BMJ Open Sport & Exercise Medicine

Hospital-treated injuries from horse riding in Victoria, Australia: time to refocus on injury prevention?

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To cite: O'Connor S, Hitchens PL, Fortington LV. Hospital-treated injuries from horse riding in Victoria, Australia: time to refocus on injury prevention? *BMJ Open Sport & Exercise Medicine* 2018;**4**:e000321. doi:10.1136/bmjsem-2017-000321

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/bmjsem-2017-000321).

Accepted 22 December 2017

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ABSTRACT

Background The most recent report on hospital-treated horse-riding injuries in Victoria was published 20 years ago. Since then, injury countermeasures and new technology have aimed to make horse riding safer for participants. This study provides an update of horse-riding injuries that required hospital treatment in Victoria and examines changes in injury patterns compared with the earlier study.

Methods Horse-riding injuries that required hospital treatment (hospital admission (HA) or emergency department (ED) presentations) were extracted from routinely collected data from public and private hospitals in Victoria from 2002–2003 to 2015–2016. Injury incidence rates per 100 000 Victorian population per financial year and age-stratified and sex-stratified injury incidence rates are presented. Poisson regression was used to examine trends in injury rates over the study period.

Results ED presentation and HA rates were 31.1 and 6.6 per 100 000 person-years, increasing by 28.8% and 47.6% from 2002 to 2016, respectively. Female riders (47.3 ED and 10.1 HA per 100 000 person-years) and those aged between 10 and 14 years (87.8 ED and 15.7 HA per 100 000 person-years) had the highest incidence rates. Fractures (ED 29.4%; HA 56.5%) and head injuries (ED 15.4%; HA 18.9%) were the most common injuries. HA had a mean stay of 2.6±4.1 days, and the mean cost per HA was $A5096±8345.

Conclusion Horse-riding injuries have remained similar in their pattern (eg, types of injuries) since last reported in Victoria. HA and ED incidence rates have increased over the last 14 years. Refocusing on injury prevention countermeasures is recommended along with a clear plan for implementation and evaluation of their effectiveness in reducing injury.

What are the new findings?

- There are more than 1600 emergency department presentations and 350 hospital admissions relating to horse-riding injuries per year in Victoria, an area with a population of 6 179 249 in 2015–2016.
- Female riders aged between 10 and 20 years had the highest rates of hospital-treated horse-riding injuries.
- Head injuries and fractures are the most common injuries treated in hospital. The pattern of injuries has remained similar compared with those reported previously.

INTRODUCTION

Horse riding in Australia is a popular activity incorporating both organised, competitive sporting events and recreational activities.[1 2] There are many different organised horse-riding sports, including professional and amateur horse racing, equestrian, eventing, show jumping, pony club, polo, hunting and rodeo.[1 3] Horse riding is also enjoyed as a recreational activity, with participants riding along open roads or public trails, in a non-organised, informal setting, as an example.

Injuries are an inherent risk in horse riding, with equipment and safety measures an important consideration for participation. Injuries and injury risks in horse-riding activities are different from other sports due to the human–animal interaction.[1 4] In a study from the early 1990s, 39% of all horse riding-related injuries presenting to emergency departments (EDs) in the Australian state of Victoria were reportedly due to horse behaviour, with the majority of these occurring because the horse was frightened and bolted, bucked or reared.[5]

Horse-riding injury studies frequently report that fractures and head injuries comprise a large proportion of injuries.[5–7] Not wearing a helmet, or wearing a substandard or incorrectly fitting helmet, is potentially associated with head injuries in horse riding.[6–9] Up to four in five injuries occur during horse riding itself, primarily due to riders falling.[5] Many of these fall-related injuries require hospitalisation,[1 5] owing to the rider being initially seated approximately 3 m above the ground[4] and often riding over an irregular terrain. In other words, riders can fall from a height onto uneven ground. Injuries can also occur during horse handling and other non-riding activities centred around horses, such as grooming, saddling, shoeing, loading/unloading and stable work.[1 3]

Recent studies from Queensland and New South Wales (NSW) suggest that the number of injuries in those states has remained constant in recent years; however, injury rates were not published.[3 10] The last report on horse-riding injuries in Victoria was published in the 1990s (as mentioned above), in which the injuries reported were primarily from falls, and crushing or kicking injuries from the horse itself.[5] Head injuries comprised a large proportion of admissions, and admissions among women in private hospitals were twice as common compared with men.[5]

