The Development and Implementation of a Concussion Education Program for High School Student-Athletes

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Abstract

Concussions are the most frequently occurring brain injury in sports (Carroll & Rosner, 2012), and the injury can be particularly problematic for adolescent athletes because of their developing brains (Carman et al., 2015). As a result, experts have highlighted the importance of improving athletes' knowledge of concussions to improve their health and safety (McCrory et al., 2013). Despite this, there is no consensus regarding the most effective way to disseminate concussion knowledge (Mrazik et al., 2015). The purpose of this dissertation was to develop and implement a concussion education program for high school student-athletes in Eastern Canada. This was accomplished through a cohesive series of four original manuscripts. The first manuscript was a review paper that investigated literature on concussion education programs. Results revealed there have been three types of concussion education programs to date: interactive oral presentations, educational videos, and computer-based learning programs. However, these interventions have been limited by the dissemination of knowledge at one time-point only and by minimally implementing qualitative methods. The second manuscript was a qualitative study that explored high school coaches' insights and perceptions of concussions. The coaches said they taught athletes skills during practices and games to improve their safety and well-being, which they said they valued more than winning championships. Coaches also mentioned that some of their athletes were occasionally disingenuous when reporting concussion symptoms. The third manuscript was a qualitative study that gathered high school athletes' insights on concussions, including the mediums through which they acquired information about the injury. Results revealed the high school athletes primarily acquired information about concussions through interactions with peers and family members, media reports involving professional athletes, and school projects. Additionally, the athletes noted they attempted to deceive coaches and health

professionals about concussions, a finding that was related to the coaches' perceptions in study two. Results from the first three manuscripts were used to create a concussion education program for high school athletes. Thus, the fourth manuscript investigated a concussion education program for high school athletes, which consisted of four interactive oral presentations that were evaluated using a mixed method design. The results revealed improvements in participants' knowledge of concussions after exposure to the concussion education program. Participants also indicated the concussion education program might influence their future in-game behaviors, such as avoiding dangerous collisions. Furthermore, the athletes said they enjoyed the interactive nature of the presentations and the use of case study examples. In sum, this dissertation contributes to the research and practice of concussion education in many ways. To our knowledge, it is the first program of research to systematically develop and implement a concussion education program for high school athletes. Results from this dissertation indicated that interactive oral presentations were an effective strategy to disseminate concussion information to high school athletes, and provides recommendations for future research in this still underdeveloped domain.

Résumé

Les commotions cérébrales sont les lésions cérébrales les plus fréquentes en sport (Carroll & Rosner, 2012), et cette blessure peut être particulièrement problématique pour les athlètes adolescents en raison de leur cerveau en développement (Carman et al., 2015). Par conséquent, les experts ont souligné l'importance d'améliorer les connaissances de l'athlète liées aux commotions cérébrales en vue d'améliorer leur santé ainsi que leur sécurité (McCrory et al., 2013). Malgré cela, il n'y a pas de consensus quant à la manière la plus efficace de diffuser des connaissances sur les commotions cérébrales (Mrazik et al., 2015). L'objectif de cette thèse était de développer et de mettre en œuvre un programme d'éducation sur les commotions cérébrales pour les athlètes au secondaire dans le Canada Est. Ceci fut accompli à travers une série cohérente de quatre manuscrits originaux. Le premier manuscrit était un article de synthèse qui a examiné la littérature portant sur les programmes d'éducation liés aux commotions cérébrales. Les résultats ont indiqué qu'il y a eu trois types de programmes d'éducation sur les commotions cérébrales à ce jour: des présentations orales interactives, des vidéos éducatives, et des programmes d'apprentissage assistés par ordinateur. Cependant, ces interventions ont été limitées par la diffusion de connaissances à un seul temps donné et par la mise en œuvre des méthodes qualitatives intégrée minimalement. Le deuxième manuscrit était une étude qualitative qui a exploré les perceptions et les idées des entraîneurs-chefs au niveau secondaire. Les entraîneurs-chefs ont dit qu'ils ont enseigné à leurs athlètes des aptitudes athlétiques durant les pratiques et les compétitions afin d'améliorer leur sécurité et leur bien-être, dont ils ont mentionné y accorder plus de valeur que de gagner des championnats. De plus, les entraîneurs ont exprimé que certains de leurs athlètes étaient, à l'occasion, malhonnêtes lorsqu'ils déclaraient leurs symptômes de commotion. Le troisième manuscrit était une étude qualitative qui a récolté

l'aperçu des commotions cérébrales des athlètes au secondaire, incluant les moyens par lesquels ils ont acquis l'information liée à la blessure. Les résultats ont révélé que les athlètes au secondaire avaient acquis l'information liée aux commotions cérébrales à travers des interactions avec leurs pairs et les membres de leur famille, grâce à des rapports médiatiques concernant des athlètes professionnels, ainsi qu'à travers des projets scolaires. En outre, les athlètes ont noté qu'ils ont tenté de tromper les entraîneurs et les professionnels de la santé à propos de leurs commotions cérébrales, ce qui est une découverte liée aux perceptions des entraîneurs de la deuxième étude. Les résultats des trois premiers manuscrits ont été utilisés pour créer un programme d'éducation sur les commotions cérébrales pour les athlètes au secondaire. Donc, le quatrième manuscrit a examiné un programme d'éducation sur les commotions cérébrales pour les athlètes au secondaire qui se composait de quatre présentations orales interactives évaluées en utilisant une méthodologie mixte. Les résultats ont révélé une amélioration quant aux connaissances des commotions cérébrales chez les participants après avoir été exposés au programme d'éducation des commotions cérébrales. Les participants ont aussi indiqué que le programme d'éducation des commotions cérébrales pourrait influencer leurs futurs comportements en compétition, tel qu'éviter des collisions dangereuses. De plus, les athlètes ont dit qu'ils ont apprécié la nature interactive des présentations orales et l'utilisation des exemples d'études de cas. En résumé, cette thèse contribue à la recherche ainsi qu'à la pratique de l'éducation sur les commotions cérébrales de plusieurs façons. À notre connaissance, ceci est le premier programme de recherche qui a systématiquement développé et mis en œuvre un programme d'éducation sur les commotions cérébrales. Les résultats de cette thèse ont démontré que les présentations orales interactives étaient une stratégie efficace pour dissimiler de

l’information liée sur les commotions cérébrales aux athlètes du secondaire et a fourni des recommandations pour les futures recherches dans ce domaine encore peu développé.

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Preface

This doctoral dissertation consists of six chapters. Chapter one is an overview of contemporary knowledge and understanding of concussions. It also outlines the purpose and objectives of this dissertation. Chapter two, an original manuscript, is a review of literature on concussion education programs that was published in *Injury Prevention* (Caron, Bloom, Falcão, & Sweet, 2015). Chapter three is a manuscript that investigated high school coaches' insights and perceptions of concussion, which was published in the *International Sport Coaching Journal* (Caron, Bloom, & Bennie, 2015). Chapter four explores high school athletes' insights on the acquisition of concussion knowledge. The manuscript is currently in preparation. Chapter five is a mixed-method investigation of a concussion education program that was disseminated to high school athletes. The manuscript is also currently in preparation. Chapter six provides a brief summary of the dissertation and outlines recommendations for future research.

Chapter One

Introduction

A concussion is a type of Traumatic Brain Injury (TBI) that has become a public health epidemic and one of the most contentious issues in sport (Carroll & Rosner, 2012). On the spectrum of TBI, a concussion is categorized as a mild TBI because the injury is *typically* not life threatening (Centers for Disease Control and Prevention, 2015). However, classifying a concussion as a type of "mild" TBI can be quite misleading, as researchers have begun linking multiple concussive and subconcussive head trauma with a number of adverse health consequences, such as depression and suicidal ideation (Caron, Bloom, Johnston, & Sabiston, Johnston, 2013; Guskiewicz et al., 2005), as well as dementia and chronic cognitive impairment (Godbolt et al., 2014; Stein, Alvarez, & McKee, 2015). Chronic Traumatic Encephalopathy (CTE) is a type of cognitive impairment that has been likened to both dementia and Alzheimer's disease because of its deteriorative effects on cognition and mood (McKee et al., 2013). In fact, more than 90% of deceased National Football League players who donated their brains to research have been posthumously diagnosed with CTE (Stein et al., 2015). Although researchers have yet to establish a conclusive link between concussions and CTE (McCrory, Meeuwisse, Kutcher, Jordan, & Gardner, 2013), evidence suggests the term "mild" is a paradoxical classification for concussions given the potentially devastating short- and long-term consequences that are being linked with the injury.

Along with growing awareness about the short- and long-term health implications of concussions, there has been a proliferation of research in the past decade. However, knowledge and understanding of concussions is still in its early stages of development. In fact, research on concussions only truly began to evolve in the early 2000s thanks, in large part, to a

multidisciplinary group of primary care physicians, neurologists, neurosurgeons, neuropsychologists, and sports medicine doctors, who are known as the Concussion in Sport (CIS) group. Since 2001, the CIS group has held conferences in Vienna (Aubry et al., 2002), Prague (McCrory et al., 2005), and the last two were in Zurich (McCrory et al., 2009; McCrory, Meeuwisse, Aubry et al., 2013). (A fifth meeting of the CIS group has been scheduled for October 27-28, 2016 in Berlin.) Each meeting has produced a summary/consensus statement that has shaped "best practice" on the evaluation, diagnosis, and management of concussed athletes, which can be evidenced by the number of citations (> 700) and downloads (> 85,000) of the 2013 consensus statement in less than three years (British Journal of Sports Medicine, 2015). The contributions of the CIS group will be briefly summarized to provide an overview of the contemporary knowledge and understanding of concussions.

