety equipment, such as body protectors/safety vests. Although some studies mentioned the use of body protection,[2 12] few studies have investigated the benefit of body protection in equestrian sports.[10 13] A study by Hessler *et al*,[13] found there was no association between wearing body protection and protection from

torso injuries in a study of 92 paediatric and adolescent equestrians. However, this study did not investigate the effects of wearing body protection in specific equestrian activities, such as show jumping and cross country.

The United States Pony Clubs (USPC) has been recognised as a leader in equestrian safety, since they were the first organisation to require their members to wear helmets when mounted,[7 8 14] and they aided in the development of the ASTM equestrian helmet standard F1163 in 1988. The USPC has collected a detailed database of incident reports and is in a unique position in that, while the organisation recommends the use of body protection vests, it has not made their use mandatory when riding at USPC activities due to the lack of scientific evidence of efficacy. Incident report data from this organisation allows the effectiveness of body protectors to be evaluated in its primarily youth population.

METHODS

Incident report data

USPC District Commissioners, Center Administrators or other leaders fill out an online or print version of an incident report form which is entered into a national database. Data elements on the forms include age, gender, certification level of member, type of activity, description of incident, description of injuries, what protective equipment was being worn and other possible contributing factors. A retrospective review of USPC's incident reports from 2011 to 2017 was conducted in this study. Each incident was given an ordinal severity level based on information received in the report: 0=no injury observed or required no treatment; 1=required treatment and continued with activity; 2=required treatment but declined to continue with activity; 3=serious injury. χ^2 and ordinal regression analyses were performed using SPSS V.24 software. P values of less than 0.05 were considered statistically significant.

Safety vest survey of membership

To better understand the current use and views of safety vests within USPC membership, an online survey was developed using SurveyMonkey (see online supplementary material 1). A link to the survey was sent directly to all USPC members' emails. Responses were received from 890 members, representing approximately 10% of the total USPC membership.

RESULTS

Incident demographics

Of the 718 incidents reported from 2011 to 2017, over 91.6% (658) indicated that the person associated was mounted on a horse when the incident occurred, which is similar to previous accounts.[15] These mounted reports were analysed in this study (table 1). Among the reports of mounted incidents, 25.0% of the riders were wearing protective vests, while 75.0% were not wearing one at the time the accident occurred. More people choose to wear protective vests when participating in jumping sports compared with non-jumping sports (30.8% and 10.0%, respectively), and within the jumping sports, many more people wore vests when riding cross country compared with show jumping (70.7% and 7.5%, respectively). The average age and gender of the riders were not significantly different in all the groups evaluated (p value for age=0.35).

Differences in outcomes observed when wearing body protection vests

Initial analyses to determine if wearing body protection had an effect on whether or not a rider was injured were performed. When comparing riders in all mounted activities wearing a body protector to riders who did not wear a vest (table 2), there was not a statistically significant difference between riders who sustained an injury compared with those who did not (p value=0.18).

In general, jumping is considered to be more dangerous than riding on the flat (ie, riding without jumps). Because of this, USEF required protective headgear for all sanctioned jumping competitions beginning in 1964,[8] while helmets were only required at lower levels of dressage since 2013; helmets are still not required in the international western discipline of reining or vaulting. Since there appears to be a difference in risk between riding on the flat and jumping, those activities were evaluated separately. Among riders participating in non-jumping activities (table 2), there was no statistical difference in injuries observed (p=0.29). Among riders participating in jumping sports (table 2), there also was no statistical difference in injuries observed (p=0.67).

Since traditionally body protection is worn almost exclusively in the cross country (XC) phase of eventing, we wanted to ensure any results obtained were not

Table 1 Demographics of incidents reported when the rider was or was not wearing a body protection vest

	Total numbers of reported mounted incidents	Median age of rider affected	Gender of rider		No. reported incidents wearing body protection	No. Reported incidents not wearing body protection
			Female	Male		
All mounted activities	658	14 (range of 5–65)	95.0%	5.0%	165 (25.0%)	493 (75.0%)
Riders not in jumping disciplines	170	13 (range of 5–57)	90.6%	9.4%	17 (10.0%)	153 (90.0%)
Riders in jumping disciplines	484	14 (range of 7–65)	96.9%	3.1%	149 (30.8%)	335 (69.2%)
Show jumping	306	14 (range of 7–65)	97.1%	2.9%	23 (7.5%)	283 (92.5%)
Cross country	174	14 (range of 7–64)	97.7%	2.3%	123 (70.7%)	51 (29.3%)