Following this, countermeasures for prevention of horse-riding injuries were developed that covered a range of areas including rules and regulations, rider education, equipment and clothing, rider experience, and the riding environment.[1] More recently, advances have been made in the development of injury prevention strategies related to horse riding, including fall prevention programmes and equipment design (such as body protectors and helmets).[4 11 12] Evaluating whether such countermeasures have been implemented or have led to a reduction in injury over the years is a critical step in the injury prevention sequence.[13] An epidemiological update of injuries in Victoria is required to determine if any changes have occurred in the types of injuries sustained and who they are sustained by. In addition, this information will facilitate identification of emerging areas for prevention with respect to current technology and safety standards.

The aim of this study was to investigate horse-related sport and recreation injuries that required either ED treatment or hospitalisation from 2002–2003 to 2015–2016 financial years inclusive, in Victoria, Australia. Specifically, data are presented to identify the number of horse-related sport and recreation injury cases and injuries per participant-years, as well as to enable examination of injuries with regard to age, sex, body region, type, mechanism, activity, location and outcome of injury. A secondary aim was to compare the new injury data with those collected in the 1990s.[5]

METHODS

Ethics

Individual consent was not required as the data were obtained as part of the admissions process in a hospital setting for routine Australian Government statistics.

Injury data

De-identified, summarised data on all horse-related injuries relating to sport and recreation were sought from the Victorian Injury Surveillance Unit and extracted from two data sets—the Victorian Emergency Minimum Dataset (VEMD) and the Victorian Admitted Episodes Dataset (VAED). The VEMD records all cases where a person sought treatment for an injury at one of the 39 Victorian EDs in public hospitals in Victoria, inclusive of all public hospitals with a 24-hour service. The data are coded according to the National Injury Surveillance Data Dictionary.[14] The VAED records data related to all state-wide hospital admissions (HA), including private and public hospitals, rehabilitation centres, extended care facilities and day procedure centres across Victoria.

For HA, a request was made for cases with International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification[15] activity classification code U63.0 (equestrian activities; online supplementary table 1). This code includes all equestrian sport and recreation, exclusive of modern pentathlon (U67.3). Admissions as a result of a transfer from another hospital, readmissions for day treatments within 30 days of the initial admission, prearranged admissions or return visits were excluded to prevent inclusion of the same injury multiple times. Cases were included from 1 July 2002 to 30 June 2016 per financial year. For ED presentations, a text narrative search of key horse-riding sport terms was used to identify cases.

Patient age, gender, principal injury diagnosis (including body region and type of injury), mechanism of injury, activity and location at time of injury, financial year, outcome of injury, and region of primary residence in Victoria were all extracted. For ED presentations only, the mechanism of injury was examined. For HA, the length of stay in hospital and economic burden due to this stay were extracted.

Population and participation data

The estimated Victorian population, as a total and by age and sex, was obtained from the Australian Bureau of Statistics.[16] This is the most accurate data available on which to calculate HA and ED presentation incidence rates (ie, using the population as denominator). For non-organised, general horse-riding participation, an estimate of the proportion of people who took part in equestrian and horse-riding activities was obtained from the Exercise, Recreation and Sport Survey annual report state tables for Victoria, covering the years 2007–2008 to 2010–2011, inclusive.[17] The proportion of non-organised participants (as a % of state population) was used as a comparator to the HA and ED cases for trail or general horse-riding injuries (excluding cases from other horse sports). This was because general trail riding was the only activity in which the injury cases could be separately derived.

Statistical analysis

Descriptive data (mean, SD (±) and range) for the length of stay in hospital as well as the estimated cost of hospital stay ($A) are reported. Proportions of injuries by age, sex, body region injured, type of injury, mechanism of injury, activity at time of injury and geographical location at time of injury, as well as discharge destination for ED, are also presented.