The CIS group defined a concussion as "a complex pathophysiological process affecting the brain, induced by biomechanical forces" (McCrory, Meeuwisse, Aubry et al., 2013, p. 250), and noted that the injury features a number of clinical, pathologic, and biomechanical constructs (see Table 1). A concussion is a diffuse – rather than focal – brain injury that can be manifested in one or more of the following: symptoms (somatic, cognitive, emotional), physical signs, behavioral changes, cognitive impairment, and sleep disturbance (McCrory, Meeuwisse, Aubry et al., 2013). The CIS group concluded there should be no same-day return to play for athletes who are suspected to have sustained a concussion. To evaluate athletes for concussion, the CIS group has recommended that health professionals use a variety of techniques, which include self-reported symptoms (e.g., Sport Concussion Assessment Tool; SCAT), objective balance assessment (e.g., Balance Error Scoring System; BESS), neuropsychological testing (e.g., Immediate Post-Concussion Assessment and Cognitive Testing; ImPACT), and neuroimaging

(e.g., functional Magnetic Resonance Imaging; fMRI). However, it is unrealistic to assume that every athletic team and organization, especially at the youth and recreational levels, has sufficient resources to (a) evaluate athletes using all four diagnostic tests, or (b) have access to health professionals at all practices and games. Nonetheless, an athlete who is suspected to have experienced a concussion should be removed from play and evaluated by a medical or health professional with expertise on concussions prior to returning to sport. Ultimately, the CIS group advised, "When in doubt, sit them out" (Aubry et al., 2002, p. 8).

Approximately 80 to 90% of concussions resolve within a two-week period (McCrory, Meeuwisse, Aubry et al., 2013). However, there are a number of modifying factors that can predispose athletes to suffering protracted concussions symptoms for more than two weeks (see Table 2). For example, child and adolescent athletes are at increased risk of suffering protracted concussion symptoms because their brains are sensitive to the shearing forces that occur during a concussion due to physical and cognitive development (McCrory, Meeuwisse, Aubry et al., 2013). Athletes who experience protracted concussion symptoms are also at greater risk for suffering psychological sequelae, such as anxiety and depression, as well as long-term symptomatology and chronic cognitive impairment (McCrory, Meeuwisse, Aubry et al., 2013). Evidently, there are a number of adverse short-and long-term health consequences associated with concussions. However, there are currently few ways to treat or reduce the effects of a concussion after the injury has occurred (McCrory, Meeuwisse, Aubry et al., 2013). Consequently, the CIS group highlighted the need to educate athletes, coaches, parents, and sport administrators about concussions to improve safety and prevention efforts.

Indeed, the CIS group has championed concussion education as an important strategy to improve the safety of sport participation. While the CIS group has established the *type* of

information that should be included in concussion education programming, such as common signs and symptoms, as well as safe management and return to play strategies, there is no consensus regarding *how* this information should be disseminated. Moreover, it is not clear *who* should disseminate concussion information to members of the sporting community.

Sport psychology professionals are trained to develop mental and emotional skills, techniques, and attitudes that can enhance the performance and enjoyment of sport (Canadian Sport Psychology Association, 2015). Furthermore, sport psychology professionals often conduct educational interventions with individuals and teams about psychosocial aspects of injury recovery (Evans & Hardy, 2002; Schwab Reese, Pittsinger, & Yang, 2012) and issues related to well being, such as doping, drug abuse, and mental health (Williams, 2010). At the second conference in Prague, the CIS group noted "sport psychology approaches may have potential application in this injury" (McCrory et al., 2005, p. 202). Researchers have previously discussed the role of the sport psychology professional as a member of the multidisciplinary sports medicine team (Bloom, Horton, McCrory, & Johnston, 2004; Johnston et al., 2004; Kontos, Collins, & Russo, 2004). In particular, Kontos and colleagues (2004) postulated that the role of trained sport psychology professionals might involve educating athletes and coaches about concussions. Taken together, evidence suggests that sport psychology professionals could help disseminate concussion education programs to athletes and coaches, as a way to maximize the safety and enjoyment of sport participants.

Purpose and Objectives of this Research

The purpose of this dissertation was to develop and implement a concussion education program for high school athletes. The specific objectives of this research were to (a) determine the extent of research that has been conducted on concussion education programs and (b) tailor a

concussion education program to student-athletes at a high school in Eastern Canada. These objectives were accomplished through a cohesive series of four manuscripts that are presented in the remainder of this thesis. Bridging text is provided immediately preceding each manuscript to assist with the transition between studies.

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Bridging Text

Chapter one provided an overview of contemporary knowledge and understanding of concussions, with a particular emphasis on the contributions of the Concussion in Sport (CIS) group. The CIS group has highlighted the importance of concussion education to improve prevention and safety efforts in sport, however little is known regarding *how* this information should be disseminated. Chapter two presents a scoping review of concussion education programs, which investigated the strengths, weaknesses, and gaps in the existing literature.

Chapter Two

An examination of concussion education programs: A scoping review methodology

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Abstract

Objectives: The primary purpose was to review the literature on concussion education programs. A secondary purpose was to inform knowledge translation strategies for concussion researchers and practitioners.

Design: Research on concussion education programs is relatively new. As a result, the current study implemented a scoping review methodology, which is a type of literary search used to provide a preliminary assessment of the size and scope of a body of literature, as well as identify strengths, weaknesses, and gaps in the research.

Methods: Levac and colleagues' (2010) five-stage process for conducting a scoping review was followed for this study: (a) identifying the research questions, (b) identifying relevant studies, (c) identifying the study selection criteria, (d) charting the data, and (e) reporting the results.

Results: Concussion education programs have been developed and implemented with populations ranging in age from nine to 49 years and have used interactive oral presentations, educational videos, and computer-based learning programs. Although the content of these programs varied, the topics generally addressed salient aspects of concussion injury and recovery. Quantitative instruments have been the preferred methods for assessment.

Conclusions: Education programs aimed at improving participants' long-term concussion knowledge, behaviors, and attitudes of concussions are needed. Researchers must consider using a knowledge translation framework to enhance concussion education programs. The application of such a framework can lead to novel and interesting ways of disseminating information about concussive injury and recovery.

Keywords: Brain Concussion, Sports Medicine, Translational Medical Research, Review

An examination of concussion education programs: A scoping review methodology

Sports-related concussions affect athletes of all age and skill levels, as well as parents, family members, coaches, and clinicians (Caron, Bloom, Johnston, & Sabiston, 2013; Carroll & Rosner, 2012). Concussions have a symptomatology that ranges from headaches, dizziness, and nausea to irritability, anxiety, and depression (McCrory et al., 2013). The severity of these symptoms is influenced by a number of factors such as age, gender, and history with the injury (McCrory et al., 2013). The growing awareness surrounding the short- and long-term consequences of concussions has concerned stakeholders in sport, and more recently, governments. In May 2014, American President Barack Obama held a summit on youth sport concussions at the White House where he convened leading experts to discuss the future of concussive injury and recovery. The President's decision to make concussions a public health issue is indicative of the growing awareness about the injury and its impact on public health, both inside and outside the sporting community. Additionally, concussion awareness has influenced legislative branches of American government to mandate concussion education in all 50 States (Adler & Herring, 2011; Centers for Disease Control and Prevention, 2014). Despite an ever-increasing body of research and public awareness about concussive injury and recovery, relatively little is known about the most effective ways to disseminate this information to knowledge users (i.e., athletes, coaches, parents, and clinicians; McCrory et al., 2013; Provvidenza et al., 2013). Knowledge translation strategies could be the "missing link" to improving the dissemination of concussion information to these knowledge users (Provvidenza & Johnston, 2009, p. 69).

Knowledge translation (KT) is defined as "the dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge…" (Canadian

Institutes of Health Research, 2014). KT aims to bridge the knowledge gap between the scientific community and knowledge users (Straus, Tetroe, & Graham, 2013). The knowledge to action cycle is one framework to examine the knowledge gap (Graham et al., 2006). The knowledge to action cycle is comprised of two sections, whereby (a) the knowledge funnel consists of refining information from basic research to the creation of a knowledge tool/product, and (b) the action cycle represents the process of implementing and evaluating the knowledge tool/product. This framework has been suggested as a potential approach to examine the KT of concussion research (Provvidenza et al., 2013). One of the most recommended and widely implemented concussion KT strategies to date is concussion education.

It is imperative that concussion education strategies are adapted to the specific audience/local context (e.g., student-athletes versus physicians), that barriers and facilitators of knowledge use are assessed, and the proper intervention strategy is chosen, implemented, and evaluated (Canadian Institutes of Health Research, 2014). Unfortunately, these elements have not been consistently utilized when developing concussion education strategies. For example, concussion education has been dominated by passive educational strategies, such as printed materials and handouts (e.g., Center for Disease Control's *Heads Up* concussion initiative; Chrisman, Schiff, & Rivara, 2011; Covassin, Elbin, & Sarmiento, 2012; Sarmiento, Hoffman, Dmitrovski, & Lee, 2014; Sarmiento, Mitchko, Klein, & Wong, 2010) and concussion-related websites (Ahmed, Sullivan, Schneiders, & McCrory, 2012; McCrory et al., 2013; Provvidenza et al., 2013). Printed materials and handouts have allowed for concussion information to be disseminated to people inside and outside the sporting community (Sarmiento et al., 2014) however some have questioned whether passive education could lead to behavior change when used as a standalone strategy (Grimshaw et al., 2001). Additionally, concussion-related websites

often contain medical jargon (Ahmed et al., 2012), making the content difficult to understand for non-medical knowledge users (Straus, Tetroe, & Graham, 2013). Taken together, the current concussion education strategies may not have been properly adapted to the local context (e.g., websites) and that the type of strategy (e.g., handouts) may not be most effective.

As a result, other types of strategies need to be implemented and evaluated, such as concussion education programs, which some feel are a more optimal type of concussion education strategy given their interactive nature (Provvidenza & Johnston, 2009). Although there is no agreed-upon definition, concussion education programs will be operationally defined as any formal program that teaches a population about aspects of concussions that is beyond passive materials (e.g., handouts and websites). Because little is known about the breadth of research on concussion education programs, a detailed review focusing on the state of concussion education programs is timely. This review would also help advance the science and practice of KT strategies with concussions.

According to Grant and Booth (2009), there are at least 14 types of literature reviews that have been used to summarize bodies of research. Selecting a type of review depends on a number of factors such as the breadth of literature in a given area and intended outcomes of the review (Arksey & O'Malley, 2005; Grant & Booth, 2009). Scoping reviews are literary searches that are used to provide a preliminary assessment of the size and scope of a body of literature as well as identify strengths, weaknesses, and gaps in the research (Arksey & O'Malley, 2005; Levac, Colquhoun, & O'Brien, 2010). Scoping reviews have been used to summarize bodies of literature on concussion rehabilitation strategies (DeMatteo et al., 2014) and on other health-related issues like Alzheimer's disease (Affoo, Foley, Rosenbek, Shoemaker, & Martin, 2013), HIV rehabilitation (O'Brien, Wilkins, Zack, & Solomon, 2010), and in settings such as trauma

centers (Moore, Stelfox, Boutin, & Turgeon, 2013) and intensive care facilities (Paradis et al., 2013). Because research on concussion education programs is relatively new, a scoping review is ideal to determine the state of these education programs. Therefore, the first purpose of this study was to review the literature by identifying strengths, weaknesses, and gaps in concussion education programs using a scoping review methodology. A secondary purpose was to inform KT strategies with concussions.

