



**AUT NATIONAL INSTITUTE FOR
STROKE AND APPLIED NEUROSCIENCES**



**AUT SPORTS PERFORMANCE
RESEARCH INSTITUTE NEW ZEALAND**



Concussion Awareness in Equestrian Sports

Stakeholder Report, January 2019

Authored by: Alice Theadom, Duncan Reid, Natalie Hardaker, Patria Hume



Citation:

Theadom, A., Reid, D., Hardaker, N., Hume, P. A., (2019). Awareness of Concussion in Equestrian Sports. *Report to Stakeholders, January 2019*. 22 pages.

Executive Summary

An online 48-item questionnaire was used to explore concussion awareness, attitudes and behaviour in equestrian sports in New Zealand (NZ). Equestrian Sports New Zealand, New Zealand Pony Club, Harness Racing NZ, NZ Thoroughbred Racing, Rodeo NZ, NZ Veterinary Association, NZ Farrier Association, and study sponsors emailed their members a link to the online questionnaire. A link was also advertised in equestrian magazines and through social media. Paper copies of the questionnaire were made available at a number of community presentations and equestrian events across New Zealand. The final sample of 1,486 participants were aged between 16 and 83, were from a wide range of equestrian disciplines and included amateurs and professionals.

Key findings:

Prevalence of concussion was high, with nearly two thirds of participants reporting having experienced at least one concussion. One in five had experienced at least three concussions. Knowledge of what concussion was, how to recognise it and key symptoms (except poor sleep) was very high (>80%). In contrast, knowledge of the function of helmets was low (e.g. only 40% identified that they reduce cuts and bruising and 87% incorrectly believed that a helmet prevented concussion). Knowledge of guidelines and how to respond following a concussion were moderate (46-82%). Few participants wore helmets when working around a horse's feet and a small but significant proportion reported not wearing a helmet when riding. Nearly half of respondents had continued to wear the same helmet after a hit to the head. The top three sources of concussion knowledge were doctors or other health professionals, TV/social media and friends or family. Only 36% had been taught what to do in a fall to reduce injury. There was very high awareness of the need to see a doctor following a suspected concussion, but concerns were raised about doctors' ability to accurately diagnose and manage concussion.

Recommendations:

- Further concussion education with regards to what happens to the brain, potential longer-term effects, function of helmets, safety standards and managing concussion with relevance to equestrian activities is needed.
- Training on how to fall from a horse to reduce risk of injury is needed.
- Knowledge of Accident Compensation Corporation (ACC) , Equestrian Sports New Zealand and Pony Club guidelines could be increased.
- Examine if helmet standards are adequate to absorb impact to help reduce concussion.

- Explore if there are available methods to check whether a helmet is damaged after a fall.
- Advice on choosing a helmet is needed.
- Effective strategies are needed to optimise information/care provided at first point of contact.

Introduction

Concussion and skull fracture are both types of a traumatic brain injury (TBI).[1] Sports-related TBI is a significant problem in New Zealand, with 21% of all TBIs sustained within a sports or recreation context every year.[2] Based on ACC data a total of 20,902 claims costing \$NZD 16,546,026 were recorded over a 10 year period between 2001 and 2011.[3] Rugby, cycling and equestrian activities have been identified as the sporting activities with the highest risk of TBI.[2] There has been a recent increase in studies of awareness of concussion in rugby players (both union and league) which have revealed that concussion knowledge and attitude and perceptions of others have been found to influence concussion reporting behaviour.[4, 5] However, despite the high prevalence of concussion in equestrian sports, little is known about concussion awareness in those engaging in activities involving horses. A horse's strength, height, speed, and unpredictability all contribute to the risk of concussion in equestrian activities.[6] Understanding people's awareness of concussion is important due to the potential risk of long-term difficulties including cognitive deficits, persistent post-concussion symptoms[7-9] and risk of a recurrent injury sustained before the brain has recovered.[10, 11] This is a particular concern given the highest prevalence of equestrian injuries is during adolescence, resulting in a potentially long lifetime burden.[12]

Assessment and management of concussion is an evolving field and recommendations have changed following each of the five International Consensus Conferences on Concussion in Sport with the most recent consensus statement released in 2017.[1] In 2014, ACC released a guideline on the management of sports concussion. A blue card scheme was introduced by Equestrian Sports New Zealand and a green card scheme by the NZ Pony club in 2018 to support the identification and treatment of concussion at registered events. However, the impact of these initiatives on concussion awareness and identification or any gaps remaining in knowledge has yet to be explored in equestrian sports.

Approximately 70% of equestrian injuries are sustained due to falling from a horse whilst riding. Additionally, more than one in five injuries (23%) are due to being knocked or being kicked in the head and 4% are due to falling over whilst leading a horse.[2] The wearing of helmets is now a mandatory requirement in competitive sport when riding a horse to

prevent risk of a skull fracture, reduce superficial injury and to absorb impact. As damage to a helmet may not always be visible (e.g. damage to the softer internal layer designed to absorb impact) manufacturers recommend replacing a helmet after a fall. Studies have shown that the majority of equestrian injuries occur during unsupervised leisure riding. Additionally, as TBIs can occur from other mechanisms as well as riding, understanding people's awareness of the function of helmets and helmet use behaviour needs to be explored, alongside raising general concussion awareness in equestrians to help to inform injury prevention messages for this population.[13]

Aim of the current study

The purpose of this cross-sectional study was to assess the current state of knowledge about concussion, awareness of guidelines and helmet use in adults involved in a range of equestrian sports across NZ.