Crude injury incidence rates for both ED presentations and HA were calculated per 100 000 person-years for the Victorian population for each financial year, with 95% CI, using the Poisson distribution. Percentage change

comparing the injury rate in 2002–2003 and 2015–2016 was calculated. Age-stratified and sex-stratified injury incidence rates and their 95% CI are presented. To identify trends in injury incidence rates over the 14 years of the study, we generated incidence rate ratios (IRR) and their 95% CIs using Poisson regression with a linear term for financial year. Differences were considered to be statistically significant where P<0.05. Injury incidence rates specific to non-organised trail or general horse riding were calculated separately using participation estimates for the years 2007–2008 to 2010–2011. IRR and 95% CI were also calculated between the three age groups most commonly injured, sex, and the differences between 2007–2008 and 2010–2011 for trail and general horse-riding injuries. Data were analysed using Stata V.13.1 and Microsoft Excel 2016.

RESULTS

There were 23 702 ED presentations and an additional 5031 HA due to horse-related injuries between July 2002 and June 2016. For ED presentations and HA, an incidence rate of 31.1 and 6.6 per 100 000 person-years was reported over the study period, respectively. There was an increase of 28.8% ED presentations and 47.6% HA over the 14 years. Female riders sustained a greater proportion of horse-riding injuries than male riders for both ED presentation (76.8%) and HA (76.9%). Table 1 presents injury incidence rates stratified by year,

Table 1 Number, percentage, population, injury incidence rates per 100 000 person-years and 95% CI for ED presentations and HA per year, sex, most common age groups injured, and trail or general horse-riding injuries

	ED			HA		
Study factor	n (%)	Population at risk	IR (95% CI)	n (%)	Population at risk	IR (95% CI)
Year						
2002–2003	1251 (6.2)	4 873 809	25.7 (25.7 to 25.7)	312 (5.3)	4 873 809	6.4 (6.4 to 6.4)
2003–2004	1379 (6.5)	4 927 149	28.0 (28.0 to 28.0)	325 (5.8)	4 927 149	6.6 (6.6 to 6.6)
2004–2005	1571 (6.4)	4 989 246	31.5 (31.5 to 31.5)	322 (6.6)	4 989 246	6.5 (6.5 to 6.5)
2005–2006	1757 (6.1)	5 061 266	34.7 (34.7 to 34.7)	306 (7.4)	5 061 266	6.1 (6.0 to 6.1)
2006–2007	1691 (5.9)	5 153 522	32.8 (32.8 to 32.8)	296 (7.1)	5 153 522	5.7 (5.7 to 5.8)
2007–2008	1488 (5.5)	5 256 375	28.3 (28.3 to 28.3)	274 (6.3)	5 256 375	5.2 (5.2 to 5.2)
2008–2009	1706 (5.9)	5 371 934	31.8 (31.7 to 31.8)	296 (7.2)	5 371 934	5.5 (5.5 to 5.5)
2009–2010	1673 (6.0)	5 461 101	30.6 (30.6 to 30.7)	304 (7.1)	5 461 101	5.6 (5.6 to 5.6)
2010–2011	1607 (6.3)	5 537 817	29.0 (29.0 to 29.0)	318 (6.8)	5 537 817	5.7 (5.7 to 5.8)
2011–2012	1730 (6.6)	5 653 429	30.6 (30.6 to 30.6)	332 (7.3)	5 653 429	5.9 (5.9 to 5.9)
2012–2013	1902 (7.6)	5 775 808	32.9 (32.9 to 33.0)	382 (8.0)	5 775 808	6.6 (6.6 to 6.6)
2013–2014	1825 (8.2)	5 901 970	30.9 (30.9 to 31.0)	410 (7.7)	5 901 970	7.0 (6.9 to 7.0)
2014–2015	2079 (11.3)	6 032 968	34.5 (34.4 to 34.5)	570 (8.8)	6 032 968	9.5 (9.4 to 9.5)
2015–2016	2043 (11.6)	6 179 249	33.1 (33.0 to 33.1)	584 (8.6)	6 179 249	9.5 (9.4 to 9.5)
Sex						
Male	5501 (23.1)	37 682 369	14.6 (14.2 to 15.0)	1161 (76.8)	37 682 369	3.1 (2.9 to 3.3)
Female	18 201 (76.9)	38 493 274	47.3 (46.6 to 48.0)	3870 (23.2)	38 493 274	10.1 (9.7 to 10.4)
Age group						
10–14	4109 (17.3)	4 681 122	87.8 (85.1 to 90.5)	735 (14.6)	4 681 122	15.7 (14.6 to 16.9)
15–19	3113 (13.1)	4 950 196	62.9 (60.7 to 65.1)	655 (13.0)	4 950 196	14.3 (12.3 to 14.3)
20–24	2390 (10.1)	5 545 199	43.1 (41.4 to 44.9)	489 (13.0)	5 545 199	8.8 (8.1 to 9.6)
Trail or general						
2007–2008	70 (19.9)	26 282	266.3 (210.7 to 336.7)	207 (22.1)	26 282	787.6 (687.3 to 902.6)
2008–2009	112 (31.8)	42 975	260.6 (216.6 to 313.6)	229 (24.4)	42 975	532.9 (468.1 to 606.6)
2009–2010	96 (27.3)	43 689	219.7 (179.9 to 268.4)	245 (26.1)	43 689	560.8 (494.8 to 635.6)
2010–2011	74 (21.0)	38 765	190.9 (152.0 to 239.7)	256 (27.3)	38 765	660.4 (584.3 to 746.5)
Total population at risk	23 702		31.1 (31.1 to 31.1)	5031		6.6 (6.6 to 6.6)

