How Do We Let the Players Play and Keep Them Safe?

The Issue of Problematic Beliefs in the Prevention of Concussion Injury

A thesis submitted to the committee on Graduate Studies in Partial Fulfillment of the Requirements for the Degree of Master of Science in the Faculty of Arts and Science

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Peterborough, Ontario, Canada

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ABSTRACT

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Michael Jorgensen

Athletes’ concussion risk is part of a complex system of personal and contextual factors. This study differentiated athletes based on attitudes and intentions towards protective behaviours. A cross-sectional survey design was used to sample varsity athletes. Three intention response subgroups (indifferent, reactive, and proactive) were identified. The indifferent group (28%) reported little-to-no intent to engage in risk reduction behaviours. These athletes reported lower belief in the efficacy of concussion management behaviours and greater risk acceptance attitudes. The proactive group (32%) reported intent to actively reduce personal concussion risk through engaging in behaviours such as confronting aggressive opponents about the risk they pose to others. The reactive group (40%) only reported intent to engage in concussion management behaviours. Indifferent athletes had the highest likelihood of concussion exposure followed by reactive athletes. The proactive athletes had the lowest likelihood. Concussion programs must address beliefs and intentions towards protective behaviours to improve effectiveness.

Keywords: Concussion, athlete, risk, injury prevention, attitudes, intentions, beliefs, protective behaviour.
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“The dream begins with a teacher who believes in you, who tugs and pushes and leads you to the next plateau, sometimes poking you with a sharp stick called 'truth'.”

- Dan Rather
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<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
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<td>SIS</td>
<td>Second Impact Syndrome</td>
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<td>CTE</td>
<td>Chronic Traumatic Encephalopathy</td>
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<td>TBI</td>
<td>Traumatic Brain Injury</td>
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<td>APOE</td>
<td>Apolipoprotein E gene</td>
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<td>HBM</td>
<td>Health Belief Model</td>
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<td>TPB</td>
<td>Theory of Planned Behaviour</td>
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<td>CSM</td>
<td>Common Sense Model of Illness Representations</td>
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<td>PMT</td>
<td>Protection Motivation Theory</td>
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<tr>
<td>mTBI</td>
<td>Mild Traumatic Brain Injury</td>
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<tr>
<td>PPM</td>
<td>Parallel Process Model</td>
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<td>NCAA</td>
<td>National Collegiate Athletic Association</td>
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<td>Summation of Tests for the Analysis of Risk</td>
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<td>ImPACT</td>
<td>Immediate Post-Concussion Assessment and Cognitive Test</td>
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<td>RTP</td>
<td>Return to Play</td>
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Preface

This thesis was part of a larger research project on concussion injury in sport conducted at Trent University focused on understanding the role of beliefs, attitudes, and emotions towards concussion on how athletes protect themselves and respond to concussion injury. My study focused in on differentiating athletes based on intentions towards protection and management behaviours with a view towards problematic intentions and their underlying attitudes. It begins with a review of the literature on concussion injury in sport, followed by a manuscript reporting on one section of the larger project, and concluding with a brief report on future directions for research.

The first chapter of my thesis contains a review of literature on concussion injury and prevention in sport. This section was divided into five parts covering key areas within the literature that I highlight due to their relevance to my research project and their importance within the field of research on concussion injury prevention. The first part includes a brief introduction to the literature review and provides contextual information on the extent of literature that was covered. I then provide a brief overview of concussion injury in sport covering the nature of concussion injury and how it is experienced. Part two reports on epidemiological data for concussion injury in sports and provides a summary of research on non-modifiable factors that may influence an individual’s concussion risk. The rationale for this section is to provide context for the reader as to the extent to which concussion injury occurs in sport and considerations for player risk. Part three provides an overview of behavioural and social science theories and models that have either been commonly used within injury prevention literature or those that I believe are useful despite the lack of use in the research. The goal of this section is to provide
reader with theoretical context for the constructs reviewed in Part 4. This section also identifies the limited treatment of theory and psychological and social science constructs in concussion research, which is subsequently discussed in the final chapter on directions in concussion research.

Part four includes research exploring the influence of several socio-cognitive factors in regards to behavioural intent and actual behavioural engagement for concussion prevention. The inclusion of this section is to provide a foundation for understanding what is known (and not) empirically about the role of psychological and social science constructs in concussion research. This section highlights the gap between concussion knowledge and actual behavioral engagement and identifies limitations in research on important constructs such as risk that are the focus of the empirical study. The final section of the review outlines research on concussion prevention types (primary and secondary) and strategies to give context to the reader in regards to chapter 3 of this thesis.

The next chapter of my thesis contains a manuscript exploring attitudes and intentions of athletes towards protective behaviours relating to concussion injury. The goal of this chapter is to identify athletes that hold problematic intentions towards these behaviours and differentiate them based on their attitudes towards the behaviours, their exposure to concussion injury, and other demographic variables. In this, I will argue that inaccurate beliefs about concussion prevention may lead to ineffective (and perhaps damaging) behaviours that increases one’s risk for concussion. Through the manuscript, I want to provide insight into the pervasiveness of problematic beliefs in a sample of varsity athletes. This study is novel in the fact that no study to date has explored
concussion beliefs relating to personal risk and protective behaviours or acknowledged groups of athletes that may be at an increased risk due to underlying behavioural tendencies.

The final chapter of my thesis includes a brief report on the current state of concussion prevention research. This report will be informed by the literature review, the findings from the manuscript, as well as the larger study from which this research is part of. The aim of this report is to highlight areas of interest and to make suggestions for future research on the prevention of concussion injury in sport. This is an avenue through which I discuss and contextualize the findings of my research and the research of others in regards to how concussion prevention research should move forward.
Chapter 1.

Review of Literature on Concussion Injury and Prevention in Sport
Part I. Introduction to Concussion Prevention in Sport

Introduction

This chapter is a review of the literature pertaining to the study of concussion injury and prevention in sport. First, a brief overview of concussion injury epidemiology is presented. The review then breaks down into the specific literature relating to concussion prevention and management. The review frames this within the context of research on general health promotion and injury prevention in sport. An overview of theoretical frameworks commonly used within the domain of health psychology is also provided. This chapter includes research exploring the influence of several socio-cognitive factors in regards to behavioural intent and actual behavioural engagement for concussion prevention. The final section of the review outlines research on concussion prevention types (primary and secondary) and strategies.

Scope of the Literature Review

The purpose of this chapter is to provide a review of the current state of literature on concussion injury and prevention. The rationale for article inclusion involved three key characteristics: being published in a peer reviewed journal, contributing to the development of the field of concussion injury and prevention research, and their relevance to this research project (i.e., concussion prevention in sport). Sources were systematically retrieved through the Trent University library database system which included psycINFO, psycARTICLES, Scholars Portal, and PubMed. Due to the novel nature of concussion research, sources were primarily from the last 15 years with the exception of the sources relating to theoretical frameworks used in health and injury
prevention research. A series of keyword searches were conducted to navigate the databases. Examples of keywords include (but are not limited to): concussion, injury prevention, sport, athlete, health psychology, second impact syndrome, head injury, recovery, injury management, attitudes, awareness, beliefs, perceptions, intentions, prevention behaviours, and social norms. Once acceptable articles were identified, I consulted the reference list to identify any relevant or associated sources of literature for use in our review. The synthesis in this report provides theoretical and empirical context for the study elaborated in Chapter 2 and the report elaborated in Chapter 3.

**Overview of Concussion Injury in Sport**

Concussion injury is a serious and prevalent injury, particularly within the context of sport. Sport is second only to motor vehicle crashes as the leading cause of head injury (Gessel et al., 2007). Per the 4th international consensus conference on concussion in sport held in Zurich, November 2012 (McCrory et al., 2013) concussion injury is defined as “a complex pathophysiological process affecting the brain, induced by biomechanical forces” (McCrory et al., 2013). Beyond this simple definition are a series of features that are often associated with concussion injury and utilized in defining the nature of a concussive head injury.

The injury is caused by a biomechanical force, which can be applied either directly to the head, or to another area of the body where the resulting force is then transmitted to the head. Often, the onset of concussion is rapid and short-lived. However, some cases result in a prolonged development of signs, symptoms, and an extended recovery period (McCrory et al., 2013). The severity and duration of symptoms is determined by a combination of many factors including previous concussion injury and
recency. Kontos et al. (2004) explains that the symptoms that manifest may be
determined by which brain region was damaged and the biomechanics of the event of the
injury. The injury itself may result in neuropathological changes. These changes are often
functional (i.e., affecting cognition), rather than structural in nature meaning that no
residual structural changes are evident following recovery (at least with current
diagnostic technology).

Concussion is referred to by the U.S. Centers for Disease Control and Prevention
(CDC) as a "silent epidemic" due to the individual experience of the injury being largely
internalized (McBride, 2012). Specifically, concussion injury consists of a series of
graded clinical symptoms experienced by individuals and often not visibly evident to
others or through imaging techniques (e.g., CT scan). These symptoms can impact one’s
somatic, cognitive, or emotional functioning. Common symptoms include: difficulty with
orientation, headaches, confusion, sleep deficits, mood changes, increased distractibility,
feelings of fatigue, and amnesia (Kontos, Collins, & Russo, 2004). McCrory and
colleagues (2013) note that loss of consciousness is no longer a requirement for a
concussion diagnoses (McCrory et al., 2013). Along with these symptoms come many
social, emotional, and mental consequences as well. These may include depressive
symptoms, anxiety, loss of confidence, or the belief that others regard them negatively
resulting from their injury, to name a few. Consequences such as these can negatively
influence one’s relationships and day-to-day functioning during the recovery period and
beyond (Kontos, Collins, & Russo, 2004). Research suggests that these experiences of
social and personal consequences may be a prohibiting factor in engaging athletes to
properly report and manage the injury (Chrisman, Quitiquit, & Rivara, 2013).
The timeframe for recovery for concussion injury is typically 7-10 days (McCrory et al., 2013). In the case of severe or multiple concussions, fatality may occur. Individuals may also experience long-term debilitation. These extreme cases are often a result of Second Impact Syndrome (SIS) where one receives multiple concussions in a period that did not allow proper recovery of the initial injury. Some research suggests that Chronic Traumatic Encephalopathy (CTE) (a progressive degenerative disease of the brain) may also be caused by multiple concussions, although the evidence remains inconclusive (McCrory et al., 2013).

**Part II. The Epidemiology of Concussion Injury in Sport**

**Incidence**

A recent study reports that between 2009-2010, 94,000 Canadians sustained a concussion or other brain injury, many due to participating in sport (Billette & Janz, 2011). It is estimated that in the U.S., 1.6 to 3.8 million sports-related traumatic brain injuries (TBI) - which includes concussion injuries - occur each year (Langlois, Rutland-Brown, & Wald, 2006). A recent U.S. statistic suggests that an estimated 600 out of every 100,000 individuals over the age of 15 are expected to sustain a concussion injury, many of which as a result of sport participation (Snell, Hay-Smith, Surgenor, & Siegert, 2013). Research by Williamson and Goodman (2006) compared official concussion injury reports to volunteer and player estimates in youth ice hockey and found that official reports of concussion injury (0.25 to 0.61 per 1000 player game hours) were lower than that of volunteers (4.44 to 7.94 per 1000 player game hours) and players (6.65 to 8.32 per
1000 player game hours). However, these estimates may be low owing to issues with injury reporting.

Of those who have suffered a concussion injury, research suggests that roughly 13.2% of reported concussions are recurrent (i.e., not the first concussion that they have sustained) (Castile, Collins, McIlvain, & Comstock, 2012). Castile and colleagues (2012) found that fewer new concussions (0.6%) than recurrent concussions (6.5%) took longer than a month to resolve. It is likely that these numbers increase in populations of higher-level athletes, such as those playing varsity or professionally (McCrory et al., 2013; Billette & Janz, 2011; Langlois, Rutland-Brown, & Wald, 2006; Gessel et al., 2007). An estimated 10% to 15% of all athletes experience persistent cognitive deficits (e.g., memory problems and decision-making impairments) and emotional-regulation difficulties (e.g., irritability and depressive symptoms) a year or more after their concussion (McCrory et al., 2013).

**Non-modifiable Risk Factors**

In health psychology, factors of risk are attributes or characteristics used to explain the likelihood of an individual to develop a disease or injury. In the literature on concussion injury, several in-depth reviews and have been conducted that document this field of research (Abrahams et al., 2014; Scopaz & Hatzenbuehler, 2013; McCrory et al., 2013; Benson et al., 2013). In these reviews, both modifiable (e.g., concussion specific knowledge) and non-modifiable (e.g., age) factors are identified from the literature. The following section will provide a brief overview of the non-modifiable risk factors considered in these articles.
Athletic exposure. Research has explored increased exposure to athletic situations as an influencer of concussion risk. It logically follows that, the more an athlete participates in sports, the greater their risk for concussion injury, and this is well supported in the literature (Williamson & Goodman, 2006; Marar, McIlvain, Fields, & Comstock, 2012). For example, Marar and colleagues (2012) conducted a descriptive epidemiological study to explore the influence of athletic exposure on concussion risk in a sample of 20 sports at various U.S. high schools. They identified an overall injury rate of 2.5 concussions per 10,000 athletic exposures, with significantly higher rates in games than practices. These findings highlight the influence of exposure type on concussion risk (i.e., game versus practice). To further this, Daneshvar, Nowinski, Mckee, and Cantu (2011) discuss the implications of the concussion risk in different types of athletic exposures. They suggest that although the concussion rate is higher in game situations, an effective way to reduce risk may be to limit unnecessary contact in practices. Other research by Lincoln et al. (2011) identified an increasing trend of concussion risk per athletic exposure. Specifically, in a school district in the U.S. sport concussion rates increased from 0.12 per 1000 athletic exposures in the 1997-1998 school year to 0.49 per 1000 athletic exposures in the 2007-2008 school year.

Concussion history. Abrahams and colleagues (2014) reviewed several articles that identified an increase in risk with American football players with a history of previous concussion of three to six times that of athletes with no previous concussion history. Beyond simply increasing one’s risk another concussion, a history of concussion may also increase one’s risk for experiencing a negative outcome in regards to their injury. For example, Castile and colleagues (2012) found greater reports of loss of
consciousness (recurrent, 7.7%; new, 4.4%) and complete medical removal from sports (recurrent, 16.2%; new, 2.9%) in athletes with recurrent, rather than new, concussion injuries. SIS can be a devastating consequence of repeat exposure in a short time (McCrory et al., 2013). Evidence is inconclusive in supporting a causative relationship between concussion injury and CTE (McCrory et al., 2013).

**Sport and position.** The research on the influence of sport and position has given some indication as to its relationship to concussion risk. For example, research by Castile et al. (2012) identified that within their large sample of high school athletes many new and recurrent concussions resulted from contact with another person (73.4% and 77.9%, respectively). It logically follows then that athletes participating in contact or incidental contact sports may be at a greater risk for concussion injury. Although it is difficult to compare sports due to variations in concussion incidence reporting rates, there is conclusive evidence that there is a greater risk for concussion in contact (e.g., boxing) and collision sports (e.g., hockey, football, and rugby) than in non-contact sports (e.g., soccer) (Scopaz & Hatzenbuehler, 2013; Marar, McIlvain, Fields, & Comstock, 2012). This relationship may even be an underestimate given the tendency for athletes to not report concussion symptoms. Research by Delaney and colleagues (2015) identified that athletes who participate in contact sports (specifically football and hockey) were more likely to not report concussion symptoms.

**Age.** The literature offers mixed support for age as a modifier of one’s concussion risk. Although research suggests that young athletes may be at risk of experiencing more severe symptoms and longer recovery times than adults, there is varied evidence showing that younger athletes are at a greater risk of concussion injury altogether (Halstead &
Walter, 2010; Register-Mihalik et al., 2013; Scopaz & Hatzenbuehler, 2013). Based on the systematic review conducted by Abrahams and colleagues (2014), the mixed findings and quality of studies provide insufficient support for the influence of age on concussion risk. Despite these conflicting views, the consensus statement on concussion in sport suggests that special considerations be given for child and adolescent athletes who suffer a concussion (McCrory et al., 2013). Specifically, priority should be given for successful return to school over return to sports, and that a specialized symptom checklist is needed with children under the age of 13 as they express their symptoms differently (McCrory et al., 2013).

Research by Guskiewicz and Valovich McLeod (2011) explains risk in terms of a window of opportunity for recurrent injury where the younger an athlete is when they receive their first concussion, the more likely it is that they will receive another. This is supported by the relationship between one’s concussion history and risk for future injury as well as the fact that younger athletes have higher potential for future athletic exposure compared to those further along in their athletic career. Despite this, there are studies that suggest that older athletes may also be at an increased risk for concussion injury, however, this is often attributed to these athletes participating at a higher level of play with bigger and stronger competition (see section below) (Abrahams et al., 2014).

**Sex.** There is much debate over whether an individual’s sex increases their likelihood of sustaining a concussion injury. Overall, the 23 studies reviewed by Abrahams et al. (2014) offered mixed results and not enough support for sex as a modifier of concussion risk. More specifically, some research suggests that females are at an increased risk for concussion as when the same male and female sports are compared,
females are reported to have a significantly higher injury rate than males (Scopaz & Hatzenbuehler, 2013; Marar et al., 2012; Kutcher & Eckner, 2010). This may be a result of neck strength as well as a greater willingness of females to report the injury (Abrahams et al., 2014; Gessel et al., 2007; Kerr et al., 2015). On the other hand, Bloom et al. (2008) found that males suffered significantly more concussions than females. This research contradicts previous work demonstrating higher concussion rates among females (Covassin et al., 2003; Gessel et al., 2007). Abrahams et al. (2014) identified several studies that found males to be at a greater risk argued that it was due to male athletes being more willing to take risks and to play high collision sports. Gessel et al. (2007) note that although in their study females were found to have a higher concussion risk, sport culture and reporting behaviours may be preventing an accurate representation of concussion among male athletes.