Table 2 Pearson χ^2 analysis of outcomes observed when wearing body protection vests in different Equestrian activities

	P values
All mounted activities	0.18
Riders not in jumping disciplines	0.29
Riders in jumping disciplines	0.67
Show jumping	0.86
Cross country	0.036

simply due to cross country being a higher risk equestrian activity than show jumping, in which the poles fall down when hit by the horse.[8 16 17] When evaluating the differences in outcomes for riders wearing safety vests in show jumping (table 2), there is no significant difference observed (p=0.86). It should be noted that of the riders participating in show jumping (n=281), only 23 riders wore a vest, which may have affected the lack of difference observed. A similar analysis of equestrians participating in cross country riding had a different outcome (table 2). Riders who wore a vest for cross country had a decrease in injuries observed compared with those who did not wear a vest. Wearing vests for cross country was correlated with a decrease in reported injuries (p=0.036) and reduced the relative risk of injury by 56% (relative risk=0.64, 95% CI 0.43 to 0.96).

To investigate the difference in outcome associated with wearing body protective vests, incident severity levels were determined based on information provided in the incident reports with 0 indicating no injury observed or required no treatment, and an incident severity level of 3 indicating a serious injury occurred. An ordinal regression analysis was performed to evaluate the effect of wearing body protection on the incident severity level. While not statistically significant, there was a trend towards a lower incident severity level (p=0.062) when body protection was worn for cross country (figure 1). This is likely not statistically significant due to the small sample size with in each incident severity level group (incident severity level 0, n=112; level 1, n=9; level 2, n=22; level 3, n=29).

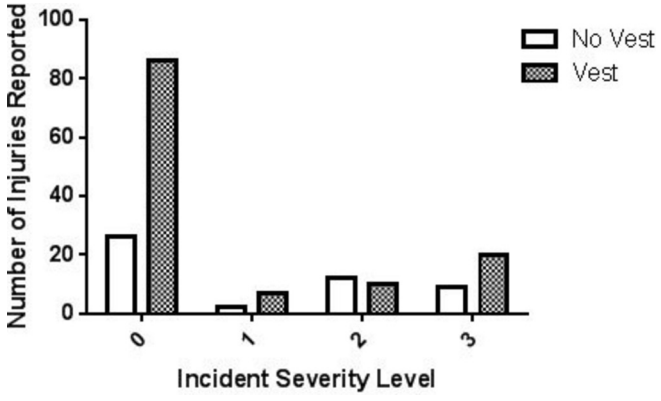

Figure 1 Differences in incident severity level observed when safety vests were worn when riders were participating in cross-country. Each incident was given an ordinal severity level based on information received in the report: 0=no injury observed or required no treatment; 1=required treatment and continued with activity; 2=required treatment but declined to continue with activity; 3=serious injury.

Differences in injuries to the torso of equestrians

Since body protective vests only cover the torso of the riders, reported injuries involving areas covered by the vests (collarbone, shoulder, ribs, chest, tailbone and so on) were specifically evaluated. Of the 493 incidents in which the rider was not wearing a vest, 232 of the injuries did not involve the torso, 123 of the injuries were reported to involve the torso (24.9% of incidents; 34.6% of reported injuries) and 138 did not report details regarding the injuries. Of the 165 incidents in which the rider was wearing a vest and the torso would likely be protected, 63 of the injuries did not involve the torso, 29 of the injuries did involve the torso (17.6% of incidents; 31.5% of reported injuries) and the details regarding the location of injuries were not reported in 73 cases. This suggests that wearing body protective vests may prevent injuries to the rider's torso.

Responses from safety vest survey of USPC membership

In an effort to better understand the current use and views of safety vests within USPC membership, a survey was developed and distributed to members in 2016. Responses were received from 890 members taking the survey, representing approximately 10% of the total USPC membership at the time. USPC members progress from beginners (uncertified to the D1, D2 and D3 levels) to intermediate (C1 and C2 levels) and advanced (National level certifications of C3, B and A), and these levels correspond to their degree of riding experience and abilities. While only 72% of the total responses indicated that the members owned a body protector, 86% of the members with a D2 certification or higher own one and 93% of the members with a C-level certification or higher own a body protective vest (figure 2A). Of the members who did not own a vest, 50% indicated cost as the primary factor, while being unsure of a benefit of wearing one, vests being uncomfortable, and difficulty in fitting were also indicated as reasons for not owning body protection (figure 2B). The majority of members who own one indicated that they wore them only for cross-country (figure 2C).

