Psychosocial Risk Factors of Sports Injury Occurrence and Severity among Elite Youth Ice Hockey Players

by

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Abstract

Psychological factors have been shown to play a role in the frequency and severity of injury among athletes. The Behaviour Assessment System for Children, Second Edition (BASC-II) was utilized to measure sixteen psychological factors and determine whether these factors predicted rate and severity of total injury and concussion versus musculoskeletal (MSK) injuries. Participants included male Bantam and Midget level ice hockey players (n=524). Participants completed the BASC-II at baseline and post injury. Injury records were completed by team designates during the hockey season during a period of six months. The five main factors included in the regression model were sensation seeking, locus of control, anxiety, depression and attention problems. The result suggested that together the five main factors could explain 10.7% of total injury occurrence and 12.0% of MSK injury occurrence. The five main factors did not significantly predict concussion occurrence or injury severity. Attention problems alone significantly predicted total injury and concussion occurrence and injury severity. Locus of control and depression significantly predicted MSK injuries. Knowledge of these psychological risk factors should guide psychosocial risk assessment and subsequent interventions.

Dedications

This thesis is first and foremost dedicated to my family. Their unwavering and unconditional love and support, words of encouragement, compassion, and wisdom made my journey through graduate school possible.

To my parents, I cannot begin to thank you enough for all you have done for me throughout my life. You have always been my greatest supporters, no matter the endeavor. You always believed in me, encouraged me to be the best person that I could be, and have provided me with precious guidance.

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This thesis is also dedicated to my dearest friends, especially my SCCP cohort. I am grateful to have gone through this journey with you. Thank you for your kind words of motivation and for sharing your wealth of knowledge. Your desire to make positive changes in the lives of children is truly inspirational.

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Chapter One—Introduction

Every year, hundreds of thousands of young athletes participate in organized sports (Canadian Heritage, 2013). Physical injury is a negative experience athletes fervently try to prevent, but the competitive and physically demanding nature of sports makes it difficult to avoid (Pargman, 1999). As such, thousands of young athletes sustain sport related injuries each year (Statistics Canada, 2010). Not only do these injuries often have serious physical consequences (Azuelos, Pearsall, Turcotte, & Montgomery, 2004; McKnight, Ferrara, & Czerwinska, 1992; Maffulli, Das, & Caine, 2000; Polites et al., 2014) but they can also have psychosocial and academic consequences (Kontos, Covassin, Elbin, & Parker, 2012; Sady, Vaughan, & Gioia, 2011; Smith & Milliner, 1994; Smith, Stuart, Wiese-Bjornstal, Milliner, et al., 1993). This is of particular importance for children and adolescents, compared to adults, as they are still maturing physically, socially, cognitively and emotionally (Purcell, 2009).

Empirical findings suggest injured athletes, compared to their non-injured counterparts, experience higher levels of tension, anger, depression, confusion, anxiety, and lower self-esteem (Chan & Grossman, 1988; Leddy, Lambert, & Ogles, 1994; McDonald & Hardy, 1990; Smith, Scott, O'Fallon, & Young, 1990; Smith, Stuart, Wiese-Bjornstal, Milliner, et al., 1993). Sports injuries can cause athletes to experience a period of emotional distress severe enough to warrant intervention from psychological professionals (Brewer, Petitpas, Van Raalte, Skiar, & Ditmar, 1995). Sports injuries, especially concussions, a type of mild traumatic brain injury, also have academic consequences. Concussions can lead to impaired cognitive functioning and deficits in reaction time, visual memory, processing speed, and verbal memory, all of which impact

a young person's ability to learn within a classroom (Hutchison, Mainwaring, Comper, Richards, & Bisschop, 2009; Sady et al., 2011). Approximately 73% of individuals ages 7 to 18 who sustain a concussion require school accommodations and 61% experience a decrease in grades. Given the possible significant psychosocial and academic consequences of sports injury, it is critical to identify risk factors to reduce or prevent the occurrence of sports injuries.

Psychological Risk Factors of Sports Injuries

There is growing realization that psychological factors may predict injury occurrence and severity (Williams & Andersen, 1998). Psychosocial variables such as life stress (Blackwell & McCullagh, 1990; Hardy & Riehl, 1988), lack of coping resources (Ivarsson & Johnson, 2010), anxiety (Kleinert, 2002; Kolt & Kirkby, 1994), depression (Lavallee & Flint, 1996), sensation seeking (Smith, Ptacek, & Smoll, 1992), locus of control (Pargman & Lunt, 1989), among others, have been found to increase the risk of sports injuries in children, adolescents and adults alike. Psychological factors have also been found to predict injury severity (Hanson, McCullagh, & Tonymon, 1992; Hardy & Riehl, 1988; Noh, Morris, & Andersen, 2005). It is important to not only consider the rate of sports injuries but the severity as well, since more severe injuries can cause greater negative psychosocial and academic consequences (Sady et al., 2011; Smith, Smoll, & Ptacek, 1990; Smith, Stuart, Wiese-Bjornstal, Milliner, et al., 1993). Given the rate of sports injuries among youth athletes and the possible subsequent negative psychosocial outcomes, it is imperative to identify psychological risk factors associated with sports injuries. Moreover, knowledge of these risk factors should guide preventive interventions to minimize the occurrence and severity of injuries.

Given the possible academic impact of sports injuries, it is important for teachers, school counsellors, coaches, and administrators to understand how sports injuries can impact young learners in classrooms and the possible psychosocial and academic outcomes. Knowing the possible outcomes of sports injuries will not only enable school personnel to minimize the academic consequences of injury, but will inform them on the need to understand psychological risk factors and implement preventative measures.

Because children and adolescents spend a considerable amount of their time at school, teachers, school counsellors, and administrators are in unique positions to address psychological risk factors of sports injuries and provide young athletes with coping skills and strategies to address these risk factors. They are in a position to identify students with more psychological risk factors and provide targeted preventive interventions. The findings of this present study will hopefully provide school personnel with valuable information they can use to help address the psychological risk factors of sports injuries. Given the deleterious effects of outcomes on attendance, assignments and examinations, course completion, and overall school success, addressing psychological risk factors is especially imperative for adolescents, as they are coming to a point in their academic career where attendance and grades are of upmost importance for graduation, job opportunities, and acceptance into post-secondary education (Allensworth & Easton, 2005).

To understand the importance of prevention, it is valuable to understand the number of young athletes who participate in sports who are at risk of injury.

Sports Injuries in Youth

Sports and recreational activities are the leading cause of injury for young people in Canada (Davison, Russell, Piedt, Pike, & Pickett, 2013). According to Statistics Canada (2010), young individuals ages 12 to 19 have the highest likelihood of injury, compared to all other age groups in Canada. Up until the age of 16, the risk of injury increases almost linearly (Bruhmann & Schneider, 2010). According to the 2009-2010 Statistics Canada data, approximately 27% of individuals ages 12 to 19 suffered an injury, twice the rate of adults (14%) and three times the rate of seniors (9%) and two out of three injuries (66%) among adolescents were associated with sport related injuries.

A retrospective survey conducted in Calgary (Alberta, Canada) determined 94% of adolescents ages 14 to 19 participated in sport in the previous year (Emery, Meeuwisse, & McAllister, 2006). Of the 2721 students who responded to the survey, approximately 65% reported they had suffered at least one sports injury in the past year. Of those individuals who reported at least one injury, 70.1% reported they had sustained multiple injuries in that year. The injury rate for those requiring medical attention (i.e. physician, nurse, athletic therapy, etc.) was 40.2 injuries/100 adolescents and was 8.1 injuries/100 adolescents for those who had to stop play and be taken to the hospital. The injury rate was 49.9/100 adolescents for injuries that caused the adolescent to miss at least one day from sport.

Injury rates suggest sports injuries are not only a concern in Canada, but internationally. In a retrospective epidemiological study in Brazil, the sport injury frequency was 12% for children (12 years old and younger) and 21% for adolescents (aged 12 to 18 years) in the previous 12 months (Vanderlei, Vanderlei, Bastos, Netto

Junior, & Pastre, 2014). In a retrospective epidemiological study in Germany, Bruhmann and Schneider (2010) concluded eight out of 100 adolescents (aged 11 to 17) sustained a sports injury in the previous 12 months. Inconsistencies in definitions of injury and means of reporting may account for the differences in rates.

Sports Injuries in Ice Hockey

Ice hockey is one of the most popular sports in Canada and is considered "Canada's game" (Hockey Canada, 2015). Every season, hundreds of thousands of Canadian youth play hockey in more than 3,500 minor hockey associations across Canada. Hockey Canada (2015) and USA Hockey (2015) reported over 635,000 and 350,000 registered players under the age of 19, respectively, in the 2014-2015 season, with a steady increase in participation over the years. Similarly to Canada and the USA, there has been a steady increase in participation rates over the years in countries such as Finland, Russia, Sweden, Germany, Czech Republic and Switzerland, who all had more than 15,000 registered youth ice hockey players under 20 years old in 2015 (International Ice Hockey Federation, 2015).

Like all contact sports, injury is an inevitable outcome in ice hockey. With the popularity of hockey among youth comes the concern of injury and the potential short-term and long-term consequences. Compared to other sports played by Canadian youth, hockey has one of the highest participation rates in Canada, but also has one of the highest rates of injury in youth sports (Caine, Caine, & Maffulli, 2006; Emery, 2003). Direct fatality and injury rates are twice as high in ice hockey compared to football (Marchie & Cusimano, 2003). Canadian data suggests that hockey related injuries could account for approximately 10% of all adolescent injuries (Emery, Meeuwisse et al.,

2006). A retrospective review of medical records across five Edmonton (Alberta, Canada) emergency departments found that ice hockey accounted for 21% of sport/recreational head injuries, with the 15 to 19 year old age group having the greatest number of head injuries and the highest percentage of head injuries compared to all other injuries in ice hockey (Kelly, Lissel, Rowe, Vincenten, & Voaklander, 2001). Based on the number of children and adolescents registered in hockey programs and the injury rates, thousands of young hockey players are experiencing the myriad negative effects from sports related injuries each year.

Rationale

The majority of research regarding psychological predictors of sports injuries has focused on college and adult athletes samples; however, the substantial risk of injury among young athletes warrants attention for this population. Moreover, very few studies have examined the psychological predictors of injuries among ice hockey players. The rate of participation in Canada, the high impact nature of the sport, and the rate of sport injuries, concussions specifically, in ice hockey highlights the need for more research for this sport in particular.

In addition, most studies that investigate the psychological risk factors associated with sports injuries do not distinguish concussion from other injuries; they are grouped into a single category of "sports injury." Research on concussions, to date, has focused mostly on psychosocial outcomes, rather than predictive factors. Studies suggest concussions can cause short- and long-term psychological, emotional, and cognitive disruptions and pose a unique threat to the developing brain of young athletes (Junn, Bell, Shenouda, & Hoffman, 2015; McCrory et al., 2013; Sady et al., 2011). Given these

findings, it is imperative to understand the psychological risk factors of concussion to reduce and prevent their occurrence. Overall, through the current exploration of psychological predictors of sports injuries occurrence and severity, and the difference of these predictors for concussion and other sports injuries, it is hoped this study will help coaches, parents, and school personnel become key participants in the identification of psychological risk factors and implementation of preventive interventions to reduce psychosocial and academic consequences of sports injuries.

Underlying Assumptions

There are a number of assumptions that underlie the formation of research questions for this study. The first assumption is that psychological factors predict injury occurrence. Research currently identifies that psychosocial factors, such as life stress, anxiety, depression, and poor coping resources increase an athlete's vulnerability of sustaining an injury. Another assumption is that these psychosocial variables also predict the severity of the injury. The last assumption is that sports injuries, concussions in particular, have both short- and long-term psychological consequences and preventive interventions are needed to address psychological risk factors. Therefore, evaluating the psychological predictors of sports injuries is relevant and important to this study.

The Present Study

The purpose of the study is to investigate 1) the predictability of psychosocial factors on sports injury rates among elite youth ice hockey players, 2) determine whether the predictability of psychosocial factors differs between concussion and other sports injuries, and 3) whether psychosocial factors predict injury severity.

A review of literature regarding the role psychological factors play in the rate and severity of injuries among athletes will follow in Chapter Two. Information on the different psychosocial outcomes of concussion versus other sports injuries will also be provided. The review will conclude with an examination of the possible psychological consequences of sports injuries, for both concussion and other sports injuries. Details regarding the study design and the methods of data collection (Chapter Three) and the quantitative statistical analysis of the data will then be presented (Chapter Four). Finally, the document will conclude with a discussion of the results, the limitations of the present study and future implications.

Chapter Two—Literature Review

This chapter will provide an overview of psychological risk factors of sports injuries, which will include a review of Williams and Andersen's (1998) stress and injury model, the theoretical base for much of the psychological risk factors of sports injuries research and this present study. The chapter will also include a review of the literature on the unique psychological and academic consequences of concussion in comparison to other sports injuries, and the effect of psychological variables on injury severity. The rationale leading to the research objectives and hypotheses will conclude the chapter. There is a substantive body of literature in sports psychology related to injury prediction and outcome. The purpose of this thesis is to focus on a subsection of this literature.

Psychosocial Injury Risk Factors

There are many factors that can contribute to sports injuries, such as environment, equipment, and the physical conditions of the player. In addition, there is growing realization that psychological factors, such as competitive and trait anxiety, life stress, depression and coping strategies may be playing a role in the frequency and severity of injuries among athletes (Blackwell & McCullagh, 1990; Johnson, 2007; Petrie, 1992). There have been several models proposed to address the psychosocial factors that influence injury risk among athletes, with the most popular and influential being Williams and Andersen's (1998) theoretical model of stress and injury. This model was selected for this study as it provides a multi-component theoretical model of stress and injury and "has helped provide the impetus and theoretical base for much of the psychology of sport injury risk research" (Williams & Anderson, 1998, p. 6).

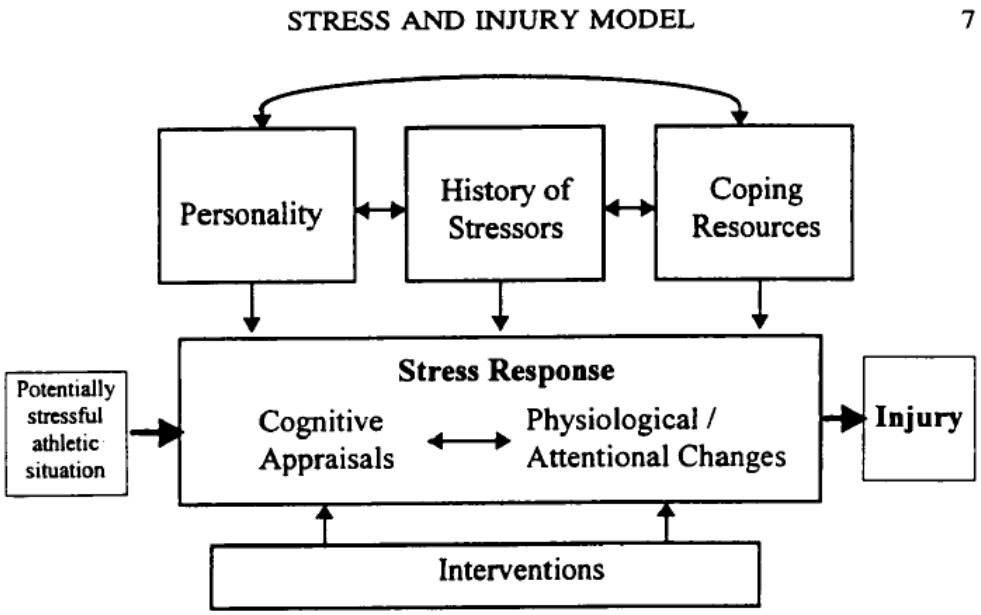
Stress and injury model.

