Concussion awareness in youth and young adults engaged in equestrian sports in New Zealand

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Abstract

Engagement of people in physical activity has benefits for both physical and mental health. However there is also an increased risk of injury, including traumatic brain injuries (TBI) and concussion. Whilst considerable attention has been given to addressing concussion in contact sports such as rugby, high rates of TBIs have also been found in people engaging in equestrian activities. There is limited research on concussion awareness in equestrian sports to inform prevention initiatives. This present research has looked at concussion awareness and helmet use within youth and young adults engaged in equestrian sports in New Zealand, through use of an anonymous, online, cross sectional questionnaire. A sample of 258 youth and young adults involved in equestrian sports completed the online survey. Participants displayed good overall knowledge of concussion symptoms, however some gaps were found to exist. Discrepancies between attitude and behaviour about concussion management were also found, particularly in relation to helmet use and returning to riding and school. Current concussion education programmes would benefit from using a multi layered approach that address some of the social elements that have been shown to impact attitude, and are particularly salient for the youth and young adult cohort. Additionally a unified set of concussion guidelines that extends across all sports would help to minimise the confusion surrounding concussion management and return to sport rules.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Ethics Approval

Ethics Application: 18/340 Concussion awareness in equestrian sports

The evidence provided, satisfied the points raised by the Auckland University of Technology Ethics Committee (AUTEC) and the ethics application has been approved for three years until 4 September 2021.

Chapter 1: Introduction

This thesis presents a quantitative research study to determine what youth and young adults understand about concussion within equestrian sports in New Zealand. This chapter provides the context for the research topic and the motivations for this thesis. The chapter then states the research question along with the overall aims of the research and presents an outline of the thesis structure.

1.1 Context for research

There is currently overwhelming evidence to suggest regular engagement in physical activity is beneficial across multiple health domains (Eime, Young, Harvey, Charity, & Payne, 2013). Increased physical activity has benefits for mental well-being and lowers the chances of obesity and related disorders, which have become a modern epidemic in society and carry a significant financial cost (Eime et al., 2013; Ogden, Carroll, Fryer, & Flegal, 2015). Recent research suggests that there is currently a high participation rate in recreational and organized sports globally (Kerr et al., 2014). However, with increased engagement in sports (particularly in adolescents) there is also an increased risk of injury, including traumatic brain injury (Daneshvar, Nowinski, McKee, & Cantu, 2011; McIntosh et al., 2011).

Traumatic brain injury (TBI) is defined as an injury sustained to the brain due to an impact force (Roozenbeek, Maas, & Menon, 2013). TBI has replaced the term head injury to highlight the damage to the brain during injury (Roozenbeek et al., 2013). TBI can be described overall as a condition due to the complex set of events that alter brain function after impact (Manley & Mass, 2013). Brain Impact can be the result of a fall, an object directly hitting the head or may take the form of acceleration and/or deceleration force causing the brain to move within the skull, resulting in shearing and tearing of the brain tissue (Lezac, Howieson, Bigler, & Tranel, 2012). A cascade of complex events may follow an impact force to the brain, including a shift in membrane permeability, altered glucose requirements and shifts in neuronal ions that can cause temporary neuronal dysfunction (Giza & Hovda, 2001). The neurometabolic changes that occur within the brain are the basis for concussive impairment and the associated symptoms experienced by an individual (McLeod & Gioa, 2010).

Classification of TBI is based on the International Classification of Diseases (ICD) and is usually classified into mild, moderate or severe brain injury (Roozenbeek et al., 2013). Classification is in relation to the scale of severity associated with neuropathological and neuropsychological changes that occur within the brain during and after injury (Lezac et al., 2012). The term mild TBI (mTBI) is synonymous with

concussion, which often represents the highest proportion of brain injury cases (Nanos, Franco, Larson, Mara, & Laskowski, 2017). For the purposes of this thesis, the term concussion will be used for mTBI and TBI used when discussing mild, moderate and severe.

Diagnosis of concussion is based on ICD, however the World Health organisation (WHO) and American Congress of Rehabilitation Medicine (ACRM) have proposed several criteria for diagnosis. Primarily a diagnosis of concussion or mTBI requires the elements of confusion (memory loss) and disorientation, and a loss of consciousness (if any) for less than 30 minutes (Roozenbeek et al., 2013). However, in reality no single definition of concussion has been widely accepted due to the spectrum of symptoms that occur (Manley & Mass, 2013). Symptoms of concussion include deficits in cognition (memory loss, attention, vision disturbance), emotion (depression, anxiety, anger), physical (headache, balance, light sensitivity), alongside sleep disturbance and the effects on multiple centres within the brain that affect sleep patterns and arousal (Roozenbeek et al., 2013).

The developing brains of children, adolescents and individuals that experience a repeat concussion may be more sensitive to the alterations in physiology and metabolism within the brain. Resulting in nerve cell damage and more permanent metabolic changes that can persist beyond the initial concussion injury (Giza & Hovda, 2001). According to the consensus statement on concussion in sport, concussion follows a sequential course of recovery as the damage of impact recovers, however some cases that persist over time are at an increased risk of further complications (McCrory et al., 2018).

Sport related brain injuries make up 15% of all concussion (Beck & Kerr, 2011). Theadom et al. (2014) found the incidence of TBI in sports-related activities in NZ to be 170 per 100,000 or 21% with approximately 51% of the sport related TBI accounted for by children and adolescents (<18). Additionally, research highlights that after America, NZ has one of the highest rates of sports related TBI (Li, Zhao, Yu, & Zhang, 2016). The type of sports related TBI varies geographically (Daneshvar et al., 2011). However rugby, soccer, cycling and equestrian sports are the most common contexts within which concussion are sustained in adults and children (Theadom et al., 2014). Rates of injury need to be considered in relation to rates of participation within a sport to determine their risk. Whilst the total of equestrian related TBIs are lower than in rugby and cycling, participation rates in equestrian activities are cited at only 3% suggesting equestrian sports carry a high risk of injury (Theadom et al., 2014).

TBI creates significant socio-economic costs to society both in the short term and long term in multiple domains, for example financial resources to cover loss of employment alongside costs for psychosocial rehabilitation and related services within the wider community (Nguyen et al., 2016; Tagliaferri, Comagnone, Korsic, Servadei, & Kraus, 2006). TBI affects the individual and their family and friends across multiple domains (Roscigno & Swanson, 2011). This is particularly relevant to the families of children and young adults with concussion, that have significant development, growth and education still to complete (Rockhill, Fann, Fan, Hollingworth, & Katon, 2010). Research has highlighted that moderate concussion in a developing brain can lead to impairment in brain recovery and plasticity long term (Giza & Hovda, 2001). Additionally, research has highlighted that concussion affects social cognition, the unique set of skills required to navigate social and emotional interactions in youth and adolescents (Turkstra, Williams, Tonks, & Frampton, 2008). The psychological consequences of impaired social cognition and emotional processing due to concussion can be devastating for an adolescent and can extend into adulthood (Turkstra et al., 2008).

Whilst recent media coverage has increased awareness of concussion knowledge, there remain many unanswered questions globally (Manley &Maas, 2013) and within NZ (Reid, Hume, Theadom, Whatman, & Walters, 2018). Several areas have been highlighted as contributing to the knowledge gap, including non-standardized reporting procedures within the sports themselves and differences in return to play guidelines across sports (Theadom et al., 2014; Nguyen et al., 2016; Reid et al., 2018). Additionally, little research has focused on the attitudes and behaviours associated with concussion in sport (Register-Mihalik, Guskiewicz et al., 2018). This is something that Register-Mihalik et al. (2013) points out has a significant impact on concussion management and recovery irrespective of knowledge.

1.2 Significance of the study

A large proportion of current concussion research has tended to focus on contact sports such as rugby and soccer (Theadom et al., 2014; McIntosh et al., 2011). Much less is known about concussion awareness in other high-risk sports such as equestrian activities (Weber et al., 2017). This is particularly concerning give that injuries sustained during equestrian sports tend to be more severe and have an increased risk of lifelong consequences (Weber et al., 2017). The relative scarcity of knowledge and awareness about TBI in the equestrian industry has been highlighted as a significant issue (Kuhl, Ritchie, Taveira-Dick, Hoefling, & Russo, 2014). Additionally, recent rule changes mandate the use of certified helmets when riding in competitions to reduce the risk of skull fracture (Havlik, 2010; McIntosh et al., 2011). However, it is not clear if

individuals understand the rationale behind helmet use or their attitude and behaviour towards helmet use.

Given public health initiatives to increase participation in sports worldwide due to the growing health crisis in obesity alongside the risk of concussion, creating awareness of TBI at both a policy and public level is of high value. This will ensure that some of the financial and social impacts can be mitigated (Nguyen et al., 2016; Ogden et al., 2015). Additionally given that TBI sustained through equestrian sports tend to be more severe and lifelong, the limited research in equestrian sports and the recent rule changes around helmet use, research to understand the knowledge, attitude and behaviours of youth and young adults surrounding concussion and helmet use within the New Zealand population, is needed.

1.3 Purpose of the research

The current research aims to find out what young adults (aged 16-21years) know and understand about concussion, how they use their helmets and their attitudes and behaviours towards concussion management and helmet use. It is hoped these findings will help to identify where the gaps in knowledge are within NZ youth and young adult population within equestrian sports and provide information that can inform both the public and private organisations about concussion injury prevention and management within equestrian sports.

1.4 Research Question

What do young adults engaged in equestrian sports within New Zealand know and understand about concussion and what is their attitudes and behaviour towards concussion?

1.5 Objectives

1. To establish what youth and young adults in NZ know and understand about concussion.
2. To establish what youth and young adults in NZ know and understand about helmet use within equestrian sports.
3. To establish the attitudes and behaviours of youth and young adults towards concussion
4. To establish the attitudes and behaviours of youth and young adults towards helmet use within NZ.

1.6 Structure of the dissertation

The dissertation is divided into five chapters, the following chapter (chapter two), presents background literature in the form of a narrative review. Chapter three outlines

the methods used to answer the research question. Chapter four presents the quantitative results, presented in a narrative and table form. Chapter five provides a discussion of the results in relation to answering the research question, strengths and limitations are discussed and overall findings are summarised.

Chapter 2: Background literature

2.1 Introduction

Sports related TBI is a growing concern for public health (Baugh, Kroshus, Kiernan, Mendel, & Meehan, 2017). TBI has a significant impact for the individual across multiple health, social and cognitive domains with a high subsequent financial burden on health-related services both in the short and long term (Zuckerman et al., 2014; Manley & Maas, 2013). Additionally, adult youth and child participation in organized sports has grown in recent years both globally and within NZ (Eime et al., 2015; Hulteen et al., 2017). Alongside increased sports participation, the incidence of TBI from sports-related activity has been increasing internationally (Nanos et al., 2017; Marin, Weaver, Yealy, & Mannix, 2014) and within NZ (Theadom et al., 2014). Current concussion research has focused predominantly on team and contact sports such as rugby and football, and although equestrian sports are less popular than some sports, they represent a significant proportion of reported TBI (Theadom et al., 2014). Under-reporting alongside a lack of knowledge and awareness about TBI present as significant issues in the management of concussion in athletes within sports including the equestrian sports (Kuhl et al., 2014; Daneshvar et al., 2011). TBI in equestrian sports is a particular concern for youth and young adults where participation rates are high and incidence of TBI is significant in comparison to other sports (Weber et al., 2017). Those affected may also go on to experience a lifetime of burden, given the developmental and cognitive demands within this age group (Davis et al., 2017). Understanding the knowledge, experience and awareness of youth and young adults engaged in equestrian sport is therefore a priority for future TBI research (Knollman-Porter, Brown, & Flynn, 2018).

This chapter presents a narrative literature review of the research on sports related concussion and TBI (with an emphasis on equestrian sports) in youth and young adults.

2.2 Narrative review

The methodological reproducibility of a systematic literature review which is depicted by a rigorous and objective search process and meta-analysis of results is often described as the gold standard within research (Siddaway, 2014). However, with the growth in the number of systematic literature reviews, some with significant diversity, the term has become somewhat ambiguous (Corcoran & Vandiver, 2006; Greenhalgh, Thorne & Malterud, 2018). Narrative reviews tend to produce a synthesis and critique of a diverse range of research, through a more interpretive process. While they do not

follow a highly circumscribed process, they are not un-systematic in their methodological process (Greenhalgh et al., 2018). Pai et al. (2004) argue that meta-analyses are superior to narrative summaries, although they point out that there are some situations where the research question is less specific and/or interventions are methodologically diverse, which is often the case in the behavioural sciences. In these situations, a narrative review is more suitable to inform evidence-based practice. Greenhalgh et al. (2018) concur that high-quality research is not exclusive to systematic reviews and that to avoid further research waste, while contributing to evidence informed practice a re-evaluation of narrative reviews is warranted.

A systematic search process was implemented for the current narrative review, using eligibility criteria defined in terms of the PICOS characteristics (participants, interventions, comparisons, outcome measures and type of study). This was conducted, in order to avoid bias and selection of evidence in support of the narrative (Greenhalgh et al., 2018; Liberati et al., 2009). Studies were identified by searching three electronic databases (Medline, CINAHL and Sports Discus) for research relevant to the research question: “What do young adults who are engaged in equestrian sports know and understand about concussion?” Separate search terms for each of the components of the research question were conducted then combined with the Boolean operator ‘AND’ to retrieve literature, for example, Teen* OR adolesc* OR “young adult*” OR “young person*”, (concussion) N5 (aware* OR perception* OR knowledge*). Two separate searches were conducted based on the research question, to capture the different but equally relevant aspects of current evidence based research. A description of eligibility criteria along with the full search strategy can be found in Appendix B.

2.2.1 Incidence and prevalence of TBI within sport globally and within New Zealand (NZ)

Sport related brain injuries represent about 15% of all TBI (Beck &Kerr, 2011). Within the Unites States (US) the proportion of sport related TBI injury in a year is between 1.6-2.3 million people (Daneshvar et al., 2011). More recently The Centre for Disease Control (CDC) in the US suggests this figure has risen to nearly 3.8 million sport related TBI, with an estimated 62,000 of those being children and young adults (Nanos et al., 2017).