Experience level of equestrians relative to degree of injuries reported

Several studies[6 8 14] have reported that injuries are inversely correlated with rider's experience level. To investigate this in our population, the numbers of reported incidents were evaluated at each USPC certification level (figure 3A). Progression through the USPC certification levels is comparable to a members' degree of riding experience and abilities. While the number of reported incidents appears to be greatest in the D2

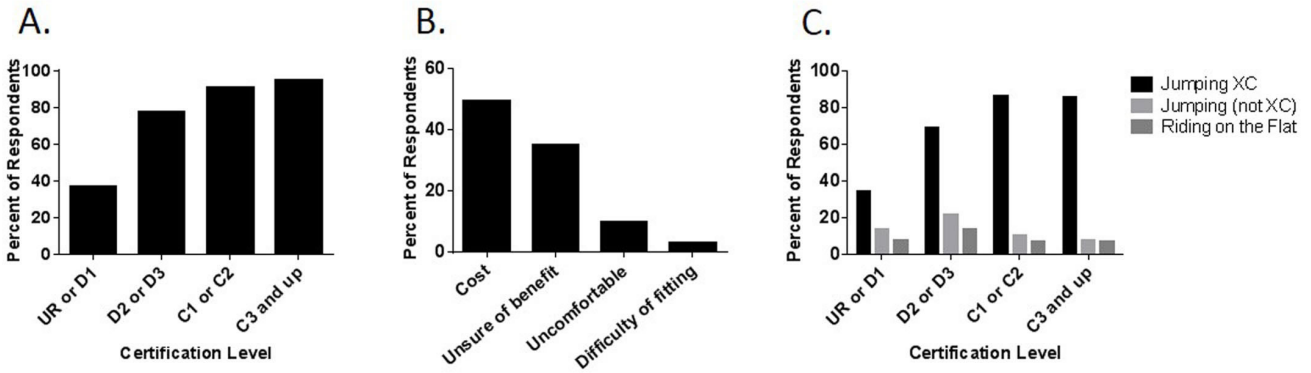

Figure 2 Responses from safety vest survey of USPC membership. (A) Percentage of members that own a body protective vest at the different certification levels; (B) reasons given for the members that do not own a body protector; (C) activities when vests are worn at the different certification levels. USPC, United States Pony Clubs.

and D3 members, it should be noted that those certifications are held by a larger number of members than those with C level certifications. Therefore, the incidents were normalised to the total number of members at each level (figure 3B). The greatest percentage of incidents after normalisation to the membership is at the D3 level with 1.5% of the members having an incident, while the intermediate or advanced levels were correlated with a decreased percentage of incidents. The percent of serious injuries out of the total reported incidents at each level ranged from 9.3% (at the D1 level) to 14.3% (at the C3 and higher levels, figure 3C). The age of the member was also evaluated at each certification level. Although the median age of an uncertified member is 13.5 years old, the average age of member increases as they progress through the certification levels, for example, D1 is 11, D2 is 13, D3 is 14, C1 is 15, C2 is 16.5 and C3 and higher is 19. Thus, age of the rider was not correlated with increased risk of injury (p=0.32).

DISCUSSION

There are few studies that have investigated the effectiveness of wearing body protection by equestrians either when riding on the flat or when jumping. Whitlock[11] reported that the Irish Jockey Club noticed fewer rib fractures once body protection was worn, but Hessler *et al*[13] was not able to show an association between wearing vests and protection from injuries to the torso. However, this may have been due to the relatively small population of 92 young equestrians investigated in their study, and lack of analysing the effects of body protection when worn during specific activities, such as cross country jumping.