Williams and Andersen's (1998) stress and injury model suggests psychosocial risk factors influence the athlete's perception and appraisal of stressful situations. These risk factors are divided into three categories: History of stressors, coping resources and personality factors. Williams and Andersen (1998) provide the following definition to explain their stress and injury model:

> According to the original stress and injury model (Andersen & Williams, 1988), when sport participants experience stressful situations such as a demanding practice or crucial competition, their history of stressors (i.e. life event stress, daily hassles, past injury history), personality characteristics (i.e., hardiness, locus of control, sense of coherence, competitive trait anxiety, achievement motivation, sensation seeking), and coping resources (i.e., general coping behaviours, social support, stress management and mental skills, and medication) contribute interactively or in isolation to the stress response. The central hypothesis of the model is that individuals with a history of many stressors, personality characteristics that tend to exacerbate the stress response and few coping resources will, when placed in a stressful situation, appraise the situation as more stressful and exhibit greater physiological activation and attentional disruptions compared to individuals with the opposite psychosocial profile. The severity of the resulting stress response, caused by the increased stress reactivity of at-risk individuals, is the mechanism proposed to cause the injury (p.6).
>
> See Figure 1 for the stress and injury model (Williams & Andersen, 1998, p.7)

Figure 1

Stress and Injury Model



The model suggests the appraisal and response of the athlete to the situation influences the strength of the stress response. The strength of the stress response can have a direct impact on the athlete's physiological (e.g., fatigue levels) and cognitive abilities (e.g. peripheral vision, attention) (Ivarsson, Johnson, Lindwall, Gustafsson, & Altemyr, 2014). Williams and Andersen (1998) argue:

> The presence of desirable personality and/or coping variables may buffer individuals from stress and injury by helping them to perceive fewer situations and events as stressful or by lessening their susceptibility to the effects of their history of stressors. Conversely, the lack of desirable personality characteristics and coping resources, or the presence of undesirable characteristics (e.g. high competitive trait anxiety), may leave individuals vulnerable to higher stress (acute and chronic) and, presumably, greater injury risk (p.7).

The following section will discuss research based on the theoretical conceptualization of Williams and Andersen's (1998) stress and injury model. It provides the theoretical basis for the present study and the inclusion of history of stressors and coping resources, as well as personality factors, provides an understanding and appreciation of the many psychological factors that influence an athlete's vulnerability to sports injuries.

History of Stressors.

The first category within the stress and injury model is history of stressors, which consists of major life events, daily hassles and history of previous injury (Williams & Andersen, 1998). Life event stress has received the most extensive research. One of the first studies conducted was by Holmes in 1970 where he administered the Social Readjustment Rating Scale (SRRS) to a University football team. Holmes (1970) found that 50% of the football athletes who had experienced high levels of life stress in the year prior to the football season sustained a sports injury, whereas only 9% and 25%, respectively, of the athletes who had low and moderate levels of life stress had similar injuries. An even stronger relationship was found between life stress and sports injuries by Bramwell, Masuda, Wagner, and Holmes (1975) when they modified the SRRS into the Social and Athletic Readjustment Rating Scale (SARRS) to make it more appropriate for intercollegiate athletes. They categorized the athlete's level of life stress into low, medium and high, and found that 30%, 50%, and 73% of the athletes, respectively, sustained sports injuries. Using the SARRS, Cryan and Alles (1983) had similar results when looking at life change. They found college football players who experienced high levels of life change were at greater risk of sustaining a sports injury and had greater risk

of sustaining multiple injuries during the season compared to athletes with low amounts of life change. Athletes with high life change were at no greater risk of sustaining a major injury compared to those with low life change.

Since the first studies, there have been dozens of studies that have investigated the relationship between life stress and sports injuries. In a review, Williams and Roepke (1993) found that 18 out of the 20 studies they reviewed found some level of positive relationship between high life stress and sports injury. They found the most significant evidence for football, but also found evidence for other sports such as figure skating, baseball, gymnastics, soccer, field hockey, wrestling, skiing, and track and field. Williams and Roepke (1993) found that injuries were two to five times more likely in high life stress athletes than low life stress, and this risk of injury increased proportionately with the level of life stress. However, the majority of these studies were on college athletes, not on children and adolescents, and none were on ice hockey. Thus, the findings may not be generalizable to youth ice hockey players, highlighting the need for more studies on this age group and sport.

The stress and injury model posits that life events can be very stressful, even those many would consider positive, such as winning the lottery, getting married, or going on vacation. Thus, many of the life stress studies separated life stress into three different categories: Negative life events (NLE), positive life events (PLE), or total life events (TLE) (Williams and Andersen, 1998). Results varied considerably. Most studies that distinguished these different types of life events found that only NLE increased risk of injury or that injured athletes had significantly higher negative life stress than noninjured athletes (Hardy & Riehl, 1988; Passer & Seese, 1983; Petrie, 1992; Petrie,

1993a; Smith, Ptacek, et al., 1992; Smith, Smoll, et al., 1990). However, TLE and PLE were also found to increase the risk of injury in some situations (Blackwell & McCullagh, 1990; Petrie, 1993b). For instance, Blackwell and McCullagh (1990) found that TLE contributed to injury occurrence, whereas PLE increased the likelihood of sustaining a severe injury. Petrie (1993b) found that PLE was the only life stressor to predict the amount of time loss due to injury.

Another component of the history of stressors portion of the model is daily hassles. Ivarsson, Johnson, Lindwall, Gustafsson, and Altemyr (2014) investigated the effect of daily hassle and daily uplifts on injury risk among Swedish elite junior soccer players. Daily hassles can be defined as "everyday irritations, such as minor problems at work, not getting enough sleep, and losing things" and daily uplifts are "events that make one feel good, for example, they produce feelings of joy, gladness, or satisfaction" (Ivarsson, Johnson, Lindwall, et al., 2014, p.307). The authors concluded that athletes with higher levels of daily hassles and lower levels of daily uplifts had higher risk of injury.

The third component of history of stressors is history of injuries. A number of studies have found that history of injury increases risk of injury (Lysens, Steverlynck, et al., 1984; Steffen, Pensgaard and Bahr, 2009; Yang et al., 2014). Lysens, Steverlynck, et al. (1984) found that physical education students who had sustained previous injury were at a greater risk of injury reoccurrence. Steffen, Pensgaard, and Bahr (2009) found that a history of a previous injury increased the risk of a sustaining an injury to the same region. They found a quarter of all acute injuries recorded were re-injuries. Furthermore, they determined the risk of injury was almost twice as high for athletes with a previous injury

to the same region than those without a history of injury, and the risk of sustaining a new sports injury increased with the number of previous injuries reported. In contrast, Smith, Stuart, Wiese-Bjornstal, and Gunnon (1997) concluded previous injury did not significantly predict present injuries.

In summary, a review of the literature suggests life stress, daily hassles, and history of injuries has a considerable impact on the occurrence of sports injuries. Although the purpose of the present study is not investigating all aspects of stressors including life stress, daily hassles, and history of injuries, as psychological risk factors of injury, the review of the literature in this area suggests there is limited to no research on youth ice hockey players. Findings from studies using adult samples and other sports may not be generalizable to youth ice hockey players. Moreover, it is important to also understand how these factors in youth ice hockey players relates to, and influences, the psychological factors explored in the present study; thus, more research is needed for this age group and sport.

Coping resources.

The stress and injury model includes coping resources, which consists of psychological coping skills, social support and stress management. Evidence is inconsistent in this area. Hanson, McCullagh, and Tonymon (1992) found the injury group had significantly fewer coping resources compared to the noninjured group. They also concluded that coping resources contributed the most in discriminating the differences between severity and frequency of injury. Ivarsson and Johnson (2010) found injured players, compared to noninjured, had significantly higher levels of poor coping skill, such as self-blame and behavioural disengagement. Noh, Morris, and Andersen

(2005) concluded coping skills were moderately correlated with frequency of injury among professional ballet dancers. In regards to social support specifically, Smith, Smoll, and Ptacek (1990) and Hardy, Richman, and Rosenfeld (1991) found that high levels of social support reduced the risk of injury.

In contrast, other studies did not find a relationship between coping resources and injury susceptibility (Dvorak et al., 2000; Ivarsson, Johnson, & Podlog, 2013; Johnson & Ivarsson, 2011; Smith, Stuart, Wiese-Bjornstal, & Gunnon, 1997). Lavallee and Flint (1996) made similar conclusions; however, in their study, social support alone did not significantly influence the frequency of severity of injury, but greater satisfaction with social support was related to lower levels of depression. This is significant since they found that higher levels of depression was positively related with rate of injury in rugby players, suggesting social support may indirectly have a protective effect; however, this has never been tested in youth ice hockey players.

Personality.

Empirical findings suggest there are several psychological variables that have been identified as moderators in the stress and injury model. These psychological variables will be the primary focus of the present study. Locus of control, anxiety, perfectionism, mood states, self-confidence, self-esteem, defensive pessimism, aggression, anger, and sensation seeking have all been shown to predict injury occurrence (Johnson, 2007; Williams & Andersen, 1998). Of these variables, locus of control, sensation seeking, anxiety and mood states have been the most extensively researched. Moreover, the BASC-II, the instrument utilized for the present study, measures these four

psychosocial factors. Thus, the following section will provide a review of the literature on locus of control, sensation seeking, mood states, and anxiety.

Locus of control.

Individuals with external locus of control tend to believe that their achievement is due to outside influences and factors, whereas individuals with an internal locus of control believe the achievement of their goals is dependent upon their own ability and effort (McLeod & Kirkby, 1995). Pargman and Lunt (1989) reported external locus control among college football players was correlated with higher rate of injury. Similarly, Dalhauser and Thomas (1979) concluded high school football players with less internal locus of control sustained more injuries. In contrast, Kolt and Kirkby (1996) reported no relationship with locus of control among nonelite gymnasts ages 9 to 18, but found that a higher internal locus of control significantly predicted rates of injury among elite gymnasts. Kerr and Minden (1988) reported no relationship between locus of control and injury among elite gymnasts ages 11 to 19. Passer and Seese (1983) and Hanson et al., (1992) found no relationship between locus of control among university athletes (football and track and field).

Sensation seeking.

Sensation seeking is "individual differences in the ability to tolerate emotional arousal produced by stressful life events" (Smith, Ptacek et al., 1992, p.1017). In a sample of high school varsity athletes, Smith, Ptacek and Smoll (1992) determined high sensation seeking functioned as a buffer against stress rather than a vulnerability factor. They concluded athletes with low sensation seeking were at greater risk of injury following exposure to a major sport stress than the athletes with high sensation seeking.

They found that high sensation seekers had higher coping scores on four subscales of the Athletic Coping Skills Inventory (ACSI): Freedom from worry, concentration, stress management, and peaking under pressure. Several other studies have reported significant correlations between negative life events and psychological distress among low sensation seekers, but not high sensation seekers (Johnson, Sarason, & Siegel, 1979; Smith, Johnson, & Sarason, 1978; Vagi & Lefcourt, 1988), suggesting low sensation seeking among athletes may be a stress vulnerability factor.

Mood states.

Among a group of male high school ice hockey players, ages 15 to 18 years, Smith, Stuart, Wiese-Bjornstal, and Gunnon (1997) found preseason depression was related with present injuries. Lavallee and Flint (1996) reported depressed mood was significantly related to rate of injury among varsity football athletes. Similarly, Williams, Hogan, and Andersen (1993) concluded athletes with a positive state of mind early in the season sustained fewer injuries than those who had a less positive state of mind. Utilizing the Center for Epidemiological Studies Depression Scale, Yang et al., (2014) found that intercollegiate athletes who experienced more depressive symptoms at baseline were more likely to sustain a sport injury compared to those who did not experience depressive symptoms. They determined one-fifth of players were experiencing symptoms of depression and that 86% of those players were also experiencing symptoms of anxiety.

Anxiety.

The empirical evidence that has examined the influence of anxiety on sports injury rate and severity has divided anxiety into two different categories: state (in the sports literature it is commonly referred to as competitive anxiety; the terms will be used

interchangeably in this paper) and trait anxiety. State anxiety is "based on a pattern of variables that covaried over occasions of measurement, defining a transitory state or condition of the organism which fluctuated over time" (Spielberger, 1966, p.13). Moreover, Spielberger (1966) suggested state anxiety is "characterized by subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system" (p.17). Trait anxiety, on the other hand, measures "stable individual differences in a unitary, relatively permanent personality characteristic" (Spielberger, 1966, p.13). Anxiety, as a personality trait, suggests there is a motive or acquired behavioural disposition that influences individuals to perceive non-dangerous situations as threatening and to respond disproportionally to the level of danger. Mixed results have been reported for trait and competitive anxiety. In general, stronger relationships were found between trait and state anxiety and injury frequency when sport-specific measures were utilized (Johnson, 2007).

Trait anxiety. Research has shown trait anxiety predicts injury occurrence among adolescents and adult soccer players (Johnson and Ivarsson, 2011; Ivarsson & Johnson, 2010). Johnson and Ivarsson (2011) and Ivarsson and Johnson (2010) found that injured players had higher levels of somatic trait anxiety at baseline, compared to their non-injured counterparts. In a more recent study with Swedish Premiere League soccer players ages 16 to 36, Ivarsson, Johnson and Podlog (2013) concluded trait anxiety was indirectly related to injury occurrence through daily hassles and negative life stress. They suggested an athlete's personality trait may not be enough to directly influence their susceptibility to injury; rather, it may increase the likelihood of the athlete appraising a

situation as threatening, increasing their physiological stress response, resulting in an increased injury risk.