Method

Levac and colleagues' (2010) five-stage process for conducting a scoping review was followed for this study. Specifically, the five stages included: (a) identifying the research questions, (b) identifying relevant studies, (c) identifying the study selection criteria, (d) charting the data, and (e) reporting the results. The first four stages will be described in this section whereas the fifth stage will be detailed in the Results section of this paper.

Identifying the research questions

The specific research questions guiding this work were: What populations have been included in concussion education programs? What types of education programs have been developed to disseminate concussion information? What is the content of concussion education programs? What instruments have been used to assess concussion education programs? What are the outcomes of these programs?

Identifying relevant studies

Databases commonly used with other literary searches on concussions were used to locate articles for this study, including ERIC (ProQuest), Medline, PsycINFO, SPORTDiscus, and Web of Science. Keywords related to *concussions* (i.e., concuss* OR "brain concuss*" OR "brain injur*" OR "sport concuss*") and *education programs* (i.e., educat* OR "educat*

intervention*" OR "concuss* educat*" OR "educat* program*") were entered into each database. The search was refined by searching the databases for *concussion* 'AND' *education program* keywords.

Identifying the study selection criteria

In order to meet the selection criteria for this scoping review, articles must have: (a) been written in English, (b) been an original article (i.e., not a review study or book chapter), (c) had a full-text copy available in one of the selected databases by February 21, 2014, (d) described an educational program that teaches a population about concussions, not including websites, handouts, or other types of passive educational materials, and (e) used the term "concussion" as defined by the Concussion in Sport group (McCrory et al., 2013). Given that concussions are classified as a type of mild Traumatic Brain Injury (mTBI), it is challenging to distinguish between mTBI and concussion. Indeed, experts have noted the terms are "often used interchangeably in the sporting context and particularly in the United States literature" (McCrory et al., 2013, p. 250). However, the terms refer to different injury constructs (McCrory et al., 2013). As a result, the current study selected articles that educated a population about "concussions".

Charting the data

The research process is presented in Figure 1 and outlines the number of articles included and discarded at each stage as well as the rationale for their exclusion.

Results

5938 records were retrieved from the five databases selected for this study. The initial search revealed seven articles that matched the selection criteria. Two additional articles were located via manual search. A total of nine articles were included in this scoping review. Disputes

regarding article inclusion/exclusion were resolved by consensus among the authors. Table 3 provides a detailed description of each of the nine studies in relation to the purpose and research questions identified for this scoping review. The remainder of this section will provide a synthesis of the main findings from each of the studies.

Overall, the concussion education programs included in this review were designed and implemented for populations that ranged from 9 to 49 years of age. Specifically, six concussion education programs were developed for athlete populations (Cook, Cusimano, Tator, Chipman, & Macarthur, 2003; Cusimano, Chipman, Donnelly, & Hutchinson, 2014; Echlin et al., 2010; Goodman, Bradley, Paras, Williamson, & Bizzochi, 2006; Manasse-Cohick & Shapley, 2014; Miyashita, Timpson, Frye, & Gloeckner, 2013), one for elementary and high school students (Bagley et al., 2012), one for university students (Koh, 2011), and one for coaches (Glang, Koester, Beaver, Clay, & McLaughlin, 2010).

The nine concussion education programs included in this review can be divided into interactive oral presentations, educational videos, and computer-based learning programs. Despite variations in the type of program, each was administered at one time point only. Four studies used interactive oral presentations to educate their populations about concussions (Bagley et al., 2012; Koh, 2011; Manasse-Cohick & Shapley, 2014; Miyashita et al., 2013), which consisted of a lecture-style format, with brief video segments and discussions incorporated within the seminar. Three of these interactive oral presentations lasted between 20 to 30 minutes (Koh, 2011; Manasse-Cohick & Shapley, 2014; Miyashita et al., 2013) while one was 40 to 60 minutes in length (Bagley et al., 2012). Two other concussion education programs were based on an educational video created by ThinkFirst, a Canadian non-profit organization dedicated to preventing brain and spinal cord injuries, called *Smart Hockey: More Safety, More Fun* (Cook et

al., 2003; Cusimano et al., 2014). The concussion education video lasted approximately 25 minutes. Another three studies mainly used computer-based learning programs to disseminate their concussion education program (Echlin et al., 2010; Glang et al., 2010; Goodman, Bradley, Paras, Williamson, & Bizzochi, 2006). It was unclear how long participants were exposed to computer-based learning programs.

The content of concussion education programs varied greatly among the nine studies. The most popular features were concussion symptoms (Bagley et al., 2012; Goodman et al., 2006; Koh, 2011; Manasse-Cohick & Shapley, 2014; Miyashita et al., 2013), followed by management strategies (Glang et al., 2010; Koh, 2011; Manasse-Cohick & Shapley, 2014), long-term sequelae (Bagley et al., 2012; Manasse-Cohick & Shapley, 2014; Miyashita et al., 2013), and the return to play protocol (Cusimano et al., 2014; Koh, 2011; Miyashita et al., 2013). Interestingly, only one of the nine studies (Glang et al., 2010) noted the content of their concussion education program was based on peer-reviewed expert guidelines (Guskiewicz et al., 2004; McCrory et al., 2009).

The instruments used to assess the concussion education programs can be grouped into three categories: questionnaires and surveys, quizzes, and other methods. Questionnaires and surveys were used by six studies to assess their concussion education programs (Cook et al., 2003; Cusimano et al., 2014; Glang et al., 2010; Goodman et al., 2006; Manasse-Cohick & Shapley, 2014; Miyashita et al., 2013). The Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS; Rosenbaum & Arnett, 2010) is one of the few standardized questionnaires used to assess the concussion knowledge and attitudes of students 13 to 20 years old. Interestingly, the RoCKAS was only used in one study (Manasse-Cohick & Shapley, 2014). Three studies assessed their concussion education programs using quizzes (Bagley et al., 2012; Echlin et al., 2010; Koh, 2011), which involved a combination of free-response, true/false, and

multiple-choice questions. Finally, two studies used other methods to assess their concussion education programs. For example, Cook et al. (2003) examined the effect of their intervention by recording the number and type of aggressive penalties taken by youth ice hockey players during games. Using another method, Miyashita and colleagues (2013) partially evaluated their concussion education program by analyzing collegiate athletes' responses to "six qualitative questions" (p. 350) in order to create a score that represented the athletes' knowledge of concussions. In sum, the instruments used to assess concussion education programs have predominantly used quantitative methods such as pre- and post-presentation quizzes, questionnaires, and surveys. Behavior change (Cook et al., 2003) and qualitative methods (Miyashita et al., 2013) are two rarely implemented methods that might be useful for evaluating concussion education programs in the future.

The main outcomes of the studies revealed that some education programs did not improve participants' knowledge, attitudes, or behaviors related to concussions (Cusimano et al., 2014; Echlin et al., 2010; Manasse-Cohick & Shapley, 2014). Despite this, the majority found that participants in the experimental groups demonstrated improved concussion knowledge immediately after exposure to the concussion education program when compared to their pre-presentation quiz scores or a control group (Bagley et al., 2012; Cook et al., 2003; Cusimano et al., 2014; Glang et al., 2010; Goodman et al., 2006; Koh, 2011; Manasse-Cohick & Shapley, 2014). One study from Glang and colleagues (2010) reported short-term improvements in the experimental group's intention to take appropriate actions, such as removing an athlete from play who potentially suffered a concussion. Long-term improvements in concussion knowledge were reported up to seven months after exposure to a concussion education program (Cook et al., 2003; Cusimano et al., 2014; Miyashita et al., 2013). For example, Cook and colleagues (2003)

found that youth ice hockey players in the experimental group took fewer aggressive penalties than the control group after being exposed to their education program, which provides some evidence of behavior change. Collectively, the majority reported short-term benefits after being exposed to their concussion education program (Bagley et al., 2012; Cook et al., 2003; Cusimano et al., 2014; Glang et al., 2010; Goodman et al., 2006; Koh, 2011; Manasse-Cohick & Shapley, 2014), while findings regarding the long-term benefits, such as improvements in participants' knowledge and behaviors (Cusimano et al., 2014) and attitudes (Manasse-Cohick & Shapley, 2014) of concussions, were less clear. Details on participants' pre-intervention concussion knowledge were not provided. Only one study articulated that background information was not available (Bagley et al., 2012). Presenting this information would provide insights on the outcomes of concussion education programs, particularly with respect to those that did not find improvements in the experimental conditions.

Discussion

The objective of this scoping review was twofold. The first purpose was to review the literature on concussion education programs and the second purpose was to inform concussion KT strategies. Results from this study determined that there are variations in contemporary concussion education programs. This section will address strengths, weaknesses, and gaps in the existing literature and recommend strategies to improve future concussion education programs.

Findings from this scoping review indicated that younger athletes scored worse on post-education program assessments than older athletes (Bagley et al., 2012; Cusimano et al., 2014). Davis and Purcell (2014) found that athletes under the age of 14 experienced different symptoms than adults, which they attributed to differences in physical and cognitive maturity, neuroplasticity, and protective abilities. Furthermore, youth athletes' concussion symptoms

typically persist for longer periods of time (Field, Collins, Lovell, & Maroon, 2003; Grady, 2010). Experts have highlighted the importance of evaluating and managing youth and adult concussions differently (Davis & Purcell, 2014; McCrory et al., 2013). As a result, we recommend that concussion education programs are created, disseminated, and assessed according to age group (Straus, Tetroe, & Graham, 2013), which is consistent with the knowledge to action cycle.

There was discrepancy in the content of concussion education programs. Often, authors provided few details about the content of their education programs, including whether they were based on empirical research and/or expert guidelines. A number of guidelines and recommendations have been forwarded regarding best practices for concussion evaluation, management, and return to play (activity) strategies (Broglio et al., 2014; Giza et al., 2013; McCrory et al., 2013). Despite the availability of these guidelines, it remains unclear whether most of the concussion education programs reviewed in this article were based on peer-review papers or expert guidelines and recommendations. We advise future research and intervention efforts to report the origins of the concussion information and content used in their programs.