This study used incident report data collected from the USPC where the utilisation of safety vests was not mandatory. There was not a statistically significant difference in injuries observed between the riders wearing vests and those not wearing them in all riding disciplines or when activities were separated into jumping sports (show jumping, jumping phases of eventing and tetrathlon) or

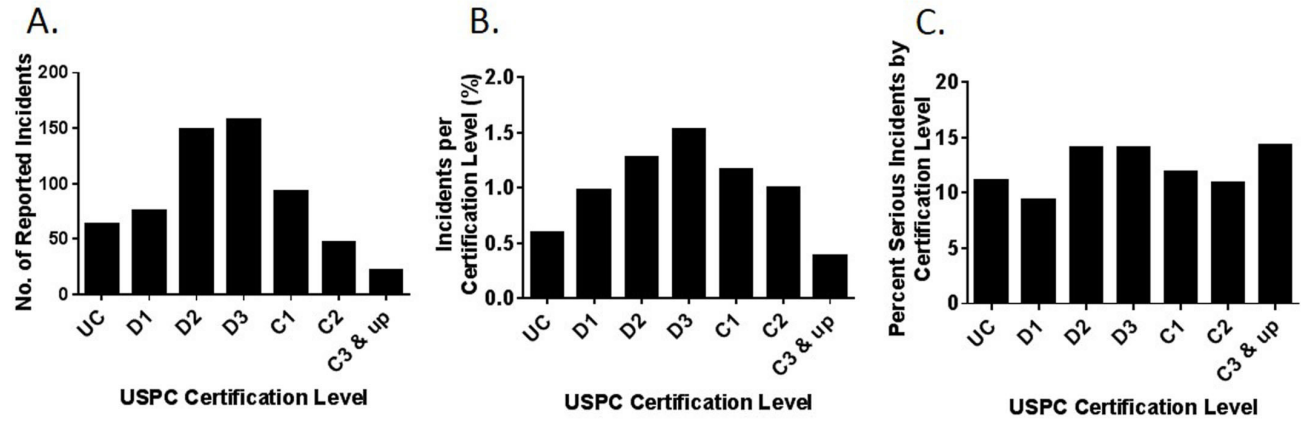

Figure 3 Differences in incidents observed in equestrians with increasing experience levels. (A) Total number of reported incidents at each certification level; (B) number of reported incidents normalised to membership numbers at each certification level; (C) per cent of serious injuries reported at each certification level. USPC, United States Pony Clubs.

non-jumping sports (dressage, games, polocrosse and so on). However, there was a statistically significant difference observed between riders wearing vests and those not wearing vests when riding cross country, and the riders who wore body protection vests had lower levels of incident severity reported. This may be due to the increased speed, solid nature of the fences, along with other obstacles, such as ditches and water that may cause refusals or falls when participating in the cross country phase of eventing. When specifically evaluating injuries that may be protected by utilisation of safety vests, the per cent of injuries to the torso was similar to previously reported studies.[11 18]

While nearly 75% of the total membership indicated that they owned a body protector, the percentage of the more advanced riders who owned a vest increased to over 90%. This is likely due to the more advanced riders also competing in national level eventing competitions for which wearing body protection when riding in the cross country phase is required. The majority of members who own a body protector indicated that they wore them only for cross country riding. Of the members who did not own a vest, primary reasons reported included cost, being unsure of a benefit, vests being uncomfortable and difficulty in obtaining a good fit for their body type.

Since several studies[6 8 14] have reported that less experienced riders are more likely to be injured, USPC members certification levels were also evaluated in the incident report data. The observation that D level members had higher proportions of injuries compared with more experienced riders is similar to that previously reported[7]; however, the percentage of serious injuries did not appear to be correlated with the rider's certification level. The observation that there was a higher number of serious injuries reported at the C3 level and above may be related to the member transitioning from learning to ride horses to training younger/less experienced mounts, leading to additional risks.

The primary limitation of this study is related to reporting compliance, as previously described by O'Brien.[16] It is suggested that there is an overestimate of serious injuries in incident report data due to non-reporting when a fall leaves a rider uninjured.[16] USPC has attempted to address this with presentations to local and regional leadership indicating the importance of filling out incident reports any time a rider falls off, and not just when there is an injury.