**Genetics.** A recent area of interest within the field of concussion research involves the identification of genetic markers of concussion predisposition and susceptibility for negative outcomes. Although these studies are limited (Abrahams et al., 2014), researchers believe the apolipoprotein E (APOE) gene may be a genetic marker of concussion risk. Out of the three studies identified by Abrahams and colleagues (2014), only one showed an association between this gene and an increase in concussion risk. Scopaz and Hatzenbuehler (2013) also noted the implication of the APOE gene in Alzheimer disease, CTE, and negative outcomes following a TBI. McCrory and colleagues (2013) also conclude that the evidence insufficient to justify the use of genetics in a clinical setting.
**Level of play.** The current literature remains inconclusive on whether the competitive level (e.g., high school, varsity, and semi-professional) at which an athlete competes influences risk for concussion. The review by Abrahams and colleagues (2014) identified six articles that met their criteria, of which there was no consistent or conclusive evidence for playing level as a factor of concussion risk. Gessel and colleagues (2007) observed collegiate athletes to have among the highest concussion rates out of all athletes.

**Part III. Theoretical Foundations: Concussion Prevention Research**

**Introduction**

Theoretical frameworks have been adopted in other health domains to aid researchers and practitioners in identifying, understanding, predicting, and modifying how individuals will behave in given situations. This allows for researchers and practitioners to guide their studies and programs towards behavioural goals or outcomes. The following section will provide an overview of behavioural theories relevant to the context of concussion prevention in sport. The theories reviewed have either been used in the literature on injury prevention (e.g., Theory of Planned Behaviour) or show promise in promoting positive behaviour change in other health domains (e.g., Common Sense Model of Illness Perceptions) (McGlashan & Finch, 2010). These theories focus on one’s beliefs towards health threats and protective behaviours. These theories also share many common features.
Health Belief Model

The Health Belief Model (hereby referred to as HBM) establishes that one’s health related behaviour depends primarily on the value one places on an outcome and one’s belief that a behaviour will achieve it (Janz & Becker, 1984). More specifically, the individual must feel that the negative condition can be avoided, believe that a behaviour will help them avoid it, and that they can successfully engage in the recommended course of action (self-efficacy). This model was originally developed to help “understand the widespread failure of people to accept disease preventatives or screening tests for the early detection of asymptomatic disease” (Rosenstock, 1974). Originally, the HBM consisted of four specific dimensions which, (like the CSM and PMT) relate to one’s perceptions of susceptibility and severity, as well as perceived benefits and barriers to engaging in the behaviours. Cues to action and self-efficacy are two dimensions that have been refined within the HBM over the course of its use in health and behaviour research.

These dimensions, as Rosenstock (1974) claims, establishes the individual with a sort of readiness to act. The HBM differs from other theories on the inclusion of perceived benefits and barriers. Rosenstock (1974) describes these dimensions as providing a preferred path of action. With this set up all that is required to trigger the behaviour is some form of stimulus, or a “cue to action” (Rosenstock, 1974). The HBM refers to the perception of susceptibility domain as one’s subjective feelings of personal vulnerability to a disease, or a concussion injury while participating in sport. The dimension of perceived severity is described as one’s subjective feelings of about how serious the outcomes of the injury are. Key aspects of this include the associated
consequences of the condition that can be either clinical (e.g., long term disability) or social (e.g., reduced social relations) in nature.

One key distinction of the HBM is that it is a terminal model (i.e., ends with the target behaviour) versus a systems approach (i.e., incorporates changing dynamics of cognitions and emotions in predicting behaviour). It works to predict health related behaviours and develop behavioural interventions. To do this, the theory includes the perceived benefit and barrier domains. Perceived benefits (e.g., reduced risk) and barriers (e.g., financial cost of treatment) refer to the positive and negative effects of a behaviour. These dimensions are believed to begin a cost/benefit analysis where positive evaluations increase the likelihood of an individual to act. For example, an individual with strong perceptions of susceptibility and seriousness of concussion injury would only accept the suggested course of action (behaviour) if they perceive it to be net beneficial. However, one of the main criticisms of the HBM model is that it is fails to consider the emotional component of behaviour. Neither does it directly address the immediate social influence of others on health behaviour.

**Theory of Planned Behaviour**

The Theory of Planned Behaviour (TPB) developed by Ajzen (1985), proposes that one’s behaviours are a direct function of their behavioural intentions and that these intentions are a function of that individual’s beliefs. The original purpose of the theory was to predict deliberate behaviour, as Ajzen and Fishbein (1975) proposed that all behaviour was planned and purposeful. However, the theory was updated to include control beliefs to account for the observations of involuntary behaviour. The theory also importantly incorporates social influences on behaviour.
Ajzen (1985) conceptualizes beliefs as three distinct dimensions: behavioural beliefs (attitude towards the behaviour), normative beliefs (subjective norms), and control beliefs (perceived behavioural control). The TPB is commonly used in the development of interventions targeting health-related behaviours. It is considered especially useful in promoting behaviours such as condom use among men who have sex with men (Andrew et al., 2016) and has also been used within the research on concussion prevention in sport (e.g., promotion of reporting behaviours) (Kroshus, Baugh, Daneshvar, & Viswanath, 2014).

The TPB assumes that all intention is a direct antecedent of behaviour, a readiness to act or perform a behaviour. Behavioural beliefs refer to an individual’s attitude toward a behaviour (e.g., will the outcome be positive?). Normative beliefs, or subjective norms, are an individual’s beliefs about how others will view a behaviour (e.g., will others support my behaviour?). Lastly, control beliefs refer to how one perceives their ability to perform the behaviour (e.g., do I have the resources to make this decision?). As such, stronger behavioural intent can be expected the more favourable an attitude and subjective norm, and the greater the perceived control (Ajzen, 1985).

One of the greatest advantages of the TPB is that it links beliefs and behaviours and accounts for involuntary behaviour that previous iterations of the theory did not. Research on condom use is one example where education campaigns (focusing on knowledge gain) fail to promote behaviour change. Other programs that target condom use behaviours using the TPB (attitudes, social norms, and behavioural control) show improvement. For instance, the study by Sheeran and colleagues (1999), exploring risk
factors in relation to HIV prevention behaviours, found a very small effect for knowledge versus attitudes and social norms.

**Common Sense Model of Illness Representations**

The Common-Sense Model of Illness Representation (hereby referred to as CSM) reasons that one’s injury related behaviours are a function of their personal beliefs and attitudes toward it, as it relates to their personal health outcomes (Leventhal, Brissette, & Leventhal, 2003). The CSM is a self-regulatory model (i.e., one that is driven and managed from within the conditions defined by the model) developed by Leventhal et al. (2003) and demonstrates how an individual will give meaning to health-related information and act upon it. The CSM is a refinement of the Parallel Process Model (PPM) which was used to demonstrate how appeals to fear operate within public health campaigns (Leventhal et al., 2003). It involves the parallel processing of threat (danger) and fear (emotion) representations of an injury and a corresponding need to manage each.

The concept of threat perception relates to an individual's perceived self-risk, whereas fear representation involves the negative emotions regarding the health threat. The CSM further defines five domains of threat representations: identity, timeline, consequences, cause, and control. Hagger and Orbell (2003) conducted a meta-analytic review of the CSM and support the use of these domains and the CSM. Each domain is inclusive of both abstract (semantic) and concrete (perceptual or experiential) information that begins to shape the model into one that is self-regulatory (Leventhal et al., 2003). More specifically, as new information is added to these domains, one’s representations of the injury are updated and reflected through an individual engaging in behaviours perceived to address the danger / threat and fear / emotion representations. These
behaviours are then appraised in regards to their efficacy, which either reinforces or deters one from engaging in those behaviours the next time an injury occurs. This self-regulatory system is completed by framing these processes within a self (e.g., personality) and social (e.g., availability of support) context.

Within the context of concussion injury in sport, the CSM is useful over other models for several reasons. One is the inclusion of the social context (Fitzsimons & Finkel, 2010). This is an important addition given the unique nature of the sporting environment, where athletes may have contradictory beliefs or external pressures influencing their decisions toward to positive health outcomes (Kroshus, Garnett, Hawrilenko, Baugh, & Calzo, 2015). The second reason is the fact that it deconstructs conceptual and experience based processes in both cognitive and emotional systems with representations of the injury (Leventhal et al., 2003).

Literature on self-regulation distinguishes the CSM from other theories by noting the emphasis placed by the CSM on content (i.e., the nature of the desired outcome, specificity of threat representation, concrete versus abstract representations) (Leventhal et al., 2003; Fitzsimons & Finkel, 2010). Leventhal et al. (2003) argue that this focus allows for greater utility in studying the self-regulation of health behaviour. The CSM considers response efficacy as part of representations of coping actions (also held at abstract and concrete levels). It is self-regulatory, which other models used in concussion research are not. It is not currently used in the context of concussion prevention, although Snell, Hay-Smith, Surgenor, and Siegert (2013) have used the CSM as a theoretical framework for understanding recovery outcomes following mild Traumatic Brain Injuries (mTBI). The
CSM has been used in the prevention of other health problems such as skin cancer (Cameron, 2008) and diabetes (Paddison, Alpass, & Stephens, 2010).

**Protection Motivation Theory**

Like the CSM, the Protection Motivation Theory (hereby referred to as PMT) was first developed to help better organize and understand fear appeals and has since been expanded “to a more general theory of persuasive communication, with an emphasis on the cognitive processes mediating behavioural change” (Norman, Boer & Seydel, 2005). The premise of PMT is that people protect themselves by engaging in appropriate behaviours due to fear appeal processes. Norman, Boer, and Seydel (2005) note that research on PMT has used the theory as a social cognition model to predict health behaviour. The PMT is like the CSM in so far as it includes perceptions of vulnerability and severity relating to the health problem and suggests that these are initiated by environmental / external and intrapersonal / internal (e.g., personality) sources.

Where the PMT differs is with the inclusion of perceived self-efficacy directly in the model (Norman et al., 2005). Within the context of behaviours relating to the prevention and management of concussion injury in sport, vulnerability perceptions refer to one’s estimates of the chance of suffering the injury, whereas severity perceptions refer to one’s estimates about the seriousness of the injury outcome (Norman et al., 2005). The PMT defines response efficacy as the belief that the recommended behaviour will be effective at removing the threat. With concussion prevention and management this means establishing realistic beliefs about vulnerability and the seriousness of concussion among athletes as well as the value (i.e., effectiveness) of primary (e.g., protective equipment) and secondary (e.g., recognizing symptoms and removal from play) prevention.
behaviours. The inclusion of self-efficacy relates to one’s ability to execute the recommended behaviours successfully (e.g., remove oneself from play after suffering a concussion injury) (Norman et al., 2005).

**Rationale for Theories**

There is concern over the extent to which behavioural and social science theories have been used in the literature (McGlashan & Finch, 2010). McGlashan and Finch (2010) conducted a systematic review of the sport injury prevention literature and classified the acquired articles as to whether they explicitly used a behavioural and social science theory as a key aspect of their research design or not. They found that 11% of the identified articles mentioned use of a theory. Common theories that were identified included the Health Belief Model (HBM) and the Theory of Planned Behaviour (TPB). McGlashan and Finch (2010) highlight a significant gap where other common theories in the behavioural literature were not used (e.g., Common Sense Model of Illness Representations; CSM, and the Protection Motivation Theory; PMT), but argue for their inclusion going forward. The rationale for including these additional theories stems from their shared emphasis on health threat and protective behaviour beliefs and how these constructs operate systematically to influence behaviour.

Others believe that including additional theories is less important than identifying key constructs that might predict behaviour (Weinstein, 1993). Weinstein (1993) compared four common models used in health prevention research and identified that many of the constructs are conceptually similar across each (e.g., self-efficacy). Weinstein (1993) suggested that the focus should not be on finding a superior model, but rather how these models best work in tandem and complement one another. Key
constructs were also identified within the domain of injury prevention in sport. Examples of such include personal (e.g., attitudes, perceptions, perceived behavioural control, knowledge, self-efficacy, and perceived susceptibility / severity), interpersonal (e.g., social norms), and environmental constructs (e.g., community, culture, and environment) (McGlashan & Finch, 2010). Table 1 summarizes theoretical constructs identified in the four models discussed and relates them to concussion injury.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Theories</th>
<th>Application to Concussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expectancy / Expectations</td>
<td>TPB,</td>
<td>“If I wear protective equipment, I will reduce the risk of concussion”</td>
</tr>
<tr>
<td>Subjective Norms</td>
<td>TPB,</td>
<td>“I believe others think I should report concussion symptoms and I value their opinion”</td>
</tr>
<tr>
<td>Efficacy Beliefs</td>
<td>TPB, HBM, PMT</td>
<td>“I am able to remove myself from play when injured”</td>
</tr>
<tr>
<td>- Self-efficacy</td>
<td></td>
<td>“Removing myself from play will prevent further injury”</td>
</tr>
<tr>
<td>- Response efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Beliefs</td>
<td>CSM, TPB, PMT</td>
<td>“I can easily report concussion symptoms to my coaches”</td>
</tr>
<tr>
<td>- Perceived behavioural</td>
<td></td>
<td>“I can deal with my concussion symptoms by removing myself from play”</td>
</tr>
<tr>
<td>control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Coping control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk Perceptions</td>
<td>CSM, HBM, PMT</td>
<td>“The effects of a concussion can last for a long time”</td>
</tr>
<tr>
<td>- Danger / Threat</td>
<td>PMT</td>
<td>“I worry about sustaining a concussion”</td>
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<tr>
<td>- Emotional / Fear</td>
<td></td>
<td></td>
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<tr>
<td>Susceptibility / Severity</td>
<td>HBM, PMT, CSM</td>
<td>“Playing sports increases my chance for receiving a concussion”</td>
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<td></td>
<td></td>
<td>“Concussion is a serious injury”</td>
</tr>
<tr>
<td>Appraisal of outcomes</td>
<td>CSM</td>
<td>“My behaviour was successful in reducing my concussion risk”</td>
</tr>
<tr>
<td>Social Context</td>
<td>CSM</td>
<td>“Others would see me as weak if I was to suffer a concussion”</td>
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<tr>
<td>Self-Context</td>
<td>PMT, CSM</td>
<td>“My competitive nature increases my risk for concussion injury”</td>
</tr>
<tr>
<td>Cues to action</td>
<td>HBM</td>
<td>“The protocol says I can't take contact until I can practice full intensity.”</td>
</tr>
<tr>
<td>Benefits / Barriers</td>
<td>HBM</td>
<td>“If I tell my coach about my symptoms he/she will help me recover quicker”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“If I tell my coach about my symptoms I won’t be able to play in the big game”</td>
</tr>
<tr>
<td>Intention</td>
<td>TPB, PMT</td>
<td>“I would confront aggressive opponents about the risk they pose to others”</td>
</tr>
</tbody>
</table>


What is notable about the breakdown of these models is that there is significant overlap between the constructs. Each construct appears to have distinct theoretical relevance, yet there are similarities (e.g., expectations / expectancies and response efficacy). Some of these constructs may apply more readily to certain situations over others. For example, constructs within the TPB may be more useful in regards to the reporting behaviours of athletes. Therefore, it may be valuable to examine these constructs within specific behavioural contexts. Empirical research examining these constructs is reviewed in the next section.
Part IV: Review of Socio-Cognitive Factors Influencing Concussion

Introduction

The following section provides a review of research relating common theoretical factors to actual behaviours. In the context of concussion injury in sports, many of these studies explore management behaviours. Specifically, the focus on is on concussion reporting and engagement in proper return-to-play behaviours. Other prevention and management behaviours, such as risk avoidance or confronting aggressive players, are not considered by the current literature. This is an important consideration for the following section, as it highlights the gaps that remain in regards to research on concussion prevention in sport.

Intentions

A primary concept within many theories of behaviour change is intention. Theoretical frameworks such as the TPB argue the intention dimension as a direct antecedent of behaviour. Within the context of concussion prevention and management, there is evidence for the relationship between intention and reporting behaviours (Kroshus, Baugh, Daneshvar, Nowinski, & Cantu, 2015; Kroshus, Baugh, Daneshvar, & Viswanath, 2014). Kroshus and colleagues (2014) found significant bivariate relationships between reporting intention and reporting behaviours in a sample of 256 American Junior ‘A’, male hockey players. Intent to report also significantly predicted concussion reporting behaviours based on the researchers proposed model (Kroshus et al., 2014).
More recent research by Kroshus et al. (2015) explored the predictive ability of preseason concussion knowledge and reporting intention on concussion reporting behaviours during the season with a sample of 116 male National Collegiate Athletic Association (NCAA) hockey players. The results identified a significant relationship between an athlete’s intention to report concussion symptoms and reporting behaviours during the season. More specifically, athletes reporting greater intentions and experienced concussion symptoms following a head impact were more likely to report symptoms than athletes with lower intentions. However, within their model, the predictive effect of intention on reporting behaviour was reportedly low. Earlier research by Register-Mihalik et al. (2013) also used the TPB to predict concussion reporting behaviours with a sample of 167 high school athletes. However, they found that intentions did not predict self-declared reporting of concussion or bell-ringer incidents. Register-Mihalik et al. (2013) reasoned that this may be due to previously formed intentions not holding during instances where decisions need to be made quickly, such as a game. In these instances, concussion-related behaviours may be reactionary and bypass deliberate action.