The incidence of TBI in sports-related activities within NZ has been estimated to be 170 per 100,000 people or 21% of all TBIs (Theadom et al., 2014). One of the challenges in determining epidemiology of sports related TBI is that many injuries go unreported. Whilst this study included injuries from multiple sources (not just hospital admissions) to reduce bias, the authors note that the data is still likely to under-

estimate current sport related TBI within NZ, as many injuries are overshadowed by other injuries sustained concurrently in the incidents, requiring more urgent medical care and further complicated by players denying symptoms, to enable them to return to play (Theadom et al., 2014). It is estimated that there have been approximately 6000 new sport related TBI claims per year in NZ since 2014, with an estimated 7000 claims in active ongoing treatment (www.acc.co.nz).

In the US, TBI is more common in younger people participating in sports than adults (CDC, 2011). Data suggests about 28% of college students have experienced concussion, while 5% have experienced either a moderate or severe TBI in conjunction with chronic ongoing health problems (Knollman-Porter et al., 2018). In NZ, children and adolescents (<18) account for 51% of all concussion's reported within NZ (Theadom et al., 2014).

Sport related TBI within young adults and youth can be sustained within a wide range of sports that vary according to geographical location (Daneshvar et al., 2011). In the US approximately half of College based concussion or mild TBI (mTBI) is sustained during American football, followed by soccer (Hootman, Dick, & Agel, 2007). Within the US and Canada, Ice hockey represents a significant percentage of concussions for both school and college age males and females, particularly given its relatively low participation rate in comparison to other sports (Daneshvar et al., 2011). In NZ an Accident Compensation Corporation (ACC) review of adult concussion from 2001-2011 collected moderate to severe concussion claims for seven different sports. A total of 20,902 sports related concussion claims were reported over seven sports, with rugby union for men and netball for women found to have the highest number of claims. However ACC highlighted that the claims data represent only 6.4% of total sports related TBI reported in this period (King, Gissane, Brughelli, Hume, & Harawira, 2014). More recently research in NZ has suggested that rugby, motor-cross and equestrian sports are the most common sports associated with TBI in adults, while children and adolescents are more likely to sustain a TBI during cycling, rugby and soccer (Theadom et al., 2014). Interestingly the research highlights that given only 3% of the adult population participate in equestrian sports, the risk of TBI is higher than sports such as rugby with higher participation rates. There is no current data on incidence of concussion specifically for children and young adults within the equestrian sports in NZ (Theadom et al., 2014).

Tagliaferri et al. (2006) caution the validity of prevalence data for concussion due to infrequent reporting within the general population, sports professionals, coaches and trainers. Research suggests as much as 50% of concussion remain un-reported

(Nanos et al., 2017). Reasons for under-reporting are multiple and include confusion surrounding terminology, lack of knowledge and social pressure or minimisation (Carroll, Cassidy, Holm, Kraus, & Coronado, 2004; Kerr et al., 2014; Register-Mihalik, Guskiewicz et al., 2013). Other reasons are: return to play guidelines and restrictions (Theadom et al., 2014), access to services and materials (Llewellyn, Burdette, Joyner, & Buckley, 2014; Kerr et al., 2014) and current criteria and screening of concussion within the medical profession, often relying on symptom self-report (Roozenbeek, Maas, & Menon, 2013). Despite the growing interest in sport related concussion there are some significant gaps in data relating to the incidence and prevalence in children (Davis et al., 2017). Given the uncertainty of prevalence data particularly for concussion, it is concerning that research has found that after the U.S, New Zealand has one of the highest rates of sports related TBI within the population (Li et al., 2016; Nguyen et al., 2016).

2.2.2 Incidence and prevalence of concussion within equestrian sports, globally and within New Zealand

The National Electronic Surveillance System (NEISS) estimates there are between 76,000 and 88,000 equestrian related injuries annually within the U.S (Havlik, 2010). However The Centre for Disease Control (CDC) estimates that the actual figure is more likely to be closer to 100,000 to capture injuries reported not only to emergency departments (as is the case for NEISS data), but also to primary care and injuries not reported at all (Havlik, 2010). Research has highlighted that despite there being centralised equestrian sports governing bodies nationally (in the U.S) and worldwide that collect equestrian injury data, injury statistics are not routinely published, which is reflected in the scarcity of epidemiologic research within the equestrian sports (Zuckerman et al., 2015; Weber et al., 2017). There is also no current legislation, in contrast to many other sports, that mandates the reporting of TBI statistics (Zuckerman et al., 2015). As a result research on TBI within equestrian sports remains relatively low (Havlik, 2010).

Equestrian sports have the highest overall severe injury statistics worldwide, with higher hospital admissions than motor-cross, rugby and skiing (Zuckerman et al., 2015). Equestrian sports also represent the highest percentage of sport related TBI (Weber et al., 2017); this is likely due to the minimal control an athlete has over the strength, speed and weight of the horse on impact (Zuckerman et al., 2015). Approximately 15% of hospitalised equestrian injuries sustain a concussion, a significant figure given there is currently a lower participation rate in comparison to other sports (Zuckerman et al., 2015); and concerning given the increasing popularity in equestrian sports globally (Weber et al., 2017). A Canadian study found from 151

hospitalised patients 48% sustained a concussion (Ball, Ball, Kirkpatrick, & Molloy, 2007); while a study in the U.S found approximately 12.4% sustained concussion (Loder, 2008). Jumping and flat racing were found to be the most common equestrian elements to sustain concussion, while (often male) carriage drivers sustained the most severe injuries (Zuckerman et al., 2015; Weber et al., 2017). A German database found 43% of 292 hospitalised patients sustained a TBI resulting from either a fall or head kick (Weber et al., 2017).Within NZ the figures are also representative, approximately 300 new equestrian related TBI claims are made to ACC each year, with nearly 400 individuals actively in treatment (www.acc.co.nz).

Approximately 39% of the equestrian related injuries are in children and adolescents (<19), with fractures and TBI the most common. Children and adolescents between 5 and 18 are at the most risk of concussion due to their large head size to body ratio (Zuckerman et al., 2015) and are susceptible to multiple injuries due to their developmental and cognitive changes (Davis et al., 2017). Within NZ the statistics are slightly higher with approximately 50% of equestrian related TBI within the 0-24 age group, and over 50% in active treatment for TBI (ACC, 2018). Females represent a higher percentage of cases in the adolescent age group, due to the high level of female participation in the sport (Havlik, 2010; Weber et al., 2017). Given the alarming statistics for TBI injury in equestrian sports globally and within NZ, particularly in children and young adults alongside the relative lack of research in the area, further research is urgently required.

2.2.3 Potential effects and costs of sport-related TBI

Both short term and long-term effects associated with sports-related TBI incur significant costs not only financially for the medical and associated health services required but also psychologically and socially for the individual and their family (Tagliaferri et al., 2006; Manley & Mass., 2013). Research suggests the long-term effects of TBI and associated costs are age dependent. Younger children with developing brains are more vulnerable to longer-term cognitive complications, while research in the adolescent age group, highlights emotional, behavioural and cognitive complications (Peterson et al., 2013; Taylor et al., 2010).

Research has highlighted that social cognition, the unique set of skills required for navigating social and emotional interactions in adolescents is affected by concussion (Turkstra et al., 2008). Additionally, concussion affects other cognitive skills, such as memory and executive functioning, developed in adolescents during complex social situations. The psychological consequences of impaired social cognition and

emotional processing due to concussion can be devastating for an adolescent and can extend into adulthood (Turkstra et al., 2008).

It is estimated that US $56 billion is incurred by sports related TBI costs annually, with approximately US $ 2.56 billion exclusively for children and adolescents with moderate-severe TBI (Rockhill et al., 2010; King et al., 2014). Long term costs associated with adult employment and income for children and adolescents affected by TBI are unknown (Rockhill et al., 2010). Further the expenditure on longer term cognitive deficits and neuro-degenerative disease as a result of TBI are also less well documented (Randolph, Karantzoulis & Guskiewicz, 2013; Baugh et al., 2017).

Within NZ significant financial costs as a result of sports related TBI have also been found (King et al., 2014). Data from ACC accumulated over a 10 year period found a cost of NZ $16.5 million for the associated 20,902 concussion claims made within the period. However the authors highlight that these figures are based only on the claims reported at the time, further, costs specific to age groups and ethnicity groups were not identified (King et al., 2014). ACC statistics estimate that the cost for all sports related TBI has increased from $ 8.5 million in 2014 to $ 16.9 million in 2018, and specific equestrian related TBI has increased from $755,951 in 2014 to $1.6 million in 2018 (ACC, 2018).

Given that the global burden of TBI is expected to rise by 2020, with approximately 46% of sports related concussion in NZ and 40% in the U.S predicted to have a high risk of associated long term complications, the actual costs and associated costs for concussion, are likely to be far greater than have been currently documented (Feigin et al., 2013; Theadom et al., 2014; Iverson et al., 2017). This is significant for NZ given our current rate of equestrian related TBI, particularly in the child and adolescent population.

2.2.4 Current concussion management and guidelines within contact and non-contact sports

The Concussion in Sport Group Consensus Statement (CISG) is a comprehensive summary of sport-related concussion prevention, diagnosis and management that has evolved from principles outlined in previous consensus statements on concussion in sport (Patricios et al., 2018). The CISG is designed to guide clinical practice and inform clinical diagnosis and management of sport-related concussion globally (McCrory et al., 2018). The statement is compiled by an expert consensus-approach and reflects the current most up-to-date research to guide all sports and participation levels, regardless of an individual sports' regulatory code of practice

(Patricios et al., 2018). At the 2016 meeting in Berlin the International Equestrian Federation (IFE) were represented for the first time (McCrory et al., 2017).

The initial challenge of concussion management is diagnosis, because the early detection of concussion is a key element in recovery and reduction of longer-term complications (Patricios et al., 2018). Due to the complex presentation and overlapping symptoms of concussion, diagnosis by a clinical team is still required (Patricios et al., 2018). There is no current procedure to measure concussion with medical bio-markers, so presentation to medical staff followed by completion of self-report forms and clinical observation remain the only diagnostic tools currently available (Baugh et al., 2017). Within elite sports, concussion evaluation (the first principle of concussion management outlined by the CISG) often starts on the side-line, due to the presence of trained medical staff or educated side-line observers, such as a first aider, coach or trainer (McCrory et al., 2018; Patricios et al., 2018). Concussion evaluation, can be initiated, when they observe an individual experience a forceful impact either directly or indirectly to the head, that results in obvious or suspected symptoms that may include visible signs (such as loss of consciousness) and individual self-report symptoms (such as headache) (McCrory et al., 2018; Patricios et al., 2018).

Concussion evaluation is an essential component for concussion management and is problematic for concussions sustained in community or recreational sports, where there are often coaches or managers with no medical training to observe or remove an individual from play and initiate a side-line concussion evaluation (Patricios et al., 2018). Concussion education is therefore imperative for individual athletes, teams, coaches and trainers for early concussion detection and management within all sports at all levels but particularly within recreational and community sports (McCrory et al., 2018).

Side-line evaluation for suspected concussion can be carried out after any initial first aid requirements. Evaluation includes rapid testing for cognitive function comprised of short neuropsychological assessments of attention and memory (McCrory et al., 2018). The Sport Concussion Assessment Tool (SCAT5), Standard Assessment of Concussion (SAC) and child SCAT5 are tools for initial concussion screening, when trained medical-staff are present. The Concussion Recognition Tool (CRT5) can be used for concussion screening by non-medically trained individuals (Echemendia et al., 2017). The SCAT 5 (which now includes a rapid neurological screen) some research suggests, is a rigorous tool for side-line evaluation immediately after injury although its effectiveness decreases several days post injury (Echemendia et al.,

2017). Side-line evaluation should not replace further neurological evaluation and diagnosis within a medical setting (McCrory et al., 2018).

The CISG have a further ten principles outlined for sports related concussion management including guidelines on assessment, recovery and return to play (McCrory et al., 2018). Early management includes removal from play immediately following a suspected concussion, followed by further evaluation, neuropsychological assessment and rest (McCrory et al., 2013). The FEI provide an online comprehensive concussion management booklet for events that includes a concussion recognition process flow chart, both the CRT5 and SCAT5 and a concussion clearance form that suggests return to ride guidelines. The concussion management process for equestrian events provided by the FEI can be found in their online Doctor's pack (Federation Equestre Internationale, 2019). Similar online material can be found within the UK for RFU and USA football.

In contrast to previous concussion statements that highlighted longer periods of rest, new guidelines indicate that an individual can return to levels of activity (after an initial 24-48 hours following injury) that avoids exacerbation of any cognitive or physical symptoms (McCrory et al., 2018). A gradual return to play (and return to school for children) protocol that follows a stepwise sequence has been suggested based on The Consensus Statement (McCrory et al., 2018). Research highlights that within all sports at all participation levels, return to play within a 24-72 hours-post injury can delay recovery and lead to cumulative cognitive impairment, therefore further clinical assessment is advised before return to play (McCrea et al., 2003). FEI Return to riding guidelines for equestrian sports are outlined in Table 1.