In contrast, Yang et al. (2014) found one-third of the collegiate football players in their study were experiencing anxiety, with 52% of those players also experiencing depression; athletes with high trait anxiety symptoms were less likely to sustain a sports injury. In comparison, Kerr and Minden (1988) reported no relationship between competitive anxiety and injury rate among adolescent female gymnasts. Kleinert (2002) took experience of injury into account and examined the effect of trait anxiety on the occurrence and severity of sports injuries in German university sport students, utilizing the Sport Injury Trait Anxiety Scale (SITAS). Kleinert (2002) concluded athletes with high experience of injury in the past 5 years, who had low trait anxiety, sustained severe injuries twice as frequently as those who had less injury experience. University sport students with high injury experience and low trait anxiety were injured three times more frequently than athletes with high trait anxiety. Those with high injury experience and high trait anxiety were not injured more frequently than athletes with low injury experience. There was no difference between non-injured students and students with previous injury/low trait anxiety. Kleinert (2002) suggested trait anxiety might have a "protective effect." Athletes with high trait anxiety may be more attentive and concentrate more, whereas athletes with low trait anxiety may underestimate physical risks in high arousal situations, focusing solely on the task or the anticipated outcome.

Competitive anxiety. Lavallee and Flint (1996) found high competitive anxiety was related to rate of injury among university varsity rugby and football players. Moreover, these athletes with high competitive anxiety had greater levels of

tension/anxiety, anger/hostility, and total negative mood states, all of which were related to severity of injury. Kolt and Kirkby (1994) reported a relationship between injury frequency not only on scores obtained by the Sport Competitive Anxiety Test (CSTAI-2), but on the anxiety scale of the Profile of Mood States (POMS) for competitive gymnasts (ages 13 to 20).

In contrast, research has also shown no relationship between competitive anxiety and injury occurrence (Dvorak et al., 2000) and competitive anxiety was the lowest predictor of injury frequency among life stress, locus of control, social support, coping resources, and minor life events (Hanson et al., 1992).

Overall, the findings of the research on psychological predictors of sports injuries have been inconsistent. Within each psychosocial variable studied mentioned above (sensation seeking, locus of control, mood states, and anxiety), there have been positive, negative and no relationships found between the psychological factor and injury occurrence. This may be in part due to different age groups and sports being studied. In general, the majority of the research on psychological risk factors of sports injuries has focused on adult populations, and little to no studies have been conducted on ice hockey players. Thus, given the lack of research in young ice hockey players, and the inconsistency of findings in the literature, the goal of the present study was to investigate how sensation seeking, locus of control, depression and anxiety influence injury risk among youth ice hockey players, and the unique influence they may have on this population and sport.

Injury Severity

The literature on sports injuries has not only found psychological variables to be predictive of injury occurrence, but injury severity as well. This highlights the need to understand the psychological risk factors to reduce the frequency of both injury occurrence and severity. The sample for the majority of the literature examining the predictability of psychological factors on injury severity has been adults (Blackwell & McCullagh, 1990; Hardy & Riehl, 1988; Hanson et al., 1992; Kleinert, 2002; Lavallee & Flint, 1996; Noh et al., 2005; Petrie, 1992; Wittig & Schurr, 1994). The literature indicates negative life stress is related to injury severity; as negative life stress increases, so does the severity of the injury (Hanson et al., 1992; Hardy & Riehl, 1988; Noh et al., 2005). Among ballet dancers, freedom from worry and negative dance life stress were significant predictors for injury severity, and accounted for 17% of the variance in injury duration.

In contrast, positive life events, such as going on vacation or getting married, have been found to increase the likelihood of sustaining a severe injury (Blackwell & McCullagh, 1990). Competitive anxiety (Blackwell & McCullagh, 1990; Hanson et al., 1992; Passer & Seese, 1983; Petrie, 1992) and stress (Noh et al., 2005; Petrie, 1992) have also been shown to increase the chance of sustaining a severe injury and is related to longer recovery times. The literature has also found individuals who are described as "tough minded" (i.e. more independent, self-assured, and assertive) sustained more severe injuries, suggesting this type of personality profile may place these athletes at greater risk for severe injuries (Wittig & Schurr, 1994). Utilizing the POMS, Lavallee

and Flint (1996) concluded higher levels of tension/anxiety, anger/hostility and total negative mood state was significantly related to greater injury severity.

Kleinert (2002) took into account the athletes' previous history of injuries and their level of concern for sustaining another injury (injury anxiety) when investigating factors that contribute to injury severity. Kleinert (2002) reported athletes with high injury experience in the past five years with concurrent low levels of injury anxiety sustained severe injuries twice as frequently as athletes with less injury experience. Athletes with high injury experience and low injury anxiety were injured three times more frequently than those with high injury anxiety.

Evidence for relationships between psychosocial variables and injury severity has also been found among children and adolescents (Coddington & Troxell, 1980; Kerr & Minden, 1988; Smith, Ptacek et al., 1992). Life stressors were found to be related to injury severity among gymnasts and football players. Kerr and Minden (1988) determined gymnasts who had experienced more life stressors tended to incur more injuries and injuries of higher severity. Utilizing the Social and Athletic Readjustment Scale (SAARS), which assesses psychosocial disturbances in an athlete's life, Coddington and Troxell (1980) concluded athletes who were experiencing high levels of parental divorce or death and family instability incurred more serious injuries than other athletes who were not experiencing these family difficulties.

When taking levels of sensation seeking into account, Smith, Ptacek et al., (1992) found a positive relation between negative sports events, as measured by the Sport Experiences Survey (consists of both positive and negative sport-specific events) and injury severity (time-loss) for low sensation seekers. They did not find support for a

competing hypothesis that high sensation seeking would increase injury vulnerability and severity due to more risk taking behaviour. Although there is some research that has investigated the effect of psychosocial factors on injury severity, there does not appear to be any research on the impact of psychological variables on injury severity among youth ice hockey players. This highlights the need for more research on this population and sport. Understanding the psychological risk factors that influence injury severity will guide preventive interventions to reduce the significant psychosocial outcomes associated with higher injury severity.

In addition to studies exploring the impact of psychological factors on injury severity, research has also evaluated the psychological consequences of injury severity. Two prospective studies have shown injury severity, which was measured by time loss, to be an important moderator of psychological response to injury (Smith, Smoll, et al., 1990; Smith, Stuart, Wiese-Bjornstal, Milliner, et al., 1993). Smith, Stuart, Wiese-Bjornstal, Milliner et al. (1993) found greater injury severity was a significant predictor of higher levels of postinjury depression. Conversely, other studies have found no relationship between injury severity and postinjury mood disturbance (Brewer, Linder, & Phelps, 1995; Brewer, Petitpas, et al., 1995).

Concussion

Concussions represent an important emerging topic within youth injuries due to the negative psychosocial and academic outcomes associated with the injury, as well as the impact it has on the developing brains of young children. Concussions can cause emotional disturbances, such as anxiety and depression (Brewer, Petitpas, et al., 1995; Leddy et al. 1994), as well as impaired cognitive functioning, with deficits in reaction

time, visual memory, processing speed, and verbal memory, following the injury (Hutchison, Comper, Mainwaring, & Richards; 2011; Kontos et al., 2012; McClincy, Lovell, Pardini, Collins, & Spore, 2006; Sim, Terryberry-Spohr, & Wilson, 2008). The decrease in cognitive functioning and the emotional disturbances can adversely affect academic performance and social functioning (Corwin et al., 2014; Covassin, Elbin, Larson, & Kontos, 2012; Hutchison, Mainwaring, et al., 2009).

Although concussions present with a unique set of symptoms compared to other sports injuries and can cause serious psychosocial and academic consequences, most studies investigating psychological predictors of sports injuries do not separate concussion from other sports injuries. Given the high incidence rates and susceptibility of sport concussion among youth ice hockey players (Brust et al., 1992; Sady et al., 2011), the fact that hockey is associated with the highest rate of loss of consciousness among all sports (Emery, Meeuwisse, et al., 2006), and the risk of short-term and permanent neurological impairment (Ponsford et al., 1999; Segalowitz & Brown, 1991; Zimmerman & Bilaniuk, 1994), it is important to investigate concussions separately from other sports injuries. The present study separated concussions from musculoskeletal injuries (MSK), which are injuries that affect muscles, tendons, ligaments, nerves, discs, and include injuries such as strains, sprains, and contusions (Hutchison, Mainwaring, et al., 2009). The following section will provide a brief overview of the definition of concussion, the symptoms associated with concussion, the vulnerability of youth to concussions, and the psychological and academic consequences of concussion. Further, a comparison between concussion and MSK injuries will be included.

Definition.

A concussion is a unique sport-related injury as in some ways, it is an "invisible" or "hidden" disability, as the injury cannot be seen and the individual often appears to be "normal" (Kissick & Johnston, 2005). A concussion is a "complex pathophysiological process affecting the brain, induced by biomechanical forces" (McCrory et al., 2013, p.555). The following provides a brief overview of the definition and presentation of a concussion:

1) Concussion may be caused either by a direct blow to the head, face or neck or a blow elsewhere on the body with an impulsive force transmitted to the head.
2) Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously.
3) Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.
4) Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. In a small percentage of cases, however, post-concussive symptoms may be prolonged.
5) No abnormality on standard structural neuroimaging studies is seen in concussion. (McCrory et al., 2009, p.756).

Symptoms.

The symptoms of concussion are typically divided into three main categories: Physical, cognitive and emotional (Junn et al., 2015). Physical symptoms include

headache, neck pain, dizziness and postural instability, visual changes and sleep disturbances, with headache being one of the most common symptoms reported following a concussion (25-58% of concussed individuals report this symptom). Cognitive symptoms include memory impairment and slowed processing speed, memory and attention impairment, and fatigue. Lastly, emotional symptoms include depression and anxiety. Most concussion symptoms will improve within 7 to 10 days after the injury, with a complete resolution of all symptoms within three months postinjury (Junn et al., 2015). However, a small number of concussed athletes will experience symptoms past this time frame.

Concussion vulnerability in youth.

Children and adolescents are at a particularly high risk of sustaining a concussion (Sady et al., 2011). For instance, in youth hockey, each season, approximately 10-12% of minor hockey players ages 9 to 17 that sustain an injury report a concussion (Marchie & Cusimano, 2003). They are more vulnerable to brain injuries, of all levels of severity, and take longer to recover compared to adults (Sady et al., 2011; Williams, Puetz, Giza, & Broglio, 2015). Research has found that young athletes who sustain a concussion are four to six times more likely to experience a second concussion, with the second concussion resulting from milder trauma than the first, compared to those who have not had a concussion (Guskiewicz et al., 2003). Moreover, repeated concussions can result in cumulative deficits (Collins et al., 2002). High school athletes who had a history of three or more concussions were nine times more likely to experience loss of consciousness, anterograde amnesia and confusion after a subsequent concussion compared to those with no experience of concussion (Collins et al., 2002).

Psychosocial consequences of concussion.

Information on the psychosocial consequences of concussions was included to highlight the negative outcomes associated with concussion and the need to investigate this type of injury separately from other injuries. The literature suggests sport-related concussions can result in negative psychosocial outcomes, such as increased rate of depression and mood disturbances, as well as a decrease in neurocognitive functioning, which has been found to be related to the higher levels of depressive symptoms (Hutchison, Mainwaring, et al., 2009; Kontos et al., 2012; Mainwaring, Bisschop, Green et al., 2004; Mainwaring, Bisschop, Comper, Richards, & Hutchison, 2010). Clinical depression occurs in approximately 6% of the 1.6-3.0 million concussions (180,000) concussions in the United States each year (Jorge & Robinson, 2002). However, this statistic likely underestimates the true incidence rate of depression among those who have sustained a concussion due to the underreporting of concussion (Kontos et al., 2012).

Further, a history of concussion is associated with a three-fold increase for the risk of depression in adolescents (Chrisman & Richardson, 2014). Kontos, Covassin, Elbin, and Parker (2012) examined the relationship between sport-related concussion and depression in high school and college athletes and found athletes who sustained a concussion had elevated levels of depression from baseline at 2 days, 7 days, and 14 days post-concussion. Further, they concluded higher levels of depression were associated with lower neurocognitive performance, specifically somatic depression, which was associated with slower reaction time and lower visual memory. Kontos et al. (2012) found verbal memory and motor processing speed returned to baseline level within a week of injury, whereas reaction time and visual and memory difficulties lasted for up to

two weeks following the concussion. McClincy, Lovell, Pardini, Collins, and Spore (2006) concluded verbal memory deficits lasted up to 14 days post-concussion and Sim, Terryberry-Spohr, and Wilson (2008) found impaired reaction time and processing speed up to six days post injury and memory deficits up to ten days post injury. The increase in depressive symptoms and mood disturbances, and the resulting neurocognitive deficits, can adversely impact a child and adolescents' academic performance.

Psychosocial Outcomes of Concussion Versus MSK Injuries

Although concussions present with unique and profound psychological consequences, few studies have compared psychosocial outcomes of concussions with musculoskeletal (MSK) injuries. Luis and Mittenberg (2002) compared 35 children with skeletal fractures without head trauma and 42 children with a MTBI. Six months post injury, they found higher prevalence rates of mood and anxiety disorders (35.7% and 21.4%) in the MTBI group than the orthopedic group (11.4% and 2.8%). Moreover, differential emotional responses have been found between athletes with concussion and minor MSK injuries. Hutchison, Mainwaring, Comper, Richards, and Bisschop (2009) found athletes who suffered concussions experienced significantly elevated levels in lack of energy and fatigue compared to those who sustained MSK injuries. Athletes with MSK injuries showed a significant increase in anger, which resolved to pre-injury level within two weeks.

Hutchison, Comper, Mainwaring, and Richards (2011) compared cognitive functioning following injury of concussed athletes to athletes who had sustained a MSK injury. Similarly to other studies, they found concussions resulted in cognitive impairment in the acute phase following the injury, but also determined MSK injuries can

lead to cognitive deficits immediately following the injury, suggesting the importance of reducing the rate of all sport-related injuries.

Given the rate of concussions, the vulnerability of youth to concussions, and the deleterious psychosocial and academic consequences of concussion, it is critical that research on psychological predictors of sports injuries investigate concussions independently from other sports injuries. It is important to understand whether there are different psychological risk factors between concussions and other sports injuries, and to implement specific preventive interventions to address these factors.

Research Objectives

Given the high incidence rates and negative psychological and academic consequences of pediatric sports injuries, specifically concussions, exploring the risk factors that increase the likelihood of sports injuries is warranted. Understanding the psychological risk factors that increase a young athlete's injury occurrence and severity should guide prevention and intervention programs to address these risk factors. Further, given the unique symptom presentation and resulting outcomes of concussion, compared to other sports injuries, it is important to investigate whether psychological factors have differing effects on concussion versus MSK injuries. Moreover, a review of the literature suggests the majority of the research in the area of psychological predictors of sports injuries is on adult samples, with only a few studies examining psychological risk factors in ice hockey. Therefore, there is a strong need for more research among youth ice hockey players. The present study will add to the current body of literature on sports injuries in youth ice hockey by exploring the predictability of sixteen psychosocial

variables, as measured by the Behaviour Assessment System for Children—Second Edition (BASC-II), on total injury, concussion versus MSK injuries, and injury severity.