Knowledge

A key factor in concussion prevention and management is making sure that the target demographic is knowledgeable about the severity and susceptibility of the injury, as well as the associated signs and symptoms. This allows them to identify the signs and symptoms and engage in the proper management behaviours. It is believed that concussion knowledge in the sporting community has improved, but experts emphasize how educational efforts still need to focus on identifying concussion injuries, and dispelling misconceptions (e.g., the belief that “bell ringers” are not concussions) (Tator,
Taylor and Sanner (2015) conducted a systematic review of the literature on the influence of concussion knowledge on reporting behaviours and concludes that the support varies based on the study (Bramley, Patrick, Lehman, & Silvis, 2012; Register-Mihalik et al., 2013; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Anderson et al., 2015; Kurowski, Pomerantz, Schaiper, & Gittelman, 2014; Kroshus et al., 2015; Kroshus, Kubansky, Goldman, & Austin, 2015). For example, research by Bramley, Patrick, Lehman, and Silvis (2012) calculated the likelihood that 60 high school soccer players would report a concussion injury and examined differences based on whether the athletes had received concussion education or not. The results demonstrate a significant association between having received concussion education and reporting a concussion to a coach.

In contrast, research by Register-Mihalik and colleagues (2013) identified a limited influence of knowledge on behaviour. More specifically, they explored relationships between concussion knowledge and attitudes towards concussion injury, education, and reporting in a sample of 167 U.S. high school athletes. The results show that knowledge was only found to influence recalled “bell-ringer” events and reporting behaviours during practices. Similarly, Kroshus and colleagues (2014) explored the relationship between knowledge and TPB constructs in a sample of 256 American Junior ‘A’, male hockey players. A weak relationship was found between knowledge and attitudes towards reporting, but no relationship was found with any other variable in the model (i.e., intention, subjective norm, behaviour, and self-efficacy) (Kroshus et al.,
Other research on athletes found no relationship at all between knowledge and actual behaviour (Anderson et al., 2015; 118 male high school football players, Kurowski et al., 2014; 496 high school athletes, Kroshus et al., 2015; 116 male NCAA hockey players; Kroshus, Kubansky, Goldman, & Austin, 2015; 116 male NCAA hockey players).

**Attitudes**

Many theories on health and injury prevention include some form of attitude dimension and advocate for its utility in modifying behaviour. The rationale is simply that an individual who is well disposed to a particular behaviour has a greater chance of actively engaging in it than one who holds less favourable attitudes. The literature on injury prevention in sport offers evidence supporting this relationship between one’s attitude toward a behaviour and actual behavioural outcomes.

One example is research on attitudes towards protective equipment use in a sample of 301 Australian football players (Braham, Finch, McIntosh, & McCrory, 2013). The results demonstrated a significant relationship between attitudes and the use of mouth guards and headgear. More specifically, more favourable attitudes towards mouth guard use was reflected in a greater reported use and less favourable attitudes towards headgear was reflected in lower use of headgear (Braham, Finch, McIntosh, & McCrory, 2013). However, the relationship between protective equipment and concussion risk remains unclear (McCrory et al., 2013).

Further support exists in relation to other potential concussion prevention and management behaviours, particularly concussion reporting (Register-Mihalik et al., 2013; Kroshus et al., 2014; Register-Mihalik et al., 2013). Register-Mihalik and colleagues
(2013) found attitudes to be significantly related. More specifically, 167 athletes from high schools in the U.S. reported their attitudes and recalled past concussion events and reporting behaviours. Better attitudes towards concussion reporting were associated with a reduced likelihood of the athlete participating in a game or practice while symptomatic. Kroshus et al., (2014) found significant bivariate relationships between attitudes towards the outcome of reporting a concussion injury and knowledge, self-efficacy, and intention to report symptoms. Attitudes were not found to be related with behaviour, but instead worked through intention within the theoretical model proposed by the researchers (Kroshus et al., 2014). Register-Mihalik et al. (2013) used constructs from the TPB to better understand intention to report concussion symptoms in a sample of 167 athletes at U.S. high schools. Attitudes were identified as being the strongest predictor of athletes’ intentions to report. However, reporting intentions were only related to reporting during practices, not games.

**Subjective norms**

Subjective norms are defined as an individual’s perception of pressure from others to perform a behaviour. With concussion injury, this may be framed within the belief that others perceive athletes as weak as a result of sustaining a concussion injury. Subjective norms are commonly used in research on behaviour change and injury prevention in sport, particularly concussion prevention (Kroshus et al., 2014; Kroshus, Kubzansky, Goldman, & Austin, 2015; Kroshus, Garnett, Baugh, & Calzo, 2015). For example, Kroshus, Kubzansky, Goldman, and Austin (2015) explored subjective norms and athletic identity in regards to concussion reporting with a sample of 116 male NCAA hockey players. In this study, subjective norms were measured as perceived reporting
norms for most athletes. Non-report recall (instances where athletes did not report concussion symptoms in-season) were also given by athletes. Results showed a significant correlation between subjective norms and reported recollection of reporting behaviour, post-season. The greater reported belief that most athletes would report concussion symptoms was related to lower reports of symptom non-reporting in-season.

More research by Kroshus, Garnett, Baugh, and Calzo (2015) explored links between perceived reporting norms and one’s intention to report concussion symptoms in a sample of 328 college-level athletes. Athletes held the misperception that they themselves have safer attitudes towards reporting concussion symptoms than their teammates. A significant relationship was found between perceived norms and reporting intention, where greater perceptions of concussion reporting among teammates was related to greater intent to report. Kroshus and colleagues (2014) found significant bivariate relationships between intention and each of the beliefs dimension of the TPB (subjective norms, attitudes, and self-efficacy / behavioural control) in a sample of 256 American Junior ‘A’, male hockey players. Intention was then found to significantly predict concussion reporting behaviours (Kroshus et al., 2014).

**Efficacy beliefs**

**Self-efficacy / behavioural control.** Self-efficacy, or one’s belief in their ability to do a behaviour, has been linked with behaviour change within the literature on concussion injury. For example, Kroshus and colleagues (2014) found significant bivariate relationships between their measure of self-efficacy regarding reporting behaviours, reporting intention, and actual reporting behaviours in a sample of 256 American Junior ‘A’, male hockey players. Specifically, greater reported self-efficacy
was related to higher reporting intentions and a reduced likelihood of failing to report concussion symptoms in-season (Kroshus et al., 2014). Similarly, Register-Mihalik and colleagues (2013) explored the influence of behavioural control on one’s intention to reporting concussions. The results found an association between direct behavioural control and intention to report concussion.

**Response efficacy.** This type of efficacy refers to one’s belief that a behaviour or action will help to avoid or reduce the risk of a threat. Response efficacy has not been explored within the context of concussion injury in sport. However, it has been explored within other health domains such as AIDS prevention through condom use (Sheeran, Abraham, & Orbell, 1999). In this instance, it appears to have a small, but significant positive effect on condom use. More specifically, of the 121 studies reviewed by Sheeran and colleagues (1999), the correlations between response efficacy and condom used ranged from 0.1 - .34, with a weighted average correlation of 0.1.

**Competitive Pressures**

Research on concussion injury in sport, includes several constructs included in the social context of prevention. These are competitive pressures experienced by the athlete that influences their behaviours. For instance, early research by Sye, Sullivan, and McCrory (2006) surveyed 477 New Zealand high school rugby players on their knowledge of concussion signs, symptoms, and proper return to play guidelines. Despite being reasonably knowledgeable about concussion signs and symptoms, when questioned about the application of their knowledge issues were identified. Specifically, 26.8% believed that concussed players should play in an important game, 76.1% believed that a
teammate had played with a concussion, and 31.7% believed a concussed teammate had experienced pressure to continue to play.

Other research by Chrisman, Quitiquit, and Rivara (2013) identified barriers to concussion reporting in a sample of 50 high school athletes. For example, an athlete’s desire to return to play would deter them from reporting a concussion. These findings are similar to that of Delaney and colleagues (2015) which identified common reasons for non-reporting in their sample of 469 Canadian varsity athletes. Several common reasons related to athletes’ experiencing some form of competitive pressure. For example, not wanting to be removed from a game, not wanting to risk missing future games, and fear of letting down teammates by being removed from a game were among the reasons most often reported by athletes. Other reasons included fear that a concussion diagnoses might affect their standing on the team, fear of being isolated from the team, and fear of receiving backlash from coaching staff because of a concussion diagnoses.

**Part V: Sport Concussion Prevention**

**Introduction**

The overarching goal of injury prevention research is to find the best strategies to reduce the risk for those who participate. Research on injury prevention is often categorized into two specific types: primary and secondary (Tator et al., 2012). Both types focus on understanding athletes’ behaviours and often do so through common strategies of behaviour change (i.e., TPB). Primary prevention is proactive. The aim is to create an environment where the injury is less likely to occur. It is a balance between the value of fun and competition and the inherent risk in the sport environment. This is often
a point of contention within the context of injury prevention in sport as a need exists to maintain value while ensuring, to the extent possible and necessary, safety. It can be argued, for instance, that attempts to completely reduce sporting injuries are a lost cause as injury is an inherent part of sport participation, and therefore unavoidable.

Secondary prevention refers to recognizing and managing the injury after it has already occurred to prevent further injury or debilitation. This is a reactive strategy that relies on the athlete engaging in proper injury management behaviours to work towards positive health outcomes. This is the area that research on concussion prevention in sport focuses on most, likely due to the potential severe outcomes of successive concussion injuries (e.g., SIS and CTE), the issue of underreporting of concussion in sports, and perhaps the assumption that concussion injury is inevitable (Tator et al., 2012; McCrory et al., 2013).

Beyond this, Tator (2012) breaks down several common prevention strategies that help guide research as it works towards these two types of prevention. These strategies include research on: epidemiology, education, engineering, enforcement / legislation of rules, and evaluation of the programs (Tator, 2012). In regards to the research on concussion prevention, the epidemiology, and education aspects are well documented (McCrory et al., 2013; Castile et al., 2012; Langlois et al., 2006; Tator, 2012; Shenouda et al., 2012; Llewellyn et al., 2014). Research on engineering strategies, protective equipment has received some focus, however the utility of protective equipment at reducing concussion risk remains unclear (McCrory et al., 2013; Daneshvar et al., 2011; Rowson et al., 2014; Rowson & Duma, 2011; Mihalik et al., 2007). Recent research has begun to explore the influences of new legislation on concussion injury in sports, and is a
positive step towards providing standard guidelines for all sporting bodies to use (LaRoche et al., 2015; Shenouda et al., 2012; Bompadre et al., 2014). Experts suggest that the literature on concussion prevention is currently lacking with its evaluation of concussion programs (Tator, 2012; McCrory et al., 2013). For instance, Tator (2012) suggests that current evaluations are either nonexistent or focus on knowledge gain criteria rather than actual concussion prevention. The following section will summarize the research on each of these five concussion prevention strategies.

**Epidemiological Research to Inform Concussion Prevention**

The epidemiological literature on concussion injury in sport has revealed some interesting trends. For instance, Lincoln et al. (2011) conducted a descriptive epidemiology study of concussion in high school sports over an 11-year period and found concussion rates to have a 15.5% annual increase. They highlight the fact that concussion injuries were observed in all sports, not just contact or male sports such as football. Rosenthal, Foraker, Collins, and Comstock (2014) conducted a more recent descriptive epidemiological study of concussion injury in high schools between 2005 and 2012. The results were like that of Lincoln et al. (2011) in that they found significant increases over time.

These trends are often attributed to greater awareness, concussion knowledge, and more sensitive guidelines for detection and treatment (Lincoln et al., 2011; Rosenthal et al., 2014). They also help to inform future education and prevention efforts. For example, as concussion injury occurs in all sports (Lincoln et al., 2011), it is important for prevention, detection, and management efforts to be multifaceted and be sport specific when possible (Tator, 2012). Another way that epidemiological studies benefit
Concussion programs is through the identification of non-modifiable risk factors that can be targeted by interventions. One example of this may be level of competition or age, as Gessel et al. (2007) identified higher concussion incidence at the college/university level compared to high school. More studies need to be conducted to better understand these trends and how they might influence concussion prevention and management.

**Concussion Education**

A major foundation to effective concussion prevention and management is educating people involved such as athletes, parents, coaches, and officials (Tator, 2012). McCrory and colleagues (2013) note the importance of proper knowledge transfer practices as part of concussion education, but highlight the need for further evaluation of the efficacy and impact of current strategies. This is reflected in the literature exploring the relationship between knowledge and reporting behaviours, where little support exists (Register-Mihalik et al., 2013; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Anderson et al., 2015). Tator (2012) highlights the fact that education must be supported by other efforts in order to effect significant reductions in concussion incidence. Similarly, Mrazik and colleagues (2015) argue that educating the sporting community on concussion management is a public health priority as current efforts have been identified as lacking or ineffective.

Research such as that by Kroshus, Daneshvar, Baugh, Nowinski, and Cantu (2014) explored the NCAA concussion education mandate in a sample of 146 male hockey players. The results reflected poorly on the educational materials as its use did not significantly change any of the measures of success (i.e., knowledge, attitudes, perceived norms, or reporting intentions) or mitigate team differences in concussion knowledge.
Other research by Echlin and colleagues (2010) suggests trends of effective knowledge transfer using a DVD resource with a sample of male hockey players (average age of 18). More specifically, no differences were found at baseline, but at 50 days following exposure to the education materials, differences between the experimental and control groups approached significance and remained at 91 days.

Despite these findings, research suggests that concussion education is improving. For instance, early reports by Kaut, DePompei, Kerr, and Congeni (2003) found that 56% of their sample of college athletes indicated no knowledge of any consequences that could result from concussion. Similarly, Cusimano, Chipman, Volpe, and Donnelly (2009) found limited knowledge of concussion injury, including the causes, signs, symptoms, and management practices with their sample of Canadian minor hockey participants (athletes, parents, coaches, and trainers). More recently, Shenouda et al. (2012) examined concussion knowledge in a sample of adults involved in youth soccer. Results revealed that the most participants believed that a concussion was a type of TBI, a serious injury, and did not require a loss of consciousness to have occurred. Participants were also able to identify that an individual should not return to play while experiencing symptoms. Positive findings of greater concussion knowledge have also been found in recent reports of high school football players (Cournoyer & Tripp, 2014; Anderson et al., 2015).

**Engineering for Concussion Prevention**

Engineering for concussion prevention has almost universally revolved around the development of helmet technologies. Interestingly, little evidence exists that supports the use of protective equipment in reducing concussion risk (McCrory et al., 2013; Tator,
2012). Nonetheless, it has been identified as an important aspect of multifaceted concussion prevention. Research by Rowson and Duma (2011) tests the development of an evaluation system, The Summation of Tests for the Analysis of Risk (STAR), for football helmets. Specifically, they developed an equation that gives consumers a simple overview of the performance of football helmets. More recently, Rowson et al., (2014) explored whether helmet design can reduce the incidence of concussion injury in sport. Practice and game head impact data was collected from 1833 collegiate football players with specialized helmets for recording acceleration of the head. Two helmet models were compared, and the results identified a significant difference in concussion rates between the two (Rowson et al., 2014).

**Legislation and Rule Change**

Research on rule and legislation changes have shown promising results. One example is the Lystedt Law - a concussion specific legislation - that has been implemented in every state in the U.S. (LaRoche, Nelson, Connelly, Walter, & McCrea, 2015). There are three main components that highlight a standard of care for athletes in sporting in regards to concussion injury (Bompadre, et al., 2014). The first makes concussion education mandatory for athletes, parents, and coaches. The second is the mandatory removal of an athlete from play following a suspected concussion incidence. The last is the permission of a licensed health care provider trained in concussion evaluation and management prior to returning to play. The main goal of this type of legislation is increased awareness about the injury and standardized management protocols for the various stakeholders (Bompadre, et al., 2014). Similar forms of legislation are taking hold in Canada, with the province of Ontario introducing the first
official concussion legislation named “Rowan’s Law” after a young athlete who passed away from SIS (Tator, 2016). The details of this law are still under development, but this represents a large step forward for Canada on this front.

Initial research on the effects of this legislation identified gaps in parent, coach, and referee concussion knowledge one year following its implementation (Shenouda, Hendrickson, Davenport, Barber, & Bell, 2012). More recently, Bompadre and colleagues (2014) explored the effect of the Lystedt Law on concussion injury documentation in high schools in Seattle, WA. They identified a higher incidence rate and an increased average number of days that athletes were held out of play in the years following the implementation of the law. These results are attributed to a greater awareness and heightened monitoring of suspected injury. LaRoche and colleagues (2015) also investigated concussion rates and reporting frequency after the implementation of a state (WI, U.S.) mandated concussion law with a sample of 784 high school or college athletes. This was compared to previous reports from 1999-2002 with a sample of 1532 football players. The results show comparable concussion rates and a greater likelihood that the recent sample of athletes would report a concussion injury.

**Evaluation of Concussion Programs**

**Heads Up.** The “Heads Up” initiative developed by the CDC, is not only one of the most widely used education programs, but also one of the best researched (Sawyer et al., 2010; Covassin, Elbin, & Sarmiento, 2012; Chrisman, Schiff, & Rivara, 2011). A study conducted by Sawyer et al. (2010) assessed high school coaches’ assessment and intent to use the “Heads Up” toolkit developed specifically for use in high school sports. The sample (N. = 5121) completed a computer assisted telephone survey on the overall
appeal, ease of use, content, and general usefulness and satisfaction with the toolkit. Results demonstrated that only about 10% of coaches reported dissatisfaction with the toolkit and many had, or planned to, begin using it. Another study by Covassin, Elbin, and Sarmiento (2012) explored the coaches’ concussion knowledge after having received the program materials at least 6 months prior. The results show that coaches had greater knowledge of the signs and symptoms of sport related concussions after having reviewed the materials and the majority rated concussions as more serious after looking over the materials (Covassin et al., 2012).