Table 1. *FEI Return to riding guidelines for equestrian sports.*

If at any of the stages indicated below the athlete becomes symptomatic, he/she should revert to the first stage of activity for 24 hours before attempting again to move on to the next stage.
1. Rest - No activity, complete cognitive and physical rest, do NOT Ride a horse. Once asymptomatic proceed to stage 2.
2. Progress to light aerobic training (walking, jogging), no resistance training.
3. Progress to sports specific exercise, e.g. riding on the flat, hacking.
4. Gradually increased training intensity.
5. Full training after medical clearance.
6. Back to equestrian competition.

https://inside.fei.org/fei/your-role/medical-safety/concussion

Sports related concussion management for children and adolescents require different considerations to adult management given their development, cognitive requirements

and school attendance, yet there is a paucity of research specific to children and youth needs (Davis et al., 2017). Research highlights the need for both cognitive and physical rest, given their physical and cognitive requirements and the impact on social interaction unique to this age group (McLeod & Gioia, 2010). Currently between 35 and 70% of students require help academically on return to school, and about 45% of children experience post-concussion symptoms with returning to school too early. There is also little research on the effects of pre-existing learning difficulties on concussion recovery (Davis et al., 2017). Additionally, a greater percentage of adolescents experience severe post-concussion symptoms in comparison to younger children, they have also shown to take longer to recover due to returning to play too quickly, higher cognitive load and non-reporting of symptoms (Davis et al., 2017).

Current concussion management for children and adolescents is based on the latest version of The Concussion Consensus Statement and follows the stepwise formula, which suggests to evaluate, remove from play, then gradual return to play (McCrory et al., 2018). Removal and Return to play guidelines originated from the 2009 Zachary Lystedt Law, passed in Washington DC, to address the high incidence of youth concussion. In subsequent years a further 43 States within America followed suit with guidelines for return to play for youth and high school athletes following concussion. There are variations between States and now countries on the return to play rules however, consensus on what they are trying to achieve is unanimous (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2019).

Current guidelines suggest that children and adolescents engaged in low level non-contact physical activity and cognitive activity within seven days of sustaining concussion, are less likely to sustain post-concussion syndrome, although a cautious approach is advised (Davis et al., 2017). Guidelines suggest children should return to sport once they are able to return to school (McCrory et al., 2018). A graduated cognitive load progression is recommended (McLeod & Gioia, 2010). However, given their different physiological, psychological and developmental response to concussion, there is conflicting research for adolescents and children regarding the length of recovery time and graduated re-exposure to cognitive and physical loads (McCrory et al., 2013). Research also highlights inconsistency seeking medical clearance for youth and adolescents with regards to return to play and school (McCrory et al., 2018; McCrea et al., 2003). Research suggests that 72% of equestrian riders determine their own return to riding time frame, without clearance from a medical specialist (Kuhl et al., 2014). Further research and validated rating scales are required for age specific concussion guidelines for children and

adolescents that will assist the management of returning to school and sport after concussion (McCrory et al., 2018).

2.2.5 Current sport concussion management and guidelines within New Zealand

New Zealand has created National Concussion Guidelines that outline concussion management for sports related concussion due to the high prevalence and incidence of concussion within NZ (Feigin et al., 2013; Theadom et al., 2014; Sports Concussion in New Zealand: ACC., 2015). The New Zealand guidelines are based on the Consensus Statement on concussion in sport (McCrory et al., 2018). The guidelines suggest, recognising, removing and referring as priority steps, highlighting that the responsibility of these steps falls on everyone present at the side-line. ACC provide concussion recognition tools for recognising signs of concussion, based on the CRT5, but highlight that removal from play is a priority even if there is uncertainty that a concussion has occurred. ACC highlight the need for concussion education surrounding recognition of concussion in those involved in sports and the use of the concussion tools (Sports Concussion in New Zealand: ACC., 2015).

The ACC rest, recover and return guidelines for concussion in sport within NZ, follow a similar format to the guidelines outlined by the CISG. Rest for a minimum of 24 hours and until acute symptoms have passed, then recovery that follows a gradual return to activity, play or school without further exacerbation of symptoms. Clearance from a medical professional regarding full return to play is recommended (Sports Concussion in New Zealand: ACC., 2015).

Equestrian Sports New Zealand (ESNZ) align with the ACC and CISG concussion guidelines outlined, however they also issue a blue card system at official equestrian events within NZ. The blue card system was initiated by New Zealand Rugby Union in 2014 to improve player welfare after a head knock sustained during play (New Zealand Rugby Union, 2019). A blue card within equestrian sports is issued to any rider suspected or having sustained an obvious concussion during competition, the card suspends the rider from returning to competition the same day and any further events until medical clearance is approved, at which point the blue card held by ESNZ is withdrawn. Disciplinary action can be taken if the guidelines are not adhered to. ESNZ suggest return to riding guidelines in the same stepwise format outlined by the FEI (Equestrian Sports New Zealand, 2019).

The New Zealand Pony Club Association (NZPCA) follow similar guidelines to ESNZ, however riders are issued with a green card rather than a blue card and are restricted

from participating in any riding events for twenty one days following a concussion (New Zealand Pony Club Association, 2019). Research suggests this time frame due to the age, developmental stage and recovery length within this cohort, and therefore the impact of concussion on the developing brain (Peterson et al., 2013; Davis et al., 2017). Riders must also gain medical clearance before returning to ride following the stepwise guidelines (New Zealand Pony Club Association, 2019).

It is argued that where rules on return to play or riding are prohibitive for competitive athletes, such as the twenty one day stand down suggested by NZPCA, non-reporting or disclosure of concussion is a risk (Theadom et al., 2014; Kerr et al., 2014). Education surrounding the guidelines and return to riding within the younger age cohort is essential for adherence to the recommended concussion guidelines and prevention of longer-term concussion symptoms (Davis et al., 2017).

Education about concussion guidelines and return to riding is provided on the ESNZ and NZPCA websites for the public, officials and ground coordinators, alongside concussion tools for use at events, based on the CRT5. However currently there is no other source of concussion education to the wider, non-eventing or competing community, recreational riders or younger riders not involved in Pony Club within NZ.

2.2.6 The problem of under-reporting concussion within sports

Current research suggests that the large proportion of concussion (up to 70%) remains unreported within sports, increasing athlete risk of longer-term concussion complications; particularly at risk are the developing brains of adolescents (Register-Mihalik, Linnan et al., 2013; Nanos et al., 2017). Concussion reporting can provide a behavioural insight into concussion education (Kroshus et al., 2015). Very little is currently known about what factors influence the reporting behaviours within sports and whether current education programmes are effective or even accessible in changing reporting behaviour (Register-Mihalik et al., 2018). What is understood is that under reporting is a significant problem in athletes, coaches and parents (Register-Mihalik, Guskiewicz et al., 2013; Whatman, Walters, & Schulter, 2018) and that concussion management and return to play rules have further encouraged under-reporting (Kerr et al., 2014).

Several areas have been highlighted as reasons for under-reporting, including inadequate understanding and knowledge about concussion symptoms, risk appraisal and athlete attitudes towards disclosure (Register-Mihalik, Linnan et al., 2013; Baugh et al., 2017). Attitude has been shown to have a significant influence on reporting intention, despite the amount of concussion knowledge (Register-Mihalik, Guskiewicz

et al., 2013). Additionally, psychosocial determinants such as personal experience and social norms have been suggested as having a huge impact on attitude (Register-Mihalik, Linnan et al., 2013). Since there is no current mechanism to measure concussion with medical bio-markers, self-report remains the only diagnostic tool, it is therefore imperative that attitudes to concussion reporting are changed (Baugh et al., 2017).

Reasons for under-reporting vary with age groups and are often dependent on level of play, type of sport and the values and social culture (and those that can influence the social behaviour) within the sports groups (Kerr et al., 2014; Register-Mihalik, Linnan et al., 2018). For example, under-reporting in high school has been linked to social acceptance and the coach/trainer mind-set, reflected in personal or peer group minimisation to continue playing (Llewellyn et al., 2012). While in university or college, athletes' sport scholarships that depend on the ability to play, present as a main reason for under-reporting (Register-Mihalik, Guskiewicz et al., 2013). Research suggests as many as 50% of high school football players do not disclose concussion due to lack of concussion understanding alongside peer pressure to continue to play, while 40% of university athletes do not disclose a concussion, primarily due to their attitude towards disclosure and not wanting to appear weak (Register-Mihalik, Guskiewicz et al., 2013).

NZ research highlights similar data: approximately 32% of high school rugby players did not report concussion due to negative peer pressure (Kerr et al., 2014). More recently a knowledge and attitude survey on concussion in sports within NZ secondary schools highlighted that approximately 50% of students concurred that concussion was regularly un-reported (Reid et al., 2018). Within equestrian sports, research is sparse although it highlights similar peer group and social factors influencing reporting attitude and behaviour, alongside knowledge confusion about the use of helmets preventing concussion (Kuhl et al., 2014).

Research suggests that under-reporting or non-disclosure of concussion can be categorized into four levels based on the socio-ecological framework. They include intra-personal, inter-personal, environment (access to information and culture within the sport) and policy levels (Kerr et al., 2014). With other factors such as geography, parental involvement, coach availability and health related behaviour also likely to influence knowledge and understanding (Register-Mihalik et al., 2018; Wallace Covassin, Nogle, Gould, & Kovan, 2017). Currently these factors are often not considered within concussion research and education programmes, which are often only focused on one element (Wallace et al., 2017). As current research suggests considering only one element for concussion education is not adequate at influencing

attitude and knowledge to impact behaviour outcomes (Wallace et al., 2017; Kerr et al., 2014). Under-reporting must be considered within multiple levels of the socio-ecological framework, concussion education that incorporates this will be more likely to create positive perception about disclosure and impact reporting behaviour, further research is required (Register-Mihalik, Linnan et al., 2013; Wallace et al., 2017).

2.2.7 Current concussion education available to adolescents and youth within sports

Concussion education is pivotal to effective concussion management given early detection of concussion is a key element in recovery and reduction of longer-term complications (McCrory et al., 2018). Concussion education is particularly relevant for recreational and community sport, where it is less likely that trained medical professionals are present on the side-line to initiate evaluation (Patricios et al., 2018).

Concussion education in The United States is mandatory to parents and youth involved in organised sport under the 2009 Zachary Lystedt Law (Patricios et al., 2018). However, elsewhere for those participating in recreational level sport or living in rural communities (like much of New Zealand) education for the general public including, youth, parents and coaches is more of a challenge and often unavailable despite being of high importance for effective concussion management (Patricios et al., 2018; Wallace, Covassin, & Moran, 2018).

Concussion education within collision sports often consists of traditional education that includes online learning modules, access to concussion tools and training for medical staff (Kroshus et al., 2014). The National Collegiate Athletic Association (NCAA) in the US provide yearly concussion education to youth that includes formal lecture style presentations, largely based on symptom recognition, handouts and quizzes (Knollman-Porter et al., 2018). However, content specificity and evaluation is currently not required and despite the yearly education mandate research highlights that different institutions vary greatly in their education content (Kroshus et al., 2014). Research also cautions that misconceptions within educators currently exist and that educators' knowledge needs to be evaluated and updated regularly (McKinley & Buck, 2018).

In Canada a large proportion of concussion education is aimed at concussion prevention for ice hockey (Caron, Bloom, Falcao, & Sweet, 2015).'ThinkFirst' provide a short video education tool to school teams followed by a short quiz. While players showed improved concussion knowledge, no difference in behaviour or attitude was observed (Caron et al., 2015). A Canadian website provides comprehensive

concussion education that includes videos, online tools and updated news and events and is available to a wide audience. However little research has been done on the effectiveness of the education material and which audience groups access it (CATT, 2019). Universities in the U.K have concussion education for students which is available primarily to rugby and soccer contact sports and is presented as concussion facts and rules for management (Kirk, Pugh, Cousins, & Phillips, 2018). The CDC launched the “Heads up” campaign to provide concussion education to coaches involved in high school sport within the US, alongside printed concussion material to provide to students and although initially successful, research suggests long term knowledge uptake has not been sustained (Kirk et al., 2018).

Within NZ, The New Zealand Rugby Union (NZRU), The New Zealand Rugby League (NZRL) and ACC have comprehensive concussion education guidelines and tools available to athletes in sport. The information is available primarily through their websites alongside education programmes that target coaches and referees in workshop style format (Murphy, Starkey, & Theadom, 2015). In other sports, such as rugby, football and netball, Reid et al. (2018) suggest the majority of concussion education comes from schools and coaches, with only a small proportion from ACC or sports clubs. Equestrian sport participants within NZ can access concussion education through the ESNZ and NZPCA websites, but there is concussion education training for event officials through ESNZ. It is not known whether there is education in any other form to youth and adolescents participating in the equestrian events and it is unlikely that those participating in equestrian sports in rural areas or those participating for pleasure receive any education at all. Research has suggested as many as 32% of youth participating in equestrian sports have been educated about concussion from their parents alone (Kuhl et al., 2014). There are no available statistics on concussion education programmes specific to NZ equestrian sports.

Despite the costly education interventions and concussion policies that currently exist, research within the last two years suggests that baseline concussion knowledge, behaviour and reporting in both college athletes and recreational athletes within a variety of sports, including equestrian sports, is still poor, with very little known about return to play guidelines and injury prevention (Knollman-Porter et al., 2018; Kirk et al., 2018; Theadom et al., 2019). Some research argues that teaching and enforcing return to play rules have further encouraged non-disclosure of concussion symptoms (Kerr et al., 2014). Current concussion education that exists for young people in sport is varied in its content and delivery, is often a one-size-fits-all approach that is not evidence based and not available to all sports and levels of ability (Wallace et al., 2018; Knollman-Porter et al., 2018). Further, little is known whether knowledge translation

occurs from costly education programmes to the youth that are involved in the sports (Caron et al., 2015).

What is evident is that current education on concussion awareness in sports is ineffective and that behaviour surrounding concussion is not influenced by education alone (Knollman-Porter et al., 2018; Theadom et al., 2019). Two main factors are highlighted psychosocial and sociocultural factors (such as attitude of self/others, risk appraisal and symptom perception). These factors have a significant influence within the culture of sports, education for youth that fits within the multiple layers of a socio-ecological framework (that encompass both psychosocial and sociocultural factors) is required (McCrory et al., 2018). Inclusion of positive reporting and disclosure cultures, fair play and ethical values need to be put in place at all youth levels regardless of the sport, level of ability or geographical location (Wallace et al., 2017; Register-Mihalik et al., 2018). Secondly, the effective dissemination of information requires adaptation of concussion education material to the appropriate audience and contexts to enhance knowledge transfer (Caron et al., 2015).