Evaluation of outcomes is standard practice in research and part of the knowledge to action cycle (Straus, Tetroe, & Graham, 2013). In the reviewed studies, quantitative instruments such as quizzes, questionnaires, and surveys were the most common evaluation methods. Additionally, two studies (Cook et al., 2003; Miyashita et al., 2013) evaluated the outcomes of their concussion education programs using different methods that might prove beneficial for future investigations. For example, Cook and colleagues (2003) evaluated hockey players' on-ice behaviors following their intervention. Evaluating the behavioral outcomes of concussion education programs is important given that behavior change, such as reducing athletes'

aggressive and reckless behaviors as well as improving concussion-reporting behaviors (Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Register-Mihalik, Guskiewicz et al., 2013; Register-Mihalik, Linnan et al., 2013), are important goals of concussion education. Given that health-related behavior change has long been the focus of research and intervention (Rickert, Ockne, & Pbert, 2014), we recommend that research on concussion education programs should focus more attention on assessing the behavioral outcomes of their interventions. Another strategy from Miyashita and colleagues (2013) used a form of qualitative methods. However, the manner in which their data were collected and analyzed suggests that qualitative methods were not used to their full potential. In brief, qualitative research is focused on providing detailed descriptions of human interactions, behaviors, and experiences using methods that range from ethnography and document analysis to individual or group interviews (Creswell, 2013). Interviewing is the most commonly used qualitative data collection strategy (Creswell, 2013) and has been recommended as an effective tool to evaluate KT interventions (Straus, Tetroe, Bhattacharyya, Zwarenstein, & Graham, 2013). One type of interviewing technique, focus groups, has commonly been used in health and management settings to help determine the effectiveness of interventions and programs (Kruger & Casey, 2000; Rubin & Rubin, 2012). Focus group interviews would allow participants to use their own words to provide a detailed description of the intervention, as well as offer insights on its strengths and weaknesses (Straus, Tetroe, & Graham, 2013). Moreover, given that concussion education programs are in their early stages of development, implementing qualitative focus group interviews would help advance the science and practice of concussion education programs and concussion KT strategies.

Some of the weaknesses of the concussion education programs reviewed in this study included limited use of interactive tools, delivery of education at one time point only, and lack of

long-term assessment. More research is needed to elucidate the factors that would improve participants' long-term knowledge, attitudes, and behaviors after being exposed to a concussion education program. One potential avenue to help overcome these limitations is to develop concussion education programs that are delivered over multiple education sessions and the outcomes are assessed over longer periods of time, such as 6- and 12-months post-delivery.

To further develop concussion education programs, researchers should explore social media platforms such as Facebook, Twitter, and YouTube (Ahmed et al., 2010; Sullivan et al., 2012; Williams et al., 2014) or a combination of different strategies. For example, Sullivan and colleagues (2012) hypothesized that Twitter, which allows users to 'tweet' messages up to 140 characters in length, could be an appropriate platform to disseminate concussion information and management strategies through short, coherent posts. However, social media platforms have yet to be incorporated into a concussion education program. Another approach could be to integrate several different strategies such as videos, case studies, social media, handouts, oral presentations, and discussions over a number of education sessions to accommodate different learning styles (Provvidenza & Johnston, 2009). More research is needed before we can conclusively recommend the best strategy for concussion education. Ultimately, researchers should consider the knowledge to action cycle when developing and implementing concussion education programs, which will help to ensure that barriers and facilitators to knowledge use are assessed, the best strategy is selected and implemented, and the relevant outcomes are evaluated.

Conclusions

Despite being in their early stages of development, research suggests that interactive concussion education programs can be an effective concussion KT strategy. Based on the findings from this scoping review, the following can be concluded:

- Concussion education programs should use KT frameworks such as the knowledge to action cycle when developing, implementing, and evaluating their programs.
- Researchers must explicitly articulate the origins of concussion information that form the foundation of their education programs.
- Given that qualitative methods have been suggested as a useful tool to evaluate KT interventions (Straus, Tetroe, Bhattacharyya et al., 2013), focus group interviews may be an ideal methodology to evaluate concussion education programs.
- Researchers must develop concussion education programs aimed at improving participants' long-term knowledge, attitudes, and behaviors.
- Future research and intervention should consider implementing concussion education programs that integrate multiple strategies and social media platforms.

What is already known on this subject?

- Concussions are a contentious issue in modern sport.
- The effectiveness of using passive concussion education strategies such as handouts and websites has been questioned.
- Educating members of the sporting community about concussions is imperative to help prevent future injuries, as well as identify symptoms and manage recovery.

What this study adds:

- Despite calls from experts (McCrory et al., 2013; Provvidenza et al., 2013; Provvidenza & Johnston, 2009), concussion education programs have largely been developed without knowledge translation frameworks.
- The outcomes of concussion education programs have primarily been evaluated using questionnaires, surveys, and quizzes. Behavior change (Cook et al., 2003) and qualitative

methods (Miyashita et al., 2013) are evaluation strategies that have rarely been implemented but are worthy of further investigation.

- A number of studies reported short-term improvements in participants' knowledge, attitudes, and behaviors, however the findings regarding the long-term benefits of concussion education programs were less clear.

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Bridging Text

Chapter two presented the strengths, weaknesses, and gaps of previous concussion education programs. Results revealed there have been a total of nine concussion education programs, which have disseminated information using interactive oral presentations, educational videos, and computer-based learning programs. Some of the weaknesses of these interventions included the dissemination at one time-point only and the minimal application of qualitative methods. A significant gap in the research and practice of concussion education programs is that they have been developed without using principles of knowledge translation (KT; Graham et al., 2006; Straus, Tetroe, & Graham, 2013). KT aims to bridge the gap between knowledge creators and users through the adaptation of knowledge to non-scientific populations. Therefore, consistent with principles of KT, the next two manuscripts in this dissertation were conducted to inform the content and delivery of our concussion education program. The first of these manuscripts is presented in chapter three, which is a qualitative study on high school coaches' insights and perceptions of concussions.

Chapter Three

Canadian high school coaches' experiences, insights, and perceived roles with sport-related concussions

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Abstract

There is a need to improve concussion education and prevention efforts for youth athletes and those responsible for their care. The purpose of this study was to understand Canadian high school coaches' insights and perceptions of concussions. Using a case study design, eight high school coaches were interviewed and the data were analysed using a hierarchical content analysis. Findings indicated that participants primarily acquired information about concussions through their own experiences as athletes and parents, and from reports in the sports media. The coaches' felt their role with concussions was to teach athletes safety techniques during practices and competitions and to encourage them to accurately report their concussion symptoms. Additionally, participants forwarded a number of recommendations to improve the dissemination of information to coaches. Results from this study will add to a limited body of concussion research with youth sport coaches. Participants' insights provide researchers and clinicians with information about coaches' perceived role with sport-related concussions.

Keywords: Coaching Science; Brain Concussion; Qualitative Research; Concussion Education; Concussion-Reporting

Canadian high school coaches' experiences, insights, and perceived roles with sport-related concussions

Concussions have been termed the silent epidemic because of the injury's prominence in North America and around the world (Carroll & Rosner, 2012). Specific to sport, youth athletes often experience more severe concussion symptoms and take longer to recover than adults (Davis & Purcell, 2014), facts that are concerning given the injury's high incidence rates in youth sports (Lincoln et al., 2011; Marar, McIlvain, Fields, & Comstock, 2012). Among youth sport participants, high school football, ice hockey, soccer, and basketball athletes have reported a high incidence of concussions (Lincoln et al., 2011; Marar et al., 2012). Evidence also suggests that athletes underreport concussions (Delaney, Lamfookon, Bloom, Al-Kashmiri, & Correa, 2015; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Torres et al., 2013), which is dangerous because of the negative health implications associated with repeated concussions such as second impact syndrome (Dessy, Rasouli, & Choudri, 2015), protracted symptomatology (e.g., Caron, Bloom, Johnston, & Sabiston, 2013), and potential link to Chronic Traumatic Encephalopathy (Galgano, Cantu, & Chin, 2014). Due to the high rates of concussions among youth athletes, the propensity to underreport the injury, and the potential for adverse long-term sequelae, researchers and stakeholders in sport must continue to explore ways to improve athletes' safety. One such method is assessing the concussion knowledge of coaches and the strategies they implement to create a safer sporting environment for their athletes.

Despite being a prominent injury in sport, research suggests that the general knowledge surrounding concussions is "substantially inaccurate" (McKinlay, Bishop, & McLellan, 2011, p. 761). A concussion is a brain injury that results from forces acting on the brain caused by a direct or indirect blow to the head, neck, or body (McCrory et al., 2013). Concussions have been called

invisible injuries (Bloom, Horton, Johnston, & McCrory, 2004) because signs of trauma, such as loss of transient consciousness, are rarely apparent following an acute concussive injury. Evidence of injury is often manifested in a series of symptoms ranging from headaches and dizziness to irritability and depression. Approximately 80% of concussed individuals recover within a two-week period, however a smaller percentage of athletes suffer from protracted symptomatology, which is exacerbated by a number of factors such as age and history of the injury (McCrory et al., 2013). Youth and high school athletes are particularly susceptible to suffering protracted symptoms because their bodies are still maturing and undergoing normal physical and physiological development (Davis & Purcell, 2014). As a result, concussion experts have favoured strategies aimed at making youth sport safer, such as implementing rule changes that eliminate or minimize contact and collisions (e.g., Caron & Bloom, 2015). Another important factor is ensuring that coaches are knowledgeable about concussions and that they are taking appropriate steps to manage the safety of the sporting environment.

Coaches are community leaders and role models who are responsible for athletes' health, well-being, and personal development (Bloom, Falcão, & Caron, 2014). Research has shown that effective coaches promote athletes' growth outside of sport in order to develop positive citizenship (Côté & Gilbert, 2009; Falcão, Bloom, & Gilbert, 2012). On the other hand, negative coaching behaviours have been associated with adverse athlete outcomes such as low self-esteem and increased anxiety (e.g., Gearity & Murray, 2011; Smith, Smoll, & Barnett, 1995). Scholars have argued that effective coaches should use sport as a tool to develop the *whole* person, because positive behaviours learned in the sport environment can be transferred to other facets of life (Bennie, 2011; Côté & Gilbert, 2009; Falcão et al., 2012). For example, sport participation enables athletes to cultivate teamwork, commitment, discipline, and time management skills.