Looking to a sample of 414 physicians, Chrisman, Schiff, and Rivara (2011) evaluated the utility of the “Heads Up” program in increasing concussion knowledge. The physicians received a survey assessing their current knowledge about concussion injury. Some of which has previously received the toolkit in the mail, and the control group had not. Results revealed no significant differences between the intervention and control groups in regards to concussion knowledge, though those who received the toolkit were less likely to recommend next day return to play to recently concussed athletes (Chrisman et al., 2011). Kroshus and colleagues (2014) evaluated a version of the “Heads Up” program with a sample of 256 adolescent male hockey players in the U.S. The results indicated no change in any measure (i.e., reporting behaviours, concussion knowledge, and concussion reporting perceptions) across all time intervals.

**ThinkFirst.** Several studies have evaluated the ThinkFirst concussion education program (Cook, Cusimano, Tator, & Chipman, 2003; Vassilyadi et al., 2009). Early research by Cook, Cusimano, Tator, and Chipman (2003) assessed the knowledge transfer and behavioral outcomes (e.g., penalty frequency) in youth hockey players who
have completed the concussion education program. Results found that retention of the information lasted up to 3 months. Furthermore, there were significantly fewer high risk penalties in the months following the implementation of the program (Cook et al., 2003). Vassilyadi et al. (2009) explored the efficacy of the ThinkFirst program curriculum on knowledge acquisition in grade 7/8 students. Student and teacher experiences were also evaluated qualitatively. All schools involved showed an increase of knowledge from baseline to post-program, and from post-program to long-term, although a ceiling effect eventually occurred.

**ImPACT.** More recent evaluations have been done on the Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) (Elbin et al., 2011; Mayers & Redick, 2012). These programs are suggested to be used to help in return to play decision making. Mayers & Redick (2012) assessed the clinical utility of the ImPACT program, looking specifically at validity, reliability, and usefulness in return to play (RTP) decision-making and found that it can be used in addition to other assessments to help guide RTP decisions, however it is not valid enough by itself. These findings are in line with the current consensus statement by McCrory and colleagues (2013) which does not currently support the use of these types of tests.

**Part VI. Gaps in the Literature and the Present Study**

In this literature review on concussion injury in sport, two important trends were identified. The first is the focus on concussion knowledge to promote behaviour change and the second is the focus on concussion management behaviours, primarily reporting. These are necessary but insufficient aspects of concussion prevention and represent significant shortcomings within the literature (Tator, 2012).
Increasing concussion knowledge appears to have limited utility in improving reporting behaviours (Register-Mihalik et al., 2013; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Anderson et al., 2015). Program evaluation data would suggest that concussion awareness has improved and there has been an overall increase in reporting (which is unlikely entirely due to increased incident). Of course, further efforts must continue to educate athletes and other stakeholders about recent developments in concussion research (Tator, 2012). However, this cannot be the sole strategy upon which prevention programs rely. As such, we need to have a thorough understanding of factors influencing athlete behaviours towards prevention beyond knowledge including their perceptions of concussion risk, the efficacy of management behaviours and the personal and social context that shapes their behaviour.

Promoting engagement in management behaviours does little to reduce actual incidence of concussion injury. Rather, it reduces risk for further injury, or recurrent concussions (Castile et al., 2012). Concussion management is an important consideration given the potential for severe outcomes following multiple concussions (e.g., SIS and CTE), however, researchers must consider the best strategies to approach concussion prevention proactively as well. As is, there exists little support for current prevention strategies on reducing concussion incidence or effecting positive behaviour change. Other factors influencing athletes’ engagement in protective behaviours need to be considered and greater efforts must be made to properly evaluate programs. These methods are often not evaluated, or are evaluated based on knowledge gain criteria rather than actual concussion incidence (Tator, 2012).
A starting point would be to include greater theoretical direction in the research. McGlashan and Finch (2010) criticize the current injury prevention literature for being too atheoretical, and this is especially apparent in the context of concussion in sport. Well-established dimensions of behaviour change theories in other domains can work as a starting point and can inform future research. To take a quote from Weinstein (1993, p. 332), “Finding that one theory correlates .4 with observed behavior and that another theory correlates .5 is not nearly so helpful as discovering what features of the theories account for the difference.” Since McGlashan and Finch (2010), concussion research has started to include some form of theoretical framework, although it remains limited (Kroshus, Garnett, Baugh, & Calzo, 2015; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Register-Mihalik et al., 2013); however, again these efforts have focused on secondary prevention.

Risk perception has particular relevance to concussion. Most programs provide messages about injury severity to evoke threat and perhaps anxiety towards concussion. Programs also provide information about efficacious and ineffective concussion prevention strategies (e.g., return to play protocols). Little is known; however, about the extent to which athletes take these messages on board. Risk perceptions are highly contextual. For example, the competitive environment of athletics might prompt different behaviours than seen in other human activities where injury risk is a concern (e.g., workplace). Some researchers have suggested examining risk taking as a function of acceptable levels of risk and the changes in perceived risk that accompany certain behaviours (e.g. protective equipment use) (McCrory et al., 2013). Currently, there is very little attention to risk in the concussion literature.
The present study uses this rationale to explore aspects of risk and behavioural intention in a sample of university athletes. It describes attitudes and intentions towards personal risk and concussion management behaviours. Included in this are concepts previously unexplored in concussion prevention literature (e.g., response efficacy). A second objective is to identify subgroups of athletes with problematic intentions towards risk reduction behaviours (e.g., willingness to give or receive a concussion in order to win). In fulfilling these objectives, the present study informs future prevention efforts by highlighting target areas for intervention. By identifying specific groups of at risk athletes, this study also brings concussion prevention research back to the level of the athletes. The rationale is that, although all athletes should be educated on concussion injury and proper management, not all athletes respond similarly to this information. As such, risk reduction may be best targeted at the behavioural level. That is, it may be underlying behaviour differences that increase the risk for concussion injury. This study helps to inform the field of research in this way.
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Chapter 2.

Manuscript:

Risk Beliefs and Intentions Towards Concussion Prevention Behaviours in Varsity Athletes: Identifying the Good, the Bad, and the Good Enough
Abstract

Objective: Identify subgroups of athletes with problematic intentions towards concussion prevention and management behaviours. Describe conflicting attitudes and intentions towards personal concussion risk and protective behaviours among varsity athletes.

Methods: Attitudes and intentions towards personal risk and concussion management behaviours were assessed using a cross-sectional survey. Varsity athletes at Trent University (N. = 175; 60% male; 55.4% contact athletes; 56.6% history of concussion) completed this survey. Cluster and discriminate analyses were used to identify athlete risk response subgroups on intention items. Clusters were examined for differences in attitudes towards concussion prevention behaviours, demographics and concussion exposure.

Results: A problematic subgroup of athletes (28% of the sample) was identified that reported low intent to engage in management practices or primary prevention behaviours. These individuals reported greater risk acceptance and lower belief in the efficacy of concussion management behaviours. They were also more likely to have sustained a concussion. Two other clusters demonstrated more acceptable behavioural intentions towards concussion prevention and management.

Conclusions: Subgroups of athletes exist that exhibit different patterns of intentions and attitudes towards concussion prevention and management behaviours. Programs need to target problematic intentions and attitudes among such athletes to improve effectiveness. Future research should examine sport culture other factors that may influence athletes’ engagement in concussion prevention and management behaviours.
Introduction

Concussion is a prevalent problem among young athletes that can cause long-term, even permanent, impairments in cognitive function and psychological well-being (McCrory et al., 2013). Among young Canadian adults, 66% of all injuries are sport-related (Billette & Janz, 2011) and an estimated 1.6 to 3.8 million sports-related traumatic brain injuries (TBI) – including concussions – occur each year (Langlois, Rutland-Brown, & Wald, 2006). Similarly, the U.S. Centers for Disease Control and Prevention (CDC) reports an estimated 250,000 children (under 19 years of age) were treated in emergency departments for a suspected concussion or traumatic brain injury (Gilchrist et al., 2011). The incidence and risk of concussion is even greater in higher-level athletes, such as those playing varsity or professionally (Gessel, Fields, Collins, Dick, & Comstock, 2007). Importantly, an estimated 10% to 15% of athletes experience persistent cognitive deficits (e.g., memory problems and decision-making impairments) and emotional-regulation difficulties (e.g., irritability and depressive symptoms) a year or more after their concussion (McCrory et al., 2013). Current research suggests that roughly 13.2% of reported concussions are recurrent, increasing the risk for these prolonged deficits (Castile, Collins, McIlvain, & Comstock, 2012).

Athletes’ concussion risk is part of a complex system of personal and contextual factors relating to athlete behaviour, sport exposure, and resources for management. These include non-modifiable factors, meaning endogenous factors pertaining to the athlete, such as age and concussion history, as well as sport type (McCrory et al., 2013; Abrahams, Mc Fie, Patricios, Posthumus, & September, 2014; Scopaz & Hatzenbuehler, 2013). Concussion risks, however, can also be influenced by modifiable factors, such as
concussion knowledge and awareness to promote concussion-protective behaviours.

Concussion education prevention programs all target modifiable factors (Bloodgood et al., 2013; Kaut, DePompei, Kerr, & Congeni, 2003; Mathema, Evans, Moore, Ranson, & Martin, 2015) and work under the assumption that by promoting a better understanding of risk factors athletes will engage in behaviours that reduce concussion incidence (Tator, 2012). A problem though, is that we have very little knowledge about how athletes perceive concussion and what targeted approach is best suited to effectively modify their behaviours and ultimately reduce their concussion risks.

There exists a health-related issue relating to prevention where providing factual information to individuals does not change their behaviour. Current primary prevention methods are ineffective as most concussion programs are evaluated based on knowledge gain criteria, but still fail to address key issues or have little bearing on behavioural outcomes of athletes (i.e., concussion incidence) (Tator, 2012). Kroshus and colleagues (2014) demonstrated the limited effect of knowledge gain in researching the effectiveness of concussion education in NCAA ice hockey. They compared six teams before and after receiving concussion specific education materials and found that despite knowledge gain, there was no difference in intention to continue playing sports while experiencing a headache resulting from a concussion. The limited influence of knowledge has also been observed in other health domains. Within the context of HIV prevention, Sheeran and colleagues (1999) conducted a meta-analysis of socio-cognitive factors impacting on safe sex behaviours (i.e., condom use) as a means of risk reduction and found a very small effect for knowledge on condom use. Hence, there is a need to know what key
perceptions about concussion need to be altered to effectively increase appropriate concussion protective behaviours.

Concussion prevention programs might become more impactful in modifying behaviours if they include greater emphasis on changing attitudes towards concussion and their related social norms (Kroshus, Daneshvar, Baugh, Nowinski, & Cantu, 2014; Delaney Lamfookon, Bloom, Al-Kashmiri, & Correa, 2015; Anderson, Gittelman, Mann, Cyriac, & Pomerantz, 2015). Unsurprisingly, attitudes and social norms, alongside knowledge, are common mechanisms involved in predicting and modifying prevention behaviours (Ajzen, 1998). Support for these factors has been observed in research within other health domains (e.g., intent to exercise, smoke / quite smoking, use condoms, and brush / floss teeth) (Godin & Kok, 1996; Armitage & Connor, 2001). Similarly, interventions targeting attitudes and normative beliefs are most effective in promoting condom (Albarracin et al., 2005).

A major limitation of the current research on concussion attitudes is that, given the competing objectives in sport, the focus is largely on concussion identification and management, rather than risk (Kroshus, Garnett, Hawrilenko, Baugh, & Calzo, 2015; Register-Mihalik, Guskiewicz, Valovich McLeod, Linnan, Mueller, & Marshall, 2013). This is an issue because concussion identification and management have had little bearing on the issue of concussion incidence rates. When we look at problematic attitudes relating to risk in other domains we see other key mechanisms influencing the engagement in prevention behaviours. Sheeran and colleagues (1999), explored risk factors in relation to HIV prevention behaviours and found attitudes and social norms were key mechanisms prompting behaviours. The prime difference between Sheeran et
al. (1999) and research done on concussion attitudes, is the convergence around risk and injury prevention through one’s attitudes rather than on management and awareness. A gap exists when exploring athletes’ problematic attitudes towards concussion with respect to risk, prevention, and intent to engage in relevant behaviours such as symptom reporting.

In the present study, we address the gap in research on athletes’ attitudes and intentions towards personal concussion risk and protective behaviours. We then use athlete responses to investigate whether we could identify subgroups of athletes with problematic intentions towards prevention and management behaviours. This type of investigation is valuable as the focus is on individual cases, rather than the variables (Clatworthy, Buick, Hankins, Weinman, & Horne, 2005). We then relate subgroups of athletes holding more or less risky intentions to attitudes towards concussion prevention and management, identifying specific attitudinal, demographic and exposure indicators that differ between the groups. Understand problematic attitudes and intentions around personal concussion risk may help researchers and practitioners develop and target interventions accordingly.

Method

Design

A cross-sectional survey design was used. Ethics approval was received from the Trent University Research Ethics Board under protocol number 22616.
Context

Trent University (6252 undergraduate students enrolled at the time of the survey) hosts a small, competitive athletics program with a total of 16 varsity teams which competed in the Ontario college league (OCAA), the Ontario university league (OUA), or a lacrosse specific league (CUFLA). Trent also has a men’s hockey team, which competes extramurally. On average, there are approximately 280 registered student athletes at Trent.

Within the athletics program, Trent University has programs in place for concussion education and management. Athletes are screened prior to their athletic season for current concussions, concussion symptoms, and concussion history. The program also includes a gradual return to play protocol based on the guidelines outlined by McCrory et al. (2013).

Recruitment Strategy

Data was collected between September 2013 and April 2015. Coaches were contacted via email and helped facilitate participation from athletes. Meetings were set up before or after a practice, game or training session. A researcher involved with the project came to the meeting, introduced the study, and asked the athletes if any of them would like to volunteer their time to complete the questionnaire. If a team was unable to meet at any other time, a link was distributed by email to an online version of the questionnaire. This version uses the Qualtrics program in compliance with the requirements of the psychology department at Trent University as well as the ethics committee. There was no reward, reimbursement, or compensation given to any individual that participated in the study.
Participants

Questionnaire responses were received from 197 athletes. A total of 22 (11%) participants were removed from analysis due to incomplete surveys or improperly answering a series of “strike” questions designed to validate cases as having properly completed the questionnaire. These 22 participants did not differ from the demographics of the rest of the sample. The final sample consisted of 175 varsity athletes. Based on demographics provided by the Trent Athletics Department it was determined that this sample slightly under represented noncontact athletes, but otherwise was reflective of the Trent varsity athlete population.

Procedure

Informed, written consent was gained prior to participation signed by one of the researchers in the study and an independent witness. Independent responding was ensured by having participants complete the questionnaire independently and in a private area under the supervision of the researcher or a research assistant. This occurred within a classroom in the Athletics Complex at Trent University following a team training session. A feedback and information sheet was provided at the end of the questionnaire. An online option was available, however 90% of participants completed the pen and paper version.

Materials

Demographics. The demographic section of the questionnaire asked the participants about their age, gender, varsity sport participation, duration of sport participation, personal concussion history, and history of concussion among people they
know. They were also asked about education they received about concussion, and which source they received this from.

**Attitudes and intentions toward protective behaviours.** These sections were developed from a self-regulatory orientation to understand how athletes perceive and utilize strategies to manage their personal risk. A review of the literature at the time of development, as well as the authors’ personal experiences with athletics helped to inform item development. The attitude scale included 17 items and used a 5-point Likert scale (ranging from 1. Strongly Disagree to 5. Strongly Agree). Items included one’s attitudes toward equipment, rule changes, body contact, and physical skill in relation to concussion injury.

The intention scale included 18 items where athletes could choose no, maybe, or yes, as to the extent they would engage in various concussion prevention behaviours. These items revolve around protective behaviours such as equipment (e.g., wearing a mouth guard), injury management (e.g., waiting the recommended recovery time), risk avoidance (e.g., avoiding contact drills in practice), fitness (e.g., get in better physical shape), and confrontation behaviours (e.g., confronting aggressive opponents). Included in this scale was one of a series of strike questions throughout the survey which were used to evaluate athlete response and promote attendance to the questionnaire items.

**Statistical Analyses**

All statistical analyses were run using either IBM SPSS Statistics v24 or R v3.3.1 software. Preliminary data inspection and cleaning was performed following the methods of Field et al. (2013). Missing demographic information was not replaced. Casewise deletion was used on a per analysis basis (the number of valid cases are noted in each of
the results tables). Items were examined for restricted ranges and tested for parametric assumptions.

Descriptive statistics were generated for demographic data and responses on the attitude, intention, and risk perception sections. Chi square goodness of fit tests were conducted to compare the sample demographics to that of the Trent varsity program to assess the representativeness of the sample. Chi square tests of independence were conducted to investigate relationships between categorical variables (gender, personal history of concussion, concussion specific education exposure, and type of sport involvement). Pearson and Spearman correlations were calculated to determine relationships between attitudes and intentions toward protective behaviours and risk perceptions.

A cluster analysis was performed on the intention factors found through PCA to identify groups of cases with response patterns. Our methods are based on those outlined by Clatworthy et al. (2005) and Clatworthy et al. (2007). Intentions scale items related to personal concussion risk behaviours were identified. Item reduction was achieved through Principal Component Analysis (PCA) with Promax rotation to create composite factors for use in cluster analysis and to minimize multicollinearity effects, as suggested by Tabachnick and Fiddell (2007). From this, intention component scores were standardized to z-scores. Ward’s method was then used to predetermine the number of clusters to be set in the follow up K-Means cluster analysis on the intention components. The z-scores were then subjected to a K-Means cluster analysis. We used Euclidean distances as our measure of similarity between clusters. Our criteria included the maintenance of a Euclidian distance 1.5 standard deviation units or greater on all
measures between neighbouring cluster centers as well as achieving convergence of the data within 10 iterations (with the convergence criterion set to 0) (Clatworthy et al., 2007). We then used a discriminant analysis as a means of checking the goodness of fit of the model found by the K-Means cluster analyses and to profile the clusters to determine if and how the dimensions significantly discriminate between the groups. We explored all the underlying assumptions in relation to the discriminant analysis.