Methods

Procedure

A cross-sectional questionnaire design was used to assess awareness, attitudes and behaviour of concussion. The online questionnaire was based on the validated questionnaire used in a previous study in high school rugby players by Register-Mihalik[4] and adapted for relevance to equestrian activities and latest information/guidelines on concussion. At the end of the questionnaire there was an open question asking people for any additional comments. Anyone aged over 16 years of age, actively engaged in working with or riding/driving horses and living in New Zealand was invited to participate. Equestrian Sports New Zealand, New Zealand Pony Club, Harness Racing NZ, NZ Thoroughbred Racing, Rodeo NZ, NZ Veterinary Association, NZ Farrier Association as well as study sponsors emailed their members a link to the online questionnaire. A link to the online questionnaire was also advertised in equestrian magazines and through social media e.g. Facebook. Paper copies of the questionnaire were made available at community presentations and equestrian events across NZ. The survey was anonymous and those completing the questionnaire were entered into a prize draw of equestrian products kindly donated by the study sponsors to encourage participation. Ethical approval was received from the Auckland University of Technology Ethics Committee (Ref: 18/340).

Data analyses

Responses to the online questionnaire were recorded through SurveyMonkey and exported into SPSS. Paper copy questionnaires were entered manually into the dataset. Means and (\pm) standard deviations or frequencies and percentages are reported as appropriate for the data gained. Levels of awareness were categorised as >80% very high, 60-79% high, 40-59% moderate, 20-39% low and <20% very low. A total knowledge score was calculated based on

the number of correct responses to the 48 knowledge items in the questionnaire. Responses to the open question asking for any further comments at the end of the questionnaire was analysed using conventional content analysis.[14]

Results

There were 1,593 people who responded to the survey invitation. There were 26 participants excluded for not meeting the eligibility criteria or who did not provide consent for further participation. A further 89 cases were excluded as no questionnaire data related to concussion was completed (only demographic questions were answered).

The final sample included data from 1,486 participants who met the eligibility criteria and completed the questionnaire. Missing data was <10% across variables. Given there was systematic missing data (e.g., higher levels of missing data on questions such as the number of concussions experienced) data were not imputed. Participants ranged in age between 16 and 83 with a mean age of 39.1 years (SD 15.4). Further demographic data are outlined in Table 1. The majority of participants (1,478, 99.5%) completed the survey online with only eight (0.5%) in paper copy. The survey captured recreational riders, coaches and elite athletes as indicated by the 303 participants who identified as a coach/trainer/instructor and 441 (29.6%) who had competed at a national level in equestrian events.

Table 1. Demographics of study participants

| Variable | Frequency (%) |
|--|---------------|
| Gender | |
| Male | 117 (7.9) |
| Female | 1361 (91.6) |
| Nonbinary | 1 (<1) |
| Missing | 7 (<1) |
| Ethnicity | |
| European | 1439 (96.8) |
| Maori or Pacific Islander | 27 (1.8) |
| Other (e.g. Asian, South African, Canadian) | 15 (1.0) |
| Missing | 5 (<1) |
| Type of equestrian activity engage in (tick all that apply) | |
| Hacking/trekking | 790 (53.2) |
| Groundwork | 766 (51.5) |
| Show jumping | 583 (39.2) |
| Dressage | 543 (36.5) |
| Eventing | 408 (27.4) |
| Farm work | 422 (28.4) |
| Adult riding | 365 (24.6) |
| Pony club | 344 (23.1) |

| | |
|---|-------------------|
| Thoroughbred racing/track work | 134 (9.0) |
| Farrier/trimmer | 113 (7.6) |
| Harness racing | 108 (7.3) |
| Endurance | 79 (5.3) |
| Driving | 86 (5.8) |
| Hunting | 53 (3.6) |
| Equine healthcare (e.g. osteopathy, nutrition, nurse, vet, saddle fitter) | 52 (3.5) |
| Showing | 42 (2.8) |
| Western/rodeo | 29 (2.0) |
| Other (e.g. breeding, breaking in/training, judging, riding for the disabled, working equitation, show hunter, rescue, polo, photography, movie work, mounted games, parents or grooms) | 114 (7.7) |
| Personal concussion history | |
| None | 366 (24.6) |
| One or more | 984 (66.2) |
| Don't know | 100 (6.7) |
| Missing | 36 (4.0) |
| Years been around horses Mean \pmSD | 25.58 \pm 14.58 |
| Hours per week around horses Mean \pmSD | 23.63 \pm 17.50 |
| Primary reason for engaging in equestrian activities | |
| Recreational | 1119 (75.3) |
| Professional | 367 (24.7) |
| Have you ever received information about concussion from any of the following? (tick as many as apply) | |
| Trainer/coach/instructor | 313 (21.0) |
| Accident compensation provider (ACC) | 638 (42.9) |
| Equestrian organisation (e.g. pony club, or equestrian sports NZ) | 593 (39.9) |
| School/work/university | 531 (35.7) |
| Other riders | 764 (51.4) |
| Doctor/physiotherapists or other health professional | 1038 (69.9) |
| TV or social media | 914 (61.5) |
| Friends or family | 1006 (67.7) |
| Other (e.g. first aid courses, health professional, through other sports, horse related magazines, personal experience) | 82 (5.5) |

Of the participants who reported experiencing at least one concussion over their lifetime, 301 reported one, 276 reported two, 362 reported three or more and 45 did not know how many. When asked about the number of concussions they had personally experienced, an open text response was allowed. Participants reported finding it difficult to recall this accurately. Many talked major and minor head injuries, or only those diagnosed by a doctor or presented numbers by different sports (e.g. only reported ones to do with horses) so the prevalence is likely to be an underestimate.