2.2.8 Translation of knowledge from current education programmes

Research suggests that concussion knowledge remains poor despite increased concussion awareness and costly concussion education programmes (Knollman-Porter et al., 2018; Kirk et al., 2018; Theadom et al., 2019). Little is known about how knowledge translation occurs from current concussion education programmes or what drives the behaviour choices of youth involved in the sports to report concussion (Caron et al., 2015). There are multiple factors that influence the link between knowledge and behaviour outcomes, social parameters have been highlighted as significant for youth athletes (Knollman-Porter et al., 2018). Additionally, psychosocial determinants such as personal experience, social pressure and social norms have been suggested as having a huge impact on attitude and behaviour (Register-Mihalik, Linnan et al., 2013). Research on health related behaviours within other contexts has suggested this to be the case, and has highlighted that in order to influence health behaviours, consideration must be given to the individual and the social environments in which they live (Kelly & Baker, 2016). There is a need to research knowledge translation within concussion education programmes to improve concussion behaviour outcomes (Caron et al., 2015; Provvidenza et al., 2013). This is particularly relevant to the younger athletes as their symptoms and recovery from concussion are significantly different to adults (Caron et al., 2015).

The CISG identify that knowledge transfer strategies require evidence based research to identify the needs and learning styles of the target education group. The CISG

highlight that knowledge transfer is a valuable part of concussion education and should include an interactive, multi-directional communication process that is ongoing, rather than just at one period of time (Provvidenza et al., 2013). Caron et al. (2015) concur that a knowledge translation framework for concussion education to youth is required. It is also evident that outcome measures that are able to assess improvements and quantify change in knowledge and awareness are required alongside such research (Chapman et al., 2018). The framework needs to consist of information in terms of the socio-ecological framework alongside implementation strategies that are adapted to different contexts and audience groups (Kroshus et al., 2014).

2.2.9 Concussion knowledge and awareness

Misunderstanding and confusion about concussion knowledge and awareness has been found in athletes of all ages and abilities within a variety of sports (Knollman-Porter et al., 2018; Kirk et al., 2018). Although research within a younger cohort and recreational sport is gaining momentum, the majority of existing research has focused primarily on college based or university contact sports (Knollman-Porter et al., 2018; Sye, O'Sullivan, & McCrory, 2006). For example, less than 20% of American football players could identify their own concussion symptoms during play (Delaney, Lacroix, Leclerc, & Johnston, 2002). Kerr et al. (2014) found that between 50-60% of hockey, soccer and football players could not identify their concussion symptoms due to a lack of concussion knowledge and awareness. The authors also highlight other areas of concern with reporting behaviour. They found a high prevalence of players did not report concussion due to unawareness of the severity of concussion, additionally inter-personal reasons such as letting team-mates down or future team selection concerns, were also identified as reasons for not reporting concussion (Kerr et al., 2014). Fedor and Gunstad (2015) found that more than 60% of football players incorrectly identified short term concussion symptoms, particularly emotional symptoms, even though the same players expected to experience a concussion at some point during play. Limited knowledge about return to play guidelines and procedures or the long-term sequelae of multiple concussions is evident in athletes and coaches across multiple sports (Kirk et al., 2018; Miyashita, Timpson, Frye, & Gloeckner, 2013).

Within NZ, research has highlighted similar findings. A survey of 600 high school rugby players revealed that only half were aware of concussion guidelines and the compulsory stand down period or return to play rules. More concerning were the statistics that suggest a large percentage of players did not seek medical clearance after sustaining a concussion before returning to play (Sye et al., 2006). More recently knowledge and a positive attitude towards concussion management have been found in some high school students, perhaps due to the implementation of the ACC

guidelines in 2014. However, the research suggests significant gaps in knowledge still exist (Reid et al., 2018). A survey on attitude to injury within netball, basketball and football athletes highlighted that 80% of the youth players did not disclose their injuries due to lack of knowledge or social pressure to remain in play. Only a small percentage (5%) of injuries sustained were specific to concussive injury. However, the overall attitude and knowledge of the youth in response to injury is likely to be similar, given the findings highlighted in previous research (Whatman, Walters, & Schulter, 2018). More recently research has further identified significant gaps in the knowledge and awareness within the equestrian sports (adolescents and adults) in NZ despite the high rate of concussion in this group of athletes and the current education programmes in place (Theadom, Reid, Hardaker, lough, & Hume, 2019).

2.2.10 Trends in paucity of knowledge and awareness

There are gaps in the knowledge of concussion among youth and adolescents globally (Register-Mihalik et al., 2018; Register-Mihalik, Guskiewicz et al., 2013) and within NZ (Reid et al., 2018; Theadom et al., 2019). Misunderstandings and incomplete knowledge on concussion symptoms and recovery are problematic for delayed diagnosis and are substantial risk factors for further injury and associated long term concussion complications, such as cognitive deficits and neuro-degenerative disease (Fedor & Gunstad, 2015; Chapman et al., 2018). Emotional symptoms are the least well understood, alongside sleep problems and the effects of concussion on academic performance, long term post-concussion syndrome is also not well understood (Hecimovich et al., 2016). There is significant confusion in many athletes surrounding reporting a concussion and return to play or riding rules (Knollman-Porter et al., 2018). The mechanism and physiology of how a concussion occurs (for example loss of consciousness does not always occur) alongside the time frame for onset of concussion symptoms is also poorly understood within NZ (Reid et al., 2018; Theadom et al., 2019). Research in NZ also highlights a poor understanding of recovery from concussion, particularly cognitive recovery after concussion (Reid et al., 2018) and inadequate knowledge about returning to play rules (Sye et al., 2006) or riding within equestrian sports (Theadom et al., 2019).

An athletes' ability to understand and recognise their own symptoms and behave accordingly is a key factor in concussion management. But for coaches, trainers and parents' knowledge and awareness of concussion is also important, as they become instrumental in removal from play and help an athlete seek medical attention, alongside monitoring return to play and recovery (Nanos et al., 2017). In fact research suggests coaches and trainers are in a unique position to teach, encourage and promote concussion knowledge and awareness (Whatman et al., 2018). Previous research has

found that only about half of coaches thought concussion warranted removal from play or even needed reporting (McLeod et al., 2007). There is often a negative environment surrounding reporting and removal of players by coaches in response to performance levels and parent pressure (Register-Mihalik, Linnan et al., 2013; Nanos et al., 2017; Whatman et al., 2018). Consideration must also be given to rural, community and recreational sports, where there are often no coaches or trainers other than volunteer parents of athletes (Patricios et al., 2018). Current concussion management and education seems to come from schools and coaches. Given significant gaps in concussion knowledge exist, concussion education and knowledge transfer frameworks need to be in place at multiple levels, including education and awareness for parents, coaches, athletes and within schools (Register-Mihalik, Linnan et al., 2018; Reid et al., 2018)

2.2.11 Paucity of knowledge and awareness within the equestrian sports

Within equestrian sports similar gaps in knowledge exist with regards to understanding of concussion symptoms, management and reporting (Kuhl et al., 2014). More significant however, is the limited knowledge and awareness surrounding helmet use which is a concern due to the high percentage of severe injury within equestrian sports (Weber et al., 2017). Poor understanding about the use and function of helmets has been consistently found both globally (Zuckerman et al., 2015; Short, Fenton, Scaife, & Bucher, 2018) and within NZ (Theadom et al., 2019).

Helmet design and its use within equestrian sports has received a large amount of interest in recent years (McIntosh et al., 2011; Bier et al., 2018). Helmet design and safety has changed significantly in the last decade within multiple sports such as bicycle sports, skiing and American football. Research has highlighted the role that helmets play in reducing the severity of TBI and focal injuries within these sports (McIntosh et al., 2011). However helmet use and design in equestrian sports has not received the same attention until recently, suggesting that equestrian knowledge on helmet use, safety and technology has been lagging behind (Forero Rueda, Cui, & Gilchrist, 2011; Havlik, 2010). Recent research highlights significant confusion that exists regarding the use of head gear as a preventative measure of concussion within sports (Reid et al., 2018)

The effectiveness of helmets in reducing severe head injury has been presumed by the mandated use of approved safety helmets in horse racing and equestrian competition, enforced by organisations such as FEI in Europe and the recent tagging of approved helmets by the NZPCA and ESNZ within NZ (McIntosh et al., 2011; NZPC, 2019).

However mandating helmet wearing cannot be enforced in recreational settings (Havlik, 2010). Research highlights there are significant gaps in knowledge about helmet use both globally and within NZ (Theadom et al., 2019; Bier et al., 2017) Further, the safety standards of helmets, alongside the need for replacement after a fall are confusing at best (McIntosh et al., 2011). As the incidence and prevalence of concussion and mTBI within equestrian sports continue to rise globally and within NZ with research highlighting the long term impact and complications of sustaining concussion, particularly in children and adolescents, literature highlights a twofold problem.

Firstly, extensive education surrounding the use and reasons for use (and enforcement where necessary) of appropriate safety helmets for all equestrian sports and levels is required, alongside education on replacing a helmet after sustaining a fall (Theadom et al., 2019). Secondly, equestrian helmet technology needs to advance to provide helmet structures for different developmental ages of youth that protect the brain from not only severe focal impact and acceleration but also TBI (mild or severe) that occurs due to oblique impact (McIntosh et al., 2011).

2.2.12 Factors influencing Knowledge and awareness

Overall youth athletes' knowledge of concussion has been shown to have increased in recent years both globally and within NZ (Knollman-Porter et al., 2018; Reid et al., 2018). In general athletes in contact sports are reported to have a higher knowledge of concussion, particularly the more common signs and symptoms, than non-contact sports (Nanos et al., 2017; Wallace et al., 2017). Athletes with a previous history of concussion tend to have better knowledge and understanding of concussion and long-term consequences of multiple concussions (Nanos et al., 2017). This is also true for equestrian sports within NZ (Theadom et al., 2019). However, an overall increase in concussion knowledge has not been shown to occur from concussion history alone (Hecimovich, King, & Marais, 2016). Athletes are aware that concussion history will increase likelihood of subsequent concussion (Kirk et al., 2018).

Demographic, geographic, culture/environment and policy have been shown to influence concussion knowledge but interestingly not reporting behaviours (Wallace et al., 2018; Kerr et al., 2014). Differences in concussion knowledge and awareness exist between white Americans and African-Americans (Wallace et al., 2018), urban schools and suburban schools (Wallace et al., 2017), different countries (Hecimovich et al., 2016), well-resourced athletes (Register-Mihalik et al., 2018), or athletes with a trainer/coach and those without (Wallace et al., 2017) and States with different concussion related policies (Register-Mihalik et al., 2018; Kerr et al., 2014). These

findings could be significant for NZ, particularly within the equestrian sports. They pose the question whether rural and community sports populations that have little or no access to coaches and concussion education programmes, have significant concussion knowledge to manage concussion, given current NZ research is predominantly based on NZ Pakeha in regional schools (Kirk et al., 2018; Reid et al., 2018). Significant differences in sport specific cultures, social norms and availability of coaches and resources within these demographics, highlight the need for wider dissemination of concussion education that follows a socio-ecological context, in order for concussion education to reach a wider audience and positively impact concussion management (Register-Mihalik et al., 2018).

Knowledge and attitude has improved within youth involved in sport, however gaps still exist. Further little is known how knowledge translates into positive concussion management and reporting, particularly in rural or community sports, urgent research is required in this area (Whatman et al., 2018).

2.3 Conclusion

Sports are one of the main life contexts in which youth and young adults sustain a concussion (Knollman-Porter et al., 2018). Yet despite the large amount of literature and increased awareness and education on the topic, the prevalence rates remain high (Knollman-Porter et al., 2018). Further, there continues to be significant gaps in athletes' knowledge and awareness of concussion (Knollman-Porter et al., 2018; Reid et al., 2019). NZ has a disproportionately high level of sport related TBI per population, particularly equestrian sports, despite current ACC, ESNZ and NZPCA concussion guidelines (Theadom et al., 2014; Theadom et al., 2019). Findings suggest that education for youth and young adults needs to be more effective in addressing areas such as positive reporting behaviours, symptom management and helmet use within equestrian sports (Knollman-Porter et al., 2018; Nanos et al., 2017; Theadom et al., 2019). Age appropriate and sport specific education programs are needed that target multiple levels of an athletes' socio-ecological framework and include athletes, parents and coaches in both elite sports and community and recreational sports (Register-Mihalik et al., 2018).

This thesis aims to find out what young adults engaged in equestrian sports within NZ know and understand about concussion.

Chapter 3: Methodology and Methods

This chapter provides an overview of the methodology and methods used to explore the research question “What do young adults who are engaged in equestrian sports in NZ know and understand about concussion?”

3.1 Methodology

Empirical knowledge forms the basis for science and is constructed from facts within the observable reality of our world. Empirical knowledge represents the naturalist methodology which is based in empiricist epistemology and is distinct from knowledge that is based on normative values not based in fact (Moses & Knutsen, 2012). Within the social sciences however, facts are socially constructed rather than purely observable, knowledge is obtained by identifying associations through reason and deduction and confirmed through empirical evidence (Moses & Knutsen, 2012).

Historically experimental methods have been preferred as they yield the cause-effect outcome between variables that is desired within the hard sciences (Punch, 2003). Experimental methods however are not the most practical for the wide range of social and health science research. This is due to the limited scope of research questions that can be answered in a cause-effect manner, alongside the ethical implications of manipulating variables that are not representative of the natural settings in which they exist (Punch, 2003).

Descriptive statistical methods are a convenient and appropriate choice of methods for identifying associations within the social and health sciences as they are more applicable to the wider scope of non-experimental research (Moses & Knutsen, 2012). Quantitative surveys are often the most commonly used in research, they have large sample sizes that are based in a natural setting and are representative of the population. Surveys have the ability to identify relationships between variables and contribute to the knowledge base within research that is often limited by time and budget (Punch, 2003). Contribution to the knowledge base is critical to informing evidence based practice (Pai et al., 2004).