The study employed a prospective design. The relationship and predictability of sixteen psychosocial variables and total injury, concussion and MSK, and injury severity will be presented. Moreover, total injury, concussion, and MSK injury rate will be described. Bantam (ages 12-14) and midget (ages 15-17) elite ice hockey players were recruited for participation in Edmonton and Calgary (Alberta, Canada). Three main objectives guide the development of the research questions proposed for this study. The following hypotheses were formulated based on review of current literature and conceptual knowledge. Areas that have not been investigated to date in the literature are framed as non-directional hypotheses (Creswell, 2009).

Objective 1: Do psychosocial factors predict the rate of sports injuries?

The first objective is to examine whether psychological factors, as measured by the BASC-II, predict the rate of injury among elite youth ice hockey players.

Hypothesis 1.

The BASC-II has not been previously used as a measuring tool to investigate the psychological antecedents of sports injuries; however, a number of the psychological variables included in the BASC-II have been explored in the literature. *Thus, it is hypothesized that the clinical scales sensation seeking, locus of control, anxiety, and depression will significantly predict sports injury rates.*

Sensation seeking.

A) Low sensation seeking will be associated with higher injury rates. Smith, Ptacek et al., (1992) found high sensation seeking acted as a buffer against stress and the

risk of injury, rather than a vulnerability factor. Thus, low sensation seekers were at greater risk of suffering an injury following a major sport stress event compared to high sensation seeking.

Locus of control.

B) External locus of control, rather than internal locus of control, will be associated with higher injury rates. Although some studies have found no relationship between locus of control and injury (Hanson et al., 1992; Kerr & Minden, 1988; Passer and Seese; 1983), Pargman and Lunt (1989) found external locus of control was correlated with higher rate of injuries and Dalhauser and Thomas (1978) concluded athletes with less internal locus of control sustained more injuries.

Anxiety.

C) High levels of trait anxiety will be associated with higher injury rates. The findings for trait anxiety are inconsistent across the literature. Studies have found positive relationships (Ivarsson and Johnson, 2010; Johnson and Ivarsson, 2011), negative relationships (Kleinert, 2002; Yang et al., 2014) and no relationship (Kerr and Minden, 1988). Although there are inconsistent findings, this hypothesis was selected as it aligns with Williams and Andersen's (1998) stress and injury model, which theorizes high state of anxiety exacerbates the stress response and leads athletes to appraise a situation as more stressful, which leads to more attentional disruption and physiological activation.

Depression.

D) Higher levels of depression will be associated with higher injury rates.

The literature suggests preseason depression (Smith, Stuart, Wiese-Bjornstal, & Gunnon, 1997; Yang et al., 2014) and depressed mood (Lavallee & Flint, 1996) are

associated with higher rate of injury. Further, a positive state of mind acted as a protective factor, with athletes sustaining fewer injuries than those who had a less positive state of mind.

Objective 2: Do psychosocial variables predict rate of injury differently between concussion and MSK injuries?

The second objective is to explore whether there are differences in the predictability of the psychosocial factors of the BASC-II between concussion and MSK injuries.

Hypothesis 2. *Psychological factors, specifically sensation seeking, anxiety, depression and locus of control, will not have different predictability between concussion and MSK injuries.*

A survey of the literature suggests there have been no studies that have separated concussion from MSK injuries when investigating the psychological risk factors of sports injuries. However, Hutchison, Mainwaring, Comper, Richards and Bisschop (2009) found no difference in emotional state between concussion and MSK groups. Although the main objective of this study was not to explore psychological predictors of injury, they did provide evidence regarding the baseline emotional state of the athletes, where they found no difference in emotional state between athletes who sustained concussion versus MSK injuries.

Objective 3: Do psychosocial factors predict injury severity?

The third objective is to investigate whether psychosocial factors influence injury severity.

Hypothesis 3. *High levels of anxiety and low levels of sensation seeking will be associated with higher injury severity.*

There have been a limited number of studies that have explored whether psychological variables predict injury severity, especially among children and adolescents. Moreover, many of the psychological variables of the BASC-II have not been investigated in regards to injury severity. Thus, this hypothesis was based on the literature that was available. Petrie (1992) and Hanson et al., (1992) found higher levels of competitive anxiety increased the likelihood of sustaining more severe injuries and Smith, Ptacek et al., (1992) found low sensation seekers who experienced negative sport events sustained more severe injuries compared to high sensation seekers.

Chapter Three—Methods

A prospective cohort study design was used to examine whether psychosocial variables 1) predict the likelihood of sport injuries, 2) vary in predictability between concussion and MSK injuries and 3) predict the level of injury severity. There have been a number of studies that have investigated the impact of psychosocial variables such as anxiety, depression, locus of control, stress, but there have been no studies to date that have utilized the Behaviour Assessment System for Children—Second Edition (BASC-II) to measure the predictability of psychosocial factors on the sports injury rate of elite ice hockey players. The BASC-II not only includes the most frequently researched psychosocial variables, such as depression, anxiety and locus of control, but also provides information on a dozen other psychosocial factors. Thus, this study intends to provide an exploration of the influence and predictive value of psychosocial variables, as measured by the BASC-II, on sports injury rates among bantam and midget elite youth hockey players. Since the BASC-II has not been previously used as a measuring tool to investigate predictive psychosocial factors of sports injury, this study is a preliminary study and considered exploratory in nature. This chapter overviews the research methods used in the study including participants, instrumentation, sampling, data collective procedures, and ethical considerations. Data was analyzed utilizing descriptive statistics, multiple linear regressions, and multivariate analyses of variance (MANOVAs).

Participants

The current study is one component of a larger prospective multi-center cohort study of concussion in youth ice hockey players. The study was conducted in Edmonton and Calgary, Alberta with 44 hockey teams enrolled. The participants included male and

female athletes from AA and AAA Bantam (12 to 14 years old) and Midget (15 to 17 years old).

Criteria for study inclusion included:

a) participation in the 2011-2012 hockey season
b) agreement by individual player and informed consent signed by a parent/guardian
c) agreement of the team coach to participate in the study
d) agreement from the team designate to collect information about individual player participation and injury throughout the season:

Exclusion criteria included:

a) developmental delay
b) unable to participate at the beginning of the study
c) cognitive impairment (mild to moderate intellectual disability)
d) any diagnosed medical condition
e) diagnosed concussion 30 days prior to the study start data

Players with ADHD and/or autism were excluded from the analysis to reduce the confounding effects of these mental disorders on the predictability of psychosocial variables on sport injury rate.

Ethical considerations

The current study was approved by the University of Alberta's Health Research Ethics Board—Health Panel and the University of Calgary's Conjoint Health Research Ethics Board, within the Faculty of Medicine, in August 2011 (see Appendix A). For recruitment, a letter of invitation (see Appendix B) to participate in the study was sent to the coaches of Bantam and Midget hockey teams who met criteria for the study. Coaches

who agreed to participate in the study were sent information packages, which included a description of the study, child assent forms (Appendix C) and parental consent forms (Appendix D). A team designate was selected for each team. Each team designate was responsible for distributing the information packages and recording injury data throughout the hockey season. All of the participants were under the age of 18; therefore, parental consent was required prior to participation in the study. Parents were instructed to have their child bring the signed consent and assent form to the research session if they wished for their child to participate. Prior to the start of the hockey season, baseline information was gathered on each player. Groups of players were tested at the same time under the supervision of a research assistant. Once the research assistant verified both parental consent and player assent forms were signed, the Pre-season Baseline Questionnaire and the paper-and pencil version of the BASC-II were administered.

Instrumentation

Two instruments were administered in this study: Pre-season Baseline Questionnaire and Behaviour Assessment System for Children—Second Edition (BASC-II).

Pre-season baseline questionnaire.

The Pre-season Baseline Questionnaire was used to obtain information about each player involved in the study (See Appendix E). Demographic information collected included age, birthdate, sex, address, telephone number, and city of residence. Information collected related to playing hockey included weight, height, dominant hand, division of hockey, years of hockey played, position played, type of safety equipment worn (e.g. mouthguard, helmet), and previous injuries and medical history. In addition,

the Pre-season Baseline Questionnaire collected information on whether players had been previously diagnosed with any of the following psychological disorders: a) intellectual disability, b) learning disorder, c) communication disorder, d) autism spectrum disorder, 3) attention-deficit/hyperactivity disorder, f) disruptive behaviour disorders, g) mood disorders (e.g. depression and bi-polar disorders, and h) anxiety disorders.

BASC-II.

The BASC-II was administered to all of the elite ice hockey players in this study to assess various psychosocial variables at baseline. The BASC-II is a norm-referenced diagnostic tool designed to evaluate social, emotional, and behavioural functioning and self-perceptions of children aged 4 to 18 years old (Reynolds & Kamphaus, 2004). The norms for the BASC-II were developed from a normative sample of approximately 4,800 participants. It is one of the most widely used behaviour rating scales for children and youth and takes approximately 10 to 15 minutes to complete. The BASC-II includes three report forms including a self-rating scale, a parent rating scale, and a teacher rating scale. For the purpose of this study, only the self-report rating scale for adolescents ages 12 to 21 was used.

The self-report rating scale for adolescents consists of twelve clinical (maladaptive) scales and four adaptive scales. The clinical scales include attitude to school, attitude to teachers, sensation seeking, atypicality, locus of control, social stress, anxiety, depression, sense of inadequacy, somatization, attention problems and hyperactivity. The four adaptive scales are relations with parents, interpersonal relations, self-esteem, and self-reliance. See Table 1 for BASC-II scale definitions.

Table 1

BASC-II Scales Definitions

Scales	Scale Definitions
Attitude to School	The tendency to feel alienated, hostile, or dissatisfied toward school
Attitude to Teachers	The tendency to resent or dislike teachers or think they are unfair
Sensation Seeking	The tendency to take risks and seek excitement
Atypicality	Excessive thoughts and behaviours that are often considered odd or unusual
Locus of Control	The belief that rewards and punishments are controlled by external events or other people
Social Stress	Feeling alone, isolated, or "picked on" in social situation
Anxiety	The tendency to be nervous, fearful, or worried about real or imagined problems
Depression	Excessive feelings of unhappiness, sadness or stress
Sense of Inadequacy	The tendency to feel unsuccessful or generally inadequate
Somatization	The tendency to be overly sensitive or to complain about relatively minor physical problems/discomfort
Attention Problems	The tendency to be easily distracted and unable to concentrate for an extended period of time
Hyperactivity	The tendency to be overly active, rush through work or activities, and act without thinking
Relations with Parents	The tendency to feel valued and supported by parents
Interpersonal Relations	Feeling liked and respected by peers
Self-Esteem	Feelings of self-respect and self-worth
Self-Reliance	Thinking that one is dependable and being confident of one's abilities

The self-report for adolescents shows relatively high internal consistency reliabilities for the individual scales, with median values around 0.80 (Reynolds & Kamphaus, 2004). The most reliable scales, with values in the middle to upper 0.80s, are attitude to school, social stress, atypicality, depression, and anxiety. The remaining scales have reliability values in the middle 0.70s to lower 0.80s. The test-retest reliability for the adolescent age range is 0.75 and higher for the individual scales. The BASC-II also has strong discriminative, construct, and convergent validity with other behavioural rating scales such as the Achenbach System of Empirically Based Assessment Youth Self-Report, the Children's Depression Inventory, the Brief Symptom Inventory and the Beck Depression Inventory-II.

In addition to the twelve clinical scales and the four adaptive scales, the BASC-II includes three validity scales, the F, L, and V index (Reynolds & Kamphaus, 2004). The F or "fake bad" index detects excessively negative responses, which may indicate the child has very maladaptive behaviour or the child rated more negatively than they should have. The L or "fake good" index measures extremely positive responses and may reflect a lack of insight, naiveté, or a lack of comprehension of the question. Last, the V index checks for carelessness, lack of comprehension or compliance. The validity scales on the BASC-II are of great value and importance as they ensure the child has responded to the questions appropriately, which allows for the results to be interpreted with confidence, a feature most measurement tools used to investigate the influence of psychosocial factors on sports injuries do not have.

The BASC-II was selected as the measurement tool for the present study for the following reasons: 1) The BASC-II assesses a wide range of psychological factors

(personality, behavioural and emotional variables); 2) the BASC-II has a self-report for adolescents (ages 12 to 21) that is age appropriate for the bantam (ages 12-14) and midget (ages 15-17) ice hockey players participating in the study; 3) the BASC-II scales have high internal consistency and test-retest reliability; 4) the norms of the BASC-II are based on a large, representative sample; 5) the BASC-II is easy to administer and score and takes only 15-20 minutes to complete; and 6) the BASC-II has three validity scales to detect untruthful responding, misunderstanding and other threats to the validity of the results.

Injury Assessment

The team designate of each team gathered information regarding injuries sustained during play (e.g. games or practices) throughout the hockey season. The team designates were responsible for identifying players with suspected concussions and removing them from play. Players with suspected concussions and MSK injuries were referred to a sports medicine physician and seen within one week of the injury. Edmonton players were referred to the University of Alberta Glen Sather Medicine Clinic and assessed by Dr. Connie Lebrun. Calgary players were referred to the University of Calgary Sport Medicine Centre and assessed by Dr. Brian Benson, Dr. William Meeuwisse, or Dr. Kelly Brett. Each physician completed a diagnosis and treatment plan form, which included the expected duration of treatment and whether or not the player was allowed to return to play. They also completed an injury report form (IRF) following an injury to report specific details of the injury. Information recorded on the IRF included injury status (e.g. new or recurrence), how the injury occurred (e.g. sudden onset with contact, sudden onset with no contact, gradual onset, overuse, or unknown), when the

injury occurred (e.g. practice, game, team conditioning), and position played at the time of the injury. It also included whether the player continued to play following the injury, the events surrounding the injury, the cause of the injury, protective gear worn at the time of the injury, injury location, and injury type.

Following the complete recovery of the injury, the team designate recorded 1) the total number of days the player was unable to participate in daily activities, hockey and other sports, 2) the contact the player had with health care professionals (e.g. physician, physiotherapist, massage therapist, emergency responders, dentist), 3) treatment received (e.g. x-rays, MRI/CT, cast, brace, etc.), and 4) and information regarding return to play.

Follow-up evaluations with the sport medicine physicians were scheduled at approximately seven days and three months after the initial evaluation. Players completed the paper-and-pencil version of the BASC-II at these times. Additional follow-up appointments were scheduled if it was deemed necessary.

Overview of Analysis

The data was entered into a spreadsheet and analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0. The data included the number of concussions and MSK injuries each player sustained during the season, as well as the total number of injuries (concussion and MSK combined). Time loss (number of days from injury to return to play) was recorded for each injury. Time loss was used to determine injury severity. Following the guidelines used in Emery, Kang et al. (2010), severe injuries were those that resulted in more than one week missed from hockey and minor injuries were those that resulted in less than one week missed from hockey. Injury severity was included to gain not only an understanding of the impact psychological factors have on

the occurrence of injury, but whether they also influence the severity of the injury. Greater injury severity has been found to increase post injury depression (Smith, Stuart, Wiese-Bjornstal, Milliner et al., 1993) and may cause greater academic consequences, especially for severe concussions, given the need for cognitive rest and the impact concussion symptoms have on an individual's ability to learn.