Social and critical thinking skills can also be developed through sport participation, which contributes to the development of positive self-concepts (Bennie, 2011; White & Bennie, 2015). Part of a coach's role may also include providing athletes with health-related information on issues such as concussions. Although coaches are not expected to have the same training as health professionals, coaches could help to protect athletes' health and well-being by promoting a safe sporting environment, reinforcing concussion safety and the importance of reporting possible head injuries. To date, research has yet to examine coaches' perceived roles with concussed athletes.

National coach certification agencies across the world have made an effort to provide coaches with information regarding injury prevention and management. For example, the Coaching Association of Canada (CAC) offers a coach certification program that strives to develop competent and ethical coaches who promote a safe and positive sporting environment. Despite their mandate, the extent to which they have prioritised concussion education is unclear. For example, the CAC developed a series of online modules aimed at educating coaches about concussions (Coaching Association of Canada, 2015), however coaches are not required to complete the modules in order to gain CAC accreditation. Moreover, researchers have yet to determine if coaches are using online concussion information and how this information is improving athletes' safety during practices and competitions.

To date, websites and other passive dissemination strategies such as pamphlets and fact sheets have been the most common methods to educate coaches about concussions (McCrory et al., 2013). For example, the US Centers for Disease Control and Prevention's "HEADS UP to concussions" campaign is one of the largest education initiatives worldwide (Sarmiento, Hoffman, Dmitrovski, & Lee, 2014). Over the past decade, the CDC has created more than 50

educational products such as pamphlets and fact sheets as well as websites to provide coaches with information about concussions (HEADS UP to Youth Sport Coaches, 2015; National Council for Youth Sports, 2015). However, some have questioned whether these types of passive educational materials are effective when used as a standalone strategy (Caron, Bloom, Falcão, & Sweet, 2015; Provvidenza & Johnston, 2009; Straus, Tetroe, & Graham, 2013). As a result, it is not surprising that a body of research found that many coaches are still lacking knowledge on aspects of concussions (Bramley, Kroft, Polk, Newberry, & Silvis, 2012; Valovich McLeod, Schwartz, & Bay, 2007; White et al., 2014). This is unfortunate when considering the high incidence of concussions among adolescents in high school (Lincoln et al., 2011; Marar et al., 2012) coupled with the prominence of a coach in an athlete's life (Bloom et al., 2014), including the recovery from injury (Podlog, Heil, & Schulte, 2014). Therefore, the purpose of the present study was to understand Canadian high school coaches' insights and perceptions of concussions. The research questions guiding this work were:

- How do high school coaches create a safe sporting environment for their athletes?
- How have concussions impacted their coaching practice?
- What is a high school coach's role when an athlete suffers a concussion?
- How do high school coaches acquire information about concussions?

Method

Design

An instrumental case study design was selected to frame high school coaches' insights on concussions (Stake, 2005). Case study is a type of methodology used in qualitative research to provide an in-depth understanding about a phenomenon, bound within a time and/or setting (Creswell, 2013; Stake, 2005). Stake (2005) noted that instrumental case studies are primarily

interested in the *phenomenon* and information about the *case* is secondary. Following Stake's recommendations, information about the high school setting (i.e., the case) will be detailed first, in order to contextualize the coaches' insights and perceptions of concussions (i.e., the phenomenon).

All eight participants coached at the same private (i.e., fee-paying) Canadian high school. This high school has resources, facilities, and a student body whose socioeconomic statuses are higher than the majority in Canada. The high school employs a full-time athletic director (AD) who is responsible for coordinating all athletic activities. The AD was knowledgeable about concussions, and had taken a number of steps to create a safe sporting environment for student-athletes at the high school, including attending concussion seminars nationally and internationally. Furthermore, the AD hired full-time athletic therapists (ATs) who attend all practices and games and who have knowledge about the concussion return to play protocol (cf. McCrory et al., 2013). ATs are specialists in the human musculoskeletal system and have expertise in emergency care, injury assessment, and rehabilitation. Taken together, contextual information about the high school (i.e., the case) was provided to generate a deeper understanding of coaches' setting as well as factors that influenced their perceptions of concussions (i.e., the phenomenon).

Participants

Six male and two female coaches participated in this study. The participants were the head coach of the male or female basketball, football, ice hockey, or soccer teams, and their athletes ranged in age from 15 to 18 years. Coaches ranged in age from 30 to 58 years old (M_{age} = 42.38) and they had been coaching at the high school level between 5 and 33 years (M_{years} = 12.88). Table 4 provides more information about the coaches' characteristics.

Procedure

Upon obtaining approval from the lead investigator's university research ethics council, the coaches were contacted via email and invited to participate in this study. Those who expressed interest identified a time and location for an individual, face-to-face interview with the lead investigator. All eight coaches provided verbal and written informed consent (Appendix A) prior to participating in this study. Each interview took place in a quiet area at the school such as the coach's office, classroom, or other meeting room. Interviews lasted between 40 and 90 minutes and all interviews were conducted in English in May 2014.

Interview Guide

All three members of the research team have experience conducting interviews in the areas of coaching and concussions. Based on our knowledge and experiences, an interview guide (Appendix B) was created to gather coaches' insights on concussions. The interview guide was divided into three parts: opening, key, and concluding questions. Opening questions gathered information about participants' athletic careers and coaching evolution (e.g., "Briefly describe your athletic career" and "Briefly describe your coaching evolution"). Key questions were more specific to the purpose and research questions identified for this study (e.g., "In what ways have concussions impacted the way you coach?" and "How has the media's portrayal of concussions influenced your perceptions of the injury?"). Concluding questions afforded each participant the opportunity to provide additional comments or pose questions to the lead investigator (e.g., "Would you like to add anything else to our interview?" and "Do you have any other questions or comments?").

Data Analysis

Interviews were audio recorded, transcribed verbatim, and stored using the NVivo 10 software package (QSR International, 2014). The 92 single-spaced pages of transcription were analysed using a hierarchical content analysis, a commonly used strategy for analysing qualitative data (Sparkes & Smith, 2014). Sparkes and Smith (2014) noted that hierarchical content analyses are a method of identifying patterns in a data set and determining how patterns interact. One of its strengths is that data are presented in a logical manner, which makes it "amenable for peer dissemination" (Sparkes & Smith, 2014, p. 117). We followed Côté, Salmela, Baria, and Russell's (1993) guidelines for conducting a hierarchical content analysis, a strategy that has previously been used to analyse qualitative data in coaching science (e.g., Greenwood, Davids, & Renshaw, 2014).

Each transcript was read several times in order to gain familiarity with the data. The first stage of analysis involved breaking up each transcript into *meaning units* (Côté et al., 1993). Each meaning unit represents one coherent idea or piece of information (Côté et al., 1993). This process yielded 370 meaning units across the eight transcripts. Once the first stage of analysis was complete, the second stage involved assigning *tags* to each meaning unit. A tag is a name or label that represents a meaning unit. The lead investigator selected a representative transcript, which was both descriptive and consistent with the majority of coaches' perspectives, to generate the first set of tags. Each meaning unit was assigned a tag. Similar meaning units were assigned the same tag. Tags generated from the transcripts were mapped onto a master list. This process was repeated with the other seven transcripts. Assigning tags to meaning units was viewed as an iterative process and the master list was modified when new ideas or concepts arose upon analysing subsequent transcripts. A total of 32 tags were generated from this stage. The third stage of the hierarchical analysis involved grouping tags into *properties* (Côté et al., 1993). Tags

that featured similar characteristics were grouped into the same property. The analysis yielded a total of six properties and they were labelled based on commonalities amongst the tags. The fourth stage of analysis involved grouping the six properties into *categories*, which represents the highest level of analysis (Côté et al., 1993). Three categories emerged from this stage.

Trustworthiness. Researchers are encouraged to outline the measures taken to ensure the trustworthiness of qualitative studies so readers can judge the quality of the findings (Sparkes & Smith, 2014). Indeed, several steps were taken to enhance the trustworthiness of this study, which included dependability, confirmability, and credibility (Lincoln & Guba, 1985; Sparkes & Smith, 2014). An audit trail was used to ensure the *dependability* of this study, whereby the research process was detailed so readers could inspect and assess the merit of the findings as well as the researchers' interpretations (Lincoln & Guba, 1985). The current study was transparent in outlining the research process, which included specific information about the high school setting, participant recruitment, data collection, as well as specific examples of the interview guide (see Appendix B) and the hierarchical content analysis (see Table 5). *Confirmability* was established by using a "critical friend" (Sparkes & Smith, 2014, p. 182), whose role was to offer alternative interpretations of findings and to ensure researcher reflexivity during the analysis. The critical friend was a colleague at the lead investigator's institution who was not otherwise involved in the project. Meetings with the critical friend occurred at each stage of the analysis to ensure findings best represented coaches' perceptions of concussions. Lincoln and Guba (1985) noted that *credibility* was another way to establish trustworthiness in a qualitative study. The current study used researcher triangulation to demonstrate credible findings by matching the participant's reality to the researcher's representation of that reality (Sparkes & Smith, 2014).

The authors met regularly through all aspects of the research process, which helped to ensure we co-created the most realistic representation of high school coaches' perceptions of concussions.

Results

Results from the inductive, hierarchical content analysis revealed three categories, which were labelled *Coach Concussion Knowledge and Training, Coaches' Roles with Concussed Athletes,* and *Recommendations for Concussion Education* (see Table 5). These three categories will be discussed using quotes from the eight participants. Pseudonyms were assigned to each participant (see Table 4) to credit their comments and to protect their identities.

Coach Concussion Knowledge and Training

In this category, coaches described how they acquired concussion knowledge, the types of concussion training they received, and the practices they implemented to maximize their athletes' health and safety.

The coaches all felt that their direct (i.e., as athletes) and indirect (i.e., as parents) experiences with concussions were a primary method of acquiring knowledge about concussions. Some of the participants had concussions as athletes and felt it helped them understand and empathize with their athletes who suffered a concussion:

> I feel like I know what it really feels like to have a concussion. I know that there are so many different depths of concussion but I feel that I know that it's not just a headache. I will never forget being concussed. Especially those first few days after it happened. I was really sick (Victoria).