Differences in attitudes were then examined across intention cluster groups. Attitude scale items related to personal concussion risk behaviours were identified. Item reduction was achieved through Principal Component Analysis (PCA) with Promax rotation to create composite factors for use in comparative analyses and to minimize multicollinearity effects, as suggested by Tabachnick and Fiddell (2007). An exploration of the underlying assumptions was performed. A MANOVA using Munzel and Brunner’s method followed with a Kruskal-Wallis test for each of the dependent variables.

**Results**

**Demographic information**

Demographics of the athlete sample (N = 175) are provided in Table 2. The majority of athletes were 19 years or younger (52.6%) and male (60%). One participant failed to report their gender. On average, athletes report involvement in their sport for 8.5 years (range 1-20), and competing at the varsity level for 1.7 years (range 1-5). The majority of the sample (55.4%) consisted of athletes from contact sports. The sports included in this sample consisted of rugby (33.1%), soccer (12.6%), lacrosse (17.7%),
curling (5.1%), rowing (10.3%), volleyball (13.7%), hockey (4.6%), and cross-country (2.9%) (Table 3).

A majority of the athletes (56.6%) reported having suffered a concussion, however only 43% of the sample reported having their concussion diagnosed by a trained health professional. Concussion history was dependent on sport type whereby of those reporting concussion, most (68%) played a contact sport, $\chi^2 (1) = 13.84, p<.001$. Those who reported a history of concussion were 3.2 times more likely to play a contact sport than those who reported no history of concussion. Essentially all athletes reported knowing someone who has sustained a concussion injury (97.7%). Most athletes reported
having received concussion specific education (89.1%). Although this number is higher than current estimates in professional athlete populations (38% Mathema et al., 2015), findings are closer to reports among high school athletes (70% Anderson et al., 2015) (Table 2).

**Table 3. Participant athletic involvement**

<table>
<thead>
<tr>
<th>Item</th>
<th>Response</th>
<th>Sample N (%)²</th>
<th>Varsity N (%)³</th>
<th>X² Goodness of fit⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Varsity Team Involvement</strong></td>
<td>Rugby</td>
<td>58 (33.1%)</td>
<td>67 (23.3%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soccer</td>
<td>22 (12.6%)</td>
<td>44 (15.3%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lacrosse</td>
<td>31 (17.7%)</td>
<td>49 (17%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Curling</td>
<td>9 (5.1%)</td>
<td>10 (3.5%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rowing</td>
<td>18 (10.3%)</td>
<td>49 (17%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volleyball</td>
<td>24 (13.7%)</td>
<td>27 (9.4%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hockey</td>
<td>8 (4.6%)</td>
<td>26 (9%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cross-Country</td>
<td>5 (2.9%)</td>
<td>8 (2.8%)</td>
<td>27.31*</td>
</tr>
<tr>
<td></td>
<td>Golf</td>
<td>0 (0%)</td>
<td>8 (2.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Type of Sport¹</strong></td>
<td>Contact</td>
<td>97 (55.4%)</td>
<td>142 (49.3%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-contact</td>
<td>78 (44.6%)</td>
<td>146 (50.7%)</td>
<td>2.77NS</td>
</tr>
</tbody>
</table>

**Notes**

¹ Contact sports included: Rugby, Lacrosse, and Hockey; Non-contact sports included: Soccer, Curling, Rowing, Cross-Country, Golf, and Volleyball

² Percentages are based on total sample (N. = 175)

³ Percentages are based on Trent varsity program (2015/16 season) (N. = 288)

* Significant, p < .05

NS Not Significant

**Attitudes and Intentions Towards Concussion Injury**

Athletes were asked to rate their attitudes towards a range of concussion risk related behaviours and declare their intention towards engaging in them. Responses are reported on across the dimensions of concussion risk behaviours. The attitude and intention scale items not related to personal risk (the interest of this study) were removed leaving 10 attitude and 9 intention items. See Appendix F for full scale. Item labels and definitions are provided in Table 4. Correlation matrices are provided in Tables 5-7.
Table 4. Scale item labels and definitions

<table>
<thead>
<tr>
<th>Item</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Att. 1</td>
<td>Protective equipment will reduce the risk of concussion</td>
</tr>
<tr>
<td>Att. 4</td>
<td>My competitive nature increases my risk of concussion</td>
</tr>
<tr>
<td>Att. 5</td>
<td>I would risk suffering a concussion to succeed in a sport that really matters to me</td>
</tr>
<tr>
<td>Att. 6</td>
<td>Wearing protective equipment is a sign of weakness</td>
</tr>
<tr>
<td>Att. 7</td>
<td>Being in better shape can physically reduce the risk of concussion</td>
</tr>
<tr>
<td>Att. 8</td>
<td>I would risk giving another player a concussion to succeed in a sport that really matters to me</td>
</tr>
<tr>
<td>Att. 10</td>
<td>I feel safer taking risks when wearing protective equipment</td>
</tr>
<tr>
<td>Att. 11</td>
<td>Waiting the recommended recovery time before returning to play is important to avoid further injury or problems</td>
</tr>
<tr>
<td>Att. 12</td>
<td>Unskilled athletes are more likely to suffer a concussion</td>
</tr>
<tr>
<td>Att. 15</td>
<td>Hiding concussion symptoms from others puts athletes at greater risk of further injury or problems</td>
</tr>
</tbody>
</table>

Intention Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int. 1</td>
<td>Wear protective headgear</td>
</tr>
<tr>
<td>Int. 2</td>
<td>Wear a mouth guard</td>
</tr>
<tr>
<td>Int. 3</td>
<td>Avoid sports that have a high risk of concussion</td>
</tr>
<tr>
<td>Int. 8</td>
<td>Confront aggressive teammates about the risk they are posing to others</td>
</tr>
<tr>
<td>Int. 9</td>
<td>Get in better shape physically to reduce the risk of suffering a concussion</td>
</tr>
<tr>
<td>Int. 11</td>
<td>Avoid contact sports all together</td>
</tr>
<tr>
<td>Int. 12</td>
<td>Confront aggressive opponents about the risk they are posing to others</td>
</tr>
<tr>
<td>Int. 15</td>
<td>After getting a concussion, I would wait the recommended recovery time before returning to play</td>
</tr>
<tr>
<td>Int. 18</td>
<td>I would hide my symptoms in order to return to play quicker</td>
</tr>
</tbody>
</table>

Table 5. Correlation matrix of attitude items

<table>
<thead>
<tr>
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<th>5.</th>
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</table>

Note: Only significant (α 0.05) correlations are included
Table 6. Correlation matrix of intention items

<table>
<thead>
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<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>8.</th>
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Note: Only significant (α = 0.05) correlations are included

Table 7. Correlation matrix of intention x attitude items

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<tr>
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<th>Int. 1</th>
<th>Int. 2</th>
<th>Int. 3</th>
<th>Int. 8</th>
<th>Int. 9</th>
<th>Int. 11</th>
<th>Int. 12</th>
<th>Int. 15</th>
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<td>Att. 5</td>
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<td>-.151</td>
<td></td>
<td>.226</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Only significant (α = 0.05) correlations are included

Concussion Management Behaviours: Most athletes (90.3%) reported that hiding concussion symptoms from others puts athletes at a greater risk for further injury or problems. Nevertheless, athletes (75.4%) agreed that others do hide concussion symptoms to not be removed from play. These items were found to be significantly related, $r_s = .256, p < .01$. A greater belief that waiting the recommended recovery time before returning to play is important to avoid further injury was significantly related to lower intentions towards hiding concussion symptoms to return to play earlier, $r_s = -.251, p < .01$. Most athletes (94.2%) agreed that waiting the recommended recovery time before returning to play is important to avoid further injury. When asked whether they would
hide their concussion symptoms to return to play earlier, a slight majority of athletes (55.2%) reported that they would never do this. Nevertheless, some athletes (8.6%) admitted that this is something they would always do, with the rest of the sample (36.2%) stating they would in some instances. This suggests that athletes are aware of the dangers of not properly reporting symptoms, but there are groups of athletes who still might not report their symptoms. Furthermore, athletes who believe that other athletes hide their concussion symptoms, report greater intention to hide symptoms themselves, \( r_s = .379, p < .001 \). This suggests that perceived social norms among athletes might influence reporting behaviours.

**Protective Equipment Use:** When asked about the use of protective equipment, most athletes (92% overall; 89.6% contact; 94.9% noncontact) agreed that using protective equipment reduces the risk of concussion. However, the majority (65.6% overall; 60.4% contact; 71.8% noncontact) agreed that they feel safer taking risks while wearing protective equipment. These two items were found to correlate (contact, \( r_s = .299, p < .01 \); noncontact, \( r_s = .323, p < .01 \)). Athletes reporting greater belief that using protective equipment is not a sign of weakness also believed in the efficacy of protective equipment in reducing concussion risk (\( r_s = .302, p < .001 \)). When asked about intention to use protective equipment, some contact athletes (40.2%) reported that they would always wear protective headgear and just under two-thirds of contact athletes (63.9%) reported that they would always wear a mouth guard. Contact athletes who reported feeling safer taking risks while wearing protective equipment held greater intentions to wear protective headgear (\( r_s = .250, p < .05 \)). No relationship was found between one’s belief in the efficacy of protective equipment in reducing concussion risk and intent to use either a
mouth guard or headgear. However, athletes reporting greater belief that using protective equipment is a sign of weakness held lower intent to wear a mouth guard, regardless of sport type (contact: \( r_s = -.298, p < .01 \); noncontact: \( r_s = -.326, p < .01 \)).

**Competitive Nature:** The results also show that roughly half of the sample agreed that their competitive nature increase their risk for concussion injury (52%). This was significantly correlated with more attitudes towards risking suffering a concussion (56.6% agreed; \( r_s = .221, p < .01 \)) and giving a concussion to someone else (30.2% agreed; \( r_s = .189, p < .05 \)). Both one’s attitude toward suffering a concussion to succeed (\( r_s = .344, p < .001 \)) and giving a concussion to someone else to succeed (\( r_s = .336, p < .001 \)) were significantly correlated with athletes’ intent to hide symptoms to return to play quicker. A Mann-Whitney U test revealed that none of these individual items were significantly related to whether the athlete reported a history of concussion. However, risk acceptance was higher among athletes who reported sustaining a concussion (\( M = .132, SD = .998 \)) versus those who had not (\( M = -.175, SD = .981 \)), Mann Whitney \( U = 2898, p = .042 \).

**Confrontation Behaviours:** Interestingly, about half of the sample reported that they might confront aggressive teammates (52.3%) or confront aggressive opponents about the risk they pose to others (52.3%). Almost half (48.3%) of the sample would always vocalize their discontent to the referees and officials for missing violent infractions (48.3%).

**Risk Avoidance:** Most of the sample (90.2%) reported that they would never avoid contact sports altogether (93.8% contact; 85.7% noncontact) to reduce their risk of concussion. Similarly, a large proportion of the sample (70.9%) reported that they would never avoid sports with a high risk for concussion, although this significantly differed
according to sport type. Unsurprisingly, those involved in noncontact sports were significantly more intent on avoiding high risk sports (82.1% contact; 57.1% noncontact), $\chi^2(2) = 13.34, p<.01$, regardless of concussion history. Among contact sport athletes with a history of concussion, 70.8% reported no intent to avoid contact in practice drills to minimize the chance of concussion. The majority of contact athletes (54.6%) agreed that full contact practices put them at a greater risk for concussion injury.

Skill and Fitness: Roughly half of the sample (51.5%) agreed that being in better physical shape can reduce the risk of concussion and 63.2% reported they would get in shape physically to reduce the risk of suffering a concussion. The strategy of learning the proper body posture for contact sports before participating, was endorsed by most athletes (75.9%) to reduce concussion risk. However, the sample was equally divided on whether unskilled athletes were more likely to suffer a concussion, where 34.8% disagreed and 43.4% agreed.

Rules to Reduce Risk: When asked whether adopting fair play rules (such as rewarding less aggressive play) would reduce the risk of concussion, most athletes agreed (71.4%), yet most athletes reported that they would not advocate for rule changes that would reduce the risk of injury (71.1%). Athletes also held negative attitudes towards the idea that body contact should be eliminated in all minor sport under the age of 15, as most (62.9%) disagreed. The sample was evenly split on whether the emphasis on winning in competitive sports increases the risk of concussion, where 43.7% of athletes disagreed and 37.3% agreed. See summary in Table 8.
<table>
<thead>
<tr>
<th>Section</th>
<th>Main Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concussion Management Behaviours</td>
<td>- Athletes are aware of the dangers of not properly reporting symptoms, but there are groups of athletes who still might not report their symptoms.</td>
</tr>
<tr>
<td></td>
<td>- Perceived social norms among athletes might influence reporting behaviours (e.g., hiding symptoms from others).</td>
</tr>
<tr>
<td>Protective Equipment use</td>
<td>- Athletes who believed equipment reduces risk for concussion also agreed that they feel safer taking risks while wearing protective equipment.</td>
</tr>
<tr>
<td>Competitive Nature</td>
<td>- Athletes who believe that their competitive nature increases their risk for concussion held more positive attitudes towards giving or receiving a concussion to succeed.</td>
</tr>
<tr>
<td>Confrontation Behaviours</td>
<td>- The sample was equally divided as to whether they would vocalize issues to referees, or confront aggressive teammates or opponents.</td>
</tr>
<tr>
<td>Risk Avoidance</td>
<td>- The majority of high risk athletes (contact sport &amp; previous concussion injury) reported little intent to avoid contact sports or practices (high risk situations).</td>
</tr>
<tr>
<td>Skill and Fitness</td>
<td>- Most athletes identified the benefit of learning proper body posture for contact in sports. However, the impact of skill on concussion risk was uncertain.</td>
</tr>
<tr>
<td>Rules to Reduce Risk</td>
<td>- The majority of the athletes believed that rule changes can be implemented to reduce risk, but they would not advocate for such rules.</td>
</tr>
<tr>
<td></td>
<td>- Most athletes did not believe contact should be eliminated in all minor sports under the age of 15.</td>
</tr>
</tbody>
</table>
Intention Response Clusters

*Principal Component Analysis of Intention Scores:* Using Principal Components Analysis, we identified five personal risk dimensions for the intention scale: risk confrontation, risk avoidance, concussion management, protective equipment usage, and fitness. Higher scores on all factor items reflect greater intent to engage in the behaviours. Two items loaded onto the risk confrontation dimensions and reflected intent to confront aggressive opponents and teammates about the risk they pose to others. The risk avoidance dimension had two items load on it and identified behaviours such as intent to avoid sports with high risk for concussion. Two items exploring one’s intent to hide symptoms to return to play quicker and one’s intent to wait the recommended recovery time before returning to play assessed concussion management intentions. Two items loaded onto the protective equipment usage dimension. These items explored one’s intent to use protective equipment such as headgear and mouth guards. A single item did not load onto any component but was included as a single personal risk behaviour intention. This fitness dimension reflected intent to getting in better shape to reduce concussion risk. In summary, principal components analysis reduced nine intention items into four components and a single item dimension reflecting personal risk intentions. Further details regarding the PCA can be provided upon request (see Table 9).

*Cluster Analysis of Intention Scores:* A K-Means cluster analysis on the 5 standardized (z-scores) intention factors (*N* = 174) allowed for a 3-cluster solution to converged in 10 iterations. Euclidean distances between cluster centers varied from 1.844 to 2.596, adhering to the criteria outlined by Clatworth et al. (2007). An ANOVA
comparing the means of the 3-cluster solution revealed that intent to manage concussion symptoms was the most influential variable for discriminating clusters and the fitness factor was the least (Table 10).

Table 9. Dimension loadings and communalities for the intentions towards protective behaviour scale dimensions

<table>
<thead>
<tr>
<th>Dimensions and Items</th>
<th>Dim. 1</th>
<th>Dim. 2</th>
<th>Dim. 3</th>
<th>Dim. 4</th>
<th>Dim. 5</th>
<th>Com²</th>
<th>M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Confront aggressive teammates about risk</td>
<td>.877</td>
<td></td>
<td>.815</td>
<td></td>
<td></td>
<td></td>
<td>2.03</td>
</tr>
<tr>
<td>12. Confront aggressive opponents about risk</td>
<td>.895</td>
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<td>.836</td>
<td></td>
<td></td>
<td></td>
<td>1.9</td>
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<td>3. Avoid high risk sports</td>
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<td></td>
<td>.628</td>
<td></td>
<td></td>
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<td>1.34</td>
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<td>11. Avoid contact sports</td>
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<td></td>
<td>.674</td>
<td></td>
<td></td>
<td></td>
<td>1.11</td>
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<td>15. Wait recommended time before returning</td>
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<td></td>
<td>.689</td>
<td></td>
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<td></td>
<td>2.68</td>
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<td>18. Hide symptoms to return to play quicker¹</td>
<td>.861</td>
<td></td>
<td>.776</td>
<td></td>
<td></td>
<td></td>
<td>1.53</td>
</tr>
<tr>
<td>1. Wear protective headgear to reduce risk</td>
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<td>.711</td>
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<td>2.15</td>
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<td>.766</td>
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<td>2.37</td>
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<td>9. Get in better physical shape</td>
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<td>.944</td>
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<td>2.57</td>
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</table>

Variance accounted for 18.3% 17.5% 15.4% 13.9% 11.5% 76.6%
Cluster labels were rationalized based on the deviation of each factor from each cluster mean (Figure 1). Cluster 1 contained 55 (31.6%) athletes with responses .5 standard deviations above the mean on all personal risk reduction factors except fitness. This cluster was labeled the proactive group as these responses reflect an athlete whose willingness to engage in risk reduction behaviours extends to each facet covered by the questionnaire. The exception to this was the fitness dimensions where athletes in this group had average responses. Each of the intention dimensions represent behaviours that can be done proactively by athletes.