For the sixteen scales of the BASC-II, both raw scores and t-scores were entered into the spreadsheet. Raw scores were used for the analysis, rather than t-scores, to more accurately indicate the number of symptoms the participant was experiencing for each scale rather than how they compared to other individuals their age.

First a correlational analysis was completed to determine the relationship between the sixteen psychosocial variables and total injuries. Then, an analysis was completed to determine whether the assumptions of a linear regression and a multivariate analysis of variance (MANOVA) were met. The assumptions of a linear regression include: No significant outliers, no multicollinearity, independence of errors, random normal distribution of errors, homogeneity of variance, linearity of data, and non-zero variances. The assumptions of a MANOVA include: Independence of observations, adequate sample size, no multivariate outliers, multivariate normality, linearity, homogeneity of variance, and no multicollinearity. Lastly, a relative-weight multiple linear regression was conducted to examine whether the psychosocial variables predicted total injury rates and a MANOVA was completed to determine whether there was a difference in total injury rates based on the psychosocial variables.

In addition to examining total injuries, separate multiple linear regressions and MANOVAs were performed to explore whether different psychological variables

predicted concussion versus MSK injuries and whether psychological factors could predict injury severity (mild vs. severe).

Chapter Four—Results

This chapter presents the results of the data analysis. The characteristics of the data sample will be presented first, followed by the findings organized by the study's three objectives. For the first objective, findings will be presented for psychological predictors of total injuries. The second objective describes the difference in psychological predictors between concussions and MSK injuries. For the third objective, findings will be presented for psychological predictors of injury severity.

Sample Characteristics

Following the collection of data, there were a total of 659 participants. Six participants had a diagnosis of ADHD and were removed from the sample. Following this elimination, the sample included 653 players. Of these 653 participants, 27 were removed due to missing data (type of injury, unknown whether it was concussion or MSK) and four players were removed due to validity concerns on the L index (were in the extreme caution range). The resulting sample (N=622) is outlined in Table 2 and includes injury variables.

Table 2

Participant Level of Play and Injury Variables

	n (%)	
	Males	Females
Total	524 (84.2%)	98 (15.8%)
Level of Participation		
Bantam	158 (30.2%)	43 (43.9%)
Midget	362 (69.1%)	55 (56.1%)
Total Injuries		
0	331 (63.2%)	71 (72.5%)
1	161 (30.7%)	24 (24.5%)
2	28 (5.3%)	1 (1.0%)
3	3 (0.8%)	2 (2.0%)
MSK		
0	412 (78.0%)	87 (88.8%)
1	96 (18.2%)	10 (10.2%)
2	18 (3.1%)	1 (1.0%)
3	0 (0.0 %)	0 (0.0%)
Concussion		
0	425 (80.5%)	79 (80.6%)
1	96 (18.3%)	18 (18.4%)
2	3 (0.6%)	1 (1.0%)
3	0 (0.0%)	0 (0.0%)

Due to the significant discrepancy in sample sizes between males and females and the limited number of females who incurred injuries, female participants were excluded from any further analyses. Research has shown males typically sustain more sport related injuries than their female counterparts (Ivarsson, Johnson, & Podlog, 2013) and males incur more severe injuries and experience greater time loss from their injuries (Schick & Meeuwisse, 2003). Moreover, gender differences begin to emerge during adolescence on a number of cognitive, emotional, social and behavioural variables (Horn, 2004). For example, gender differences are evident for self-esteem, with females reporting lower self-esteem than their male counterparts (Horn, 2004). There are also gender differences

in activity levels, injury rates, risk-taking behaviour, rating of injury severity, and parents reaction to this risk taking behaviour and psychosocial variables (e.g. anxiety and depression) (Wiese-Bjornstal, 2003). Thus, for these reasons, females were excluded.

Linear Regression Assumptions

The first step in the linear regression was to determine whether all of the assumptions were met. The histogram of standardized residuals, the normal P-P plot of standardized residuals and the scatterplot of standardized residuals indicated the data did not meet the assumptions of homogeneity of variance, linearity and normal distribution, likely due to the significantly higher proportion of participants who did not sustain an injury compared those who did. To address the concern of normal distribution, 32 participants were randomly selected from the zero injury and one injury participant group to match the 32 participants who had sustained two or more injuries (there were 32 in total for this group). Thus, there were three groups: Zero injuries, one injury and two or more injuries. The random sample included 96 males who ranged in age from 12 to 17 (mean 15.05). There were 26 Bantam players (27.1%) and 70 Midget players (72.9%) with an average of 6.15 years of playing on a hockey team. Of the 96 participants, 3 participants (3.1%) had two concussions and 31 participants (32.3%) had one concussion. In regards to MSK injuries, 16 participants (16.7%) incurred two MSK injuries and 31 participants (32.3%) had one MSK injury. This sample was used for all analyses.

Correlations.

A correlational analysis was completed to determine the relationship between the sixteen scales of the BASC-II and total injuries. See Table 3 for the results.

Table 3

Correlations of BASC-II Scales with Total Injuries

BASC-II Scales	Total Injuries
Clinical Scales	
Attitude to School	-.038
Attitude to Teachers	-.024
Sensation Seeking	-.210*
Atypicality	-.024
Locus of Control	-.061
Social Stress	.060
Anxiety	-.026
Depression	.142
Sense of inadequacy	.150
Somatization	.047
Attention Problems	.257*
Hyperactivity	.159
Adaptive Scales	
Relations with Parents	.078
Interpersonal Relations	.084
Self-Esteem	-.141
Self-Reliance	-.078

* $p < .05$

Results indicated there was a statistically significant correlation between sensation seeking and attention problems with total injuries. There were no other statistically significant correlations. Typically, given these results, only sensation seeking and attention problems would be included in the multiple linear regressions. However, this study is a preliminary study and exploratory in nature. As such, in addition to sensation seeking and attention problems, anxiety, depression and locus of control were selected for inclusion in the multiple linear regression analysis and MANOVA, as they are the most frequently studied psychosocial variables in the literature and may collectively have an impact on sports injury.

Linear Regression and MANOVA Assumptions (Random Sample)

An analysis was conducted for the random sample to determine whether the assumptions of a linear regression were met in the random sample. Outliers, collinearity of data, independent errors, random normal distribution of errors, homoscedasticity, linearity of data, and non-zero variances were addressed. An analysis of standard residuals was carried out, which showed the data contained no outliers (Std. Residual Min = -2.025, Std. Residual Max = 2.726). Tests to see if the data met the assumption of collinearity indicated that multicollinearity was not a concern (sensation seeking, Tolerance = .931, VIF = 1.074; locus of control, Tolerance = .683, VIF= 1.464; anxiety, Tolerance = .694, VIF = 1.440; depression, Tolerance = .674, VIF = 1.483; attention problems, Tolerance = .839, VIF = 1.192). The histogram of standardized residuals indicated that the data contained approximately normally distributed errors, as did the normal P-P plot of standardized residuals.

The data did not meet the assumption of independent errors (Durbin-Watson value = .373). The scatterplot of standardized residuals showed that the data did not meet the assumptions of homogeneity of variance and linearity, likely due to the limited range in values of the dependent variable (no injury, one injury, two or more injuries). Additionally, all variables met the assumption of non-zero variances, with the exception of total injuries (total injuries, Variance = 0.798*; sensation seeking, Variance = 8.700; locus of control, Variance = 7.621; anxiety, Variance = 22.694; depression, Variance = 3.743, attention problems, Variance = 11.329).

An analysis was also conducted to determine whether the assumptions of a MANOVA were met. The analysis concluded all assumptions of a MANOVA were met

with the exception multivariate normality and linearity. As stated previously, this study is a preliminary study and is exploratory. Although all of the assumptions of a linear regression and a MANOVA were not met, a multiple linear regression and MANOVA were completed to explore the predictive value of sensation seeking, locus of control, anxiety, depression, and attention problems. Since the assumptions were not met, the results should be interpreted with caution.

The Analysis

Objective 1: Do psychosocial factors predict the rate of sports injury?

A relative-weight multiple linear regression was conducted to determine whether the psychosocial factors, sensation seeking, locus of control, anxiety, depression, and attention problems predicted the rate of sports injuries in elite youth ice hockey players. Descriptive statistics can be found in Table 4.

Table 4

Descriptive Statistics for Total Injuries

Predictors	Mean (Raw Scores)	Standard Deviation
Total Injuries	1.042	.893
Sensation Seeking	13.625	2.950
Locus of Control	3.829	2.761
Anxiety	7.8542	4.764
Depression	1.438	1.935
Attention Problems	5.365	3.366

Results suggested that sensation seeking, locus of control, anxiety, depression, and attention problems explained a statistically significant amount of variance in injury rates ($F(5,90) = 3.279$, $p < .05$, $R^2 = .393$, $R^2_{\text{Adjusted}} = .107$). The analysis showed

attention problems alone significantly predicted rate of injury (Beta = .313, t(95) = 2.955, $p < .05$) See Table 5 for the summary of the total injury regression.

Table 5

Summary of Total Injury Regression

Predictor	Total R2 (Adjusted)	F	Beta
Overall Model	.107	3.279	
Sensation Seeking			-.176
Locus of Control			-1.97
Anxiety			-.063
Depression			.164
Attention Problems			.313*

* $p < .05$

Utilizing a one-way MANOVA, no statistically significant differences were found in total injuries based on psychosocial factors F(15, 243) = 1.445, ns; Wilk's $\Lambda = .790$.

Objective 2: Do psychosocial variables predict the rate of injury differently between concussion and MSK injuries?

In addition to conducting a multiple linear regression to investigate the predictability of sensation seeking, locus of control, anxiety, depression, and attention problems on total injuries, an analysis was also completed to determine whether there were significant differences between concussion and MSK injuries. The analysis showed that sensation seeking, locus of control, anxiety, depression, and attention problems did not explain a statistically significant amount of variance for concussion, (F(5,90) = 1.783, ns, $R^2 = .300$, $R^2_{Adjusted} = .040$) but explained a statistically significant amount of variance for MSK injuries (F(5,90) = 3.579, $p < .05$, $R^2 = .407$, $R^2_{Adjusted} = .120$).

Concussion.

The analysis showed attention problems alone significantly predicted the rate of concussion (Beta = .270, t(95) = 2.457, $p < .05$). Table 6 summarizes this information.

Table 6

Summary of Concussion Regression

Predictor	Total R2 (Adjusted)	F	Beta
Overall Model	.040	1.783	
Sensation Seeking			-.085
Locus of Control			.004
Anxiety			.134
Depression			-.183
Attention Problems			.270*

* $p < .05$

Utilizing a one-way MANOVA, there was no statistically significant difference in concussion rate and psychosocial factors, $F(10, 178) = 1.174$, ns; Wilk's $\Lambda = .880$.

MSK.

The analysis found that sensation seeking, locus of control, anxiety, depression, and attention problems explained a statistically significant amount of variance in MSK injury rates ($F(5,90) = 3.579$, $p < .05$, $R^2 = .407$, $R^2_{\text{Adjusted}} = .120$). The analysis also showed that locus of control and depression alone significantly predicted rate of MSK injuries (locus of control, Beta = -.237, $t(95) = -2.034$, $p < .05$; depression, Beta = .329, $t(95) = 2.802$, $p < .05$). See Table 7 for summary of MSK regression.

Table 7

Summary of MSK Regression

Predictor	Total R2 (Adjusted)	F	Beta
Overall Model	.120	3.579	
Sensation Seeking			-.147
Locus of Control			-.237*
Anxiety			-.173
Depression			.329*
Attention Problems			.174

* $p < .05$

A one-way MANOVA found there was statistically significant differences in MSK injury rate and psychosocial factors, $F(10,178) = 2.016$, $p < .05$; Wilk's $\Lambda = .807$. A Tukey post-hoc test revealed there was a statistically significant difference within the sensation seeking construct between zero MSK injuries and two MSK injuries ($p = .042$). This indicates that athletes who sustained two MSK injuries had significantly lower levels of sensation seeking compared to those who did not sustain a MSK injury.

Objective 3: Do psychosocial factors predict injury severity?

Of the 64 participants who incurred injuries, within the random sample of 96, 21 injuries (32.8%) were considered mild (time loss < 7 days) and 43 injuries (67.2%) were considered severe (time loss > 7 days). A multiple linear regression was conducted to determine whether sensation seeking, locus of control, anxiety, depression, and attention problems predicted injury severity. Results suggested these psychosocial factors did not explain a significant amount of variance in injury severity ($F(5,90) = 2.017$, ns, $R^2 = .317$, $R^2_{\text{Adjusted}} = .051$). The analysis showed attention problems alone significantly predicted injury severity (Beta = .278, $t(95) = 2.548$, $p < .05$). See Table 8 for the summary of the injury regression analysis.

Table 8

Summary of Injury Severity Regression

Predictor	Total R2 (Adjusted)	F	Beta
Overall Model	.051	2.017	
Sensation Seeking			-.163
Locus of Control			-.162
Anxiety			-.011
Depression			.018
Attention Problems			.278*

* $p < .05$

A one-way MANOVA found there was not a statistically significant difference in injury severity based on psychosocial factors, $F(10, 178) = 1.326$, ns; Wilk's $\Lambda = .866$.

Chapter Five—Discussion

This chapter expands upon the results presented in the previous chapters and provides a summary and interpretation of the research findings, the applied and research implications, limitations of the present study and recommendations for future direction in this area of research.

Summary and Discussion of Findings: Objective 1

Do psychosocial factors predict the rate of sports injury?

It was predicted that sensation seeking, locus of control, anxiety and depression would significantly predict sport injury rates. The specific hypotheses were as followed:

1) Lower levels of sensation seeking would be associated with higher injury rates.
2) Higher levels of external locus of control would be associated with higher injury rates.
3) Higher levels of anxiety would be associated with higher injury rates.
4) Higher levels of depression would be associated with higher injury rates.

The hypothesis that sensation seeking, locus of control, anxiety and depression would significantly predict sports injury rates was partially supported. The results indicated statistically significant correlations between two clinical scales of the BASC-II and total injury rate: sensation seeking and attention problems. No statistically significant correlations were found for anxiety, depression and locus of control.

However, with attention problems included in the regression model, results found sensation seeking, attention problems, anxiety, depression and locus of control could explain a statistically significant amount of variance (10.7%) in injury rates. Attention

problems alone significantly predicted total injury. This would suggest that perhaps attention problems by itself would predict injury and not the other emotional factors.

In regards to each individual clinical scale, higher levels of attention problems were statistically significantly associated with higher rates of injury. Although Williams and Andersen's (1998) stress and injury model does not explicitly include attention problems, the central hypothesis is that history of stressors, personality characteristics, and lack of coping resources in a stressful situation leads to attentional disruption; thus, athletes who have attention problems (e.g. trouble focusing, paying attention and easily distracted) may experience the same attentional disruption caused by a heightened physiological response. Although the relationships between sensation seeking, anxiety, depression and locus of control and injury rate were insignificant, the results still provide informative information regarding the direction of the relationship.