ED, emergency department; HA, hospital admission; IR, incidence rate.

sex and age groups most commonly injured. We found an increase in HA for female riders from 2013–2014 to 2014–2015 (IRR 1.40; 95% CI 1.22 to 1.61).

Trail or general horse-riding injuries presented with an average HA of 617.6 (95% CI 579.3 to 658.5) and ED presentations of 232.0 (95% CI 209.0 to 257.6) per 100 000 non-organised horse-riding participants per year. ED presentations (IRR 0.87; 95% CI 0.67 to 1.1) and HA (IRR 0.84; 95% CI 0.70 to 1.01) decreased between 2007–2008 and 2010–2011; however, this was not statistically significant.

People aged 10–14 years, followed by 15–19 years and 20–24 years, were the most commonly injured in both the ED presentations and HA. Those aged 10–14 years had a greater incidence of presentations to the ED (IRR 1.19; 95% CI 1.07 to 1.32) and HA (IRR 1.40; 95% CI 1.34 to 1.47) than those aged 15–19 years old. Those aged 15–19 years had a greater injury incidence than those aged 20–24 years old for both ED presentations (IRR 1.51; 95% CI 1.34 to 1.70) and HA (IRR 1.46; 95% CI 1.38 to 1.54).

Table 2 presents the body region of injuries. The head was the most common body region injured for both ED presentations and HA. In ED presentations, injuries to the wrist and hand and foot and ankle were also common. Injuries to the abdomen, lower back, lumbar spine, pelvis, and elbow and forearm accounted for a relatively large proportion of HA. Fractures were most common for both ED presentations and admissions to hospital. In the ED, dislocations, sprains and strains were the second most common type of injury reported.

Where the specific site was reported, horse-related injuries that presented to the ED occurred most often on a farm (25.1%) or at home (22.2%). Similarly, of those that could be specified, horse-related injuries that required hospital admittance mainly occurred in sports and athletic areas (17.4%).

Most cases that presented to an ED occurred during leisure (65.7%) and sports (10.0%). For ED presentations, most injuries were due to a fall from a horse, or being struck or bitten by a horse (56.0%) (Table 3). Transport was the primary cause of horse-related injuries that required HA (88.0%).

The mean length of stay in a hospital was 2.6±4.1 (1–101) days, with the majority in hospital for less than 2 days (57.1%), followed by 2–7 days (37.0%), 8–30 days (5.4%) and greater than 31 days (0.4%). The mean cost of horse-related injuries following HA was A$5096±8345 (A$631–A$188 412).

DISCUSSION

This study presents an update of ED presentations and HA as a result of horse-riding injuries in Victoria, Australia. The number of hospital-treated horse-riding injuries has increased over the last 14 years. While this can initially appear to be of concern, further analysis with accurate participation data to enable stronger comparison of incidence rates is required, as the change may be

Table 2 Body region injured, type of injury and location of injury occurrence for ED presentations and HA from 2002-2003 to 2015-2016