Evidence based practice is the process of obtaining the most recent and relevant information from empirical research then used in combination with clinical expertise to inform decision making within a clinical setting (Sackett, Rosenberg, Muir Gray, Haynes, & Richardson, 1996). It has been adopted by the health sciences as standard practice for informing clinical work (Pai et al., 2004). The Accident Compensation Corporation (ACC) sports collaboration group and equestrian agencies are involved

within the present research so its results can be used to inform policy and concussion prevention strategies. It is hoped that the data and analysis within this thesis is used in part to inform clinicians who manage concussion but also individuals involved in equestrian activities at all levels.

3.2 Methods – Current research

3.2.1 Survey development

Cross-sectional surveys are the most appropriate for public health research to assess prevalence of outcomes associated with particular areas of interest. Surveys are carried out at one time point and can provide a considerable amount of data (Levin, 2006). A cross-sectional survey was used to address the current research question and hoped to provide data on knowledge and awareness of concussion in equestrian sports within NZ.

Survey design is based on the overall objective of the research question, and what data needs to be collected within each specific question of the survey. Inductive and deductive question formulation ensures the questions are connected, each question represents only one concept and language is clear and relevant in order to adequately capture the overall data (Punch, 2003). The anonymity of the survey improves assessment of participant attitude, understanding and knowledge (Lindell & Whitney, 2001).

The survey used in this study was modified from a knowledge, attitude and concussion reporting behaviour survey that was used to assess concussion in high school students participating in soccer, football, lacrosse and cheerleading in the US (Register-Mihalik, Guskiewicz et al., 2013). The authors based the survey on a theoretical framework, The Theory of Reasoned Action and Planned Behaviour (TRA/TRB). TRA/TRB is a helpful predictor for understanding the link between attitude and behaviour within health in relation to social influences, which is particularly salient for sport related concussion knowledge and awareness (Register-Mihalik, Linnan et al., 2013). Research also suggests that the TRA/TRB framework provides better estimates of attitude, than observational studies, towards self-report health related behaviours (Register-Mihalik, Linnan et al., 2013).

This modified survey has previously been used to assess awareness of concussion in sport in secondary schools within New Zealand (Reid et al., 2018). Question items were further adapted by authors Theadom et al (2019) to be meaningful for a range of equestrian activities. Adaptations included demographic details, participant equestrian experience, concussion knowledge and additional questions to assess helmet use. The

adapted questions were not piloted. Thirty-five multiple choice questions assessed concussion knowledge based on symptom recognition and awareness, reporting and attitude to concussion. The questions are aimed at asking both direct and indirect questions to measure attitude and behavioural control for reporting concussion, for example an athlete may believe and know concussion is serious but may still choose not to report or disclose the injury (Register-Mihalik, Linnan et al., 2013).

The survey took approximately 10 mins to complete and was completed by participant's online using SurveyMonkey software. The full itemised survey can be viewed in Appendix D.

3.2.2 Ethics approval

Ethics approval for the survey research was granted by Auckland University of Technology Ethics Committee (AUTEC 18/340) in conjunction with a larger research project by Theadom et al. (2019). See appendix A; Ethics approval.

3.2.3 Sample

Inclusion criteria for participants to complete the online survey included being 16 years and older and being currently involved in riding, working and driving around horses in New Zealand. For the purposes of this study looking at concussion awareness in young adults (sub-analysis of the main study which looked at all age groups), data for those aged between 16 and 21 years of age were extracted.

3.2.4 Cultural Aspects of Participation

Cultural aspects for participation within the New Zealand population were taken into consideration for this research. A consultation process was undertaken within the ethics process to acknowledge the suitability of the questionnaire for different ethnic groups. Findings from a similar study of concussion awareness in high school rugby players, which involved the questionnaire being evaluated by a Maori cultural advisor and piloted within at least four diverse ethnic groups for cultural appropriateness (Murphy, 2015), informed the presentation of the current questionnaire. The study also respected individual differences by maintaining confidentiality and offered options for open text feedback for some questions.

3.2.5 Distribution

The survey was distributed by Equestrian Sports New Zealand (ESNZ), New Zealand Pony Club (NZPC), Harness Racing New Zealand (NZ racing) and New Zealand Track Racing to their members and licence holders and through social media, advertising in

equestrian magazines, private equestrian clubs, and associations and through personal contacts. The survey was completed online or available as a hard copy which the student researcher then manually entered onto the survey database.

Non-response is always a potential issue, one that can affect bias within the results (Cannon, 2018). Techniques to minimise sampling bias were taken, for example for the opportunity to enter a prize draw following survey completion, national distribution across equestrian activities, several response options (online or hard copy) and ensuring the brevity of the questionnaire (Levin, 2006). Distribution of the survey was carried out over approximately three months, with closure of the online survey in December 2018.

3.2.6 Consent to participate

When participants accessed the online survey, they were guided to read the participant information sheet (See appendix C), which outlined the research process and what will happen to the information collected. Participant selection was explained in conjunction with their agreement or consent to take part in the survey and lead researcher contacts were also given if a participant should want to contact the research team. The participants were then guided to complete the online survey.

3.2.7 Participant confidentiality

Participants were allocated a unique registration number generated by the database; the registration number was used to link all study data relating to the participant, to preserve participant confidentiality (Cannon, 2018). Participants were only asked for their name and email address or mobile phone contact number collected in a separate spreadsheet if they wished to enter the prize draw. Following completion of the study and prize draw selection these identifying details were deleted.

3.2.8 Data collection and procedure

Completed survey data was collected within surveymonkey, then exported to the computer software SPSS (a statistical package for social sciences). SPSS version 25 was used.

Four sections of questions were included. Firstly sociodemographic data was collected from participants (including age, gender, ethnicity). The second section of questions was designed to obtain the type of equestrian activities and length of time the participant had been involved with equestrian activities, alongside the level of professionalism of the participant. This was to assess any sub-group differences in level of participation. A third section of questions were chosen to obtain information

about participants' knowledge on concussion and information on their health-related behaviours such as reporting concussion and returning to ride after concussion. The questions in this section were asked primarily in a yes or no format, with remaining questions providing options to select. The final section was related to helmet use within equestrian activities and personal experience of concussion. This section adds further context to the health-related behaviour answers obtained in the previous section, by indicating participant attitude to knowledge and health related behaviour in relation to concussion. An open field for additional comments was provided for participants at the end of the questionnaire. There were no validity scales within the survey due to the discrete nature of the questions.

3.2.9 Data cleaning and Analysis

Data cleaning to remove errors or inconsistencies within the main data set was carried out by the lead supervisor Alice Theadom. Data was cleaned using range and logic checks to ensure data quality and meaningfulness. Incomplete surveys with minimal missing data were included and participants that had completed less than 20% of the survey were excluded. Research suggests that when more than 20% of data is missing, including the variable to be considered, then case-wise deletion can be considered rather than replacement methods (Schafer & Graham, 2002). Case-wise deletion has the advantage of leaving parameters of observed values complete for analysis, in contrast the disadvantage is that results may be biased and must be reported as so (Schafer & Graham, 2002).

Missing data in this study could be the result of item non-response (e.g. the question wasn't relevant to the participant), or subject non-response (e.g. the participant chose not to answer the questions) (Cannon, 2018). Incomplete surveys, where multiple non-response items were present, were discarded rather than carrying out case-wise deletion, due to the nature of the items of non-response (Howell, 2008). Data imputation can sometimes be relevant for missing data that results from item non-response, where some items of a questionnaire or measure might be missing, (Garson, 2015). However, the decision to not impute data for participants with missing data was made based on the nature of the participant sample. This decision was guided by two factors, firstly the assumption that the diversity within the sample would impact the ability to reliably predict how people would respond and secondly the missing data in itself is meaningful for interpretation (Cannon, 2018).

The survey comprised a total of 35 items. Within section three of the survey, (the concussion knowledge and health related behaviours section), six concussion knowledge questions were presented with the option to choose multiple answers

resulting in a total of 48 concussion knowledge items in the section. Participants were asked to select from a range of possible options, the items were scored as one point for all correct answers and zero for incorrect. A total knowledge score was obtained for this section ranging between 0-48. A similar format followed in the final section on helmet use and personal concussion history. Two questions designed to assess attitude to helmet use and concussion management were presented using a five-point Likert response choice, (strongly agree, agree, disagree, strongly disagree). The remaining questions contained options in the form of yes or no format or choices with multiple options (where correct answers scored one, while incorrect scored zero). Finally, the remainder of the questions in the final section required text answers.

Data was analysed and summaries were included of baseline sample characteristics and general descriptive summary statistics including means and standard deviations and percentages of correct knowledge answers. Scores obtained for concussion knowledge, behaviour and attitude are presented using tables. Conventions for data analysis in a TRA/TRB based survey suggest that average direct scores of knowledge, behaviour and attitude can be calculated from construct items within the survey (Francis et al., 2004; Register-Mihalik, Linnan et al., 2013).

Chapter 4: Results

4.1 Introduction

This chapter presents the results from the online equestrian survey. The participant sample and demographics will be presented, followed by descriptive statistics and key knowledge scores for the concussion data.

4.2 Demographic details

A total sample of 258 participants between the age of 16 and 21 (mean age 18.4: SD 1.6) gave consent to participate in the research and completed the online survey. There were no surveys completed in paper format. Missing data was less than 10% across the variables, with a pattern of missing data within the concussion knowledge section. As missing data was systematic it was not imputed.

Demographic and descriptive data for the sample is presented in Table 2. Given the sample size and age range of the cohort (16-21 years), 70 participants (27.1%) professionally engaged with horses, while 107 (41.5%) participants engaged in some form of work around horses (farming/healthcare/farrier). There was an approximate even split between Pony Club members 124 (48.1%) and Non-Pony Club members 134 (51.9%), and 63 (24.5%) of the non-Pony club sample participate in either thoroughbred racing, harness racing or driving.

A small percentage of the participants (22.1%) had never experienced concussion although 34 participants (13.2%) either did not know whether they had experienced concussion or did not answer the question. Additionally, 97 participants (37.6%) had experienced two or more concussions, but it is not clear how many are related to engaging with horses. Knowledge and information about concussion was primarily sourced for 255 participants (98.8 %) from advertising materials including posters, magazines and other sports alongside personal experience, with approximately half of the sample obtaining information from coaches/trainers or official organisations such as ACC.

Table 2. *Demographics of study participants*

	Frequency (%)		*Pony Club*		*Non Pony Club*	
Gender						
Male	8	(3.1)	2	(1.6)	6	(4.5)
Female	249	(96.5)	122	(98.4)	127	(94.8)
Non-binary	1	(<1)			1	(0.7)
Missing	0	(0)				
Ethnicity						
European	248	(96.1)	116	(93.5)	132	(95.5)
Non-European	10	(3.9)	8	(6.4)	2	(1.5)
Type of equestrian activity(ies) engage in (tick all that apply)						
Hacking/trekking	134	(51.9)	70	(56.5)	64	(47.8)
Groundwork	125	(48.4)	58	(46.8)	67	(50.0)
Show jumping	189	(73.3)	103	(83.1)	86	(64.2)
Dressage	130	(50.4)	80	(64.5)	50	(37.3)
Eventing	125	(48.4)	89	(71.8)	36	(26.9)
Farm work	80	(31.0)	33	(26.6)	47	(35.1)
Adult riding	22	(8.5)	12	(9.7)	10	(7.5)
Pony club	124	(48.1)	124	(100)	134	(100)
Thoroughbred racing/track work	43	(16.7)	9	(7.3)	34	(25.3)
Farrier/trimmer	15	(5.8)	9	(7.3)	6	(4.5)
Harness racing	11	(4.3)	4	(3.2)	7	(5.2)
Endurance	8	(3.1)	5	(4.0)	3	(2.2)
Driving	9	(3.5)	5	(4.0)	4	(3.0)
Hunting	4	(1.6)	1	(0.8)	3	(2.2)
Equine healthcare (e.g. osteopathy, nutrition, nurse, vet, saddle fitter)	12	(4.7)	4	(3.2)	8	(6.0)
Showing	8	(3.1)	4	(3.2)	4	(3.0)
Western/rodeo	6	(2.3)	0	(0)	6	(4.5)
Other (e.g. breaking in/training, barrel racing, mounted games, para dressage, polo, show	7	(2.7)	2	(1.6)	5	(3.7)

hunter)						
Personal concussion history						
None	57	(22.1)	27	(21.8)	30	(22.4)
One or more	167	(64.7)	79	(63.7)	86	(64.2)
Don't know	27	(10.5)	15	(12.1)	12	(9.0)
Missing	7	(2.7)	1	(0.8)	6	(4.5)
Primary reason for engaging in equestrian activities						
Recreational	188	(72.9)	102	(82.3)	86	(64.2)
Professional	70	(27.1)	22	(17.7)	48	(35.8)
Have you ever received information about concussion from any of the following? (tick as many as apply)	97	(37.6)	54	(43.5)	43	(32.1)
Trainer/coach/instructor	127	(49.2)	54	(43.5)	73	(54.5)
National accident compensation provider (ACC)	129	(50.0)	69	(55.6)	60	(44.8)
Equestrian Organisation (e.g. pony club, or equestrian sports NZ)	151	(58.5)	73	(58.9)	78	(58.2)
School/work/university	172	(66.7)	91	(73.4)	81	(60.4)
Other riders	193	(74.8)	88	(71.0)	105	(78.4)
Doctor/physiotherapists or other health professional	173	(67.1)	82	(66.1)	91	(67.9)
TV or social media	210	(81.4)	102	(82.3)	108	(80.6)
Friends or family	255	(98.8)	123	(99.2)	132	(98.5)
Other (e.g. advertising/posters, first aid courses, through other sports, horse related magazines, personal experience						

4.3 Knowledge of concussion

Concussion knowledge data is outlined in Table 3. Overall the participant sample had a good knowledge of concussion symptoms, management and recovery. Over 94% of the sample correctly recognising the five most common concussion symptoms (confusion, headache, amnesia, loss of consciousness and blurred vision). Symptoms such as insomnia and nausea are less well known, only 115 (44.6%) correctly identified insomnia as a symptom. Symptoms that were presented as distractors (false positives) and not associated with concussion caused a significant amount of confusion. Overall 56 participants (21.7%) incorrectly identified all of the distractor symptoms as concussion symptoms, while numbness in arms and weakness in the neck were the most common (N=110, 42.65%) symptoms incorrectly identified by participants as symptoms of concussion. There was no significant difference between Pony Club and non-Pony Club members in total symptom recognition.