The hypotheses that there would be a negative relationship between sensation seeking with injury and a positive relationship between depression and injury rates were supported. In contrast, the hypotheses that there would be a positive relationship between anxiety and external locus of control was not supported. Rather, the results suggest lower levels of anxiety and lower levels of external locus of control are associated with higher levels of injury. In regards to anxiety, mixed findings have been found in the literature. Yang et al. (2014) and Kleinert (2002) both concluded low trait anxiety was related with higher levels of injury rate and that higher levels of trait anxiety may have a "protective effect." In regards to locus of control, this review of available literature did not find an inverse relationship between external locus of control and injury rate; however, numerous

studies found no relationship (Hanson et al., 1992; Kerr & Minden, 1988; Kolt & Kirkby, 1996; Passer & Seese, 1983).

Overall, the findings suggest attention problems alone significantly predict total injury rates among youth elite ice hockey players. Attention problems have never been studied alone in the psychological risk factors of sports injury literature in general. These findings provide novel information to the literature as a whole, as well as for youth athletes in ice hockey. The results suggest pre-season psychosocial assessment tools may benefit from incorporating attention problems as a risk factor for sports injuries, and preventive interventions should focus on providing athletes with strategies to improve their concentration and focus and reduce their distractibility.

Summary and Discussion of Findings: Objective 2

Do psychosocial variables predict rate of injury differently between concussion and MSK injuries?

At present there is little research on whether sensation seeking, anxiety, depression, locus of control and attention problems have varying levels of predictability for concussion versus MSK. It was predicted there would be no difference between these two types of injuries. This hypothesis was not supported. The results showed these five psychological factors had differing predictability between concussion and MSK injuries. The multiple linear regression found that sensation seeking, locus of control, anxiety, depression, and attention problems did not explain a significant amount of variance for concussion but explained 12.0% of the variance for MSK injuries. Similarly to total injuries, attention problems alone significantly predicted the rate of concussion, whereas locus of control and depression significantly predicted the rate of MSK injuries. A

statistically significant difference was found within sensation seeking between zero MSK injuries and two MSK injuries, meaning athletes who sustained two or more MSK injuries had significantly lower levels of sensation seeking compared to those who did not sustain a MSK injury. Thus, athletes with low sensation seeking and high levels of external locus of control and depression are at greater risk of sustaining a MSK injury, and athletes with attention problems are at greater risk of sustaining a concussion.

These findings suggest there are different risk factors for concussions and MSK injuries, a result that would have not been found had concussion and MSK injuries not been separated in objective two. Objective one combined concussions and MSK injuries into a *total injury* category and found attention problems significantly predicted total injuries. However, given the findings for objective two, attention problems only predict concussion, not MSK injuries, and new psychological predictors (locus of control, depression, and sensation seeking) emerged for MSK injuries. These findings not only add novel and important evidence to the literature, but also provide valuable information for the development of preventive interventions to address these risk factors. It is critical to reduce the rates and severity of both concussions and MSK injuries; thus, interventions should target the psychological factors that predict both concussion and MSK injuries: Sensation seeking, locus of control, depression and attention problems.

Summary and Discussion of Findings: Objective 3

Do psychosocial factors predict injury severity?

The hypotheses that low levels of sensation seeking and high levels of anxiety would be associated with greater injury severity were not supported. The hypothesis regarding anxiety was based on studies that investigated competitive anxiety rather than

trait anxiety (Hanson et al., 1992; Petrie, 1992), which may account for the lack of support found in the present study. Further, the hypothesis regarding sensation seeking was based on a study that incorporated the impact of experiencing negative sport events, rather than sensation seeking alone, again possibly explaining the lack of support for the hypothesis in the present study (Smith, Ptacek, & Smoll, 1992). Moreover, neither study investigated these factors among youth ice hockey players.

The results found that sensation seeking, locus of control, anxiety, depression and attention problems did not predict injury severity; however, greater attention problems predicted greater injury severity. This finding provides even more evidence for the importance of targeting attention problems as a risk factor. Not only has it been shown to predict the occurrence of total injuries and concussions, but it also predicts more serious injuries, leading to the potential of longer recovery times, psychological maladjustment, and negative academic consequences such as missing school and decline in grades (Sady et al., 2011).

Implications for Research and Practice

The results of the present study can help guide the direction of future research on psychological predictors of sports injuries and the development of interventions to address these risk factors. Although this study was designed as a preliminary study and was exploratory in nature, the findings have practical implications and provide direction for future studies in this area.

Research implications.

This study adds to the growing body of literature on psychological predictors of sports injuries in a number of ways. The majority of studies in this area use adult

samples, with very few studying the sport of ice hockey. Thus, this study expanded knowledge of psychological risk factors of sports injuries to youth and ice hockey. Moreover, most studies combine concussion and MSK injuries into a single category of "sports injuries." It is important to investigate concussion separately from MSK injuries given the vulnerability of youth to concussions, the high rate of concussion in hockey, and the psychosocial and academic consequences associated with concussion (Brewer, Petitpas, et al., 1995; Emery, Meeuwisse et al., 2006; Sady et al., 2011). Thousands of young athletes play hockey in Canada and are at risk of concussion; thus, it is important to understand whether there are unique psychological risk factors associated with concussion, compared to other sports injuries (Hockey Canada, 2015). The present study explored whether there are different psychological risk factors between concussion and MSK injuries. The research findings suggest there are different psychological predictors for concussions, compared to MSK injuries, in youth hockey players. Future research may want to separate concussion from other injuries to further understand how psychological factors predict injury and how they can be prevented, as the goal is to reduce and prevent both types of sports injury in youth.

The results of this study may help guide the development of assessment tools to identify athletes who are at greater risk of sustaining a sport related injury due to some of their psychological characteristics. Moreover, the findings can guide the creation and implementation of appropriate interventions and support coaches, athletic trainers, medical personnel and school personnel help athletes to minimize and avoid preventable injuries.

Practical applications.

There are many practical applications of the current results for young athletes involved in elite ice hockey and likely other youth contact sports. Parents, coaches, athletic trainers, physician, and school personnel can benefit from knowing about psychological factors that increase a young hockey player's chance of sustaining a sport-related injury. Because of their close relationship with athletes and the considerable time they spend with them, coaches, athletic trainers, and school staff are in positions to recognize and identify athletes who are at greater risk of injury and help prevent injury. They are in a position to educate players and parents about factors associated with injury risk; moreover, they can help teach players appropriate coping skills, such as deep breathing, progressive muscle relaxation, and visualization, to address the psychological risk factors. Findings from this study suggest players with attention problems are at greater risk for injury in general, as well as concussions, and are more likely to sustain a severe injury. A review of the literature on psychological predictors of sport injuries suggests attention problems have not been directly studied. Studies have investigated how other psychological factors may cause attentional disruption, but have not examined the impact of attention problems alone on sports injury rate and severity. Thus, this finding adds novel information to the literature.

The present study also found individuals with lower levels of external locus of control and depression are at greater risk of sustaining an MSK injury. Locus of control and depression has not been previously studied among youth ice hockey players; thus, these findings provide valuable information for this population. Including a measurement tool that assesses psychosocial risk factors during physical examinations at the start of the

season may help to identify players who are at greatest risk. Given the findings of this study, the measurement tool for ice hockey players should assess attention problems, locus of control and depression. Preventative interventions should target athletes with these risk factors, which may further help to reduce the rate and severity of injury in individuals who are at higher risk.

Thus far, only a handful of studies have found empirical support for the effectiveness of psychological interventions to reduce or prevent the occurrence and severity of sport related injury, with only a few showing a reduction in injury (Davis, 1991; Johnson, Ekengren, & Andersen, 2005; Kerr & Goss, 1996; Maddison & Prapavessis, 2005).

Davis (1991) utilized progressive muscle relaxation combined with imagined rehearsal with college football players and swimmers and achieved a 33% reduction in football injuries and a 52% reduction in swimming injuries. Johnson, Ekengren, and Andersen (2005) implemented a cognitive-behaviourally based brief intervention program to soccer players. The program consisted of somatic and cognitive relaxation, stress management coping skills, goal setting skills, self-confidence training and discussions about critical incidents that had occurred during sport, as well as everyday life. They found a significant difference between the treatment group and the control group. Kerr and Goss (1996) utilized a stress management prevention intervention with gymnasts and found significantly fewer injuries in the intervention group compared to the control group. Lastly, Maddison and Prapavessis (2005) utilized a prospective approach, examining the effectiveness of cognitive behavioural stress management on reducing injury vulnerability for rugby athletes who were identified as having an at-risk

psychological profile. The interventions led to a reduction in injury vulnerability; moreover, the intervention was associated with decrease in worry and concentration disruption and an increase in coping skills.

Although there have been a few studies that have explored prevention interventions to reduce the risk of injury, they have primarily been with adult athletes and ice hockey has not been explored. Moreover, few studies have utilized a prospective approach, identifying and targeting specific risk factors. What works for college level athletes in other sports may not generalize to youth playing ice hockey and general interventions may not address the unique risk factors of each player. Interventions should target the unique needs of the sport and age of the players. Thus, the findings from this current study could serve as the foundation for the development and implementation of prevention interventions for youth ice hockey players.

Given the results of the present study, difficulties with attention problems should be the main target of preventative interventions. Johnson (2007) suggests athletes should keep daily or weekly journals during the season to identify and recognize everyday stressful events, emotions, and feelings towards upcoming practices, games and tournaments. The players can use the journal to mentally prepare for sport events and take necessary steps to reduce stressful situations and negative emotions. This same strategy could be used to address athletes with attention problems. Athletes could identify and record situations where attention difficulties appear to be more prevalent and they can work with their coach or school personnel to develop strategies to minimize the effects of their attention problems. Moreover, the present study also found locus of control and depression to predict likelihood of concussions. The journal could be used to

identify and monitor how their mood or their outlook may be impacting their behaviour or performance. The cognitive-behavioural interventions discussed above could also be modified to address attention problems, locus of control and depression, specifically. Johnson (2007) also suggests athletes should engage in progressive muscle relaxation and guided mental imagery. Coaches and school staff could teach and utilize these general techniques in addition to implementing more targeted preventive interventions.

Limitations and Considerations for Replication

Although this study found prospective evidence of psychological predictors that increase the rate of injury risk and severity among elite youth ice hockey players, several limitations warrant mention.

The first limitations of the study are associated with statistical methods. The first limitation is that some of the assumptions of the linear regression (independent errors, homogeneity of variance and linearity and non-zero variances) and the MANOVA (multivariate normality and linearity) were not met. Given this was a preliminary study and deemed exploratory in nature, the analysis was completed notwithstanding the failure to meet all assumptions. As such, the present findings should be interpreted with some caution.

The correlational analysis found only two of the sixteen clinical scales on the BASC-II, sensation seeking and attention problems, to be significantly correlated with injury occurrence. Typically, given these findings, only sensation seeking and attention problems would have been included in the regression model. However, this was a preliminary study and was exploratory in nature, so anxiety, depression and locus of control were also included in the regression model. These variables were included

because they are the most frequently studied psychosocial factors in the research and there is a lack of research of these variables among youth ice hockey athletes. They are most frequently studied among athletes involved with other sports. Incorporating these variables in the regression model added valuable information to the literature regarding the effect of these variables on injury occurrence and severity among youth ice hockey players; however, including these variables in the regression model may have weakened or reduced the strength of the findings for sensation seeking and attention problems. In other words, had sensation seeking and attention problems been the only factors included in the regression model, sensation seeking and attention problems would have likely predicted greater amount of variance for injury rate and severity.

In addition, separate correlational analyses could have been completed for each objective, rather than for total injuries alone. The regression models for objective two (concussion versus MSK) and three (injury severity) could have been based on the findings of their own correlational analyses. However, as stated above, the most extensive research has been on locus of control, sensation seeking, anxiety and mood states, and attention problems was found to have a strong correlation with total injuries. As such, the purpose of the study was to understand how these five psychological factors predicted total injury, concussion versus MSK, and injury severity. Therefore, it was decided to base each regression model on the correlational analysis of total injuries.

Raw scores rather than standardized scores (t-scores), were used from the BASC-II. The raw scores were used to highlight the number of symptoms each player was experiencing within each psychosocial construct, rather than in comparison to same-aged peers; however, as a result, the psychometric properties of the BASC-II previously

discussed (e.g. internal consistency, test-retest reliability) do not apply to raw-scores. Thus the reliability of test scores used in this analysis are unknown leaving increased susceptibility of threats to internal reliability.

The BASC-II has not been tested on a sport-related population and is typically utilized within clinical populations. As a result, the items in the questionnaire may not be suitable for predicting psychological risk factors in sports injury research.
Johnson (2007) argues sport-related questionnaire appear to be more effective than general questionnaires, such as the BASC-II, in predicting the likelihood of sports injury. The BASC-II is a comprehensive measuring tool, investigating twelve clinical scales and four adaptive scales; however, as a result, there is less depth of coverage across all psychosocial variables (e.g. only 6-8 questions for each construct). Johnson (2007) argues it is important to incorporate multidimensional measures of each construct of interest. For example, he suggests utilizing the Sport Anxiety Scale to measure trait anxiety as it includes three interrelated variables of anxiety, worry, concentration disruption and somatic anxiety. Therefore, it may be more beneficial to utilize sport-related measures that address one individual construct, rather than multiple.

Another potential limitation related to the BASC-II, is that overall, the sample was a group of psychologically healthy individuals. On the BASC-II, a T-score above 70 is considered in the "Clinically Significant" range and suggests the behaviour is not typical for a child at this age and should be an area of concern (Reynolds & Kamphaus, 2004). A T-score between 60 and 70 is considered in the "At-Risk" range and either identifies a problem that may not be severe enough to require formal intervention, but should still be monitored, or the potential of the problem becoming clinically significant.

A T-Score below 60 is considered in the "Average" range and suggests no clinical concerns. See Table 9 for the BASC-II data for sensation seeking, locus of control, anxiety, depression, and attention problems across the random sample of 96 participants.

Table 9

BASC-II Score Data

			N (%)		
Predictors	Mean (T-Score)	Std. Deviation	Average Range	At-Risk Range	Clinically Significant Range
Sensation Seeking	52.44	7.11	80 (83.3%)	16 (16.7%)	0 (0.0%)
Locus of Control	45.10	6.35	93 (96.9%)	3 (3.1%)	0 (0.0%)
Anxiety	46.23	7.85	89 (92.7%)	6 (6.3%)	1 (1.0%)
Depression	42.72	3.74	95 (99.0%)	1 (1.0%)	0 (0.0%)
Attention Problems	45.44	7.74	88 (91.7%)	8 (8.3%)	0 (0.0%)

Table 9 indicates most participants were not experiencing any concerns with sensation seeking, locus of control, anxiety, depression and attention problems, with the overwhelming majority falling within the Average range. As such, this may limit the predictability of these psychosocial factors on injury rate, concussion, MSK and injury severity. Moreover, only elite-level youth ice hockey players participated in this study. Thus, the findings may not be generalizable to other levels of hockey, age groups, or sports.