	ED presentations		HA	
	n	Percentage	n	Percentage
Body region injured				
Head	3641	15.4	951	18.9
Neck	904	3.8	215	4.3
Shoulder and upper arm	2242	9.5	637	12.7
Elbow and forearm	2040	8.6	682	13.6
Wrist and hand	3314	14.0	245	4.9
Thorax	1255	5.3	471	9.4
Abdomen, spine and pelvis	2271	9.6	850	16.9
Hip and thigh	1090	4.6	281	5.6
Knee and lower leg	1865	7.9	578	11.5
Ankle and foot	2659	11.2	92	1.8
Eye	34	0.1	0	0.0
Ear, respiratory tract and alimentary tract	10	0.0	0	0.0
Unspecified body region	343	1.4	15	0.3
Body region not required	27	0.1	14	0.3
Type of injury				
Fracture	6963	29.4	2843	56.5
Dislocation, sprain, strain	5372	22.7	226	4.5
Other and unspecified injury	3492	14.7	680	13.5
Superficial injury	2685	11.3	258	5.1
Muscle and tendon	1586	6.7	73	1.5
Open wound	1401	5.9	159	3.2
Intracranial injury	1108	4.7	536	10.7
Crushing injury	511	2.2	11*	0.2
Eye injury	77	0.3	–	–
Poisoning or toxic effects	45	0.2	–	–
Burns	27	0.1	–	–
Injury to internal organs	249	1.1	182	3.6
Foreign body	66	0.3	0	0.0
Traumatic amputation	49	0.2	15	0.3
Injury to blood vessels	32	0.1	9	0.2

Continued

Table 2 Continued

	ED presentations		HA	
	n	Percentage	n	Percentage
Injury to nerves and spinal cord	32	0.1	28	0.6
Other and unspecified effects of external causes	7	0.0	11	0.2
Location of injury occurrence				
Farm	5940	25.1	241	4.8
Home	5273	22.2	222	4.4
Sports and athletic areas	1999	8.4	874	17.4
Road, street and highway	562	2.4	77	1.5
Trade and service area	222	0.9	16†	0.3
School and public buildings	100	0.4	–	–
Residential institution	29	0.1	–	–
Industrial and construction area	24	0.1	–	–
Other specified places	7013	29.6	349	6.9
Unspecified places	2540	10.7	3252	64.6

*Crushing injury, eye injury, poisoning or toxic effects, and burns are presented as grouped data due to small numbers.
†Trade and service area, school and public buildings, residential institution, and industrial and construction area are presented as grouped data due to small numbers.
ED, emergency department; HA, hospital admissions.

accounted for by an increased number of participants. Only a limited selection of participation data were available for 3 years of trail or horse-riding injuries. In this, a trend for a reduction in injuries between 2007–2008 and 2010–2011 was observed, but the decrease was not statistically significant.

Who is at risk?

In Victoria, the ratio of women to men requiring hospital-treated injuries has increased from 2:1 reported by previous research in the 1990s[5] to 3:1 over the last 14 years. The findings in Victoria are similar to the 2.8:1 ratio noted in a hospital in NSW,[10] but higher than in Queensland at 1.2:1.[3] Young female riders aged between 10 and 20 years are still at greatest risk of sustaining horse-riding injuries requiring hospital treatment in Victoria, most likely reflecting the high participation rates of this population than other age and sex groups.[18] However, the percentage of ED presentations aged 10–14 years has reduced by 6.7%.[5] Hospital-based research in Queensland,[3] United Arab Emirates,[19] New Zealand[18] and the USA[20] supports this finding, highlighting women and older children/adolescents aged between 10 and 19 years as those at most risk of horse-riding injury.

While a trend for decreased HA from injuries that occurred during trail or general horse-riding injuries was noted, it was not statistically significant. Recent research in New Zealand[21] has highlighted the injury risk during non-organised recreational horse-riding activities. This highlights the need for research to recommend and implement injury prevention strategies in organised horse-riding sports, and to tackle how best to implement these strategies in non-organised horse-riding activities.

How does it happen?

Falling from or being struck or bitten by a horse and falling from a height were frequent mechanisms of injury. Falls were also the most prevalent injury mechanism reported back in 1995, with as much as 77% of injuries occurring due to a fall.[5] This is supported by previous hospital data from Queensland,[3] Perth Royal Hospital,[19] New Zealand[21] and the USA.[20] While fall techniques have long been promoted, mandatory fall prevention programmes that teach appropriate fall technique strategies at a young age may be valuable. In addition, new advancements have been made with safety equipment and their application in horse riding,[3 4] so updated countermeasure recommendations may be required.

What are the common injuries?