There were 129 participants (26.5%) that incorrectly identified concussion as an injury to the head (rather than brain). Additionally the false positive knowledge question that a direct hit to the head is required to experience concussion, was less well known by 20.2% (N = 52).

Possible complications of multiple concussions or returning to riding too soon after concussion were well recognised within the sample, however only 107 (41.4%) of participants knew the correct length of time to wait after a concussion before riding. Concussion management is also less well known within the sample. Approximately a third of participants (N=87, 33.6%) did not know that screens including TV, computers and mobile phones should be avoided after a concussion. While returning to riding was correctly identified as an activity to be avoided for concussion management, other activities such as returning to school (including homework) and paid work are less well known, with only 162 participants correctly identifying this concussion management strategy. No significant difference between Pony Club and non-Pony Club members was found for concussion knowledge.

Table 3. *Knowledge of concussion*

Knowledge Items	Total % Correct N=		Pony Club Members N=		Non-Pony Club Participant N=		Test of difference Mann Whitney U
Please indicate which of the following you would consider to be a sign or symptom of concussion (please check all that apply)							
Confusion (true)	247	(95.7)	118	(95.2)	129	(96.3)	
Headache (true)	254	(98.4)	121	(97.6)	133	(99.3)	
Amnesia (true)	248	(96.1)	120	(96.8)	128	(95.5)	
Loss of consciousness (true)	243	(94.2)	116	(93.5)	127	(94.8)	
Blurred vision (true)	245	(95.0)	119	(96.0)	126	(94.0)	
Dizziness (true)	253	(98.1)	121	(97.6)	132	(98.5)	
Nausea (true)	223	(86.4)	111	(89.5)	112	(83.6)	
Insomnia/trouble sleeping (true)	115	(44.6)	56	(45.2)	59	(44.0)	
Bleeding from the ear (false)	192	(74.4)	85	(68.5)	107	(79.9)	
Numbness of tingling in the arms (false)	153	(59.3)	71	(57.3)	82	(61.2)	
Sharp burning pain in neck (false)	178	(69.0)	83	(66.9)	95	(70.9)	
Weakness in neck movements (false)	143	(55.4)	66	(53.2)	77	(57.5)	
Black eye (false)	226	(87.6)	110	(88.7)	116	(86.6)	
Fever (false)	224	(86.8)	105	(84.7)	119	(88.8)	
Joint stiffness (false)	234	(90.7)	112	(90.3)	122	(91.0)	
Skin rash (false)	256	(99.2)	122	(98.4)	134	(100.0)	
Total symptom recognition score 1-16							U = 8.820 P = 0.38

Knowledge Items	Total % Correct N=		Pony Club Members N=		Non-Pony Club Participant N=		Test of difference Mann Whitney U
Which of the following people would you say might be concussed?							
A couple of hours after a fall, the person complains of feeling sick with a headache (hasn't been drinking alcohol)	235	(91.1)	111	(89.5)	124	(92.5)	
After a fall, the person complains of headaches and has blurred vision	239	(92.6)	114	(91.9)	125	(93.3)	
After a fall, the person starts to make mistakes and seems confused	220	(85.3)	101	(81.5)	119	(88.8)	
After a fall, the person is left on the ground not moving	196	(76.0)	97	(78.2)	99	(73.9)	
After a fall, the person complains of stinging or burning in the calf muscles (false)	249	(96.5)	121	(97.6)	128	(95.5)	
Total situation recognition score 1-5							U = 8.408 P = 0.85

Knowledge Items	Total % Correct N=		Pony Club Members N=		Non-Pony Club Participant N=		Test of difference Mann Whitney U
Complete the sentence. Concussion is an injury to the…							
Brain (correct answer)	181	(70.3)	91	(73.3)	90	(66.8)	
Head (less specific answer)	75	(29.1)	33	(26.6)	42	(31.3)	
Other (terminology confusion with horse leg injury)	2	(0.8)	0		2	(1.4)	
A concussion only occurs if you lose consciousness (False)	250	(96.9)	119	(96.0)	131	(97.8)	
Symptoms of concussion can occur several hours or days later (true)	255	(98.8)	121	(97.6)	134	(100.0)	
You need to directly hit your head to experience a concussion? (False)	206	(79.8)	96	(77.4)	110	(82.1)	
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)	107	(41.4)	62	(50.0)	68	(50.8)	
Number that didn't know	14	(5.4)	21	(16.9)	17	(12.7)	

Knowledge Items	Total % Correct N=	Pony Club Members N=	Non-Pony Club Participant N=	Test of difference Mann Whitney U
Of the following what are the possible complications of experiencing multiple (more than one) concussions? (tick all that apply)				
Increased symptoms or delayed recovery (true)	238 (92.2)	114 (91.9)	124 (92.5)	
Increased risk of further injury (true)	215 (83.3)	108 (87.1)	107 (79.9)	
Joint problems (false)	249 (96.5)	117 (94.4)	132 (98.5)	
Paralysis (false)	164 (63.6)	80 (64.5)	84 (62.7)	
Of the following, what are the possible complications of returning to riding/driving or working with horses too soon?				
Increased symptoms or delayed recovery (true)	218 (84.5)	104 (83.9)	114 (85.1)	
Increased risk of further injury (true)	239 (92.6)	115 (92.7)	124 (92.5)	
Joint problems (false)	241 (93.4)	112 (90.3)	129 (96.3)	
Reduced sports performance (true)	195 (75.6)	97 (78.2)	98 (73.1)	
If someone has suffered a concussion who is the best person to decide if they should ride/drive/work with horses again?				
Doctor	244 (94.6)	118 (95.2)	126 (94.0)	

Knowledge Items	Total % Correct N=		Pony Club Members N=		Non-Pony Club Participant N=		Test of difference Mann Whitney U
Which of the following activities should be avoided following a concussion? (tick all that apply)							
Texting or using a mobile phone	169	(65.5)	83	(66.9)	86	(64.2)	
Using a computer	175	(67.8)	87	(70.2)	88	(65.7)	
Watching TV	170	(65.9)	87	(70.2)	83	(61.0)	
Going for a long walk	109	(42.2)	54	(43.5)	55	(41.0)	
Jogging/running	214	(82.9)	106	(85.5)	108	(80.6)	
Gym training	226	(87.6)	111	(89.5)	115	(85.8)	
School/work	162	(62.8)	82	(66.1)	80	(59.7)	
Going to sleep	89	(34.5)	39	(31.5)	50	(37.3)	
Riding/driving or handling horses	245	(95.0)	116	(93.5)	129	(96.3)	
What does wearing a helmet do?							
Reduces risk of cuts, bruises and grazes (true)	93	(36.0)	42	(33.9)	51	(38.1)	
Reduces risk of concussion (false)	31	(12.0)	9	(7.3)	22	(16.4)	
Reduces risk of skull fracture (true)	244	(94.6)	119	(96.0)	125	(93.3)	
Absorbs impact from a fall (true)	234	(90.7)	114	(91.9)	120	(89.6)	
Total concussion knowledge score							U = 7.671 P = 0.34

4.4 Attitude and behaviour towards concussion

Responses to the attitudes and behaviour items are shown in Table 4. The results highlight the majority of the sample (92.6%) agreed that a concussion should be reported to a medical professional (doctor). Additionally, 94.6% of the sample agreed that a doctor would be the best person to decide when they should return to riding, school or work. However despite the high rate of agreement within the participants to seek medical advice before returning to ride, the behaviour shown by the sample is somewhat different. Just over 50% of participants would wait three weeks or more or until symptoms have gone away before riding again. This percentage aligns with the percentage of participants that displayed knowledge of the how long to wait before riding (as indicated in Table 2, 41.4%), rather than the 94.6% that stated they would consult a doctor prior to riding. There was no significant difference between Pony Club and non-Pony Club members.

Further discrepancy between attitude and behaviour is observed with helmet use and replacement. While a large proportion (81%) of the sample agreed that a helmet should be replaced after a fall, only 37 participants, less than a quarter, actually did so. Again, there was no statistical difference between Pony Club and non-Pony Club members for helmet replacement. Helmet use in general was somewhat varied. Over 90% of the sample said they wear a helmet for riding activities such as hacking, schooling and competing. The percentage of participants that wear a helmet for other activities such as groundwork (25.2%), lunging (27.1%) and teaching or coaching (3.9%) was much lower. Only 17.1% of participants that drive horses said they wear a helmet, additionally helmet wearing while picking out horses' hooves is very low (6.2%). The helmet wearing figures showed fairly similar distribution between all participants and between Pony Club and non-Pony Club members.

Further guidance on choosing which helmet to buy was indicated by the majority of the participants that wrote additional comments in the open field section at the end of the questionnaire. Participants wanted to know more about safety testing and helmet standards alongside which helmets were best for different types of equestrian activities.

Table 4. *Attitude and behaviour towards concussion*

Attitude Items. To what extent do you agree with the following statements?	Total, N (%)	Pony Club	Non-Pony Club	Test of difference
It is important to report a possible concussion to a medical professional				
Strongly agree or agree	239 (92.6)	117 (94.4)	122 (91.0)	
Not Sure or disagree	19 (7.4)	7 (5.6)	12 (8.9)	
				χ^2 = 1.03 p = 0.31
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 or agree	209 (81.0)	102 (82.3)	107 (79.8)	
Not sure, Disagree or strongly disagree (and missing data)	42 (16.3)	21 (16.9)	27 (20.2)	
				χ^2 = 0.40 p = 0.53
Behaviour Items				
Have you ever continued to use the same helmet after a hit to the head?				
The number that answered yes	172 (66.7)	81 (65.3)	91 (67.9)	
				χ^2 = 0.19 p = 0.66
How long would you wait before riding/driving or working with horses after a concussion? (correct is 3 weeks or when symptoms have resolved)				
Straight away, between 1 and 2 weeks or 4 weeks and more (and missing data)	128 (49.6)	76 (61.2)	75 (56.0)	
3 weeks or when the symptoms have resolved (gone away)	130 (50.4)	48 (38.7)	59 (44.0)	
				χ^2 = 0.75 p = 0.39

Chapter 5: Discussion

This thesis aimed to investigate, what youth and young adults (16-21) engaged in equestrian sports within NZ, know and understand about concussion.

5.1 Prevalence of concussion

The data from the survey highlights that the majority of participants (65%) had experienced of least one concussion in their lifetime, which suggests that the incidence of concussion within this 16-21 year old group, is actually higher than that currently documented by ACC or found in previous research (Theadom et al., 2014). There may be several reasons for this finding: firstly that the prevalence of concussion within the 16-21 cohort is increasing as predicted (Feigin et al., 2013), secondly, that the data captured is a more realistic reflection of the total number of concussions experienced within the cohort or thirdly, this may have reflected that those with a history of concussion, may have been more likely to participate in the survey.

As Tagliaferri et al (2006) point out, prevalence data should be used with caution. It is not clear from the data whether all concussions reported were sustained within equestrian activities alone or in combination with other sporting activities. It is also not clear which type and level of equestrian activity participants were engaged in while they sustained a concussion, and whether some activities prompted concussion disclosure more than others, based on the values and social culture held within the discipline (Kerr et al., 2014; Register-Mihalik et al., 2018). Additionally, given this data was based on self-report rather than medical records there may be a risk of over or under reporting. Some knowledge and awareness gaps were found within the age cohort, and a small number of participants indicated they did not know whether they had experienced a concussion or not. Consequently, it is not conclusive whether the number of concussions reported by the participants is a true reflection of the actual number experienced. This factor has previously been suggested to influence reporting and therefore prevalence data (Register-Mihalik, Linnan et al., 2013). What is evident from this current study is that the prevalence of concussion, as self-reported within youth and younger adults in NZ is concerning. Particularly given the long-term risks and complications associated within the age group at a critical developmental stage of their brains (Peterson et al., 2013; Taylor et al., 2010).

5.2 Knowledge of concussion

The participants overall displayed good knowledge of concussion symptoms, particularly the most common signs including confusion, memory loss and headache.

This is promising for self-awareness and early detection of concussion within this cohort, particularly as symptom identification has been previously highlighted within the research as problematic in several sports (Patricios et al., 2018).

Symptoms of concussion such as sleep problems and nausea were less well known within the cohort. Additionally, just over half of the participants understood concussion to be an injury to the brain, or that concussion can occur without direct impact to the head. Previous research has highlighted the importance of concussion evaluation after either direct or indirect impact to the brain, particularly within community sports where there is less likely to be trained medical staff and/or coaches and trainers available to initiate concussion evaluation (Patricios et al., 2018). This is particularly relevant for participation in community or recreational equine activities in NZ, where it is important that riders become aware and can remove themselves from participation and seek medical evaluation. Deficits in understanding concussion symptoms and not seeking medical treatment could potentially be problematic for both psychological and physical recovery both in the short and long term. This could lead to a delayed recovery or complications, particularly the emotional, behavioural and cognitive effects associated within this age group (Peterson et al., 2013; Taylor et al., 2010). It is therefore imperative that young adults and youth engaged in equestrian activities have further education to highlight the full complexity of how concussion can occur and associated concussion symptoms, so that they are able to detect concussion early on and follow the recommended removal, rest and recovery procedures to optimise recovery from injury.