The dynamic nature of psychological status of the athletes presents as another limitation of the study. The psychosocial variables were measured at the start of the hockey season and post-injury. Given the fact the study spanned the length of a full

hockey season (October to March), the psychological status of the players may have changed between baseline and the occurrence of their injury. Thus, the athletes' levels of sensation seeking, locus of control, anxiety, depression and attention problems could have changed before their injury occurred.

Future Directions

It is nearly impossible to conduct a study that includes all possible psychological influences on the rate and severity of injury. Although a number of predictive factors of sports injury rate and severity have been found in this study and the literature, further research in this area is needed to support past findings, identify new predictive factors and better understand the relationship of these variables to each other.

Much of the injury prevention efforts have not incorporated psychological perspectives, and evidence from this study suggests this is a promising and necessary approach. The following statement from Williams and Andersen's (1998) stress and injury model paper still resonates to this day:

> Perhaps the most exciting future research will come from implementing and testing the effectiveness of interventions aimed at modifying the psychosocial risk factors and reducing stress reactivity. Only through such empirical efforts as the preceding will knowledge grow regarding the relationship of psychosocial factors in injury vulnerability and the role that interventions might play in reducing the cost and trauma of potentially avoidable injuries (p.22).

Future research should continue to identify psychological risk factors of sports injury and utilize this knowledge to identify individual players who are at greatest risk of injury and explore the usefulness of interventions to reduce injury vulnerability.

Moreover, it would be valuable to investigate how school personnel could implement preventative interventions, determine the most effective means of delivering these interventions, and their effectiveness in reducing injury vulnerability.

It is also important to acknowledge that not all variance in injury risk is likely to be explained by psychosocial factors alone; thus, research should continue to explore the relationship and influence between psychosocial factors and physical and biomechanical factors.

Lastly, given the finding that most of the independent variables (psychological scales on the BASC-II) did not correlate with the dependent variable (total injuries), with the exception of sensation seeking and attention problems, perhaps sport specific measures would be more appropriate for future research.

Conclusions

Sports and physical and recreational activity can be highly beneficial for the emotional and physical health of children and adolescents (Janssen & LeBlanc, 2010). Sport participation is positively related to higher self-esteem (Bowker, 2006; Findlay & Coplan, 2008), better social skills (Findlay & Coplan, 2008; Hansen, Larson, & Dworkin, 2003), fewer depressive symptoms (Boone & Leadbeater, 2006; Gore, Farrell, & Gordon, 2001) and greater confidence (Holt, Kingsley, Tink & Sherer, 2011; Zarrett et al., 2009). Engaging in regular physical activity can help prevent future health complications such as high cholesterol, blood pressure, obesity, low bone mineral density and depression (Janssen & LeBlanc, 2010). However, sport participation and physical activity brings the risk of injury and the short- and long-term consequences associated with injury (Azuelos et al., 2004; Jorge & Robinson, 2002; McKnight et al., 1992; Maffulli et al., 2000). Such

consequences include physical impairment and emotional and cognitive disruptions, directly and indirectly impacting a youth's ability to function in an academic setting (Sady et al., 2011). Given the increasing frequency of sport injuries, concussions specifically, and the resulting psychological and academic consequences of those affected, preventive interventions are urgently required (Sady et al., 2011). This is of utmost importance, especially for adolescents, who are in a critical period of their academic career where attendance, grades, and overall school success is crucial for graduation and future vocational and educational achievement (Allensworth & Easton, 2007; Balfanz, 2009). Such interventions will hopefully reduce or prevent the occurrence and severity of sport-related injuries, allowing young players to continue to enjoy the sport they love and reap the many benefits of playing sports.

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Appendix A

03:36:10 p.m. 08-08-2011

FACULTY OF MEDICINE | UNIVERSITY OF CALGARY

OFFICE OF MEDICAL BIOETHICS
Room 93, Heritage Medical Research Bldg
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2011-08-04

Dr. Carolyn Emery
Faculty of Kinesiology
University of Calgary
KN B 121
Calgary, Alberta

Dear Dr. Emery:

RE: Evaluation of a Neurocognitive Tool in Youth Ice Hockey Players Before and After Sport-Related Concussion

Ethics ID: E-24026

The above-named research, including the Questionnaire (BASC-2 SR; PRS Questionnaire; Pre-Season Baseline Questionnaire; Weekly Exposure Sheet; Injury Report Form; Hockey 2011-2012 Assessment; SACT-2; Pocket SACT-2; Recording Sheet for Vestibular and Cervical Tests), Consent Form (Coaches, version 1, July 19, 2011; Parents/Guardians, version 3, July 19, 2011; Assent, version 1, August 4, 2011; Team Trainers, version 1, July 19, 2011), Letter of Invitation , Letter of Support (Hockey Canada, June 16, 2011), Letters (George H. Buck, University of Alberta, June 17, 2011), Protocol , Committee Sign Off has been granted ethical approval by the Conjoint Health Research Ethics Board of the Faculties of Medicine, Nursing and Kinesiology, University of Calgary, and the Affiliated Teaching Institutions. The Board conforms to the Tri-Council Guidelines, ICH Guidelines and amendments to regulations of the Food and Drugs Act re clinical trials, including membership and requirements for a quorum.

You and your co-investigators are not members of the CHREB and did not participate in review or voting on this study.
Please note that this approval is subject to the following conditions:
(1) appropriate procedures for consent for access to identified health information have been approved;
(2) a copy of the informed consent form must have been given to each research subject, if required for this study;
(3) a Progress Report must be submitted by **August 04, 2012**, containing the following information:

i) the number of subjects recruited;
ii) a description of any protocol modification;
iii) any unusual and/or severe complications, adverse events or unanticipated problems involving risks to subjects or others, withdrawal of subjects from the research, or complaints about the research;
iv) a summary of any recent literature, finding, or other relevant information, especially information about risks associated with the research;
v) a copy of the current informed consent form;
vi) the expected date of termination of this project.

4) a Final Report must be submitted at the termination of the project.

Please accept the Board's best wishes for success in your research.
Yours sincerely,

Glenys Godlovitch, BA(Hons), LLB, PhD
Chair, Conjoint Health Research Ethics Board

GG/emcg
c.c. Child Health Research Office Dr. W. Giles (information) Ms. Sharon Van Oort, Research Services - Main Campus Ms. Maria Romiti (Research Coordinator) Ms. Kathryn Schneider, Ms. Andrea Krol (Student) Dr. Winnie Mecuwisse, Dr. Karen Barlow, Dr. Brian Brooks, Dr. Martin Mrazik, Dr. Connie LeBrun, Dr. Tish Doyle Baker, Dr. Jian Kang, Kirsten Taylor, Tracy Blake (Co-Investigators)
Office of Information & Privacy

Appendix B

Letter of Invitation: Elite Youth Ice Hockey Concussion Study

Dear coaches, players and parents,

This is an invitation to participate in an upcoming Ice Hockey Concussion Study that will begin in the fall of 2011 and run throughout the 2011-2012 season. Please find a brief description of the study below.

Background and Purpose:
Concussions are the most common injury type in elite youth ice hockey. Concussions can lead to longer term sequelae including prolonged symptoms (i.e. headache, dizziness, neck pain) and neurocognitive deficits. **The primary purpose of this study is to evaluate two** neurocognitive **tools** (SCAT2 and ImPACT computerized neurocognitive test) in the assessment of neurocognitive function (i.e. reaction time, memory, concentration, attention and processing speed) both **pre-season and following concussion**. The SCAT2 is a standardized evaluation of concussion used on the bench and in clinical return-to-play decisions in elite levels of play (i.e. major junior, NHL). The validity of the SCAT2 and the added value of the ImPACT in return to play decisions in youth elite ice hockey is unknown. This study will evaluate the validity of baseline neurocognitive testing (i.e. SCAT2 and ImPACT) and examine the utility of these tools in medical return to play decisions and in predicting prolonged recovery from concussion.

What is involved?
Baseline Testing:
We will recruit 30 teams from Bantam and Midget AAA and AA Quadrant Hockey and Female AAA Bantam and Midget in Calgary (and 10 teams in Edmonton). Pre-season testing will be completed at the Sport medicine Centre, University of Calgary in September 2011. This will provide a baseline to evaluate neurocognitive changes that may occur following a concussion and throughout recovery. This testing is not the current standard of practice in elite youth ice hockey but more typical in elite adult leagues (i.e. major junior, NHL). Baseline testing will take approximately 90 minutes.

Before baseline testing, there will be an information package sent home that includes a consent form, a preseason medical questionnaire and a behavioral questionnaire. On the day of testing, each participant will complete the SCAT2 (which is completed with a

research assistant and an iPad) and one ImPACT test on a computer. Each participant will also be wearing a heart rate monitor (to monitor fluctuations in heart rate that occur during the session) and will do tests of neck and balance function. These measures will allow for evaluation of changes that occur following concussion, many of which have not been evaluated in youth ice hockey players previously.

During the season:
During the season, if the team trainers suspects a player has sustained a concussion, they will have the opportunity to follow-up with the study sport medicine physician at the Sport Medicine Centre at the University of Calgary within a week following the injury. At this time, the player will also repeat the baseline tests. Athletes will be assessed weekly until return to play and at three months following concussion. The same measures will be repeated at each visit.

Why do this study?
This research is important when one considers the potential for concussion in elite youth ice hockey and the large numbers of youth participating. The preseason measures will facilitate assessment of changes that may occur following a concussion and allow monitoring of recovery. This will help develop a greater understanding of concussion outcomes in youth ice hockey players and inform the development of standard of care assessment and treatment guidelines.

We hope that you will consider participating in this study and look forward to working with you and your team during the season.

For more information, please contact:
Dr. Carolyn Emery
Sport Injury Prevention Research Centre
University of Calgary
(403) 220.4608

Appendix C

Assent Form for Players (under 18 yrs)

TITLE: Elite Youth Ice Hockey Concussion Study

INVESTIGATORS

Principal Investigator: Dr. Carolyn Emery

Co-Investigators (University of Calgary): Dr. Willem Meeuwisse, Dr. Brian Brooks, Dr. Karen Barlow, Dr. Tish Doyle-Baker, Dr. Jian Kang, Kathryn Schneider (PhD Student), Tracy Blake, Kirsten Taylor

Co-Investigators (University of Alberta): Dr. Martin Mrazik, Dr. Connie Lebrun, Andrea Krol (PhD Student)

This consent form is only one part of agreeing to be in this study. It should give you the basic idea of what the research is about and what being a part of it will mean. Please, take the time to read and understand the information. If you have questions or need more information about this study, please let us know. ***If you choose to participate, please keep a copy of this form and return the other copy (signed and witnessed) to your team designate.***

BACKGROUND

A concussion is a mild brain injury. It is the most common injury in elite youth ice hockey. Concussions can lead long lasting problems like headache, dizziness, and neck pain as well as problems with concentration and memory. The SCAT2 is a standardized test for those who have had concussions. It is used to help doctors to make return-to-play decisions. ImPACT is a test that checks reaction time, how fast your brain makes sense of information, and memory. We do not know how important the SCAT2 and the ImPACT are in return-to-play decisions in youth elite ice hockey. This study will look at the validity of the SCAT2 and ImPACT; how helpful they are in making choices about returning to sport; and predicting who will take longer to get better after a concussion.

Concussions can also change how other parts of your body works, like your heart, your neck, how well you can balance, and how you act, think and feel. Part of this study will look at if your heart works differently after a concussion by measuring your heart rate and the time in between heartbeats. We do not have a good understanding about how these change after a concussion.

Many people have dizziness and problems balancing after a concussion. The inner ear plays a big part in balance and is important in order to have clear vision when the head is

moving quickly. We do not have a good understanding about these things change after a concussion.

Headaches and neck pain are also common after a concussion. In this study, we will test balance, how the neck moves and how strong the neck muscles are before and after a concussion and to see if there is a difference.

Concussions can make some people think, feel and act differently. We will ask you to answer some questions that will help us see if any changes happen after a concussion.

Your team has been randomly selected to participate in this study. We would like to invite you to be involved. More than 1000 hockey players are expected to take part in this study.

WHAT IS THE PURPOSE OF THE STUDY?

The purpose of this study is to look at how well the SCAT2 and ImPACT work for testing how hockey players 13-17 years old think, react, remember and focus before and after a concussion.

WHAT WOULD I HAVE TO DO?

We will be asking 30 teams in Calgary (and 12 teams in Edmonton) from Bantam and Midget AAA and AA Quadrant Hockey and Female Bantam and Midget AAA teams to be in the study. Pre-season testing will take place at the Glen Sather Clinic, University of Alberta in September 2011. Testing will be done after team rosters are set but before the regular season starts. This will give us information that we can look back on so we can see any changes that may happen after a concussion. This testing is not currently done in every elite youth hockey league, but is used regularly in major junior hockey and the NHL. Pre-season testing will take about 60 minutes.

Before pre-season testing, there will be an information package sent home that you and your parents will fill out. It includes this consent form, questions about your medical and injury history and questions about how you think, act and feel. These forms must be returned to your team designate BEFORE you are allowed to take part in the study. The name of your team designate will given to you when you receive your package. On pre-season test day, you will do the SCAT2 on the iPad and one ImPACT test on a computer.

During the season:

During the season, if your team trainer thinks that you have had a concussion, you will be able to see the study sport medicine doctor at the Glen Sather Clinic at the University of Alberta within one week. You will see the doctor every week until you are back to sport as well as three months after your concussion. You will repeat the pre-season tests at each visit.

If one of your teammates has a concussion, you might be asked to act as a healthy control. This will involve coming into the Sport Medicine Centre and repeating the baseline tests at the same time as your teammate.

If you get injured and have to miss more than one week of hockey (practices and/or games), you will have the chance to see the study sport medicine doctor at the Sport Medicine Centre at the University of Calgary.

ARE THERE ANY BENEFITS FOR ME?

If you agree to be in this study there may or may not be a direct medical benefits. You may have less risk of injury during the study but there is no guarantee that this research will help you. If you have a sports injury during the study, your team therapist will assess you and give you advice about any treatment they think would help you.

DO I HAVE TO BE IN THE STUDY?

If you agree to be in the study, we need you to sign and return one copy of this form to your volunteer team designate. Please have another adult witness your signature on the copy that you return to us. Please keep the other copy for your records.

Taking part in this study is voluntary. You may leave the study at any time by telling the Research Coordinator, Nicole Lemke by phone by email (nlemke@ualberta.ca). Your involvement and registration in the club/team will not change if you do not want to be in the study. Your coaching staff will know who is or is not in the study. This knowledge will not have any effect on how your relationship with your coaches or on the coaches' decisions about playing time. Please feel free to ask any questions you have that come up during the study that you think will help your understanding. You will be told of any new information that is available during the study.