Responses to the concussion knowledge items from the questionnaire are outlined in Table 2. Total concussion knowledge scores ranged between 19 and 47 (possible range 0-48) with

a mean score of 38.4 ± 4.01 . There was no meaningful difference in knowledge of concussion between amateur/recreational riders (38.6 ± 4.0) and professionals (37.9 ± 4.3).

Whilst there were very high levels of awareness of concussion symptoms (except insomnia) and recognition of clinical scenarios, there did appear to be some confusion between symptoms more indicative of a more severe brain or spinal cord injury (e.g. 41% incorrectly indicated that a sharp burning pain in the neck was a sign or symptom of concussion). Less than half of participants were aware of concussion guidelines and there was considerable diversity in responses to how long a person should wait before riding/driving or working with horses following a concussion. Knowledge of the functioning of a helmet was low, with only 13% of participants correctly identifying that a helmet does not prevent concussion. Only 80% of participants correctly stated that a concussion was an injury to the brain. This increased to 99.1% if the term head 'was' also accepted as a correct answer. A few participants responded that concussion can occur to a horse's leg (a true phenomenon).

Table 2. Knowledge of concussion

| Knowledge Items | Frequency (%) |
|--|---|
| Have you heard of the term concussion? Yes No or not sure | 1467 (98.7) 19 (1.3) |
| Have you heard of any 'guidelines' on concussion? Yes No Not sure Missing | 835 (56.2) 468 (31.5) 178 (12.0) 5 (<1) |
| Complete the sentence. Concussion is an injury to the... (correct answer = brain) | 1189 (80.0) |
| Please indicate which of the following you would consider to be a sign or symptom of concussion (tick all that apply) Confusion (true) Headache (true) Amnesia (true) Loss of consciousness (true) Blurred vision (true) Dizziness (true) Nausea (true) Insomnia/trouble sleeping (true) Sharp burning pain in neck (false) Bleeding from the ear (false) Numbness or tingling in the arms (false) Bleeding from the nose (false) Weakness in neck movements (false) | 1449 (97.5) 1427 (96.0) 1418 (95.4) 1415 (95.2) 1407 (94.7) 1382 (93.0) 1339 (90.1) 695 (46.8) 610 (41.0) 610 (41.0) 515 (34.7) 426 (28.7) 345 (23.2) 315 (21.2) |

| | |
|--|---|
| Black eye (false) Bleeding from the mouth (false) Fever (false) Joint stiffness (false) Skin rash (false) | 272 (18.3) 133 (9.0) 124 (8.3) 21 (1.4) |
| Which of the following people would you say might be concussed? (tick all that apply) A couple of hours after a fall the person complains of feeling sick with a headache (hasn't been drinking alcohol) After a fall the person complains of headaches and has blurred vision After a fall, the person starts to make mistakes and seems confused After a fall the person is left on the ground not moving After a fall the person complains of stinging or burning in the calf muscles | 1428 (96.0) 1425 (95.9) 1395 (93.9) 1201 (80.8) 75 (5.0) |
| A concussion only occurs if you lose consciousness? (False) True False Missing | 29 (2.0) 1453 (97.8) 4 (<1) |
| Symptoms of concussion can occur several hours or days later (true) True False Missing | 1469 (98.9) 14 (<1) 3 (<1) |
| You need to directly hit your head to experience a concussion? (False) True False Missing | 348 (23.4) 1126 (75.8) 12 (<1) |
| If a person gets concussed how long should they wait before returning to riding/driving or working with horses? (correct answer - when symptoms have resolved or 3 weeks) Straight away 1 week 2 weeks 3 weeks 4 weeks When the symptoms have resolved (gone away) Don't know/Missing | 7 (<1) 82 (5.5) 133 (9.0) 185 (12.4) 141 (9.5) 713(48.0) 225 (15.1) |
| Of the following what are the possible complications of experiencing multiple (more than one) concussions? (tick all that apply) No complications exist Increased symptoms or delayed recovery Increased risk of further injury Joint problems Paralysis Don't know | 10 (<1) 1364 (91.8) 1239 (83.4) 56 (3.8) 412 (27.7) 109 (7.3) |