Head injuries were the most frequent body region injured. This was slightly higher than previously reported ED presentations in both children (13%) and adults (12%) in Victoria[5] and similar to the 15.5% of injuries recorded on the Queensland Trauma Registry.[3] Helmets have the potential to drastically reduce the number of severe and fatal head injuries[22 23] and are significantly associated with lower HA rates.[10] In Australia, many equestrian sport organisations have rules in place to ensure helmet use is mandatory during riding.[12] However, a US study found that the majority (91.9%) of those sustaining

Table 3 Mechanism of horse-related injury for emergency department (ED) presentations between 2002–2003 and 2015–2016

	ED presentations	
Mechanism	n	Percentage
Fall from, struck or bitten by horse	13278	56.0
Fall from >1 m	4105	17.3
Fall from same level or <1 m	2756	11.6
Bite/kick/stomp/crush	1822	7.7
Collision with object	991	4.2
Cutting, piercing injuries	27	0.1
Other specified causes	501	2.1
Unspecified causes	222	0.9

horse-related injuries did not wear any safety equipment.[20] In Victoria, Australia between 2003 and 2008, the situation was only marginally better, as 31% of people aged less than 18 years were not wearing a helmet during the injury event,[24] and 43% in a 1995 study.[25] Exploration of risk perceptions and protective equipment behaviours could provide further insight as to why riders do not wear helmets. In addition, new advancements have been made for horse-riding safety equipment,[11 12] and so updated recommendations may be required.

Fractures have remained the most common type of injury in comparison with the previous analysis, but dislocations, sprains and strains have increased.[5] Wrist, hand and elbow fractures were frequent, possibly because these types of injuries are commonly associated with falls from a horse, where the rider may fall with their arms outstretched.[19] Abdomen, spine and pelvic injuries were the second most common body region requiring HA. The use of protective vests may reduce the risk of injury to the trunk; however, only 7% of US horse riders classified as novice to professionals wore them,[26] and so an examination of the use of protective vests in horse riders in Victoria would be beneficial.

Outcomes of the injuries

In Victoria, the mean days of HA has decreased from 4 days[5] to 2.6 days, possibly indicating that the countermeasures implemented may have led to a reduction in the overall injury severity and burden, or as a reflection of a change in the healthcare treatment. However, horse-related injuries led to a substantial financial burden. Unfortunately, costing data were not available from the previous analysis in Victoria completed in the 1990s, which limits comparison. When converted to enable comparison with other currencies, the financial impact of a horse-riding injury HA in Victoria was higher than the reported cost in New Zealand (NZ$3000)[21] but lower than the USA (US$29 654).[20] This may be due to varying hospital costs between countries and treatments.[27] Horse-riding injuries are often serious and have a high financial burden, highlighting the clear need for their prevention to be prioritised.

Limitations

This study examined horse-related injuries that were presented to the ED or were admitted to hospital only. Thus, injuries that did not require hospitalisation and were presented solely to their local general practice or healthcare professional were not included. Injury rates were primarily expressed with respect to population data, as accurate participation in horse riding was not available for the full time period examined. Establishing accurate participation data of both organised and non-organised horse riding would provide more accurate rates.

CONCLUSION

Despite previous countermeasures having been proposed following the last report on horse-riding injuries in Victoria in the 1990s, injuries that require hospital treatment are still prevalent. Thus, detailed examination of the countermeasures previously proposed, their adaptation to policy, and their implementation and uptake across both organised and non-organised horse riding is recommended.

Acknowledgements The authors thank the team at the Victorian Injury Surveillance Unit, Monash University Australia, for providing the data used in this study.

Contributors SOC and LVF conceived the study. SOC completed the data analysis. SOC and LVF wrote the first draft of the manuscript, and all authors critically reviewed the work before approving the final version of the manuscript. All authors will act as study guarantors for this paper.

Funding This paper was funded by the Irish Research Council New Foundations scheme. ACRISP is one of the international research centres for the prevention of injury and protection of athlete health supported by the IOC. PLH is supported by funding from Racing Victoria (RVL), the Victorian Racing Industry Fund (VRIF) of the Victorian State Government, and the University of Melbourne.

Competing interests None declared.

Ethics approval Ethical approval was obtained from the Federation University Australia Human Research Ethics Committee (C17-020).

Provenance and peer review Not commissioned; externally peer reviewed.

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