In addition to experiences as athletes, some of the participants were parents and said they learned about concussions by observing their children experience this injury. Their experiences can be summarized by a quote from Charles:

> I mean… you observe concussions from the outside, but unless you have ever had one it is hard to understand what they are going through. In this case, it was my own son who just came off the ice because he got hit in the head. That really brought it to life for me. The difficulties that he went through for a good two-week period… I could see that within the first week the panic in his voice and through the discussions we had. There was definitely a sense of, 'Am I going to be like this forever? I am having trouble understanding things people are saying to me. I am forgetting things two minutes after hearing them.' My son's concussion experience really made it much more real for me. It was real before but now it was profound.

The participants also discussed how media reports helped them become more aware of concussions and acquire additional knowledge and information about the injury:

> I think media reports have changed the way I think about concussions. I take them more seriously. How many times did we get our bell rung and get back into a game? When you hear about the retired football, hockey, and rugby players who are describing what they are going through… I'm sure that current players would not want to experience that in their retirement (Mark).

The coaches described some recent events in North American professional sports that shaped their perceptions of concussions:

> Some of the reports in sports media have definitely opened my eyes to concussions. If we talk about some of the former National Football League players… Those guys are screwed up! Their brains are fried. I mean… look at what's happening to some of those guys. We didn't really look into concussions back then and now they are paying a price (Thomas).

Some of the coaches alluded to specific professional athletes and their concussion issues. Given the popularity of ice hockey in Canada, it was not surprising that a number of coaches discussed professional hockey players whose concussion issues were well documented in sports media:

> Sidney Crosby's concussion was a high profile case that caused people, who wouldn't call themselves hockey fans to realize, 'Oh wow! He was out for a long time. He didn't miss two-weeks or a month… we're talking five or six months.' The Crosby concussion created a lot of awareness (Kevin).

In addition to informal methods of learning about concussions, such as personal experiences and media reports, the coaches discussed their lack of exposure to formal concussion education. Of the eight coaches, Charles was the only one who reported that he participated in a formal concussion-training course, "Hockey Canada has training on concussions designed for coaches." The other seven coaches reported no exposure to formal concussion education training.

The coaches described how the growing awareness of concussions has impacted their coaching style. For example, Jessica noted: "This is high school soccer. This is not professional or World Cup. I don't care what level it is. It's just not worth risking their health." Additionally, Thomas said:

> At the end of the day, the athlete's health comes first. Their health comes first before me saying, 'I want to win the championship.' My job isn't on the line if I don't win. But it's on the line if someone has a concussion and I screw up by putting him or her back in. We play it safe and that's fine. At the end of the day, their health is most important.

The coaches also described some of the strategies they taught their athletes to help prevent concussions:

> Body checking is not allowed in girl's hockey so I'm not training them how to hit. But I have always trained them to keep their heads up. We definitely practice skating with their heads up so they can see where they are going, the play developing, their options, and who they can pass to. But, at the same time, it teaches them to avoid running into other people (Charles).

At the senior high school level (i.e., ages 15 to 18) in Canada, full contact/collision is permitted in boys' hockey and football. As a result, the coaches of these teams felt it was important to teach their athletes proper technique for body checking in hockey and tackling in football. They felt that incorporating hitting and tackling drills in practices helped improve their athletes' awareness during competitions:

> I focus on teaching kids how to body check properly. When I'm explaining what I want, I'm very clear with guys. So when I say, 'Run the guy, lay the body, or be hard in front of the net', I try to do a better job of delineating for guys what is okay and what isn't. By doing that, you're educating players that you're not supposed to strike people in the head (Kevin).

> My quarterbacks hit because I can't have a quarterback who goes four weeks without contact. When he throws an interception, he becomes a tackler. Quarterbacks have to hit and tackle sometimes. I cross my fingers because I don't want a quarterback to get injured tackling during practice. But I'd rather have a kid get nicked up during practice and miss a game rather than going to a game unprepared and making a live tackle in an open field and have something terrible happen (Martin).

Coaches' Roles with Concussed Athletes

In this category, coaches detailed the series of events that unfolded when one of their athletes (potentially) suffered a concussion, which included their interactions with ATs, parents, and athletes.

The school's strict protocol for dealing with athletes with a concussion was discussed by all coaches, whose comments can be summarized by Richard:

> We have developed a concussion protocol at the school in the last four or five years. Concussions are totally out of my hands. I'm not involved with it [diagnosis, management] at all, except to ask when they've completed their return to play. I don't have a say in it.

The coaches said they were thankful their school had a concussion protocol in place because it took all concussion-related decisions "out of their hands".

The concussion protocol was created and monitored by the AD and the full-time ATs. The coaches noted that the majority of high schools in their region did not have the resources to employ ATs for their teams. As a result, they described feeling fortunate they worked in a setting where support was provided for them:

> For the past six or seven years, I've been in the enviable position of having an AT with my team all the time. When a kid gets hurt on the ice, I have someone who can evaluate them immediately and take care of them so I can concentrate on coaching. The AT then tells me 'Yes, he's fine' or 'Just to be cautious, let's keep him out for the rest of the game' (Kevin).

Additionally, all eight coaches described interactions they had with ATs when one of their athletes suffered a possible concussion during a practice or game:

> After evaluating the injury, the AT will come speak to me. If she says to me that a player can't play again, I say, 'No problem'. To me, the game isn't big enough. I let her do what she needs to do. Then I go out and talk to my player. 'You're not going to play again today and this is why…' There is no discussion until after the game or the next day (Jessica).
>
> Ultimately if [name of AT] says, 'This kid can't go' – he can't go. She has the training. I don't have the same type of training. I have some basic foundations but she is the expert. I'd rather her tell me, 'He physically can't…' – good. Decision made. Go sit down (Mark).

Once the decision to remove an athlete from play was made, coaches said they communicated frequently with the AT during the recovery process to learn about their athlete's progress. Martin noted: "I communicate with the AT everyday when one of my players is injured. I can text with the AT during the day." Additionally, Charles said:

> There is always communication with the AT via email when one of my athletes is out with a concussion. Once the player has been assessed, we will get an email from the therapist telling us that one of our players has suffered a concussion and that he/she will be working with them over the next few days. They give us progress reports.

Coaches also discussed communicating with parents after an athlete was diagnosed with a concussion:

> I think it helps that I call the parents when one of my athletes gets a concussion. Not from a credibility standpoint but so they know I am supporting the ATs decision. I think it's important the parents recognize that the coach is on board with the AT (Kevin).

> I don't think it's part of the concussion protocol but I will call home that evening to check on the injury and how they're feeling. The athlete will come and see me next time they're at school. If they're feeling okay, they will come in the next day and tell me what's up and that they're going to a therapy appointment after school with the AT (Victoria).

Coaches said the majority of parents were supportive and appreciative when coaches updated them on their child's concussion. However, the coaches also detailed some negative interactions with parents, such as when parents wanted their child to continue playing, despite potentially having a concussion:

> Parents come from another generation. I know some fathers who are former football players. They played community football or whatever. There is a bit of machismo – you know, 'Back in my day, we had concussions and we didn't even know it was a concussion. We were a little dizzy and then 10 minutes later they put us back in the game and we played through it. Oh, these kids today…' That's the type of thing you hear. There is still a certain amount of disbelief about concussions (Charles).
>
> You have some dads who think that their kid was never hurt and think they should toughen them up. You need to say to them, 'No. The AT needs to sign off on these five steps… it's going to go slow. Your son can return when they are symptom free' (Mark).
>
> In one particular case, my player got hit in the head and her dad was watching the game. I told her dad, 'I'm not going to play your daughter in the final.' He goes, 'Don't be f****** ridiculous! She can play. She gets sick all the time. Don't worry about it – she's fine.' I said, 'No, I'm not going to play her. If anything happened to her I would never be able to live with it.' No matter what the dad said, he wasn't going to win that battle with me (Jessica).

Although the majority of coaches reported positive interactions with parents, participants noted that some parents would occasionally try to pressure coaches into returning their child to play, despite having concussion symptoms.

In addition to communicating with the AD, ATs, and parents, the coaches also spoke with their athletes who suffered a concussion. Participants felt it was important to ensure their athletes were not hiding concussion symptoms. Coaches noted they spoke with their athletes and emphasized the importance of being honest about their symptoms:

> One of the big things for athletes is to make sure they don't hide stuff. You don't want a kid to tell you they're okay when they're not. I'm very clear with my guys. I tell them, 'It's very simple – tell the truth. If you got hit, whether I saw it or not, and now your head hurts, there's no interpretation involved – it's just honesty. It's the easiest policy' (Kevin).

Nonetheless, some participants felt that athletes were occasionally disingenuous and would report concussion symptoms, despite being asymptomatic, to avoid participating in academic or athletic endeavours. That is, athletes would "play up" or inflate their concussion symptoms. For example, Richard said that one of his colleagues discussed athletes reporting a higher number of concussions around examination periods:

> Somebody I know who coaches at another school said there was an inordinate amount of concussions one week before exams. It was ridiculous… like 18 or some silly number. Students were coming in with notes for concussions. Stuff like, 'I fell in the bathtub'… It's a really tough thing for educators and doctors to assess. It's a tricky area to tell a kid, 'You don't have a concussion.'

As a result, some coaches expressed feelings of frustration when dealing with concussions and can be summarized by Kevin's comments:

> I had two kids that were held out this year who ended up not having concussions. Just to be *incredibly* cautious we didn't let them play even though we knew they didn't have a concussion. Trust me, I was frustrated.

Furthermore, the coaches discussed the challenges of interacting with athletes whom they felt were "faking" concussions. Thomas said, "The more you know your players, I think you can tell if they are faking a concussion or not. And I know it's delicate because you don't want to accuse them of something that they are not doing." Additionally, two other coaches described interacting with athletes who were potentially "faking" concussions:

> It's getting to the point now that the kids at our school know what to say to have a concussion without having it, you know? They know the terms and what they have to say to make it seem like they have a concussion even though they do not. But you have to go with what they say (Victoria).

> We knew about kids faking concussions. But this year was the first time I've ever heard someone say, 'You're not concussed' to a player. The AT came to me and said, 'He's not concussed. I don't know if he's going to get back in the game but he's okay.' The boy came back to school three days later and participated in a charity running event. He ran…. I don't know how many laps on the field. He ran hard the whole time. He never played football again. I think he just decided that he was done with football. No one ever spoke to him about not having a concussion. We just left it (Martin).