| | |
|---|--|
| <p>Of the following, what are the possible complications of returning to riding/driving or working with horses too soon? (tick all that apply)</p> <p>No complications exist Increased symptoms or delayed recovery Increased risk of further injury Joint problems Reduced sports performance Don't know</p> | <p>7 (<1) 1240 (83.4) 1355 (91.2) 54 (3.6) 1018 (68.5) 79 (5.3)</p> |
| <p>If someone has suffered a concussion who is the best person to decide if they should ride/drive/work with horses again?</p> <p>The person themselves Coach/trainer/instructor Doctor Parents/colleague/friends Other</p> | <p>64 (4.3) 9 (<1.0) 1369 (92.1) 6 (<1.0) 38 (2.6)</p> |
| <p>Which of the following activities should be avoided following a concussion? (tick all that apply)</p> <p>Texting or using a mobile phone Using a computer Watching TV Going for a long walk Jogging/running Gym training School/work Going to sleep Riding/driving or handling horses</p> | <p>738 (49.7) 865 (58.2) 787 (53.0) 559 (37.6) 1218 (82.0) 1192 (80.2) 694 (46.7) 606 (40.8) 1374 (92.5)</p> |
| <p>What does wearing a helmet do? (tick all that apply)</p> <p>Reduces risk of cuts, bruises and grazes Reduces risk of concussion Reduces risk of skull fracture Absorbs impact from a fall Don't know</p> | <p>601 (40.4) 1297 (87.3) 1398 (94.1) 1322 (89.0) 2 (<1.0)</p> |

There was variation in knowledge scores by equestrian activity as shown in Table 3.

Table 3. Knowledge scores by equestrian activity

| Equestrian Activity | Range | Mean (SD) |
|----------------------------|--------------|------------------|
| Eventing | 19-47 | 39.08 (3.68) |
| Dressage | 24-47 | 38.99 (3.61) |
| Showjumping | 19-47 | 38.97 (3.79) |
| Pony club | 19-47 | 38.76 (4.05) |
| Hacking/trekking | 24-46 | 38.67 (3.84) |
| Farmwork | 19-47 | 38.21 (3.94) |
| Endurance | 26-46 | 37.66 (4.13) |

| | | |
|---|-------|--------------|
| Track riding/Thoroughbred racing | 21-47 | 37.14 (4.55) |
| Harness racing | 21-44 | 36.13 (4.68) |

The majority of participants responded that a doctor is the best person to decide if someone should return to ride/drive or work with horses again. In line with ACC and ESNZ guidelines (Table 2) there was strong agreement of the need to see a medical professional following a concussion. However, many participants chose the 'other' option that it needed to be a collaborative decision between the doctor and the person themselves. Many participants made additional comments regarding concerns that they did not feel confident that their GPs or emergency clinicians knew enough about concussion to make the best decision.

Table 4. Attitude Items

| To what extent do you agree with the following statements? | N (%) |
|--|--------------|
| It is important to report a possible concussion to a medical professional. | |
| Strongly agree | 915 (61.6) |
| Agree | 468 (31.5) |
| Not sure | 79 (5.3) |
| Disagree | 20 (1.3) |
| Strongly disagree | 3 (<1) |
| Missing | 1 (<1) |
| You should not use a helmet again after a fall where there was a hit to the head and a new one should be purchased? | |
| Strongly agree | 843 (56.7) |
| Agree | 451 (30.3) |
| Not sure | 95 (6.4) |
| Disagree | 45 (3.0) |
| Strongly disagree | 14 (<1.0) |
| Missing | 38 (2.6) |

Table 5, outlines people's behaviour towards concussion. Whilst the majority wear a helmet when riding, up to one in ten choose not to. Rates of helmet use when driving, leading, lunging, or picking out horse's feet, were very low to moderate. Of concern, nearly half of participants reported continuing to ride in the same helmet following a hit to the head (Table 5). This appears discrepant with participants' responses indicating good agreement with the statement of the need to purchase a helmet following a fall (Table 4).

Table 5. Behaviour Items

| | Frequency (%) |
|--|----------------------|
|--|----------------------|

| | |
|---|-------------|
| Do you usually wear a helmet during the following activities? | |
| Hacking | 1329 (89.4) |
| Schooling | 1306 (87.9) |
| Competing | 1267 (95.3) |
| Driving horses | 318 (53.9) |
| Groundwork | 361 (24.3) |
| Lunging | 291 (19.6) |
| Tacking up | 181 (12.2) |
| Picking out or working around horse's feet | 93 (6.3) |
| Leading a horse | 76 (5.1) |
| Teaching /coaching | 42 (2.8) |
| Bathing/grooming | 40 (2.7) |
| Cleaning paddocks | 6 (<1) |
| Have you ever continued to use the same helmet after a hit to the head? | 688 (46.3) |
| How long would you wait before riding/driving or working with horses after a concussion? | |
| Straight away | 180 (12.1) |
| 1 week | 157 (10.6) |
| 2 weeks | 103 (6.9) |
| 3 weeks | 105 (7.1) |
| 4 weeks | 93 (6.3) |
| When the symptoms have resolved (gone away) | 743 (50.0) |
| Don't know/Missing | 105 (7.1) |

There was a small disconnect between knowledge of return to riding/driving guidelines and likely behaviour, with one in ten (153, 10.3%) participants stating that they would return to riding sooner than they believed was recommended. Only a third of participants (527, 35.5%) had been taught how to fall to reduce the risk of injury. A high proportion of participants (1,010, 68.0%) wanted to know more about concussion.