WILL I BE PAID FOR BEING IN THE STUDY, OR DO I HAVE TO PAY FOR ANYTHING?

You will not get paid for being a part of this study. You will not have to pay for anything.

WILL MY RECORDS BE KEPT PRIVATE?

All of the information collected from the survey will be anonymous and will remain strictly confidential. Only the investigators responsible for this study, the research assistants who will be doing the baseline assessments, the statistician who will analyze the data and the University of Alberta Human Research Ethics Board (HREB) will have access to this information. Confidentiality will be protected by using a study identification number in the database. Any results of the study, which are reported, will in no way identify study participants.

IF I SUFFER A RESEARCH RELATED INJURY, WILL WE BE COMPENSATED?

If you are injured from participating in this research, the University of Alberta, Alberta Health Services and the researchers will not provide compensation. You still have all your legal rights. Nothing said here will in any way alter your right to seek damages.

SIGNATURES

If you agree to allow your child to participate, we require you to sign and return this form to your designated team study personnel. Two copies of the form are provided. Please keep one for your records. Please have another adult witness your signature on the copy that you return to us.

Your signature on this form indicates that you have understood to your satisfaction, the information regarding participation in this research project and agree to allow your child

participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. Your child is free to withdraw from the study at any time without jeopardizing your health care. Continued participation should be as informed as your initial consent, so you should feel free to ask for clarification throughout your child's participation. You will be informed if there is new information available through this study period. If you have further questions concerning matters related to this research, please contact:

Dr. Martin Mrazik (Principal Investigator) (780) 492-8052

If you have any questions concerning your rights as a possible participant in this research, please contact the Research Ethics Office (REO), University of Alberta, (780)-492-0459.

CONSENT FOR ELITE YOUTH ICE HOCKEY CONCUSSION STUDY

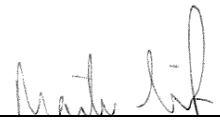
Player´s Name (Print)	Signature and Date

Contact Information

Address:

Phone:

Witness' Name (Print)	Signature and Date



Investigator/Delegate's Name

The University of Alberta Human Research Ethics Board has approved this research study.

Appendix D

Consent Form for Parents/Guardians

TITLE: Elite Youth Ice Hockey Concussion Study

Funding: **Alberta Children's Hospital Research Institute, Max Bell Foundation**

INVESTIGATORS

Principal Investigator: Dr. Carolyn Emery, University of Calgary

Co-Investigators (University of Calgary): Dr. Willem Meeuwisse, Dr. Brian Brooks, Dr. Karen Barlow, Dr. Tish Doyle-Baker, Dr. Jian Kang, Kathryn Schneider (PhD Student), Tracy Blake, Kirsten Taylor

Co-Investigators (University of Alberta): Dr. Martin Mrazik, Dr. Connie Lebrun, Andrea Krol (PhD Student)

This consent form is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. For further details about this study, or to have your questions addressed please contact us. Please take the time to read this carefully and to understand any accompanying information. If you choose to participate, please keep your copy of this form and return the study copy (signed and witnessed) to your team designate.

BACKGROUND

Concussions are the most common injury type in elite youth ice hockey. Concussions can lead to long term side effects including prolonged symptoms (i.e. headache, dizziness, neck pain) and neurocognitive deficits. The SCAT2 is a standardized evaluation of concussion used on the bench and in clinical return-to-play decisions in elite levels of play (i.e. major junior, NHL). The validity of the SCAT2 and the added value of the ImPACT in return to play decisions in youth elite ice hockey is unknown. This study will evaluate the validity of baseline neurocognitive testing (i.e. SCAT2 and ImPACT) and examine the utility of these tools in medical return to play decisions and in predicting prolonged recovery from concussion.

Behavioral, emotional and social changes have also been shown to occur after concussion in some individuals. We will be using a behavioural questionnaire to assess for any changes before and after concussion. Currently there is little research that has been conducted in this area.

A number of Alberta Bantam, Minor Midget and Midget Hockey Teams have agreed to take part in this research project. We would like to invite your child to participate. Your child's team has been randomly selected to participate in this study. There are more than 1000 hockey players expected to participate in this study.

WHAT IS THE PURPOSE OF THE STUDY?
The primary purpose of this study is to evaluate two neurocognitive tools (SCAT2 and ImPACT computerized neurocognitive test) in the assessment of neurocognitive function (i.e. reaction time, memory, concentration, attention and processing speed) both during the pre-season and following a concussion.

WHAT WOULD MY CHILD HAVE TO DO?
We will be recruiting 30 teams in Calgary (and 12 teams in Edmonton) from Bantam and Midget AAA and AA Quadrant Hockey and Female AAA Bantam and Midget. Pre-season testing will be completed at the Glen Sather Clinic, University of Alberta in September 2011. Testing will occur after team rosters have been finalized but before regular season games begin. This will provide a baseline to evaluate neurocognitive changes that may occur following a concussion and throughout recovery. This testing is not the current standard of practice in elite youth ice hockey but more typical in elite adult leagues (i.e. major junior, NHL). Baseline testing will take approximately 60 minutes.

Before baseline testing, there will be an information package sent home that includes a consent form, a preseason medical questionnaire and a behavioural questionnaire. On the day of testing, each participant will complete the SCAT2 (which is completed with a research assistant on an iPad) and one ImPACT test on a computer.

During the season:
During the season, if a team trainer suspects that your child has sustained a concussion, they will have the opportunity to follow-up with the study sport medicine physician at the Glen Sather Clinic at the University of Alberta within a week following the injury. At this time, your child will also repeat the baseline tests. Athletes will be assessed weekly until return to play and at three months following concussion. The same measures will be repeated at each visit.

Your child may also be asked to act as a health control, in the event that one of your child's teammates sustains a concussion. This will involve coming into the Glen Sather Clinic and repeating the baseline tests at the same time as your child's teammate.

If your child sustains an injury that causes your child to miss more than one week of hockey practices and/or games, your child will have the opportunity for follow-up assessment with the study therapist as the Glen Sather Clinic at the University of Alberta.

ARE THERE ANY BENEFITS FOR MY CHILD?

If you agree to participate in this study there may or may not be a direct medical benefit to your child. His/her injury risk may be decreased during the study but there is no guarantee that this research will help him/her. If your child experiences a sports injury during the study duration, the team therapist (who will be attending every practice and game) will be assessing for injuries and making recommendations for follow-up treatment. The information we get from this study may help us to provide better sport injury prevention in future adolescent sport activities.

DOES MY CHILD HAVE TO PARTICIPATE?

If you agree to allow your child to participate, we require you to sign and return this form to your volunteer team designate. Two copies of the form are provided. Please keep one for your records. Please have another adult witness your signature on the copy that you return to us.

Participation in this study is voluntary and you may withdraw your child from the study at any time by contacting the Research Coordinator, Ms. Nicole Lemke at nlemke@ualberta.ca. Your child's involvement and registration in the club/team will not be affected if you chose not to consent for your child to take part in the study. Continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your child's participation. You will be informed if there is new information available through this study period.

WILL THERE BE FINANCIAL COMPENSATION, OR WILL THERE BE COSTS FOR THE PARTICIPANT?

There will be no financial compensation to the child or costs to the child as a participant in this study.

WILL MY CHILD'S RECORDS BE KEPT PRIVATE?

All of the information collected from the survey will be anonymous and will remain strictly confidential. Only the investigators responsible for this study, the research assistants who will be doing the baseline assessments, the statistician who will analyze the data and the University of Alberta Human Research Ethics Board (HREB) will have access to this information. Confidentiality will be protected by using a study identification number in the database. Any results of the study, which are reported, will in no way identify study participants.

IF MY CHILD SUFFERS A RESEARCH RELATED INJURY, WILL WE BE COMPENSATED?

In the event that your child suffers an injury because of participating in this research, the University of Alberta, Alberta Health Services or the researchers will provide no compensation. You still have all your legal rights. Nothing said here will in any way alter your right to seek damages.

SIGNATURES

If you agree to allow your child to participate, we require you to sign and return this form to your designated team study personnel. Two copies of the form are provided. Please keep one for your records. Please have another adult witness your signature on the copy that you return to us.

Your signature on this form indicates that you have understood to your satisfaction, the information regarding participation in this research project and agree to allow your child participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. Your child is free to withdraw from the study at any time without jeopardizing your health care. Continued participation should be as informed as your initial consent, so you should feel free to ask for clarification throughout your child's participation. You will be informed if there is new information available through this study period. If you have further questions concerning matters related to this research, please contact:

Dr. Martin Mrazik (Principal Investigator) (780) 492-8052

If you have any questions concerning your rights as a possible participant in this research, please contact the Research Ethics Office (REO), University of Alberta, (780)-492-0459.

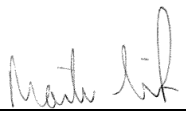
CONSENT FOR ELITE YOUTH ICE HOCKEY CONCUSSION STUDY

Parent/Guardian's Name (Printed)	Signature and Date
Child's Name (Printed)	

Contact Information

Address:

Phone:

	
Investigator/Delegate's Name (Printed)	Signature and Date
Witness Name (Printed)	Signature and Date

The University of Alberta Human Research Ethics Board has approved this research study.

PLEASE SIGN THIS PAGE AND RETURN THE
<u>FULL</u> DOCUMENT TO YOUR TEAM DESIGNATE.

KEEP THE OTHER COPY FOR YOUR RECORDS

Appendix E

Sport Injury Prevention Research Centre

Pre-season Baseline Questionnaire

OFFICE USE ONLY:
SSID:_____
Team number:_____

Player name:_____

Date (MM/DD/YY): _____/_____/_____

Person completing form:
❑Mother ❑Father ❑Player ❑Other:_____
Parent phone#:_____
Parent email:_____

Birth date (MM/DD/YY): _____/_____/_____

Dominant hand (writing): ☐Right ☐Left

Sex: ☐Male ☐Female

Height:_____ft/inches OR _____cm

Weight:_____lbs OR _____kg

City:_____

Association:_____

Level of Play: ☐Pee Wee ☐Bantam ☐Midget

Team name:_____

Division: ☐AAA ☐AA ☐A ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 ☐11 ☐12 ☐Rec.

Position: ☐Forward ☐Defense ☐Goalie

Have you ever participated in a University of Calgary Hockey Study?
☐No ☐Yes - If yes, what year?_____

Years of organized hockey you have played prior to this season:
☐0 yrs ☐1 yr ☐2 yrs ☐3 yrs ☐4 yrs ☐5 yrs ☐6 yrs ☐7 yrs
☐8 yrs ☐9 yrs ☐10 yrs ☐11 yrs ☐12 yrs ☐12 yrs ☐Other:_____

EQUIPMENT (check all that apply):

Mouthguard:
worn at GAMES: ☐Always ☐Less than 75% ☐Never

worn at PRACTICE: ☐Always ☐Less than 75% ☐Never

type: ☐Dentist custom-fit ☐Off the shelf (incl. boil and bite)

Helmet:
make: ☐Bauer ☐CCM ☐Itech ☐Jofa ☐Mission ☐Nike ☐RBK ☐Other:_____

model:_____

type: ☐Full clear visor ☐Full wire cage ☐Combination visor/cage

age: ☐New this season ☐New last season ☐2-3 yrs old ☐>3 yrs old

MEDICAL HISTORY:

Have you ever been diagnosed by a physician with a:
☐Bone fracture, arthritis, or other muscle or bone condition?
Year:_____ Describe:_____
☐Systemic disease (eg, cancer, thyroid disease, heart disease)?
Year:_____ Describe:_____
☐Circulation or heart problem (eg, murmur, congenital deformity, irregular beat)?
Year:_____ Describe:_____
☐Neurological disorder (eg, cerebral palsy, pinched nerve, "stinger", MS)?
Year:_____ Describe:_____

Have you ever experienced headaches? ☐No ☐Yes
If **yes**, are they associated with:
☐Nausea ☐Vomiting ☐Light sensitivity ☐Noise sensitivity

Have you been diagnosed with migraines? ☐No ☐Yes
If **yes**, year of diagnosis:_____

Do any family members experience headaches? ☐No ☐Yes
If **yes**, which member?_____

Have you ever been concerned that you have an attention or learning issue? ☐No ☐Yes
If yes, describe:_____

Have you ever been diagnosed by a health care professional with any of the following (check all that apply):
☐Cognitive delay ☐Learning disability
☐ADHD ☐Persuasive developmental disorder
☐Mood disorder ☐Communication disorder
☐Anxiety disorder ☐Disruptive behaviour disorder
☐Depression ☐Oppositional defiant disorder
☐Conduct disorder ☐Bi-polar disorder
☐Other:_____

Are you currently taking:
Medications (eg, inhaler, Tylenol, antidepressants, birth control)?
☐No ☐Yes:_____
Supplements (eg, vitamins, minerals, protein powder)?
☐No ☐Yes:_____

INJURY HISTORY:

Have you ever had a concussion (either diagnosed or not) or been "knocked out" or had your "bell rung"? ☐No ☐Yes

If **yes**, please list below:

Date (MM/DD/YY)	Sport/activity at the time	Time unconscious (minutes or seconds)	Memory loss?	Time loss before FULL return to sport (days)
			☐No ☐Yes	
			☐No ☐Yes	
			☐No ☐Yes	
			☐No ☐Yes	

If **yes**, do you have persistent problems with:

Memory? ☐No ☐Yes
Dizziness? ☐No ☐Yes
Headaches? ☐No ☐Yes

In addition to injuries listed above, have you had any injury requiring medical attention OR at least 1 day of missed participation from sport or physical activity in the past 12 months? ☐No ☐Yes

If **yes**, please list below:

Date (MM/DD/YY)	Sport/activity at the time	Injury type	Body part	Treatment? (eg, first aid, physio, etc.)	Time loss before FULL return to sport (days)

Do you have any incompletely healed injuries? ☐No ☐Yes - describe:_____

If **yes**, are you currently receiving treatment for this injury/these injuries? ☐No ☐Yes - describe:_____

The following questions ask about body checking in hockey. We ask that you answer as honestly as possible, without any influence from other people. Please circle the number that best matches your answer:

	Strongly disagree	Disagree a little	Neither	Agree a little	Strongly agree
	1	2	3	4	5
1) I like body checking.	1	2	3	4	5
2) I like to be body checked.	1	2	3	4	5
3) My coach encourages me to body check.	1	2	3	4	5
4) My parents encourage me to body check.	1	2	3	4	5
5) My teammates encourage me to body check.	1	2	3	4	5
6) I could be seriously injured by a body check.	1	2	3	4	5
7) I could seriously injure someone else with a body check.	1	2	3	4	5
8) I think body checking increases my teams' chances of winning.	1	2	3	4	5
9) I would try to harm an opponent with a body check if it would increase my team's chance of winning.	1	2	3	4	5
10) I think body checking should be allowed in Pee Wee hockey.	1	2	3	4	5
11) I would body check another player even if I know it would injure them.	1	2	3	4	5