The coaches all noted they had directly dealt with or indirectly learned about instances when athletes were disingenuous by either playing up or by downplaying their concussion symptoms.

Although the coaches expressed feelings of frustration related to dealing with concussions, they noted it was not their job to question the validity of an injury. All athletes who reported concussion symptoms were removed from play and were assessed by the AT.

In sum, coaches said that part of their role involves interacting with school personnel such as the AD and ATs. Based on their personal experiences, including interactions with parents and athletes, the participants recommended a number ways to improve concussion education initiatives.

Recommendations for Concussion Education

Participants offered a number of insights to help guide future concussion efforts with athletes, parents, and coaches. Jessica and Victoria discussed ways to educate athletes about concussions:

> I think athletes could be exposed to concussion information in the pre-season or at the beginning of the season. I think injuries can be addressed at that time. They should know where to go if they have an injury as well as the protocol at the school. I think that knowledge is important. Student-athletes should be aware with our concussion protocol and our return to play protocol (Jessica).
>
> I think concussion information has to be given at an assembly or something. It has to be given to the masses. It's not something that should be for just this team or that team. It's a protocol for the whole school. We're concerned about every student regardless of whether they play on the senior girls basketball team (Victoria).

Coaches also felt that parents needed to receive more education about concussions. Despite reporting some negative interactions with parents, overall coaches felt that most parents were aware of the dangers of concussions:

> Concussions are certainly on parents' radar now. Our rugby turn out this year was very low. We have barely enough for a 7s rugby team. Why? Is it concern about concussions or is it just a lack of interest in rugby? I'm guessing parents are more and more concerned about athletes being involved in sports because of concussions (Richard).
>
> Are parents pulling their kids out of football or not allowing their kids to play football because of concussions? I think that many high school and prep school football coaches in Canada and the United States are experiencing – not all, but many – fewer kids in training camp every year (Martin).

Somewhat paradoxically, although coaches felt that parents were aware of concussions, they did not feel as though parents were necessarily knowledgeable about the injury:

> Awareness doesn't translate to knowledge. Parents need to be educated about the injury. I think that we've done a pretty good job at this school, but we can probably do better. Maybe we could have an information evening for parents to come in and learn about our concussion protocol (Kevin).

The eight participants also discussed the importance for coaches to be educated about concussions:

> I think all coaches should receive training about concussions in addition to First Aid training. I think coaches should be able to recognize – not so much the post-concussion symptoms that happen three hours after the concussion – but watching the play on the field and the infractions or the collisions of the injuries that have occurred and having the knowledge to say, 'I should probably grab [name of AT] to talk to that player at half time' (Jessica).

Additionally, they discussed some ways to improve their own knowledge of concussions through formal concussion training. In particular, they recommended that online dissemination strategies might be particularly useful:

> I think that coaches should have some type of concussion training. Coaches should be able to know the general symptoms at least. And they should know the return to play protocol. How hard could a concussion test be? You can do an online course on your own time. It doesn't take more than 45 minutes or an hour. It's a piece of literature and you answer the questions (Mark).

> I think it would be really useful if coaches had concussion training available online. Online stuff is very good because you can go to it when you want on your own time and look at the videos. It would be really cool to have that kind of training (Charles).

Finally, the participants were unclear about their role in educating athletes about concussions:

> Do coaches need to provide concussion information to their athletes? That's a good question. Do I need to meet with my senior players before the year starts? Do we need to hold a clinic with all our senior athletes and talk about the symptoms of a concussion? I don't have these answers (Richard).

Discussion

Using a case study approach, the purpose of the present study was to understand Canadian high school coaches' insights and perceptions about concussions. Despite the school's progressive policies and procedures regarding concussions, which included hiring full-time health professionals to monitor their sports teams, seven of the eight coaches primarily acquired their knowledge *informally* through their experiences as athletes, coaches, and parents, as well as from reports in the media. Additionally, none of the participants used or were aware of the free

online materials offered by the CAC (Coaching Association of Canada, 2015). Research has shown that coaches who had not been exposed to *formal* concussion education were lacking knowledge on the injury and were less likely to recognize concussion symptoms in their athletes (Bramley et al., 2012; Valovich McLeod et al., 2007; White et al., 2014). Furthermore, evidence suggests that coaches who completed online concussion training improved their knowledge and perceptions of the injury (Glang, Koester, Beaver, Clay, & McLaughlin, 2010). Results from the present study underscore the importance for coach certification agencies such as the CAC to consider prioritizing formal concussion education efforts for coaches.

Knowledge translation (KT) is the field of study concerned with bridging the gap between the scientific community and knowledge users by determining the most effective methods, tools, and strategies for disseminating knowledge to a population (Straus et al., 2013). As a result, principles from KT could be helpful to guide future concussion education efforts for coaches (Caron et al., 2015; Provvidenza & Johnston, 2009; Straus et al., 2013). In fact, concussion researchers Provvidenza and Johnston (2009) postulated that KT strategies could be the "missing link" (p. 69) to improving formal concussion education initiatives. Given the present sample of coaches did not appear to learn about concussions through materials supplied by coach certification agencies, researchers, clinicians, and coach certification agencies are encouraged to work collaboratively to ensure that concussion materials are developed and disseminated using principles from KT. Thus, implementing principles from KT would help to ensure coaches are receiving concussion information that is tailored to meet their needs.

All coaches in the present study felt their role with concussions involved promoting a safe sporting environment for their athletes by teaching preventative measures such as safe body checking or tackling techniques. Additionally, participants stressed the importance of adhering to

the ATs suggestions and prioritising athletes' health and well-being over winning in competitions, which is congruent with an athlete-centred coaching style (Cassidy, 2013; International Sport Coaching Framework, 2013). Athlete-centred coaching ideals recognize coaches' influence beyond improving athletes' performance during competitions. Results from the current study suggest that participants were focused on the growth of the whole person (Bennie, 2011; Falcão et al., 2012), which is more likely to increase athletes' enjoyment and help them to develop psychosocial skills that promote their long-term interest in sport participation (Bennie, 2011). Our results suggest that coach certification agencies should continue to develop and train coaches who put athletes' health, safety, and well-being at the forefront of their coaching practices. Additionally, coaches should be equipped with the ability to teach athletes concussion safety and prevention skills during practices and competitions.

The coaches felt another part of their role with concussions was centred on communication, particularly because their athletes were occasionally disingenuous about their concussion symptoms. Previous empirical results have found that athletes have hidden concussion symptoms in order to continue playing (Caron et al., 2013; Delaney et al., 2015; Kroshus et al., 2014; Torres et al., 2013). Nearly 20% of athletes surveyed in Delaney and colleagues' (2015) study said they did not report concussion symptoms within the previous 12 months, and the most common reason was feeling their concussion was not serious/severe and there was little danger involved in continuing to play. Torres et al. (2013) found that 43% of the athletes in their sample hid concussion symptoms to continue playing, and that 22% were "unlikely or very unlikely" (p. 283) to report concussion symptoms in the future. Results from the current study contribute to this growing body of literature on athletes underreporting concussion symptoms by adding insights and perceptions from a sample of high school coaches.

The current findings suggest that coaches should communicate with athletes and stress the importance of accurately reporting concussion symptoms, an approach that would also help them foster a safe and supportive sporting environment (Cassidy, 2013; International Sport Coaching Framework, 2013). These results also suggest that part of a coach's role involves interacting with health professionals who are on-site during practices and games to help them identify athletes who might be suffering from a concussion.

Unique from previous empirical accounts (e.g., Delaney et al., 2015; Kroshus et al., 2014; Torres et al., 2013), the coaches in the present study felt that some of their athletes occasionally "played up" the severity of concussion symptoms to avoid sports or academic requirements, or perhaps because they wanted to discontinue playing sports but did not know how to communicate these intentions to coaches. Participants expressed feelings of frustration in relation to athletes being deceptive with concussions, however the origins of their frustrations were not clearly articulated. Given that participants' coaching practices appeared to be in line with athlete-centred coaching ideals (Bennie, 2011; Cassidy, 2013; Falcão et al., 2012), it is unlikely they were frustrated with their athletes being withheld from practices and/or competitions due to the school's strict concussion protocol. A more likely interpretation was that coaches were frustrated with the uncertainty of concussions, and particularly because they could not easily tell (a) if athletes were concussed, (b) if they were concussed and trying to downplay their symptoms, or (c) if they were not concussed but were trying to play up symptoms commonly associated with concussions. This finding further highlights the need to improve concussion education for coaches, which should include information that athletes may try to be deceptive with concussions by either playing up or downplaying their symptoms. Additionally, athlete-centred coaches

should consider why athletes are being deceptive about concussions and discuss their motives for not accurately reporting symptoms of the injury.

Conclusion

The current findings offer insights on coaches' perceived knowledge of and roles with concussions. These results highlight the need to improve formal concussion education efforts for coaches, and suggest that coaches need to be aware that some athletes may attempt to hide or exaggerate their concussion symptoms. Future investigations should explore this topic from the athlete's perspective, using either individual or focus group interviews that would allow them to provide in-depth descriptions and insights using their own words. Additionally, the eight participants in the current study coached at a privileged high school with superior resources, such as access to full-time ATs, compared to most North American high schools. It would be interesting for future research to investigate coaches that work in different socioeconomic contexts and who do not have access to similar resources. In sum, we believe findings from the present study are valuable for the development of curriculum and educational interventions designed to improve the quality and safety of the youth sport environment.

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Bridging Text

Chapter three presented an original manuscript that investigated high school coaches' insights and perceptions of concussions. Results indicated that coaches taught athletes strategies and skills during practices and games that were aimed at improving their health and safety. The coaches also noted that some of their athletes were occasionally disingenuous when reporting concussion symptoms. Chapter three was the first of two manuscripts that were conducted to inform the content and delivery of our concussion education program. Building on the data gathered from the high school coaches, chapter four presents a qualitative study that explored high school athletes' insights on concussions, including the mediums through which they have acquired information about the injury.