5.3 Knowledge of helmet use

Data on helmet use in previous research has been varied. Weber et al. (2017) were not able to publish results due to limited documentation of helmet use, while research by Theadom et al. (2019) highlighted that within their data only 13% of participants understood the correct use of a helmet (Theadom et al., 2019).Participants within this research displayed a better understanding of the reasons for wearing a helmet during equestrian activities and when a helmet should be replaced. More than three quarters of the participants understood that wearing a helmet does not prevent concussion but is primarily worn to absorb impact and prevent skull fracture, cuts and grazes. This is interesting given that the data suggests there is confusion about concussion being an injury to the brain and that it can occur without direct impact. Perhaps the tagging of helmets in equestrian competition alongside the increased awareness of helmet use in general within other sports is starting to have an effect on youth understanding of helmet use. Havlik (2010) suggest this could be the case and that helmet wearing and

use is becoming more common, particularly in situations where equestrian organisations are present. Consideration too of the prevalence of concussion within this cohort may also explain increased understanding of helmet use given concussion experience is high. However, as Hecimovich et al (2016) highlight, concussion history alone has not been previously shown to increase knowledge.

5.4 Knowledge of Concussion management

5.4.1 Returning to ride

Returning to riding too early after a concussion was correctly identified by a large percentage (95%) of the participants as an activity to be avoided for concussion management. However, the time frame for standing down from riding was poorly understood, with approximately 35% of participants suggesting up to one week as an appropriate recovery time frame for concussion. Additionally, there was considerable diversity in the timeframe suggested by participants to return to riding. This may reflect the different messages regarding return to sport guidelines (and associated symptom recovery) available for youth and adolescents, particularly those involved in equestrian competition or that play other sports where they are exposed to disparate sets of return to play guidelines.

In addition to the NZ National Concussion Guidelines, that are based on the Consensus Statement and the ACC concussion rest, recover and return guidelines (Sports Concussion in New Zealand: ACC., 2015) available for youth participating in a variety of sports within NZ, there is also a card system in place for competitive equestrian riders that outlines time frames before returning to ride. A blue card system operates for adults and youth involved in competitive events organised by ESNZ, that removes a rider from competition for the remainder of the event and until medical clearance. A green card system operates under the NZPCA organised events, which restricts riders from participating for 21 days, at which point they require medical clearance to return to ride. While all of the concussion guidelines available in NZ are based on CISG recommendations, there is no consistency regarding associated symptom recovery or return to riding time frames within the equestrian sports between adults and youth or the sports collectively in NZ. Research highlights that when rules are viewed as prohibitive, non-reporting of a concussion is a risk (Kerr et al., 2014). This is particularly salient to those involved in equestrian activities in a rural non-competitive or professional capacity, where potential time loss from working would cause significant financial strain. Providing a unified and clear set of guidelines, based on the current research surrounding return to play, across all sports for concussion in youth and young adults in NZ is required.

5.4.2 Returning to school

Concussion management of activities such as returning to school (including the activities such as reading, homework, use of a computer), are also less well known and understood within youth and young adults in NZ. Concussion management strategies such as using a mobile phone or computer were also poorly understood. A little over half of participants were aware that texting, watching TV or playing computer games would add additional cognitive load to the recovering brain. These findings suggest the effects of concussion on academic performance and the requisite need for cognitive recovery have not been clearly translated or well understood within this cohort. Research highlights that overloading the brain after concussion, through mental exertion, can cause additional neurometabolic demand that can aggravate concussion symptoms and delay recovery, something that avoiding sport participation by rest alone cannot improve (McLeod, 2010).

The lack of understanding surrounding cognitive load on returning to school after concussion has been highlighted in previous research conducted within different sports (Reid et al., 2018). Given the current drive by organisations in NZ promoting concussion awareness, this finding is particularly concerning. Further emphasis by schools and sports clubs, in the context relevant situation, outlining the impact of concussion on cognitive demand and social cognition is warranted. Additionally, graduated return to school or cognitive activities needs to be assimilated into a unified set of concussion guidelines for this cohort.

5.5 Attitude and behaviour towards concussion

An athletes' ability to understand and recognise their own symptoms and then behave accordingly, is a key factor in concussion management (Nanos et al., 2017). Despite the current data suggesting the participants have a good overall knowledge and understand signs and symptoms of concussion, helmet use and replacement and return to riding guidelines, they report somewhat contrasting behaviours. Research highlights that attitude has been highlighted as having a significant impact on reporting intention and observed behaviour (Register-Mihalik, Linnan et al., 2013). Additionally, simply trying to 'get a message across' through education, either from an expert or via the media, has not been shown to be effective at changing health related behaviour (Kelly & Barker, 2016).

Evidence suggests that the Theory of Reasoned Action and Planned Behaviour (TRA/TRB) can help define the relationship between attitude and behaviour (Register-Mihalik, Linnan et al., 2013). Additionally, the theory explains why focusing on the

attitude towards a behaviour is more beneficial than focusing on the behavioural outcome required (Register-Mihalik, Linnan et al., 2013). Psychosocial determinants such as personal experience, social pressure and social norms have been suggested as having a huge impact on attitude (Register-Mihalik, Linnan et al., 2013). It is not surprising that the culture and the social referents within which youth and young adults are involved have such a strong influence on the relationship between attitude and behaviour, given that team mates, coaches and all those involved in their participation provide much of the support required for perceived behavioural control (Register-Mihalik, Linnan et al., 2013). This is something that Register-Mihalik, Linnan et al (2013) believe is an important factor in relation to the emotion surrounding concussion reporting. Further, research has reported that if an individual has the intention (a reflection of knowledge) to behave in a certain way, they are more likely to follow through with the behaviour (Register-Mihalik, Linnan et al., 2013). The TRA/TRB research suggests that education programmes that target the socioecological framework of this age group and influence multiple layers in their complex social network, are more likely to impact attitude and subsequent behaviour (Register-Mihalik, Linnan et al., 2013).

More recently however, research suggests there is still limited success changing health related behaviours based on the TRA/TRB theory and cite the role of emotions and beliefs as factors affecting intention and attitude (Sniehotta, Presseau, & Araujo-Soares, 2014). Further, authors Sniehotta et al (2014) argue that self-determination and self-regulation measures also predict behaviour, as well as complex psychosocial factors such as health and socio-economic status. Additionally, research into other health behaviour such as smoking and alcohol consumption, highlight the need to look at preceding conditions (such as patterns and practices) that influence the behaviour to unravel the cause of the behaviour (Kelly & Barker, 2016). Research suggests using a regressive inference approach within the context of the sport to understand the attitude and behaviour towards concussion, rather than trying to predict future behaviours (Kelly & Barker, 2016).

What is evident is that giving people concussion education and assuming they will take it on board, and act rationally, is unlikely to influence a change in their behaviour (Kelly & Barker, 2016). Unfortunately, current ACC concussion management guidelines within NZ follow this rationale. The health related behaviours of individuals and the social environments in which they live have been highlighted as a pivotal factor in health epidemics, it is therefore crucial to include the social context of the individual in order to change the related behaviour (Kelly & Baker, 2016). Research suggests that while intention, perceived control and attitude are important to consider in behaviour change,

incorporating a broader approach to behaviour change that includes theories such as self-regulation and goal setting, would benefit those designing and delivering health education messages but also those receiving it (Sniehotta et al., 2014). The authors point out that making small changes to behavioural options, in terms of self-regulation and motivation, avoids cognitive assumptions and are more likely to influence behaviour (Sniehotta et al., 2014).

5.6 Concussion education

Concussion education is pivotal to effective management, given that early detection of concussion is a key in recovery and reduction of longer-term complications (McCrory et al., 2018). Concussion education is particularly relevant for recreational and community sport, where it is less likely that trained medical professionals are present on the side-line to initiate evaluation (Patricios et al., 2018).

In this research, knowledge and information about concussion was primarily sourced for over 95% of the participants from advertising materials alongside personal experience. The data suggests that only a half of the participants obtained education and information about concussion from their coaches/trainers or official organisations such as ACC. This is concerning given the influence of social referents within the age group, the knowledge gaps that exist and some of the current behaviours reported. Additionally, the considerable investment in concussion programmes by ACC does not appear to be targeting the youth and young adult cohort. Previous research highlighted that the majority of concussion education comes from schools (Reid et al., 2018). However, the research was primarily centred around secondary school team sports (such as rugby and basketball), whereas equestrian sports are unlikely to have the same attention or resources within NZ schools. What is apparent is that providing a unified and clear set of concussion education and guidelines across all sports for youth and young adults in NZ is needed.

Further education on helmet use, specific for equestrian sports is also required, given their unique role in comparison to other sports requiring helmet use (McIntosh et al., 2011). The current data suggests that although equestrian organisations are enforcing helmet use in competitive settings, youth and young adolescents (and their families) require further knowledge on helmet use in the form of their design, tolerance and consequences of impact, within the context of their equestrian sport (Havlik, 2010). Further guidance on choosing which helmet to buy was indicated by participants, in the open field for additional comments at the end of the questionnaire. Participants wanted to know more about safety testing and standards and which helmets were best for different types of activities.

5.7 Concussion education going forward

The CISG highlight that knowledge transfer is a valuable part of concussion education and should include an interactive, multi-directional communication process that is ongoing rather than occurring at just one time point (Provvidenza et al., 2013). Kelly and Barker (2016) concur that a multiple layer approach akin to other health behaviour change programmes is required and that a good starting point for education is within the micro-social structures of youth and young adolescents within their relative institutions. Additionally, research suggests that creating an environment within schools that promotes positive concussion awareness and behaviours could be the most effective at changing behaviours (Register-Mihalik, Linnan et al., 2013). For this reason, schools seem the most appropriate centre to further educate the youth age group, although difficulties may occur when integrating theory based education into an already overburdened school environment (Kelly & Baker, 2016). Research suggests the use of social media and online education tools such as video games in addition to an interactive education process, may be highly effective (Provvidenza et al., 2013). An updated collaborative approach is required in the area of knowledge translation and concussion education if we want to see a change in concussion behaviour not only in equestrian sports but across all sports within NZ.

5.8 Strengths and limitations

It is difficult to make generalizations about the findings on concussion knowledge, attitude and behaviour to the wider equestrian population, based on the participant sample. There is a risk that those who are not linked to riding organisations may have been less likely to see the study advertisements. Additionally, the small sample size prevented exploration of any potential gender differences in concussion knowledge. Although females represent a higher proportion of participation within the age group (Weber et al., 2017), inclusion of more male participants would provide some useful gender comparison data. Including a wider age range (<16) could also provide some useful data for attitude and behaviour in relation to helmet use and replacement and return to ride guidelines. Due to low sample size it was not possible to explore the attitude and behaviour questions in relation to the type of equestrian activity the participant was involved in. This additional data could help to identify knowledge, attitude and behaviour (such as helmet use) within specific equestrian activities. There were limited questions on the nature of diagnosis and severity of the concussion sustained; additional questions within the survey on concussion history and previous management would have provided beneficial data for analysis of concussion history in relation to type of equestrian participation. Further, the current survey provides limited

data on concussion education, additional data would be beneficial for future concussion education and management.

Previous research has highlighted that a poor understanding of emotional symptoms has been found when knowledge about less well-known symptoms are poor, for example, sleep and the effects of concussion on academic performance (Hecimovich et al., 2016). This research did not ask concussion symptom questions on emotional symptoms (such as depressed or anxious mood), something that previous research suggests would also be poorly understood within this cohort. Although the emotional symptoms can be less pervasive than some of the other associated concussion symptoms, misunderstandings about them are problematic for delayed diagnosis (Taylor et al., 2010). Additionally, emotional symptoms are significant for this age cohort given their behavioural and emotional requirements for social functioning and development, which often happen within the school environment (Bellerose et al., 2015). Additionally social and cognitive difficulties can further impact academic adjustment and how they perform within school (Bellerose et al., 2015). Given that previous research has highlighted a general lack of understanding about emotional symptoms after concussion (Knollman-Porter et al., 2018; Reid et al., 2018), alongside the unique developmental and psychological needs of youth and young adults, future research would benefit from including specific emotional symptom knowledge questions.

The use of anonymous reporting within this research is a strength, as this may have enabled participants to be more open about their experience of concussion than previously reported. Factors previously highlighted as impacting reporting behaviours, such as peer or social pressure and acceptance, (Kerr et al., 2014; Register-Mihalik, Linnan et al., 2013) particularly salient within this cohort, may have influenced participants' online answers if responses were not anonymous. The ease of participation in an online survey may well have contributed to the diverse range of equestrian sports that were collated. However, selection bias could be at play with those participating having a particular interest in the research. Additionally, the nature of the research could have invited over reporting, author Levin (2006) highlights that response bias can occur when there is high likelihood that the participant has the outcome characteristic of the survey.

5.9 Future Recommendations

- Create one set of cohesive and clear concussion management guidelines that address all sports within the youth and adolescent age group and outline clear return to play rules.

- Initiate within school education programmes that educate all those involved in youth sport, such as peer groups, parents, coaches and teachers.
- Initiate self-directed student led learning that addresses the social aspects of this age cohort in relation to concussion management strategies.
- Further education and knowledge dissemination is required within equestrian sports on the purpose and use of helmets including helmet replacement after a fall. Helmet construction and technology education (and cost effective options) would be very useful for all those involved in equestrian sports.
- The current ACC Sports Smart guidelines need to be amended so that they ensue it is not implied that concussion can be prevented with the use of a helmet. Additionally, ACC national guidelines on concussion need to include that helmet replacement is necessary after any impact within a sport involving a helmet.

5.10 Conclusion

Sports related TBI is a growing concern for public health. Not only because it is one of the main contexts within which youth and young adults sustain a concussion, but because the incidence and prevalence rates continue to rise despite the current increase in awareness and education programmes available (Knollman-Porter et al., 2018). Within NZ, equestrian sports represent a disproportionately high level of sustained TBI in relation to participation levels, particularly within the younger cohort (Theadom et al., 2014; Zuckerman et al., 2015). Significant gaps in concussion knowledge, awareness and management have been found both globally and within NZ in youth and young adults within a range of sports including equestrian sports (Knollman-porter et al., 2018; Reid et al., 2018; Theadom et al., 2019).