Table 10. Final cluster centers for a 3-cluster grouping of athletes’ intention responses

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Final Cluster Centers (z-scores)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proactive</td>
<td>Reactive</td>
</tr>
<tr>
<td>Confrontation</td>
<td>0.76</td>
<td>-0.24</td>
</tr>
<tr>
<td>Avoidance</td>
<td>0.52</td>
<td>-0.43</td>
</tr>
<tr>
<td>Management</td>
<td>0.50</td>
<td>0.53</td>
</tr>
<tr>
<td>Protective Equipment</td>
<td>0.82</td>
<td>-0.41</td>
</tr>
<tr>
<td>Fitness</td>
<td>0.14</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Notes: The z-scores reflect where the cluster responses scored in comparison to the average score (z-score = 0) on each of the dimensions on the intention scale. Omega squared effect size is given in the column on the right for the cluster differences for across intention dimensions.

Cluster 2 contained 70 (40.2%) athletes with responses .5 standard deviation units above the mean only on the concussion management factor. This cluster was labeled the reactive group as the only above average intention response was on a reactive risk reduction behaviour - properly managing the injury works to reduce risk of further injury.
Cluster 3 contained 49 (28.2%) athletes with responses .5 standard deviation units below the mean on the confrontation factor and 1.5 standard deviation units below the mean on the concussion management factor. This cluster was labeled the *indifferent* group. These athletes reported little to no intention to engage in any risk reduction behaviours. With all scores falling below the mean, we identified this cluster as a problematic response group.

![Intention Clusters](image)

*Figure 1. Standardized average responses on intention dimensions for response clusters. The radar line 0 represents the average standardized score for each dimension. Proactive cluster reports above average scores on all dimensions. Reactive cluster only reports above average scores on management and fitness. Indifferent cluster reports no above average scores on any dimension.*

A Discriminate analysis was used to determine which intention dimensions are driving the clustering. This analysis revealed two distinct functions. The correlations between the intention factors and the discriminant functions revealed that the concussion management (function 1, $r = .867$; function 2, $r = -.333$) and fitness (function 1, $r = .139$; function 2, $r = -.051$) factors loaded predominantly on function 1. Whereas the remaining factors, protective equipment (function 1, $r = .23$; function 2, $r = .602$), avoidance (function 1, $r = .041$; function 2, $r = .457$), and confrontation (function 1, $r = .279$;
function 2, \( r = .443 \) factors loaded predominantly on factor 2. The discriminant function plot (Figure 2) suggests that function 1 works to discriminate the indifferent group from the proactive and reactive groups, and function 2 discriminates the reactive group from the proactive and indifferent groups. (See summary in Table 11)

![Canonical Discriminant Functions](image)

**Figure 2.** Combined-groups plot for discriminant functions of the intention clusters. On the X axis, Function 1 differentiates the indifferent cluster from the proactive and reactive clusters. On the Y axis, Function 2 differentiates the reactive cluster from the indifferent and proactive clusters.

**Table 11.** Summary of cluster and discriminate analyses

<table>
<thead>
<tr>
<th>Intentions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal</td>
<td>Proactive (N = 55) Members report intent to engage in all protective dimension except fitness</td>
</tr>
<tr>
<td>Acceptable</td>
<td>Reactive (N = 70) Members only report intent to engage in concussion management behaviours</td>
</tr>
<tr>
<td>Problematic</td>
<td>Indifferent (N = 49)</td>
</tr>
</tbody>
</table>
Members report little to no intent to engage in any risk reduction behaviours, particularly proper concussion management behaviours.

Comparisons Across Intention Clusters

*Group comparisons for intention clusters:* Further analyses revealed an overall omnibus effect on concussion history, $\chi^2(2) = 7.05$, $p<.05$. This effect reflected increased odds of suffering a concussion when in the indifferent group compared to the proactive group (OR = 2.6, CI$_{lower}$ = 5.8, CI$_{upper}$ = 1.2). In addition, the reactive group also experienced a higher likelihood of suffering a concussion compared to the proactive group (OR = 2.2, CI$_{lower}$ = 4.5, CI$_{upper}$ = 1.1). Interestingly, the majority (65.3%) of athletes in the *indifferent* cluster had previously suffered a concussion. Although cluster membership did not significantly differ based on gender or sport type, the majority of athletes in the *indifferent* group were males (67.4%) and played contact sports (69.4%).

*Differences in attitude dimensions across intention clusters:* Lastly, we wanted to explore any relationships between athletes’ attitudes and intentions clusters. Six personal risk dimensions were identified from the Principal Components Analysis for the attitude scale: risk acceptance, injury management, risk compensation, skill, fitness, and competitiveness. Three items loaded onto the risk acceptance dimension. A high score on this reflects a greater belief that they would risk giving or receiving a concussion and that wearing protective equipment is a sign of weakness.

Two items loaded onto the concussion management dimension, where high scores represent a positive attitude towards properly managing the injury through symptom reporting and giving the proper time to recover. Two items loaded onto the risk compensation factor. These items reflected risk compensation beliefs as they relate to
protective equipment usage such that higher scores reflected greater attitudes toward protective equipment usage but also increased risk taking with protective equipment.

Table 12. Dimension loadings and communalities for the attitudes towards protective behaviour scale dimensions

<table>
<thead>
<tr>
<th>Dimensions and Items</th>
<th>Dim. 1</th>
<th>Dim. 2</th>
<th>Dim. 3</th>
<th>Dim. 4</th>
<th>Dim. 5</th>
<th>Dim. 6</th>
<th>Com²</th>
<th>M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Risk suffering a</td>
<td>.826</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.754</td>
<td>3.35 (1.26)</td>
</tr>
<tr>
<td>concussion to succeed¹</td>
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<td></td>
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<tr>
<td>6. Wearing equipment is a</td>
<td>.585</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.691</td>
<td>1.8 (.953)</td>
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<tr>
<td>sign of weakness¹</td>
<td></td>
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<td>8. Risk giving a</td>
<td>.785</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.851</td>
<td>2.51 (1.37)</td>
</tr>
<tr>
<td>concussion to succeed¹</td>
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<td></td>
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<tr>
<td>11. Waiting proper recovery</td>
<td>.756</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.714</td>
<td>4.51 (.749)</td>
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<tr>
<td>time before returning</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>15. Hiding concussion</td>
<td>.848</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.793</td>
<td>4.38 (.901)</td>
</tr>
<tr>
<td>symptoms increases risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1. Protective equipment reduces risk</td>
<td>.606</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.735</td>
<td>4.34 (.724)</td>
</tr>
<tr>
<td>10. I feel safer taking risks wearing equipment</td>
<td>.898</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.850</td>
<td>3.65 (1.04)</td>
</tr>
<tr>
<td>12. Unskilled athletes are at higher risk</td>
<td>.892</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.838</td>
<td>3.07 (1.25)</td>
</tr>
<tr>
<td>7. Being in better physical shape reduces risk</td>
<td>.897</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.851</td>
<td>3.34 (1.15)</td>
</tr>
<tr>
<td>4. My competitive nature increases risk</td>
<td>.959</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.952</td>
<td>3.23 (1.2)</td>
</tr>
</tbody>
</table>
Variance accounted for  

\[
\begin{align*}
18.1\% & \quad 15.1\% & \quad 12.5\% & \quad 11.7\% & \quad 11.2\% & \quad 10.4\% & \quad 78.8\%
\end{align*}
\]

Note: Dim. 1 - Risk Acceptance; Dim. 2 – Management; Dim. 3 – Risk Compensation; Dim. 4 - Skill; Dim. 5 – Fitness; Dim. 6 – Competitiveness.

1 Item reverse scored, 2 Com = communality, 3 Dim. = Dimension

Three items did not load onto components but were included as individual dimensions indicating a single attitude belief. The first item reflected skill beliefs. High scores on this item reflect a greater belief that unskilled athletes are more likely to suffer a concussion. Item two identified fitness beliefs such that high scores represented a greater belief that being in better shape can physically reduce the risk of concussion. The third item assessed athlete’s beliefs around competitiveness where higher scores reflect a greater belief that one’s competitive nature increases their risk for concussion injury. In summary, principal components analysis reduced the initial 10 items to three components and three individual items reflecting different dimensions of personal risk attitudes (Table 12).

![Boxplots of attitude scale score by intention cluster](image)

**Figure 3.** Boxplots of attitude dimension scores across intention clusters for the risk acceptance and risk management attitude dimensions. Data points are jittered vertically.
A MANOVA using Munzel and Brunner’s method, revealed a statistically significant difference in students’ scores attitude dimensions based on their intention cluster membership, \( F(5, 169) = 3.29, p < .001 \) (Figure 3). A follow up of individual Kruskal-Wallis rank sum tests found risk acceptance \( (\chi^2(2) = 30, p < .001) \) and concussion management attitudes \( (\chi^2(2) = 20, p < .001) \) differ significantly across clusters. A post hoc analyses for risk acceptance attitudes found that the indifferent group has a significantly \( (p < .05) \) greater inclination toward a higher risk acceptance versus the proactive and reactive groups, who do not differ. In contrast, a post hoc analysis found that the indifferent group is significantly \( (p < .05) \) lower than either the proactive or reactive groups in attitudes towards concussion management who do not differ. Additionally, risk acceptance was higher among athletes who reported sustaining a concussion \( (M = .132, SD = .998) \) versus those who had not \( (M = -.175, SD = .981) \), Mann Whitney \( U = 2898, p = .042 \). These findings are unsurprising and serve to further validate cluster membership.

**Discussion**

The interest of this study was threefold. First, we wanted to investigate attitudes and intentions towards personal concussion risk in a sample of varsity athletes, with an eye towards conflicting or risky attitudes and intentions. Our second aim was to use athlete responses to investigate whether subgroups of athletes with problematic intentions towards risk behaviour could be identified. Thirdly, we wished to examine differences in attitudes across intention clusters and determine whether clusters differed on demographics, sport involvement, concussion exposure and education. Unlike other
reports on concussion attitudes and intentions (Register-Mihalik et al., 2013; Register-Mihalik et al., 2013) this study explored concussion attitudes and intentions in relation to personal concussion risk combining prevention and response to identify groups of athletes holding potentially problematic attitudes and intentions.

Problematic Attitudes and Intentions

Our investigation of problematic attitude and intention responses revealed some interesting results relating to concussion management behaviours, risk compensation, the competitive imperative of sport, and social norms relating to personal risk. These revolve around personal risk perceptions and highlight a disjunction between concussion knowledge, attitudes, and intent to engage in proper risk reduction behaviours.

Concussion Management Behaviours: The current findings clearly demonstrate groups of athletes holding more or less adaptive behaviours towards concussion management. The findings from Anderson et al. (2015) were comparable to our own results as our sample was also well educated and reported a similar level of intent to report symptoms of concussions. Anderson et al. (2015) explored attitudes relating to risk factors (e.g., importance of symptom reporting and abstaining from play when injured) in a sample of high school athletes. They found that despite having knowledge of concussion symptoms and severity (either through concussion education (70%) or experience (25%)), many athletes still held negative attitudes towards reporting concussion symptoms or remaining out of play following a concussion injury. Of their sample, 54% would always or sometimes report symptoms (Anderson et al., 2015). Of the current sample, 55.2% of athletes reported that they would never hide concussion symptoms with essentially all athletes having some form of concussion knowledge
(89.1% - education; 56.6% - experience). This disjuncture between knowledge gain and behaviour is further supported by Delaney and colleagues (2015) who found that 19.6% of their sample of varsity athletes believed they had suffered a concussion injury. Despite this, 78.3% of these athletes did not seek medical attention during the athletic session where the injury occurred. Although knowledge was related to reporting concussion events in practices, Register-Mihilak et al. (2013) found no relationship between concussion knowledge and remaining in a game or practice while symptomatic among high school athletes.

*Risk Compensation / Homeostasis:* In this sample, we observed the coinciding and potentially paradoxical views relating to the usage of protective equipment. The majority of athletes believe that protective equipment reduces risk and reported greater feelings of safety while wearing protective equipment while simultaneously reporting a greater willingness to take risks while wearing protective equipment.

Wilde (1998) discusses personal risk perceptions as part of a large framework and notes that some individuals are simply more comfortable engaging in riskier behaviours than others. This notion of an acceptable level of risk is referred to as a risk homeostasis (or risk compensation) insofar as it is used to describe the process in which one optimizes risk management through perceptions around risk management behaviours. Risk homeostasis, as proposed by Wilde (1998) is based on four specific factors: the perceived costs and benefits of risky behaviours and the perceived costs and benefits of safe behaviours. Another explanation of this is given by McCrory et al. (2013), and explains that risk compensation (referred to as risk homeostasis by Wilde, 1998) is where an athlete’s behaviour changes, usually by engaging in riskier behaviours, as a consequence
of beliefs about another risk reduction factor. In the context of concussion injury this occurs as a result of the belief that protective equipment use will reduce risk. Thereby prompting an increase in high risk behaviour to restore risk homeostasis.

With our sample, we found that most athletes agreed that using protective equipment will reduce the risk of concussion yet, many athletes also agreed that they feel safer taking risks while wearing protective equipment. A significant relationship was found between these items and the two items combined in factoring. These findings support the presence of risk homeostasis by demonstrating relationships perceptions of risk management and behavioural intentions. The issue of risk compensation is compounded by the fact that there is little evidence that protective equipment does reduce risk (McCrory et al., 2013). Athletes may be putting themselves at risk by the false belief that their own actions in wearing protective equipment will reduce risk.

On items relating to one’s injury management behaviours, most of our sample agreed that waiting the recommended recovery time before returning to play is important to avoid further injury and recognized that hidings symptoms put athletes at risk for further injury. However, we identified latent contradictions in these responses as the majority of the sample believed that athletes hide their concussion symptoms and a portion exhibit disregard for proper concussion management behaviours. This suggests that athletes are aware of the dangers of not properly reporting symptoms, but may not report symptoms. Other literature also offers some support for this assertion. For instance, Chrisman, Quitiquit, and Rivara (2013) show similar findings in their study with nine focus groups of high school athletes. Specifically, three focus groups stated that they would take a brief break then continue to play and the remaining six groups stated
that they would just keep playing immediately. Reasons for this included the desire to continue playing and the belief that their symptoms could be due to another issue (e.g., dehydration). Athletes knew that reporting symptoms would likely result in immediate removal from play, and potentially remove them for extended periods of time. This may reflect athletes considering the costs and benefits of engaging in protective behaviours as explored by Register-Mihilak et al. (2013), and suggested by the risk homeostasis theory (Wilde, 1998).

**Competitive Imperative of Sport:** The majority (56.6%) of athletes in the current study reported willingness to receive a concussion, with some (30.6%) reporting willingness to give a concussion to succeed in sport. We also found that one’s attitude toward suffering a concussion to succeed and giving a concussion to someone else to succeed were positively correlated with a greater intent to hide symptoms to return to play quicker. This willingness to give or receive a concussion reflects the competitive imperative of sport.

These novel findings are supported by other current research (Delaney et al., 2015; Anderson et al., 2015; Chrisman et al., 2013) which demonstrate a lack of reporting and a low level of reporting despite athletes being knowledgeable about concussions. Register-Mihilak et al. (2013) found no association between knowledge, or attitudes towards reporting, and in game reporting behaviours. This is indicative of the tension that exists in the competitive environment where knowledge may not be enough to influence engagement in proper injury management behaviours.

**Norms towards management and prevention behaviours:** We found that athletes who believe that other athletes hide their concussion symptoms, report greater intention
to hide symptoms themselves. We reasoned this to be an influence of perceived social norms on management behaviours. It may also be the involvement of perceived social norms in the cost and benefit systems of risk homeostasis insofar as athletes may observe others not engaging in these behaviours experiencing no negative outcome as a result. This observation may lead to the athletes themselves fail to engage in these behaviours. Kroshus and colleagues (2015) had related results. They identified three subgroups of athletes who experience varying social pressures pushing them towards returning to play while symptomatic (from teammates, coaches, parents, and fans) while recovering from injury. They identified a low-pressure group (experienced little pressure from all sources), a team pressure group (experienced moderate pressure from coaches and teammates), and a high-pressure group (experienced high amounts of pressures from all sources). In regards to symptom reporting behaviours, results found that the high-pressure group held significantly less intent to report symptoms than both the team pressure group ($d = .50$) and the low-pressure group ($d = .40$).

**Intention Response Clusters, Attitudes and Group Comparisons**

The next objective of this study was to expand on these issues and to do this we wanted to take our analyses, in a sense, back to the athletes themselves by identifying subgroups of athletes who hold these problematic intentions towards personal concussion risk. Our cluster and discriminative analyses revealed three intention response groupings - proactive, reactive, and indifferent. Athletes within the indifferent intention cluster (n. = 49, 28.2%) were at the greatest risk as these were conceptualized as high risk response patterns due to the poor intention responses. These athletes also held greater attitudes towards risk acceptance and report a lower belief in the efficacy of management
behaviours than the other groups. This is of interest given the particularly low intent to engage in management behaviours reported by athletes in the indifferent cluster.

Current research is unanimous on the benefits of engaging in proper injury management behaviours (e.g., reporting concussion symptoms to coaches) (McCrory et al, 2013). The fact that this cluster holds such a poor disposition is unsettling. In regards to intent to engage in these behaviours, this is not uncommon for athletes to want to return to play or engage in behaviours that would allow them to before they have recovered (Kroshus et al., 2014; Delaney et al., 2015; Kroshus et al., 2015; Chrisman et al., 2013). While not covered by this study, other research has found social norms to influence reporting intentions (Kroshus et al., 2015; Register-Mihalik et al., 2013). No previous research has identified subgroups of athletes with problematic behavioural intentions.