Responses to the open question asking for any additional comment

Responses from 316 participants were collated and categorised. Eight categories were identified and included; (1) learning from personal experience; (2) concussions not just from equestrian activities; (3) attitudes and behaviour dependent on context; (4) riding helmet safety; (5) theory versus practice; (6) guidelines need a supportive infrastructure; (7) knowing more and (8) change in culture needed. Comments embedded within each category are summarised below, supported by participant quotes.

Learning from personal experience

Supporting the findings from the numerical data, participants talked about having learnt about concussion predominantly through their own or other's personal experience;

"I think it would really help to be educated with concussions as I only learnt a bit about them after a fall which resulted in a concussion."

"We have not received concussion information in our equestrian journey but have a family member who suffered a TBI from a car accident so understand a bit about it."

Participants also commented that they did not believe concussion could have longer-term effects or that multiple concussions could be problematic until they had experienced this themselves or witnessed it in other people.

"I did not think concussion was accumulative UNTIL a friend became disabled from repeated falls - I have learnt all I know from her (shared) experiences."

Concussions not just from equestrian activities

Many participants highlighted that when asked about the number of concussions that they had experienced, that if they had experienced a concussion, it was not necessary the result from being around horses;

"Not all my concussions were from horse riding - a couple as a child were falling off my bike and skiing."

"The concussion I had wasn't related to horses - it was related to netball."

Attitudes and behaviour dependent on context

Some participants reported finding the questions difficult to answer as their attitude and behaviour changed depending on the context they were in. This was evident in terms of health care seeking following an incident;

"A lot depends on how bad the concussion is whether I would go to a doctor or not."

Changing attitudes and behaviour were also noted with regards to whether participants decided to wear a helmet or not;

"How I act around horses varies to a large extent as to the horse I am with - a lot more careful/cautious with a young horse than the old faithful - I would wear a helmet lunging, grooming etc if the horse was young and excitable."

A further participant stated that they only wore a helmet when they were compelled to;

"I ONLY wear a helmet when I am compelled to - venue or competition rules. I have had injury caused entirely by wearing a helmet - broken nose. Helmets are not the magic solution touted - especially when they don't fit."

Riding helmet safety

A large proportion of comments related to wanting to know more about riding helmets, their function and under which circumstances they should replace a helmet. For example, one participant stated;

"It would be nice to have access to information on when is a good time to replace your helmet."

Easier access to information on safety testing standards was also desired to help people to decide which helmet to purchase. Information was currently difficult to access and provided by the manufacturing companies and it was not clear whether more expensive helmets were any safer in what way.

"More independent testing should be done on helmets, data should be published."

Some participants felt that helmet safety standards needed to be improved.

"I strongly believe that helmet standards need to be raised."

Whilst many participants appreciated the need to replace a helmet after a fall, the financial cost of buying a helmet was perceived to be a key barrier, particularly for those who experienced a fall more often.

"Most of us will agree with the rules around replacing a helmet after a fall landing on one's head. However, they [helmets] are so expensive (I am referring to trackwork/racing helmets), that many riders can't afford to do so. As a result they carry on using a potentially useless helmet."

Others commented on whether it was possible for helmets to be checked to see if they had been damaged or not to inform whether to purchase a new one or not;

"Helmets should only be replaced if compromised and they can be checked for this. It's too much money to constantly change helmet specs and doesn't change the frequency accidents may happen"

“Why not X-ray helmets after knock. Replace if fractured. Track riders can’t replace a helmet every time financially.”

Theory versus practice

Following on from the discrepancy between understanding the need to wear a helmet and balancing financial cost, a further discrepancy was identified between the knowledge of the timeframe people should wait before returning to riding/driving/working with horses and likely behaviour following concussion;

“I don't imagine I'm unique in that while I understand (some /most of) the impacts of concussion and how important it is to take time to recover, I'm usually straight back out there after”

This seemed to be a particular issue for professionals or those looking after their own or other people’s horses as the horses needed to be cared for and kept fit/in training;

“I think it's hard for people to stop working with horses when they have no-one else available to help, which is often the case. I've often seen people continue to work with horses after concussion due to necessity”

This was also highlighted to be an issue within the racing industry;

“A lot of trainers will not stand a rider down with a concussion as they are struggling to get their team of horses worked. Riders will not stand themselves down due to being paid per horse ridden only.”

Guidelines need a supportive infrastructure

There was a lot of positive support for ACC guidelines and ESNZ concussion initiatives however, concern was raised as to how these could be effectively implemented. A key issue of concern raised by many participants was a lack of confidence in medical practitioners (both emergency physicians and GPs) to recognise and diagnose concussion. Many participants described personal experiences where themselves or others who had experienced an accident and the concussion had been missed;

“I had a bad fall from riding track work in 2016 and to this day I get headaches three of four times a week, the hospital didn’t check my head even with me being knocked out for 5mins and not moving.”

There was also confusion as to how someone can be checked for concussion immediately after a fall and deemed fit to ride when there could be delayed symptoms;

"I was checked by ambulance and cleared to ride, I had delayed concussion so if they get it wrong...?"