This thesis has found that there are knowledge gaps in concussion education and management. This was particularly an issue for these less well-known concussion symptoms, such as sleep problems. Additionally, managing cognitive load on return to school was poorly understood. This thesis has added to previous literature by highlighting discrepancies between attitude and behaviour with regards to concussion management, particularly in relation to helmet use and timeframes to return to riding.

What is evident is that current concussion education within NZ to youth and young adults is not having the desired effect. Changes need to be made to incorporate a multi layered approach to concussion education that incorporates at the least the social context in which this cohort live. Additionally, NZ could benefit from a unified set of

concussion guidelines across different sports to prevent confusion resulting from different return to play rules and concussion management.

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Appendices

Appendix A: Ethics Approval

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

4 September 2018

Alice Theadom
Faculty of Health and Environmental Sciences

Dear Alice

Re Ethics Application: **18/340 Concussion awareness in equestrian sports**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 4 September 2021.

Non-Standard Conditions of Approval

1. Please ensure that the gender and ethnicity questions are asked according to the NZ Statistics (census) standard.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/research/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/research/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/research/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation, then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries, please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: Patria Hume; duncan.reid@aut.ac.nz

Appendix B: Electronic database search strategy: CINAHL, Medline and Sports Discus via Ebsco host

Search #1

1. (concussion) N5 (aware* OR perception* OR knowledge*)
2. Teen* OR adolesc* OR “young adult*” OR “young person*” OR “youth*” OR “secondary school” OR “College*” OR university
3. 1 AND 2
   (Total articles retrieved: 361)

Search #2

1. Concussion OR “TBI” OR “traumatic brain injur*” OR “acquired brain injur*”
2. Equestrian OR horse*
3. 1 AND 2
   (Total articles retrieved: 200)

Eligibility criteria

The eligibility criteria are defined in terms of the PICOS study characteristics (participants, interventions, comparisons, outcome measures and type of study). The PICOS characteristics assist in defining the systematic search process, in order to reduce bias and provide reproducible and transparent methods for searching (Liberati et al., 2009).

1. Participants

For the purposes of this study looking at concussion awareness in young adults (sub-analysis of the main study which looked at all age groups) data for those aged between 16 and 21 years of age and currently involved in riding, working and driving around horses in New Zealand provided the criteria for search terms.

2. Interventions

   There are no psychological interventions required for the research however, an intervention can be described as something that modifies the outcome. Concussion knowledge, awareness and perception are concepts that modify the outcome and are therefore relevant to the search criteria.

3. Comparator

There is no comparator for the search process.

4. Outcomes

The outcomes can be defined in terms of the experience of having a TBI.

5. Study design

   A mixture of randomised, non-randomised, non-experimental and narrative studies were retrieved from the search for inclusion in the narrative review. Studies were included if their main aim was to evaluate knowledge and awareness of concussion or TBI in youth or young adults (16-21) currently involved in riding, working and driving around horses.

Appendix C: Participant Information Sheet

Participant Information Sheet

Date Information Sheet Produced: 03/08/2018

Project Title: Awareness of Concussion in Equestrian Sports

About the research

My name is Alice Theadom and I am a Researcher at Auckland University of Technology. I carry out research studies looking at concussion. I am working in collaboration with other researchers at AUT and in partnership with the Accident Compensation Corporation, Equestrian Sports New Zealand, New Zealand Pony Club, NZ Racing and Harness Racing New Zealand to find out what people know about concussion. The study aims to help us identify if there are any areas where we can be doing more to ensure people are well advised about concussion in equestrian sports. A postgraduate student (Jules Lough) will be working with us to complete an aspect this research as part of her programme of study in Rehabilitation Psychology.

An Invitation

We would like to invite you to participate in this research study about concussion. Your participation is voluntary. You are free to discontinue your participation at any time without any disadvantage.

The first question will ask you if you have read this information sheet and consent to take part in the study. Answering yes to this question will indicate that you have freely given your consent to participate, and that there has been no coercion or inducement to participate by the researchers from Auckland University of Technology or anyone else.

How was I identified and why am I being invited to participate in this research?

Anyone aged over the age of 16, living in New Zealand, who takes part in an equestrian activity will be invited to take part. This study will be advertised in equestrian related publications/online pages or you may be invited to participate at an equestrian event. Our partner organisations will also invite their members to participate.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice). You will be able to stop completion of the questionnaire at any time. Once the questionnaire has been completed, we will not be able to identify your data in order to delete. However you can withdraw from the study at any time but not completing any further questions and exiting the survey.

What will happen in this research?

All you will need to do is complete a questionnaire, either electronically (online) or using a paper copy. The survey will take about 10 minutes or your time. As a thank you for your time at the end of the survey you will be offered the option of entering into a prize draw to win a prize of up to $250 kindly donated by nz equestrian suppliers.

What are the benefits?

Information gained from this research will help us to better understand people's knowledge of concussion and to identify if there any areas where more can be done to increase knowledge.

What are the costs of participating in this research?

Participating in this research project will not cost you apart from your time that you provide to complete the survey.

How will my privacy be protected?

The survey will be anonymous and we will not ask for your name. You will not be able to be identified in any report from the study. The data collected will be held in secure storage at Auckland University of Technology under the responsibility of the main researcher, in accordance with the New Zealand Privacy Act (1993).

If you would like to be entered into the prize draw you will be asked to provide an email address or mobile phone number so that we can contact you if you have been drawn for a prize. Your email address will be stored separately to your questionnaire data so that we will not be able to link your details with your answers. Your email address will not be used for any other purpose and will be deleted after the prize draw has taken place.

What opportunity do I have to consider this invitation?

The questionnaire will be available to be completed between 5th September and 14th December 2018. You will be able to complete the questionnaire any time within this period.

What will happen with the results of the study

The findings will be made available across all our partners' websites. We will write up the findings for an academic paper for publication and we will present them at conferences and sports education events. You will not be able to be identified in any of these reports. Our student will also write up the findings as part of her research project.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Alice Theadom, alice.theadom@aut.ac.nz, 0212460728*.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz*, 921 9999 ext 6038.

Whom do I contact for further information about this research?

Dr Alice Theadom

Email: alice.theadom@aut.ac.nz

Phone: 09 921 9999 x7805

Mobile: 021 246 0728.

Approved by the Auckland University of Technology Ethics Committee on *04/09/2018*, AUTEC Reference number *18/340*.

Appendix D: Survey

Equestrian awareness

About you

1. Do you consent to take part in this survey?

- ◯ Yes
- ◯ No

2. What is your age in years?

3. What is your gender identity?

- ◯ Male
- ◯ Female
- ◯ Trans male
- ◯ Other (please specify)
- ◯ Trans female
- ◯ Non-binary

4. Which ethnic group do you most associate with?

- ◯ European
- ◯ Maori
- ◯ Pacific Islander
- ◯ Asian
- ◯ Other (please specify)

5. What type of equestrian activities do you regularly take part in? (You may check more than one box)

- [ ] Showjumping
- [ ] Eventing
- [ ] Dressage
- [ ] Endurance
- [ ] Thoroughbred racing
- [ ] Trackwork
- [ ] Harness racing
- [ ] Hacking
- [ ] Pony club
- [ ] Adult riding club
- [ ] Groundwork/handling training
- [ ] Lessons
- [ ] Farm work
- [ ] Driving
- [ ] Farrier or barefoot trimmer
- [ ] Coaching/Training/Instructing
- [ ] Vet
- [ ] Other (please specify)

6. Approximately, how many years have you been around horses? (Excluding any breaks)

7. Approximately, how many hours are you around horses each week (Including riding/driving, grooming, feeding etc...)?

8. Are you around horses mostly for recreational (e.g. leisure) or professional (e.g. to earn money) purposes?

- ◯ Recreational
- ◯ Professional
- ◯ Other (please specify)

9. Do you enter competitions or organised events with horses?

- ◯ Yes
- ◯ No

10. If yes, what is the highest level you have competed/been involved at?

- ◯ Local events/competitions
- ◯ Regional events/competitions
- ◯ National events/competitions
- ◯ Thoroughbred racing
- ◯ Harness Racing

Equestrian awareness

About concussion

11. Have you heard of the term concussion?

- ◯ Yes
- ◯ No
- ◯ Not sure

12. Have you ever received information about concussion from any of the following?

	Yes	No	Not applicable
Trainer/Coach/Instructor	◯	◯	◯
Accident Compensation Provider (ACC)	◯	◯	◯
Equestrian organisation (e.g. Pony Club or Equestrian Sports New Zealand	◯	◯	◯
School/work	◯	◯	◯
Other riders	◯	◯	◯
Doctor, Physiotherapist or other health professional	◯	◯	◯
TV or social media	◯	◯	◯
Friends, family	◯	◯	◯

Other (please specify)

13. Have you ever heard of any "guidelines" on concussion?

- ◯ Yes
- ◯ No
- ◯ Not sure

14. Complete the sentence. Concussion is an injury to the....

15. Please check the box beside the following statements which you would consider to be a sign or symptom of concussion. Please check all that apply

- [ ] Abnormal sense of smell
- [ ] Abnormal sense of taste
- [ ] Amnesia (not remembering what happened before or after the accident)
- [ ] Joint stiffness
- [ ] Blurred vision
- [ ] Black eye
- [ ] Bleeding from the ear
- [ ] Bleeding from the mouth
- [ ] Bleeding from the nose
- [ ] Confusion
- [ ] Fever
- [ ] Dizziness
- [ ] Headache
- [ ] Insomnia (trouble sleeping)
- [ ] Loss of consciousness (being knocked out)
- [ ] Nausea (feeling sick/the need to vomit)
- [ ] Numbness or tingling in the arms
- [ ] Skin rash
- [ ] Sharp burning in the neck
- [ ] Weakness in neck movements

16. Which of the following would you say might be concussed? (You can check more than one box)

- [ ] After a fall, the person starts to make mistakes and seems confused
- [ ] After a fall, the person complains of headaches and has 'blurred vision'
- [ ] After a fall, the person is left on the ground not moving
- [ ] After a fall, the person complains of stinging or burning in their calf muscles
- [ ] A couple of hours after a fall, the person complains of feeling sick, with a headache (hasn't been drinking alcohol)

17. Concussion only occurs if you lose consciousness?

- ◯ True
- ◯ False

18. Symptoms of concussion can occur several hours or days later

- ◯ True
- ◯ False

19. You need to directly hit your head to experience a concussion

- ◯ True
- ◯ False

20. If someone gets concussed how long should they wait before riding/driving or working with horses again?

- ◯ Straight away
- ◯ 1 week
- ◯ 2 weeks
- ◯ 3 weeks
- ◯ 4 weeks
- ◯ When the symptoms have resolved (symptoms have gone away)
- ◯ Don't know

21. How long would **you** wait before riding/driving or working with horses again?

- ◯ Straight away
- ◯ 1 week
- ◯ 2 weeks
- ◯ 3 weeks
- ◯ 4 weeks
- ◯ When the symptoms have resolved (symptoms have gone away)
- ◯ Don't know

22. Of the following, what are the possible complications of experiencing multiple (more than one) concussions? (You may check more than one box)

- ☐ No complications exist
- ☐ Increased symptoms or delayed recovery
- ☐ Increased risk of further injury
- ☐ Joint problems
- ☐ Increased of developing medical conditions (such as diabetes or asthma)
- ☐ Paralysis
- ☐ Don't know

23. Of the following, what are the possible complications of returning to riding/driving or working with horses too soon?

- [ ] No complications exist
- [ ] Increased symptoms or delayed recovery
- [ ] Increased risk of further injury
- [ ] Joint problems
- [ ] Increased risk of developing medical conditions (such as diabetes or asthma)
- [ ] Reduced sports performance
- [ ] Don't know

24. If someone, has suffered a concussion who is the best person to decide if they should ride/drive/work with horses again?

- ◯ The person themselves
- ◯ Coach/Trainer/Instructor
- ◯ Doctor
- ◯ Parents, colleagues, friends
- ◯ Other (please specify)

25. Which of the following activities should be avoided following a concussion? (You may check more than one box)

- [ ] 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

26. To what extent do you agree with the following statement. It is important to report a possible concussion to a medical professional (e.g. doctor or emergency clinic)

- ◯ Strongly Agree
- ◯ Agree
- ◯ Not sure
- ◯ Disagree
- ◯ Strongly disagree

Equestrian awareness

Helmet use and personal experience of concussion

27. What does wearing a helmet prevent? (You may check more than one box)

- ◯ Cuts, bruises and grazes
- ◯ Concussion
- ◯ Neck injury
- ◯ Skull fracture
- ◯ Don't know

28. Do you usually (most of the time) wear a helmet during the following activities?

	Yes	No	Not applicable (don't do this activity)
Leading a horse	◯	◯	◯
Picking out or working around horses feet	◯	◯	◯
Tacking up	◯	◯	◯
Bathing/grooming	◯	◯	◯
Hacking	◯	◯	◯
Schooling	◯	◯	◯
Competing	◯	◯	◯
Groundwork	◯	◯	◯
Lunging	◯	◯	◯
Cleaning paddocks	◯	◯	◯
Teaching/Coaching	◯	◯	◯
Driving horses	◯	◯	◯

29. To what extent do you agree with the following statement?
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
- ☐ Agree
- ☐ Not sure
- ☐ Disagree
- ☐ Strongly disagree

30. Have you ever continued to use a helmet after a hit to the head?

- ◯ Yes
- ◯ No

31. Have you ever been taught to how to fall to reduce risk of injury?

- ◯ Yes
- ◯ No

32. Have you ever had a concussion?

- ◯ Yes
- ◯ No
- ◯ Don't know

33. If yes, how many concussions have you had?

34. Would you like to know more about concussion?

- ◯ Yes
- ◯ No

35. Are there any other comments you would like to make?

Thank you so much for taking the time to complete this survey

36. If you would like to enter the prize draw, please enter your email address or phone number here. You will not be contacted unless you win a prize

Email Address

Phone Number