The USPC participates in several competitive equestrian sports, such as dressage, eventing, show jumping, games, polocrosse, tetrathlon and the unmounted sport of quiz. Additionally members participate in other equestrian disciplines, such as distance riding, driving, fox hunting, hunter seat equitation, vaulting and western. There are dramatic differences in the use of body protection in the different equestrian sports. While the authors know of no published reports indicating a correlation between speed of equestrian activity and increased injuries, that is entirely possible as falling from an increased speed would likely amplify the force applied to the body during a fall. The sports that currently require body protection demand riding at faster speeds, such as racing and the cross country phase of eventing. While the cross country phase of eventing at recognised competitions requires wearing safety vests, the lower numbers of riders wearing vests in disciplines other than eventing are likely due to factors such as the desire to wear traditional riding attire, and the additional heat associated with wearing a vest in warmer climates. The lower numbers of riders wearing vests in other equestrian sports, such as dressage and show jumping, make it difficult to determine statistical significance in this data set.

This study does not address newer pieces of safety equipment commonly known as air vests, in which an air bag is worn over the torso and is deployed when a rider exceeds a certain distance from their saddle, such as during a fall. These vests have only been on the market in the USA for several years, so more data will need to be collected prior to an analysis of their ability to prevent injury.

In summary, while riding and equestrian sports are considered to have a certain degree of risk associated with them, there are ways of making them safer for the rider. Utilisation of safety equipment, such as helmets and body protection, and obtaining education and experience can lessen the chances of having serious injuries associated with falls.

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Competing interests None declared.

Patient consent Not required.

Ethics approval Our retrospective study was reviewed by the Institutional Review Board at the University of Louisville (17.0290) and was determined to not meet the 'Common Rule' definition of human subjects' research.

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REFERENCES

1. Winkler EA, Yue JK, Burke JF, *et al*. Adult sports-related traumatic brain injury in United States trauma centers. *Neurosurg Focus* 2016;40:E4.
2. Zuckerman SL, Morgan CD, Burks S, *et al*. Functional and structural traumatic brain injury in equestrian sports: a review of the literature. *World Neurosurg* 2015;83:1098–113.

3. Lemoine DS, Tate BJ, Lacombe JA, *et al*. A retrospective cohort study of traumatic brain injury and usage of protective headgear during equestrian activities. *J Trauma Nurs* 2017;24:251–7.
4. Short SS, Fenton SJ, Scaife ER, *et al*. Helmet under-utilization by children during equestrian events is associated with increased traumatic brain injury. *J Pediatr Surg* 2018;53:545–7.
5. Srinivasan V, Pierre C, Plog B, *et al*. Straight from the horse's mouth: neurological injury in equestrian sports. *Neurol Res* 2014;36:873–7.
6. Bilaniuk JW, Adams JM, DiFazio LT, *et al*. Equestrian trauma: injury patterns vary among age groups. *Am Surg* 2014;80:396–402.
7. Bixby-Hammett DM. Pediatric equestrian injuries. *Pediatrics* 1992;89(6 Pt 2):1173–6.
8. Guyton K, Houchen-Wise E, Peck E, *et al*. Equestrian injury is costly, disabling, and frequently preventable: the imperative for improved safety awareness. *Am Surg* 2013;79:76–83.
9. Papachristos A, Edwards E, Dowrick A, *et al*. A description of the severity of equestrian-related injuries (ERIs) using clinical parameters and patient-reported outcomes. *Injury* 2014;45:1484–7.
10. 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.
11. Whitlock MR. Injuries to riders in the cross country phase of eventing: the importance of protective equipment. *Br J Sports Med* 1999;33:212–4.
12. 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.
13. Hessler C, Eckert V, Vettorazzi E, *et al*. Effectiveness of safety vests in pediatric horseback riding. *Klin Padiatr* 2012;224:443–7.
14. Mayberry JC, Pearson TE, Wiger KJ, *et al*. Equestrian injury prevention efforts need more attention to novice riders. *J Trauma* 2007;62:735–9.
15. Camargo F, Gombeski WR, Barger P, *et al*. Horse-related injuries: causes, preventability, and where educational efforts should be focused. *Cogent Food Agric* 2018;4.
16. O'Brien D. Look before you leap: what are the obstacles to risk calculation in the equestrian sport of eventing? *Animals* 2016;6:E13:13.
17. Paix BR. Rider injury rates and emergency medical services at equestrian events. *Br J Sports Med* 1999;33:46–8.
18. Ekberg J, Timpka T, Ramel H, *et al*. Injury rates and risk-factors associated with eventing: a total cohort study of injury events among adult Swedish eventing athletes. *Int J Inj Contr Saf Promot* 2011;18:261–7.