There were also concerns about GPs' ability to decide whether someone was fit to return to riding and help someone to manage their concussion. Many participants reported that they had previously not felt that doctors have taken concussion seriously in the past (even recent past);

"I actually found doctors seemed unconcerned when I said I'd fell off and landed on my head and had symptoms of concussion. They didn't give me any information or even seem to believe it was that bad, and sometimes I wonder if I'm still affected by it."

"There has been an increased awesomeness of concussions yet I still see riders having knock out concussions and being told by Drs they can ride after 3 weeks, while still having symptoms. I feel delayed concussions are least understood as there are no apparent immediate effects and if at events paramedics give the go ahead to continue competing yet hours later they are impaired."

Some participants did express concern about the need to get medical clearance for suspected concussion and there was some resistance to this approach;

"Most riders will generally know whether they are ok or not to continue after a fall. In a sport where continuing if you can is important (not getting straight back on the horse develops irrational stigma and can cause lack of confidence) leaving that decision to another (ie- waiting on a doctor inspection) is counterproductive. Let the rider make the decision in the first instance unless there are obvious symptoms of concussion in which case stewards should intervene. Over my 18+ years of riding and of my 100+ falls, none of my falls have been bad enough not to justify getting back on."

Participants expressed a desire for guidelines to remain realistic and to be based on scientific evidence given the challenges of implementing guidelines both at organised events and for recreational riders;

"Would be great for more guidelines and information about concussion (medical-science based facts rather than opinions) to be shared in equestrian groups - but let's not go overboard with regulations we have too many of those nowadays."

In addition, participants felt that there needed to be a balanced view when providing information about concussion;

“Realistically most falls are relatively harmless, just bruising and damage to one’s ego more than anything... not being allowed to get straight back on is even more detrimental for one’s self-confidence.”

Knowing more

Many participants stated that they found completing the questionnaire helpful to establish what they knew and needed to know;

“Just realised how much I don't know when I struggled to a couple of the questions!

In support of the numerical data many participants expressed feeling confident knowing the immediate signs and symptoms of concussion but wanted to know more information on what actually happens to the brain;

“Although you hear a lot about concussions from people falling, you never really get taught about the implications of getting concussion. For example, I have been concussed 3 times in the years I’ve been riding and I have never really had anybody explain how it’s affecting my body etc.”

Participants also wanted to know more about the potential longer-term implications of concussion. There was particular concern following recent media attention on a potential increased risk of dementia and if there were ways to prevent potential long-term impacts.

“It seems there are more ongoing problems after concussion than originally thought. I would be interested to learn more about these consequences & how to manage concussion.”

Change in culture needed

Many participants felt that there needed to be more equestrian specific information on concussion and felt that equestrian organisations and employers could be doing more to raise awareness;

“Through rugby I feel I am well aware of concussions, risks, implications etc. concussions from knocks from working with horses (not race falls) are probably not really considered in the industry”

“It would be great if Pony Clubs and other equestrian sports clubs, we require to provide training & education around brain injury, helmet care and use and how to fall and reduce injury.”

There was identified need to shift the 'just get back on the horse' culture within equestrian sports as a potential barrier to taking the risk of concussion seriously;

"Concussion is something that I think is really frequent in horse riding, but the she'll be right/get back on the horse mentality often makes the issue feel non-existent or unimportant."

Comments from parents and coaches stated that they had an interest in raising awareness of concussion but that access to accurate information was needed;

"Awareness is growing however education for coaches etc of those that are teaching needs to be more accessible so that the correct information can be passed on."

Discussion

This study aimed to determine attitudes and behaviour and assess the level of awareness of concussion within adults engaged in equestrian activities in NZ. Prevalence of concussion was high, with nearly two thirds of participants reporting having experienced at least one concussion over their lifetime. Awareness of the key signs and symptoms and being able to recognise concussion from clinical scenarios was very high. In contrast, knowledge of the potential implications, guidelines, how to respond following a concussion and the function of riding helmets was low to moderate. The most common sources of information on concussion were doctors or other health professionals, TV/social media and friends or family. Only 36% had been taught how to fall to reduce injury. There was very high awareness of the need to see a doctor following a concussion, but concerns were raised with regards to confidence in clinicians' ability to recognise and treat concussion effectively.

The prevalence of concussion was high in the sample, with nearly two thirds of participants reporting experiencing at least one concussion in their lifetime. One in five participants had experienced three or more concussions. The prevalence of concussion was higher than reported in a previous study of equestrian athletes (44%) although this may reflect differences in the sampling approaches used.[15] The findings are also likely to be an underestimate as many more participants were unable to state the exact number of concussions they had experience due to them being too numerous. The qualitative data augmented the numerical data on concussion history but highlighted that not all concussions reported in this population were caused from engaging in equestrian activities and is an important consideration to capture in future research.

Determining true prevalence of concussion was also affected by people's understanding of concussion. Whilst there was high awareness of key signs and symptoms of concussion, there was also a high false-positive rate on distractor symptoms (pain in the neck and neck weakness). This highlighted that there was some confusion between concussion, broader head injuries and more severe TBI and spinal cord injury and between indicators that may make someone check for concussion but are not direct symptoms e.g. black eye. Similar findings regarding confusion of concussion symptoms with other psychological and neurological diagnoses has previously been noted.[16] A few participants also noted that the term 'concussion' can also refer to an injury in horses' legs. A concussion in this context refers to the force sent vertically up the leg each time a horse's hoof strikes the ground and can be an issue if the horse is working too hard on hard ground. Careful use and clarification around terminology is needed in this population.