A responsible intention cluster was also identified. This group of athletes reported higher intentions towards concussion risk reduction and management strategies. Interestingly, this group also was found to have a significantly lower likelihood of having previously suffered a concussion when compared to the other two groups. Ideally, all athletes would be a member of this subgroup and would properly engage in preventative behaviours. The current sample is a prime example of how the ideal is also the unlikely. Despite having a concussion education and management program in place for the athletes, many athletes still fail to engage in proper behaviours after suffering a concussion, let alone work towards preventing a concussion altogether. Table 13 provides suggests target areas for intervention for concussion prevention and management.
Table 13. Targets for intervention towards optimal attitudes and intentions for concussion prevention and management

<table>
<thead>
<tr>
<th>Attitudes</th>
<th>Intentions</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acceptable</strong></td>
<td><strong>Increase intent towards confronting referees and aggressive players</strong></td>
<td><strong>Athletes engaged in proactive risk reduction strategies</strong></td>
</tr>
<tr>
<td><strong>Problematic</strong></td>
<td><strong>Increased belief in response efficacy for management of concussions</strong></td>
<td><strong>Athletes reporting concussions and engaging in proper management behaviours</strong></td>
</tr>
</tbody>
</table>

Beyond simply acknowledging areas that could be improved, it is important to consider whether they can be improved. Other health related domains have shown promising results, particularly in regards to other risky behaviours. For instance, a study by Valdiserri and colleagues (1989) explored predictors of condom use among a sample of women. They found attitudes to be the only significant independent predictor of condom use and suggest that programs must target this to be successful. Caron, Godin, Otis, and Lambert (2004) evaluated an AIDS/STD education program on condom use and intercourse prevention with high school students. They found that the experimental group positively modified their attitudes and intentions toward using a condom and postponing sexual intercourse above and beyond that of the control group. This example demonstrates that attitude change occurs within other health domains, particularly in a context where social norms and other efficacy-related factors influence behavioural engagement.
Conclusions

The use of cluster sampling was a major strength of this study. We believe that the clusters that we identified would be found at other institutions and within other related populations such as provincial sport teams or parents of athletes. Although the generalizability of our sample may be limited (due to it being from a single, small to medium university) the extent to which our sample reflected that of the varsity program at Trent University is another strength of this study. Due to the small athlete population at Trent, we did not ask students to report their year of study to keep the respondents anonymous. Neither did we ask students to report the number, severity, or recency of their concussions. However, this allowed us to draw easy comparisons between athletes with and without a history of concussion. As the aim of prevention is incidence reduction, understanding the differences between these groups was one of our main interests. Another strength of this study is that it provides novel insight into the relationship between attitudes and intentions within the context of concussion in sport. This is an important step towards understanding how to change the behaviours of athletes.

Prevention programs play a pivotal role in addressing the issue of concussion in sports. However, the success of such programs is predicated on targeting behavioural attitudes and intentions that are going to impact on concussion risk. This study identified conflicting attitudes and intentions towards personal concussion risk, problematic groups of athletes, and inaccurate beliefs around effective concussion management behaviours in a sample of varsity athletes despite having an active concussion education and management program at the university. These findings highlight the importance of examining athlete attitudes and intentions, of considering lay beliefs held by athletes, as
well as the importance of being aware of conflicting motivations. With a focus on concussion reduction, programs may find it useful to refer to the results of this study when developing future intervention and program materials.

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.
References


Chapter 3.

Brief Report:

Next Steps for Concussion Prevention Research
Part I. Introduction

Over the last 15 years, global concussion awareness has developed as the result of a growing field of literature, education and management programs, many personal stories from high-profile professional athletes being disclosed to the public, and tragic stories of young athletes. This progress has led Ontario to pass the first provincial concussion law (Rowan’s Law in Ontario) mandating concussion awareness education and resources to better identify and manage concussions. Rowan’s Law follows the lead of the state of Washington State in the U.S. that implemented the Lystedt Law in 2009, which has led to similar mandates in all other states (Harvey, 2013; Tator, 2016). These are positive steps towards managing this injury, and the success of these efforts is shown in the improved injury reporting rates of athletes, improved education and awareness, and through greater accessibility to resources at lower levels of sport (LaRoche et al., 2015; Bompadre et al., 2014; Harvey, 2013).

Nevertheless, athlete reporting and adherence to return to play guidelines remains a problem (McCrory et al., 2013; Delaney et al., 2015; Register-Mihalik et al., 2016). As well, advances in policy around management have not been matched by efforts to address concussion risk and proactively reduce concussion incidence. Recent literature on the implication of concussion education and prevention within sport suggests that efforts need to refocus around proactive risk reduction strategies, rather than continuing to push education and management alone (Tator, 2012; Rivara, 2012; Greenwald, Chu, Beckwith, & Crisco, 2012). Third, injury research in general and concussion research specifically has been limited in its application of relevant theory to understanding the psychological and social underpinnings of athlete behaviours as they pertain to concussion management.
and prevention (McGlashan & Finch, 2010). Therefore, the focus of this report will be two-fold. First, we would like to critically review the literature on current concussion research as it relates to prevention, with a particular focus on the relative emphasis placed on primary versus secondary prevention and the lack of theoretical integration in present research. Second, we will offer suggestions for future directions for concussion prevention research and frame these suggestions within current concussion literature as well as prevention in other health-related domains.

**Part II: A Critique of Current Concussion Prevention Research**

**Primary Prevention Research**

The goal of primary prevention is to prevent the injury from occurring altogether. It is a proactive effort that uses strategies such as education and legislation to effect change in behaviours that might reduce incidence (e.g., reckless or dangerous play). In regards to concussion injury in sport, the question that needs to be addressed is “how do we reduce the number of concussion injuries experienced by athletes?” Current research on concussion prevention does not provide an answer to this, or at least, not one that has significantly reduced concussion incidence rates (Tator, 2012). This is not surprising given the fact that until recently, concussions were a relatively unrecognized and unknown injury. Now that the field of knowledge has developed and there is a greater awareness of the injury, we need to identify how to best respond to this question.

Tator (2012) suggests the enforcement of legislation and rule change, which is one of the 5 E’s of effective prevention. Current legislation developments such as the Lystedt Law tend to target secondary, rather than primary, prevention (i.e., managing the
injury after it occurs). Nonetheless, Canada has recently explored the possibility of removing contact from youth hockey (16 years of age and under) (Johnson, 2010). By eliminating contact early on, these athletes are less likely to suffer a concussion during important developmental stages.

Research on primary concussion prevention has targeted rules. For example, Emery et al. (2010) identified a 3-fold increase in risk for injury (including concussion, severe injury, and severe concussion classifications) in hockey players (ages 11-12) in provinces that permit body-checking. Other research by Macpherson and colleagues (2006) found that young athletes (aged 10-13 years) were more likely to experience a concussion where body checking was permitted.

Other examples would be fair play rules, that is, rules that are established to promote sportsmanship and clean competition. Benson and colleagues (2013) conducted a critical review and identified a paucity of research regarding the influence of rule changes on concussion risk. However, the articles that were identified showed potential for reducing athletes’ risk for concussion injury. One hockey education program targeting violent infractions and promoting sportsmanship discovered a significant (30%) reduction in dangerous infractions at a 4-year follow-up. In another study, fair-play rules (e.g., giving bonus points for remaining under a certain amount of infractions or penalties) reduced concussions among high-school hockey players, when compared with the regular tournament ruling (Roberts et al., 1996, as referenced in Benson et al., 2010). Brunelle, Goulet, and Arguin (2005) with a sample of 52 youth hockey teams (ages 14-15).

Looking at the Fair-Play Program (FPP) (a program geared towards reducing violent
transgressions to reduce injuries), they found a reduction in penalty minutes and violent infractions, however, no differences in injury rates were observed.

Attitudes towards such change can help or hinder advances in primary prevention. Some argue that athletes who do not experience contact early on will not be properly trained in how to deal with contact once it is allowed, therefore, increasing their risk for serious injury. In a recent study exploring athletes’ attitudes towards rule changes by Jorgensen, O’Hagan, and Lehmann (2016), the majority of athletes (71.4%, N. = 175) agreed that adopting rules, such as rewarding less aggressive play, would reduce the risk of concussion. However, most athletes were against rule changes that would eliminate body contact in minor sport (62.9%). Research has also found this to be true of parents of athletes (O’Hagan, Lehmann, & McMullen, 2015). This suggests that even though athletes (and parents) are aware of the benefits, they accept the fact that there is some inherent risk involved in playing sports and rule change to eliminate such risk is not universally favoured.

A common opinion held by athletes and other key individuals (i.e., parents and coaches) is that concussion can be mitigated, to some extent, through equipment use (Greenwald et al., 2012). Thus, this has been an area of focus for concussion prevention research. However, the most recent concussion guidelines point out that there is not enough evidence to support this claim (McCrory et al., 2013).

Going forward, research needs to explore other aspects of primary prevention. Factors of behaviour change are one example and have been explored in other health domains, but remain unexplored in the context of concussion prevention in sport (Sheeran et al., 1999). These may include factors such as athletes’ beliefs, attitudes, and
intentions, and the sport environment. Inaccurate beliefs about concussion prevention may lead to ineffective (and perhaps damaging) behaviours (e.g., belief in the utility of protective equipment at reducing concussions). Personality factors such as competitiveness, athletic identity, or personality characteristics (e.g., dark triad traits - narcissism, Machiavellianism, and psychopathy) are areas that may inform primary prevention efforts in the context of concussion in sport. Another common suggestion that doesn’t have empirical support is to improve one’s fitness or skill. The rationale is that athletes who have low physical fitness will become fatigued earlier in the game. Thus, their ability to avoid or react to certain situations may increase their risk for concussion. The same logic follows for one’s skill where athletes with lower skills will not be able to react to risky situations during the game as well as other skilled individuals (Kontos, Elbin, & Collins, 2006). Jorgensen et al. (2016) found that the majority of athletes (51%) believe that improved fitness will reduce one’s concussion risk. They also found that almost half of their sample (43%) believe that skill is similarly protective. The implications of such beliefs on primary prevention behaviours should continue to be explored. Thus, a key target area for research to explore beliefs held by individuals about primary prevention measures.

**Secondary Prevention Research**

Secondary strategies are essential to providing an effective and multifaceted approach to the prevention of devastating injury and debility. The focus of secondary concussion prevention is largely on athlete reporting behaviours and the implementation of return to play protocols. This has developed as a result of athletes hiding their concussion symptoms and continuing to play despite being at an increased risk for further
injury (McCrory et al., 2013; Delaney et al., 2015; Register-Mihalik et al., 2016). For example, Delaney and colleagues (2015) explored underreporting concussion symptoms in a sample of Canadian varsity athletes. They found that 92 (19.6%) of their sample believed they had suffered a concussion within the last year while playing their respective sport. Of these athletes, 72 (78.3%) did not seek medical attention during that athletic session. Similarly, results from a recent report by Register-Mihalik and colleagues (2016) found a high proportion of concussions went underreported.

Proper management and concussion reporting is unanimously supported in regards to its utility to reduce risk and further injury (McCrory et al., 2013). Yet, research suggests that athletes are conflicted when given a choice of success in their sport over their personal safety (Delaney et al., 2015). This is why it is important to understand factors affecting athletes’ decisions to continue playing while symptomatic. Examples of such factors include: subjective norms, pressures on athletes, athletic identity, competitiveness, efficacy beliefs, legislation and rules.

In regards to legislation, the Lystedt Law is concussion specific legislation that has been implemented in every state in the U.S. (LaRoche, Nelson, Connelly, Walter, & McCrea, 2015). It consists of three main components that highlight a standard of care for athletes in sporting in regards to concussion injury (Bompadre, et al., 2014). These include mandatory concussion specific education for players, parents, and coaches, the removal of an athlete from play following a suspected concussion incidence, and the permission of a licensed health care provider trained in concussion evaluation and management prior to returning to play (Benson et al., 2013). This has primarily resulted in higher incidence rates (presumably from greater awareness and reporting behaviours)
and an increase in the number of days an athlete is withheld from returning to play (LaRoche et al., 2015; Bompadre et al., 2014). Similar forms of legislation are beginning to develop in Canada, with the province of Ontario introducing the first official concussion legislation named “Rowan’s Law” after a young athlete who passed away from second impact syndrome (Tator, 2016).

Research by Kroshus et al. (2014) found a significant relationship between subjective concussion reporting norms and reporting intentions. Novel research by Jorgensen, O’Hagan, and Lehmann (2016) found that within their sample of 175 varsity athletes, those who had little belief in the efficacy of management behaviours (e.g., removal from play) held significantly lower intentions to engage in those management behaviours. Furthermore, athletes who believe that other athletes hide their concussion symptoms, report greater intention to hide symptoms themselves (Jorgensen et al., 2016). This suggests that perceived social norms among athletes might influence reporting behaviours. Kroshus et al. (2015) explored subjective reporting norms and athletic identity in regards to how they might impact athletes’ concussion reporting behaviours. They found that athletes who held the belief that others would report concussion injuries, were more likely to report head injury symptoms (in-season). Athletic identity weakly moderated this relationship, suggesting that when one holds a strong athletic identity, the likelihood of not reporting symptoms increases.

Further support for this is Kroshus, Garnett, Hawrilenko, Baugh, & Calzo (2015) who identified social pressures experienced by athletes to fail to report concussion symptoms and return to play while symptomatic. Over a quarter of their sample reported having experienced pressure to continue playing while symptomatic. They identified a
high-pressure group who reported experiencing high pressure from all sources (i.e., coaches, teammates, parents, and fans) and were significantly more likely to continue to play than athletes experiencing lower levels of pressure. Register-Mihalik and colleagues (2013) identified subjective norms, alongside attitudes, to be the strongest predictors of intention which was associated with a decreased prevalence of returning to play while experiencing symptoms of concussion (both practice and game).

Not yet considered, are how social factors (e.g., social norms and sport culture in specific sports) and personality factors (e.g., competitiveness) influence athletes’ reporting behaviours. This is an area that has yet to be explored, but one that would be very informative for secondary prevention efforts within the context of concussion prevention in sport. Given the intense and emotional environment of competitive sport, athletes may have difficulty making decisions regarding what is best for their health versus what will help them win. The interest in competitiveness as a personality factor is interesting to consider in regards to competitive versus recreational athletes. One might predict that increased competitiveness relates to lower reporting rates, however this has not been explored yet.

Part III: Theory Use

Current concussion prevention is limited in its ability to effect behavioural change, perhaps because of limited theoretical integration (McGlashan & Finch, 2010). McGlashan and Finch (2010) conducted a systematic review of injury prevention research and identified sparse use of behaviour and social science theories (11% of the articles reviewed). Common theories that were used included the theory of Planned Behaviour (TPB) and the Health Belief Model (HBM). Given that both the TPB and
HBM are both terminal (have a definitive end, i.e., the behaviours) models, this also highlights the limited theoretical diversity (i.e., a small number of theories are used). Systems (self-regulatory) models, such as the Common Sense Model of Illness Representations (CSM), are missing almost entirely from concussion research.

The issue of theoretical under-utilization and minimal diversification are especially problematic in regards to concussion prevention research. Research to date on concussion management has primarily included dimensions of the TPB (i.e., attitudes, social norms, efficacy belief, knowledge, and intentions) to explore their influence on management behaviours (Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Kroshus, Daneshvar, Baugh, Nowinski, & Cantu, 2014; Kroshus, Baugh, Daneshvar, Nowinski, & Cantu, 2015; Kroshus, Kubzansky, Goldman, & Austin, 2015; Ajzen, 1998). Snell Hay-Smith, Surgenor, and Siegert (2013) used the Common Sense Model of Illness Representations to study concussion recovery outcomes. The use of other theory that includes aspects of risk and response efficacy such as the Common-sense model or Protection Motivation Theory would be valuable additions to the concussion prevention literature.

Experts suggest a multifaceted approach to concussion prevention (McBride, 2012; Tator, 2012; Rivara, 2012; Greenwald, Chu, Beckwith, & Crisco, 2012). Current efforts are not. What is needed is an expanded focus that includes other psychosocial processes (e.g., as risk perceptions), greater implementation of behavioural and social science theories and their constructs, and consideration for how to best apply the theories. Some theories might be better applied to certain behavioural outcomes and processes. For example, being a terminal or outcome focussed model, the TPB might be best when
examining reporting behaviours as there is a definitive end. On the other hand, PMT may be of greater use in the context of primary prevention, particularly in regards to risk perceptions, as athletes are continuously adjusting and readjusting risk perceptions based on new information. Lastly, when evaluating programs, success criteria should be founded on their theoretical basis rather than knowledge gain criteria as they currently are (Tator, 2012).

**Part IV: Conclusions**

Recent efforts have been made to promote awareness of concussion injury, to involve athletes and the rest of the sporting community to engage in proper management of the injury, and to develop legislation that promotes both engagement in sport and the safety of its participants (McCrory et al., 2013). These are areas that have been highlighted by experts as particularly troublesome and, as per their suggestion, have become a focal point of recent research (McBride, 2012; Tator, 2012; Rivara, 2012; Greenwald, Chu, Beckwith, & Crisco, 2012). Although this focus is necessary, it remains insufficient given the potential for severe outcome following concussion injury, such as Second Impact Syndrome (McCrory et al., 2013), the associated issue of underreporting of symptoms (Register-Mihalik et al., 2016), and lack of adherence to RTP protocols. What has not been addressed is how to effectively reduce the incidence of concussion injury in sport (Abrahams et al., 2014). Alongside this comes several important considerations for researchers, such as:

1. How do we promote safe behaviour without sacrificing the competitive nature of sport?
2. How can we evaluate programs to improve their efficacy and utility in different sporting contexts?