Knowledge of concussion is important as accurate and timely diagnosis may facilitate early recovery.[16] As many concussions occur without a healthcare professional present this makes equestrians, parents and coaches and stewards an important part of ensuring appropriate care.[16] It was interesting to know that there was no impact on level of experience (amateur vs professional) on knowledge of concussion. The study revealed that knowledge of key signs and symptoms of concussion and being able to recognise concussion from clinical scenarios is very high. However given that participants stated that they 'didn't take it seriously until they had witnessed the effects for themselves' a new approach may be needed in future awareness strategies regarding what happens to the brain, how helmets work and potential longer-term effects to improve public awareness to challenge health beliefs and improve health related behaviour. Greater emphasis could also be placed on lesser known symptoms of concussion such as tonic posturing, vacant look, balance and seizure to assist people to recognise concussion. Many trainers and coaches were keen to support awareness initiatives and wanted easier access to accurate information to support broader organisation messages.

Awareness of concussion guidelines was found to be lower in this study (56%) than in a previous study of equestrian athletes in the US (65%).[15] Indeed there was considerable diversity in responses to the question regarding when a person should return to riding following a concussion. This may reflect that the ESNZ guidelines were only released six months prior to the study or it may also reflect confusion from different messages from different organisations (e.g. some state gradual return when symptom free, whereas others specify a specific timeframe e.g. 3 weeks). This is a particular issue given that many participants reported that they would return to riding sooner than what they believed to be the recommended timeframe.

One of the key areas where there was a gap in knowledge was in relation to the function of riding helmets. A high proportion (87.3%) incorrectly believed that wearing a helmet would

prevent concussion. This misconception may indicate that people don't really understand the physiology of concussion and what happens to the brain. Additionally, only 40% correctly identified that helmets are designed to reduce risk of cuts/bruises and grazes to the head. In contrast there was very high awareness that a riding helmet reduces the risk of skull fracture and absorbs impact from a fall. Whilst the majority of participants reported wearing a helmet a small proportion chose not to. Use of helmets when not riding e.g. when lunging, doing groundwork or picking out hooves was low (6.3-24.3%). This could be a key area to target for injury prevention to prevent injuries from these lesser known additional causes. Encouraging people to put their helmet on a little earlier when grooming and tacking up the horse not just as they are able to mount the horse may help protect against these other mechanisms of brain injuries.[2, 6]

Many participants stated that they found the riding helmet safety testing standards difficult to understand and access. They also reported that the function and design of helmets was unclear which is likely to affect people's behaviour in how they wear a helmet. For example, many participants reported finding the new safety standards introduced in New Zealand in 2017 confusing, as it was not clear how the new standards had improved the design of helmets and increased safety. An independent guide to understanding safety standards and the testing conducted with regards to all the different functions of the helmet e.g. to reduce skull fracture, head wounds and to absorb impact would be helpful to support people to make informed decisions. Currently most information available only refers to protecting against skull fracture e.g. penetration test, a compression test, a test to certify the resistance capacity against impact with sharp surfaces, and stability with little reference to tests regarding absorption of the impact of a fall (a critical component in the minimisation of harm from an impact to the head). This is particularly important as the study revealed that cost was a key barrier to replacing a helmet following a fall. With little awareness that there may be internal damage to a helmet without any external signs many people (46%) continued to wear a helmet after a hit to the head thinking they would still be protected. Many queried whether there was a way helmets could be checked for internal damage and some clarity from employers and organisations may be helpful here to reduce risky behaviour.

Only a third of study participants had received training in how to fall from a horse to reduce injury. Whilst falling often happens quickly and without warning there are techniques that can help to minimise injury such as trying to release feet from the stirrups, tucking in arms and rolling away from the horse to prevent being kicked or landed on by the horse and to reduce fracture to wrist and hands.[6] This could be added into training programmes to help reduce both concussion and other external injuries.

There was wide support for increasing awareness of concussion and tackling the equestrian culture of "getting straight back on the horse" to prevent risk of further injury and

exacerbating any delayed effects.[15] However, there were many concerns about finding the right balance, ensuring strategies were practical and being able to follow recommendations e.g. the need to still continue to care for a horse/work after injury. Many participants expressed that their behaviour often changed dependent on the context e.g. they were more likely to wear a helmet and be more cautious with a young, unfamiliar or unpredictable horse. Medical care seeking was felt to be very dependent on the perceived severity of injury at the time and previous personal experience.