Providing a competitive environment that maintains participants’ safety is one of the biggest difficulties facing the sporting community. This is especially the case when it comes to concussion injury. Some may argue that injury (particularly concussion) is an inherent part of sport and cannot be completely mitigated. However, we believe that concussion injury may be, in part, a reflection of an underlying problematic behavioural pattern that places certain athletes at risk of repeat concussion. We see this when athletes fail to report concussion symptoms despite knowledge gained through personal experience and formal education sources (i.e., seminars), we see this when athletes return to play while still symptomatic, and we see through aggressive and competitive tendencies such as a willingness to take risks while participating in sport or a reluctance to reduce contact (Delaney et al., 2015; Jorgensen, O’Hagan, & Lehmann, 2016). Yet, few studies have directly explored this (Jorgensen, O’Hagan, & Lehmann, 2016).

*Table 14. Summary of directions for future research*

<table>
<thead>
<tr>
<th>Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand theoretical orientations</td>
<td>Other theoretical orientations that include risk perceptions (e.g., protection motivation, health belief model, common-sense model)</td>
</tr>
<tr>
<td>Primary prevention</td>
<td>The influence of sport culture, social environment, and personality traits on incidence rates and risk for concussion.</td>
</tr>
<tr>
<td>Sport culture</td>
<td>Regard for other, duty of care</td>
</tr>
<tr>
<td>Personality</td>
<td>Athletic identity, competitiveness, risk acceptance, dark triad traits</td>
</tr>
<tr>
<td>Secondary prevention</td>
<td>Continue to identify ways to engage athletes in proper management behaviours (i.e., symptom reporting)</td>
</tr>
<tr>
<td>Social environment</td>
<td>Evaluate the influence of others (e.g., parents)</td>
</tr>
</tbody>
</table>
Effective evaluation methods

Explore how to best assess the utility and efficacy of concussion programs.

The focus of this report was to highlight this issue within the literature and to provide insight into how researchers might go about answering this question. In fulfilling this objective, the present study informs future prevention efforts by highlighting target areas for intervention. Future research must identify other factors of behavioural change. As this report outlines, concepts such as athletic identity and sport culture are but a few of the potential factors that should be explored. Table 14 provides a summary of the areas highlighted in this report. These have been highlighted in recent literature as well as international guidelines on concussion in sport. One way to do this is to include greater theoretical integration in research. This will serve to inform future program evaluations, as current procedures are underdeveloped or missing entirely. Wider use of behavioural and social science theories and their constructs is also needed. This will give those who develop concussion prevention programs the ability to tailor these theories and constructs to different contexts as they arise. Further exploration of behavioural factors will hopefully begin to answer the question of how to reduce the number of incidence experienced by athletes while maintaining engagement and safe competition.
References


Appendix A – Consent Form

CONSENT FORM TO PARTICIPATE IN THE STUDY
“Its all in the head: Concussion perceptions and prevention practices”
Research Ethics Board Protocol #22616

Contact: Fergal O’Hagan, Ph.D. (705-748-1011 x 7086)

This study has been approved by the Trent University Research Ethics Board

Purpose of the Study: I understand that this study is about the nature of my thoughts and experiences surrounding concussion injuries and how those thoughts relate to prevention behaviours like wearing protective equipment.

Description of the Study: I understand that by taking part in this study I will be asked to complete a questionnaire. The questionnaire will take approximately 30 minutes.

Benefits: I understand that there will be no direct gain for taking part in this study. The results of this study will provide knowledge that will help injury prevention programs be more effective.

Potential Harm: I understand that there are no known harms associated with participating in the interviews for this study. If I have had a concussion, completing the questionnaire may bring back some bad memories.

Confidentiality: I understand that my involvement in the study will not be revealed to anyone by the researchers. My confidentiality will be respected and no information regarding my identity will ever appear in any publications or presentations. Specifically, the research team will maintain my confidentiality by removing names and other identifying information from the transcript, and I will be asked to use a pseudonym during interviews.

Participation: I am aware that my participation is voluntary and I have the right not to participate or to freely withdraw from this study at any time during its course.

Information Storage: I understand that the researchers will store any information gathered from me in a secure cabinet that only they will have access to. I understand that any computer files containing my information will be secured with passwords and stored on secure computers. Any computer files sent over electronic media will be encrypted. After five years, data will be destroyed.

Use of Information: I understand that this information will be used in reports, presentations, and journal articles. This information may be used to develop subsequent theories, programs, or practices to prevent and manage concussion injuries.

Approved by Trent Research Ethics Board on September 13, 2013 Version 2
**Conflict of Interest:** I understand that the researchers have no commercial interest in completing this study. I also understand that this study is not funded by any commercial interest.

**Consent:** The research study and procedures have been explained to me and any of my questions have been answered to my satisfaction. The potential harms have been explained to me and I also understand the benefits to taking part in this study. I know that I may ask now, or in the future, any questions that I have about the study or the research procedures. I have been assured that no information will be released or printed that would disclose my personal identity.

If I have questions about the study I can contact the researcher listed at the top of this page. I may also contact Karen Mauro at the Trent University Research Ethics Office at 705-748-1011 x 7050 if I have any questions about my involvement as a research participant.

I will be provided with a copy of this consent form for my records.

Participant Name:
Signature:
Date:

Witness Name:
Signature:
Date:

Researcher Name:
Signature:
Date:
Appendix B – Demographics

Demographic Information

Please provide us with some general information about yourself.

1. Age:

2. Gender:
   - Male
   - Female

3. What school do you attend?

4. Have you ever personally experienced a concussion?
   - Yes
   - No

5. If you have sustained a concussion, was it diagnosed by a trained physician or not?
   - Diagnosed
   - Undiagnosed

6. Has anyone that you know personally ever had a concussion?
   - Yes
   - No

7. Have you ever received information or education about concussion?
   - Yes
   - No

8. If yes, please specify where you have received the most information from. (you may select more than one)
   - Personal research (i.e., internet search, self teaching)
   - Concussion education program (i.e., ThinkFirst Canada, CDC’s “Heads Up!”, etc)
   - University lecture
   - Information seminar (i.e., coaching clinic)
   - News media (i.e., newspapers)
   - Other
9. If "Other" was selected in the previous question, please specify where.

10. What varsity team(s) do you play for?
   - Rugby
   - Soccer
   - Lacrosse
   - Curling
   - Rowing
   - Volleyball
   - Football
   - Wrestling
   - Basketball
   - Gymnastics
   - Swimming
   - Hockey
   - Field Hockey
   - Baseball
   - Other

11. Which league do you compete in?
   - OUA
   - OCAA
   - Extramural
   - Other

12. If other was chosen in the previous question, specify where.
### Appendix C – Attitude Scale

**Attitudes and Beliefs Towards Protective Behaviours**

In this section we are interested in your views on concussion prevention behaviours and activities. Please indicate how much you agree or disagree with the following statements about concussion prevention by ticking the appropriate box.


<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Protective equipment will reduce the risk of concussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adopting fair play rules (rewarding less aggressive play) will reduce the risk of concussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The emphasis on winning in competitive sports increases the risk of concussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My competitive nature increases my risk of concussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would risk suffering a concussion to succeed in a sport that really matters to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wearing protective equipment is a sign of weakness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being in better shape can physically reduce the risk of concussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would risk giving another player a concussion to succeed in a sport that really matters to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body contact should be eliminated in all minor sports under the age of 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel safer taking risks when wearing protective equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waiting the recommended recovery time before returning to play is important to avoid further injury or problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled athletes are more likely to suffer a concussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full contact practice puts me at greater risk of concussion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athletes hide their concussion symptoms so as to not be taken out of play.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hiding concussion symptoms from others puts athletes at greater risk of further injury or problems.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Forms of media ever publicize concussion injuries.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forms of media overstate the problems associated with concussion injuries.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix D – Intention Scale

### Intentions Towards Protective Behaviours

In this section we are interested in understanding your intentions towards protective behaviours. Please indicate the extent to which you would engage in the following concussion prevention behaviours by ticking the appropriate box.


<table>
<thead>
<tr>
<th></th>
<th>1. No/Never</th>
<th>2. Maybe/Sometimes</th>
<th>3. Yes/Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wear protective headgear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Wear a mouth guard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Avoid sports that have a high risk of concussion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Play sports recreationally rather than competitively</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Only play sports in non-contact leagues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Advocate for rule changes that would reduce the risk of injury (e.g. removing tackling from football)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. If you are paying attention please pick ‘3. Yes/Always’.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Confront aggressive teammates about the risk they are posing to others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Get in better shape physically to reduce the risk of suffering a concussion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Vocalize your discontent to the referees and officials for missing violent infractions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Avoid contact sports altogether</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Confront aggressive opponents about the risk they are posing to others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Adopt a less aggressive style of play to reduce the risk I pose to others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I feel confident in demonstrating my right to safe play, even if it means not competing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. After getting a concussion, I would wait the recommended recovery time before returning to play</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I would learn proper form to go into contact before engaging in a contact sport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I avoid contact in practice drills to minimize the chance of concussion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. I would hide my symptoms in order to return to play quicker</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E – Debrief Form

Debriefing: “It’s all in the head: Concussion perceptions and prevention practices”

Principle Investigators:

Supervisor: Fergal O’Hagan Ph.D.
Department of Psychology
Trent University
Ph: (705) 748-1011 ext. 7086
E-mail: fergalohanag@trentu.ca

M.Sc. Student: Michael Jorgensen
E-mail: mjorgensen@trentu.ca

Dear participant,

We would like to thank you for participating in this study. The goal of this research is to identify the perceptions and the level of understanding that varsity athletes have about concussions. We are also interested in how this level of understanding may influence any attitudes and intentions towards concussion prevention and management behaviours.

You may contact me, Michael Jorgensen, with any questions about this study at mjorgensen@trentu.ca, or my thesis supervisor Fergal O’Hagan at fergalohanag@trentu.ca. The services listed below can help those struggling with the effects of concussion. If you are interested in the results of the study, please contact us directly.

Questions or concerns about the study can also be directed to Karen Mauro at the Trent University Research Ethics Office at 705-748-1011 x 7050.

Thank you very much for your participation and support,

Michael Jorgensen

Four Counties Brain Injury Association
158 Charlotte St.
Peterborough, Ontario, K9J 2T8
Phone: (705) 741-1172
Email: fcbia@nexicom.net

Trent University
Counseling Centre
Blackburn Hall, Suite 113
Peterborough, Ontario, K9J 7B8
Phone: (705) 748-1386
Email: counselling@trentu.ca

Research Ethics Board Protocol #22616
## Appendix F – Distribution and Descriptive Statistic Tables

### Table 15. Response frequencies of attitude items

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Responses</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protective equipment will reduce the risk of concussion</td>
<td>175</td>
<td>0 (0%)</td>
<td>6 (3.4%)</td>
<td>8 (4.6%)</td>
<td>82 (46.9%)</td>
<td>79 (45.1%)</td>
</tr>
<tr>
<td>2. Adopting fair play rules (rewarding less aggressive play) will reduce the risk of concussion</td>
<td>175</td>
<td>7 (4%)</td>
<td>22 (12.6%)</td>
<td>21 (12%)</td>
<td>79 (45.1%)</td>
<td>46 (26.3%)</td>
</tr>
<tr>
<td>3. The emphasis on winning in competitive sports increases the risk of concussion</td>
<td>174</td>
<td>27 (15.4%)</td>
<td>49 (28%)</td>
<td>33 (18.9%)</td>
<td>55 (31.4%)</td>
<td>10 (5.7%)</td>
</tr>
<tr>
<td>4. My competitive nature increases my risk of concussion</td>
<td>175</td>
<td>15 (8.6%)</td>
<td>42 (24%)</td>
<td>27 (15.4%)</td>
<td>69 (39.4%)</td>
<td>22 (12.6%)</td>
</tr>
<tr>
<td>5. I would risk suffering a concussion to succeed in a sport that really matters to me</td>
<td>175</td>
<td>19 (10.9%)</td>
<td>31 (17.7%)</td>
<td>26 (14.9%)</td>
<td>68 (38.9%)</td>
<td>31 (17.7%)</td>
</tr>
<tr>
<td>6. Wearing protective equipment is a sign of weakness</td>
<td>175</td>
<td>77 (44%)</td>
<td>74 (42.3%)</td>
<td>11 (6.3%)</td>
<td>8 (4.6%)</td>
<td>5 (2.9%)</td>
</tr>
<tr>
<td>7. Being in better shape can physically reduce the risk of concussion</td>
<td>174</td>
<td>12 (6.9%)</td>
<td>32 (18.3%)</td>
<td>40 (22.9%)</td>
<td>64 (36.6%)</td>
<td>26 (14.9%)</td>
</tr>
<tr>
<td>8. I would risk giving another player a concussion to succeed in a sport that really matters to me</td>
<td>175</td>
<td>53 (30.3%)</td>
<td>47 (26.9%)</td>
<td>20 (11.4%)</td>
<td>35 (20%)</td>
<td>17 (9.7%)</td>
</tr>
</tbody>
</table>
9. Body contact should be eliminated in all minor sports under the age of 15.

10. I feel safer taking risks when wearing protective equipment.

11. Waiting the recommended recovery time before returning to play is important to avoid further injury or problems.

12. Unskilled athletes are more likely to suffer a concussion.

13. Full contact practice puts me at greater risk of concussion.

14. Athletes hide their concussion symptoms so as not to be taken out of play.

15. Hiding concussion symptoms from others puts athletes at greater risk of further injury or problems.

16. Forms of media over publicize concussion injuries.

17. Forms of media overstate the problems associated with concussion injuries.
<table>
<thead>
<tr>
<th>Item</th>
<th>Total Responses</th>
<th>Strongly Disagree</th>
<th>Neither agree nor disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wear protective headgear</td>
<td>174</td>
<td>38(21.7%)</td>
<td>72(41.1%)</td>
<td>64(36.6%)</td>
</tr>
<tr>
<td>2. Wear a mouth guard</td>
<td>174</td>
<td>32(18.3%)</td>
<td>45(25.7%)</td>
<td>97(55.4%)</td>
</tr>
<tr>
<td>3. Avoid sports that have a high risk of concussion</td>
<td>172</td>
<td>122(69.7%)</td>
<td>41(23.4%)</td>
<td>9(5.1%)</td>
</tr>
<tr>
<td>4. Play sports recreationally rather than competitively</td>
<td>174</td>
<td>121(69.1%)</td>
<td>49(28%)</td>
<td>4(2.3%)</td>
</tr>
<tr>
<td>5. Only play sports in non-contact leagues</td>
<td>174</td>
<td>146(83.4%)</td>
<td>24(13.7%)</td>
<td>4(2.3%)</td>
</tr>
<tr>
<td>6. Advocate for rule changes that would reduce the risk of injury (e.g. removing tackling from football)</td>
<td>173</td>
<td>123(70.3%)</td>
<td>42(24%)</td>
<td>8(4.6%)</td>
</tr>
<tr>
<td>8. Confront aggressive teammates about the risk they are posing to others</td>
<td>174</td>
<td>39(22.3%)</td>
<td>91(52%)</td>
<td>44(25.1%)</td>
</tr>
<tr>
<td>9. Get in better shape to reduce the risk of suffering a concussion</td>
<td>174</td>
<td>11(6.3%)</td>
<td>53(30.3%)</td>
<td>110(62.9%)</td>
</tr>
<tr>
<td>10. Vocalize your discontent to the referees and officials for missing violent infractions</td>
<td>174</td>
<td>24(13.7%)</td>
<td>66(37.7%)</td>
<td>84(48%)</td>
</tr>
<tr>
<td>11. Avoid contact sports all together</td>
<td>174</td>
<td>157(89.7%)</td>
<td>15(8.6%)</td>
<td>2(1.1%)</td>
</tr>
<tr>
<td>12. Confront aggressive opponents about the risk they are posing to others</td>
<td>174</td>
<td>50(28.6%)</td>
<td>91(52%)</td>
<td>33(18.9%)</td>
</tr>
<tr>
<td>13. Adopt a less aggressive style of play to reduce the risk I pose to others</td>
<td>174</td>
<td>89(50.9%)</td>
<td>70(40%)</td>
<td>15(8.6%)</td>
</tr>
<tr>
<td>14. I feel confident in demonstrating my right to safe play, even if it means not competing</td>
<td>173</td>
<td>61(34.9%)</td>
<td>84(48%)</td>
<td>28(16%)</td>
</tr>
<tr>
<td>15. After getting a concussion, I would wait the recommended recovery time before returning to play</td>
<td>173</td>
<td>10(5.7%)</td>
<td>36(20.6%)</td>
<td>127(72.6%)</td>
</tr>
<tr>
<td>16. I would learn proper form to go into contact before engaging in a contact sport</td>
<td>174</td>
<td>13(7.4%)</td>
<td>29(16.6%)</td>
<td>132(75.4%)</td>
</tr>
<tr>
<td>Question</td>
<td>Count</td>
<td>Yes (%)</td>
<td>No (%)</td>
<td>Other (%)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
<td>---------</td>
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</tr>
<tr>
<td>17. I avoid contact in practice drills to minimize the chance of concussion</td>
<td>173</td>
<td>109 (62.3%)</td>
<td>51 (29.1%)</td>
<td>13 (7.4%)</td>
</tr>
<tr>
<td>18. I would hide my symptoms in order to return to play quicker</td>
<td>174</td>
<td>96 (54.9%)</td>
<td>63 (36%)</td>
<td>15 (8.6%)</td>
</tr>
</tbody>
</table>