Whilst many agreed that concussion needed to be taken more seriously within the sport and welcomed information to increase awareness, there was concern that needing to seek medical clearance before riding was problematic. There was low confidence in medical practitioners' ability to make the final decision, with many reporting that they have previously not found seeking medical assistance helpful and many felt that the decision should be a collaborative one between the person affected, a parent if a child was affected and medical professional. It was also noted that many health professionals with training could identify a concussion not just a medical doctor e.g. allied health professional working in a concussion clinic. This clarification could be reflected in the language used. This finding is consistent with research into concussion awareness in other sports where gaps in GP and emergency practitioners' knowledge in management and treatment of concussion were identified.[17]

This study has highlighted key areas for injury prevention messages to focus on, including aspects relating to areas for further education, rider behaviour, protective equipment and prevention of secondary injury. A strength of the study was that there was representation from a wide diversity of equestrian activities including those breaking-in and working with young horses, jockeys, western and rodeo riders, as well as pleasure riders and those who do not ride or drive horses themselves but are still involved in working closely with horses and at risk of concussion (e.g. parents, breeders, coaches and in-hand showing). However, the generalisability of the findings may be affected by a lower proportion of males. Other epidemiological studies have identified that a higher proportion of females are injured in equestrian activities with 70% of those attending emergency clinics identifying as female.[12] However this rate is lower than the male to female ratio in this study suggesting that males may have been less likely to participate. A further limitation is that participants' concussion histories were based on self-report and it is unclear of the proportion of these injuries for which participants sought medical attention due to the anonymity of the survey. Identifying and examining the frequency and factors influencing medical attendance following suspected concussion would be a useful area for further research. Whilst the study was conducted across New Zealand, the geographical capture of participants also remains unclear and so the findings need to be generalised to all equestrians with caution.

Potential areas for further research

- In order to keep the questionnaire at a reasonable length to reduce participant burden and encourage participation not all signs and symptoms of concussion were included. Awareness of these other symptoms would be useful to identify.
- Qualitative research may help to identify the factors influencing people's attitudes and beliefs and behaviour more in depth.
- As this study looked at equestrian activities as a whole, further analyses could be conducted by type of equestrian activity to identify if there are any differences in attitudes, knowledge and behaviour to identify areas to be targeted by injury prevention initiatives.
- Awareness of the CRT5 tool to assist with identification of concussion would be helpful to include in future work on concussion awareness.
- Changes in knowledge, attitudes and behaviour towards concussion in equestrian sports could be tracked over time by re-running the survey again in the future.

Acknowledgements

With thanks to Jules Lough who supported the recruitment of participants and to the study sponsors HippoHealth, Equibrew and SuperGoo.

References

1. McCrory P, et al., *Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016*. British Journal of Sports Medicine, 2017.
2. Theadom, A., et al., *Sports-related brain injury in the general population: An epidemiological study*. Journal of Science and Medicine in Sport, 2014. **17**(6): p. 591-596.
3. King, D., et al., *Sport-related concussions in New Zealand: A review of 10 years of Accident Compensation Corporation moderate to severe claims and costs*. Journal of Science and medicine in sport, 2014. **17**(3): p. 250-255.
4. Register-Mihalik, J.K., et al., *Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study*. Journal of Athletic Training, 2013. **48**(5): p. 645-653.
5. Register-Mihalik, J.K., et al., *Using theory to understand high school aged athletes' intentions to report sport-related concussion: implications for concussion education initiatives*. Brain Injury, 2013. **27**(7-8): p. 878-886.
6. Abdulkarim, A., et al., *Equestrian Injury Presentations to a Regional Trauma Centre in Ireland*. Emergency Medicine International, 2018. **Article ID 7394390, 5 pages**.
7. McMahan, P., et al., *Symptomatology and Functional Outcome in Mild Traumatic Brain Injury: Results from the Prospective TRACK-TBI Study*. Journal of Neurotrauma, 2013. **31 Epub ahead of print**.
8. Theadom, A., et al., *Persistent problems 1 year after mild traumatic brain injury: a longitudinal population study in New Zealand*. British Journal of General Practice, 2016. **66**(642): p. e16-23.

9. Theadom, A., et al., *Population-based cohort study of the impacts of mild traumatic brain injury in adults four years post-injury*. PLoS One, 2018. **13**(1): p. e0191655.
10. Theadom, A., et al., *Frequency and impact of recurrent traumatic brain injury in a population-based sample*. J Neurotrauma, 2015. **32**(10): p. 674-81.
11. Cantu, R.C., *Scold-impact syndrome*. Clinical Sports Medicine, 1998. **17**(1): p. 37-44.
12. Selassie, A.W., et al., *Incidence of sport-related traumatic brain injury and risk factors of severity: a population-based epidemiologic study*. Annals of epidemiology, 2013. **23**(12): p. 750-6.
13. McCrory, P. and M. Turner, *Equestrian Injuries*, in *Epidemiology of Pediatric Sports Injuries*, D.J. Caine and N. Maffulli, Editors. 2005, Karger. p. 8-17.
14. Hsieh, H.F. and S.E. Shannon, *Three Approaches to Qualitative Content Analysis*. Qualitative Health Research, 2005. **Nov 1**.
15. Kuhl, H.N., et al., *Concussion history and knowledge base in competitive equestrian athletes*. Sports Health, 2014. **6**(2): p. 136-138.
16. Patricios, J.S., et al., *Consensus statement. Implementation of the 2017 Berlin Concussion in Sport Group Consensus Statement in contact and collision sports: a joint position statement from 11 national and international sports organisations*. British Journal of Sports Medicine, 2018. **52**(10): p. 635-641.
17. Stoller, J., et al., *Do family physicians, emergency department physicians, and pediatricians give consistent sport-related concussion management advice?* Canadian Family Physician, 2014. **60**(6): p. 548-552.