Chapter Four

Adolescent athletes' insights on the acquisition of concussion knowledge

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Abstract

Research has found that adolescent athletes are more likely to suffer protracted concussion symptoms than adult athletes. As a result, it is important that adolescent athletes are educated about the injury to help improve their safety while participating in sports. The purpose of this study was to gather adolescent athletes' insights on the acquisition of concussion knowledge. Interviews were conducted with 18 (9 boys, 9 girls) adolescent high school athletes aged 15 to 18 and data were analyzed using a hierarchical content analysis. All 18 participants in this study said they felt it was important for athletes their age to be knowledgeable about concussions, however only one reported having previously participated in a formal concussion information session. Adolescent athletes said they primarily acquired concussion information informally through direct and indirect experiences with the injury, interactions with peers and family members, sports media reports, and school projects. The current findings are beneficial to all those who are involved in the training, preparation, care and well-being of adolescent athletes, as they provide insights on the primary channels through which they are acquiring knowledge of concussions.

Keywords: Brain Concussion; Brain Injuries; Adolescent; Athletes; Concussion Education; Knowledge Translation

Adolescent athletes' insights on the acquisition of concussion knowledge

A concussion is a type of brain injury that results from impulses transmitted to the head via direct or indirect blows to the head, face, or elsewhere on the body (McCrory, Meeuwisse, Aubry et al., 2013). Sport-related concussions have garnered considerable attention in recent years due to the long-term health consequences that have been linked with the injury, such as second impact syndrome (Dessy, Rasouli, & Choudri, 2015), Chronic Traumatic Encephalopathy (Galgano, Cantu & Chin, 2014) and protracted symptoms that can persist from months to years (e.g., Caron, Bloom, Johnston, & Sabiston, 2013). While concussion sequelae affects athletes of all ages, researchers have suggested that adolescent athletes, under 18 years, suffer from a more severe symptomatology than adults (Davis & Purcell, 2014; Williams, Puetz, Giza, & Broglio, 2015). Additionally, rehabilitation strategies for concussions are in the early stages of development (Broglio, Collins, Williams, Mucha, & Kontos, 2015) and, as a result, there is currently little medical and health professionals can do to treat or reduce the effects of a concussion after the event (McCrory, Meeuwisse, Aubry et al., 2013). Thus, it is vital to ensure adolescent athletes receive appropriate concussion education that, in turn, would help to improve their safety while competing in sports.

It is important to consider the critical brain development that occurs during adolescence (Boyd, Johnson, & Bee, 2014). The first period of growth occurs between the ages of 13-15 and involves the hardening of cerebral cortex and improved efficiency of neuronal pathways, developments that allow adolescents to think abstractly and reflect on their cognitive processes (Fischer & Rose, 1994). A second period of brain development begins at 17 years and extends into young adulthood. It involves the development of the frontal lobes of the cerebral cortex, regions of the brain that are heavily involved in logic and planning (Davies & Rose, 1999).

Researchers have found that adolescent athletes (e.g., 13-18 years) are particularly sensitive to the axonal damage that occurs with a concussion during the two critical brain growth periods (Blakemore & Choudhury, 2006; Carman et al., 2015). Furthermore, researchers have suggested concussions suffered during these developmental periods contribute to a prolonged recovery for adolescent athletes, which persists, on average, for twice as long as collegiate and professional athletes (Babcock et al., 2013; Grady, 2010; Williams et al., 2015). Although much remains unknown about concussions within the adolescent population (e.g., Williams et al., 2015), important cognitive development occurs throughout adolescence which indicates a need to improve concussion prevention efforts for this cohort. One way to prevent and/or reduce the number of concussions is to ensure adolescent athletes are appropriately educated about the injury.

Indeed, a number of consensus panels have highlighted the importance of educating adolescent athletes about concussions (Broglio et al., 2014; Harmon et al., 2013; McCrory, Meeuwisse, Aubry et al., 2013). For example, Broglio and colleagues (2014) suggested that concussion education should include symptom recognition and health professional referral, prevention, return to play/activity, and consequences of improper management. Although there appears to be agreement among experts regarding the *type* of concussion information that athletes should be receiving, there is little consensus regarding *how* this knowledge should be disseminated to athletes (Caron, Bloom, Falcão, & Sweet, 2015; Williamson et al., 2014).

Athletes have been educated about concussions through printed materials (e.g., Sarmiento, Hoffman, Dmitrovski, & Lee, 2014), websites (e.g., Ahmed, Sullivan, Schneiders, & McCrory, 2012) and, to a lesser extent, formal concussion education programs (e.g., Bagley et al., 2012). Printed materials such as pamphlets, posters, and fact sheets have likely been the most

popular method of educating adolescent athletes about concussions. For example, in North America, the *Heads Up* initiative has created over 50 educational tools that have been distributed to adolescent athletes over the past decade (see Sarmiento et al., 2014 for a review). Although printed materials have been useful in disseminating concussion information on a large scale, researchers have questioned whether printed materials could improve adolescent athletes' concussion knowledge when used as a standalone strategy (Caron et al., 2015; Grimshaw et al., 2001). Concussion-related websites are another method that has been used to disseminate concussion knowledge. Ahmed and colleagues (2012) reviewed 43 concussion-related websites and found that many contained medical jargon, which may not be the most appropriate way to disseminate concussion knowledge, particularly to young athletes. Formal concussion education programs have also been used to educate adolescent athletes about concussions through interactive oral presentations, educational videos, and computer-based learning programs (Caron et al., 2015). In their review of concussion education programs, Caron and colleagues (2015) found that adolescent athletes scored worse on post-educational intervention assessments than collegiate athletes, which suggested the content and/or delivery of concussion education programs may not have been appropriately adapted to adolescent athletes. Taken together, despite the increased availability of concussion education initiatives in recent years, there is little consensus on the most appropriate ways of disseminating concussion knowledge to adolescent athletes. To inform these efforts, it would be beneficial to understand adolescent athletes' perceptions of concussions, including how they have acquired knowledge about the injury.

Interviews are a type of qualitative research method that allows interviewees to speak about and elaborate on information they feel is most important (Creswell, 2013; Denzin & Lincoln, 2000; Rubin & Rubin, 2012). Interviews have previously been used in the social and

health sciences to gather adolescent athletes' perceptions of health-related issues such as eating disorders (Martinsen & Sundgot-Borgen, 2013), doping (Pappa & Kennedy, 2014), injury recovery (Podlog et al., 2013) and concussions (Chrisman, Quitiquit, & Rivara, 2013). Specific to the current study, implementing qualitative interviews would allow adolescent athletes to reflect on their experiences with concussions and describe how they have typically acquired concussion knowledge. The purpose of this study was to gather adolescent athletes' insights on the acquisition of concussion knowledge. The research questions guiding this study were: What are adolescent athletes' experiences with concussions? How do adolescent athletes acquire information about concussions? Who are the main social influences on adolescent athletes' knowledge of concussions? How would adolescent athletes prefer to be educated about concussions?

Method

Design

An instrumental case study design was used to frame adolescent athletes' insights on and perceptions of concussions (Stake, 2005). Case studies are used to understand contemporary issues, questions, or concerns that are bound within a specific time and setting (Stake, 2005). When using a case study design, researchers are encouraged to detail information about participants and their setting (i.e., the case) so readers have background information about their realities as well as the factors that have may have influenced their perceptions about the phenomenon under investigation (Stake, 2005). Participants in the current study all attended the same private (i.e., fee-paying) Canadian high school. Given that the high school's tuition is higher than most universities in our country, it can be assumed the participants' socioeconomic statuses are above average. Moreover, the high school has superior resources and facilities than

public high schools in the region and country. For example, the school employs full-time athletic therapists (ATs) who attend all practices and games, interact regularly with members of the senior athletic teams, and administer concussion baseline testing with athletes at the beginning of the season. ATs are specialists in the human musculoskeletal system and have expertise in emergency care, injury assessment, and rehabilitation. ATs are responsible for diagnosing athletes with a concussion at the school and monitoring them throughout the return to play (RTP) protocol (cf. McCrory, Meeuwisse, Aubry et al., 2013). Information about participants' background and experiences was outlined to frame their insights and perceptions of concussions by providing a detailed understanding of the school environment.

Participants

Nine male and nine female (n=18) adolescent athletes participated in this study. Participants all competed on one of the school's organized varsity sports teams. Twelve of the 18 student-athletes reported they had previously been diagnosed with a concussion and none reported being symptomatic of a concussion at the time of the study. Table 6 provides more information about the participants, 15-18 years, in this study. Each participant was assigned a pseudonym to protect his or her identity.

Procedure

After obtaining approval from our university research ethics council, the Athletic Director (AD) from a local high school was contacted and agreed to serve as third party for this study. More precisely, the AD was asked to recruit student-athletes who were members of one of the school's senior (i.e., grade 9-12) athletic teams. The AD was asked to recruit an even number of boys and girls. History of concussions was not a requirement for participation. Those who were interested in participating collected a sealed envelope from the AD, which contained

parent/legal guardian consent (Appendix C) and athlete assent (Appendix D) forms. Once both forms were completed and returned by the student-athletes, the AD arranged a time for a meeting between participants and the lead investigator.

Data Collection

Individual, face-to-face interviews were conducted with the 18 adolescent participants, which allowed them to use their own words to provide in-depth descriptions about their perceptions of concussions, including the acquisition of concussion knowledge (Rubin & Rubin, 2012). Meeting times and locations were selected by the AD. The interview times did not interfere with participants' academic or athletic commitments and the meeting locations consisted of classrooms, meeting rooms, and/or offices on the school's campus. At the beginning of the meeting, each student-athlete was verbally explained his or her rights as a research participant prior to beginning the interview questions by the lead investigator.

The same semi-structured interview guide (Appendix E) was used with each participant and consisted of two sections: demographic and main interview questions. Demographic questions were asked to obtain biographical information about their sporting history (e.g., "What is your date of birth?"; "What grade are you in?"; and "Which high school team(s) did you play on this past year?"). The second section comprised the main questions for the interview, which included three parts: *opening*, *key*, and *concluding* questions. Opening questions were used to help the lead investigator establish rapport with participants, as well as gather information about the types of injuries the student-athletes and their teammates have experienced (e.g., "Can you describe the type of injuries that happen most often in the sports you play?" and "Have you or your teammates ever been injured and/or suffered a concussion while playing sports? If yes, describe what happened."). Key questions were more specific to the purpose and research

questions identified for this study (e.g., “Has anyone ever talked to you about concussions before? If so, what types of things did they tell you?”, “Can you think of any professional athletes who have suffered a concussion? If so, tell me what you have heard”, and “Do you think it is important for athletes your age to learn about concussions? Why or Why not?”). Concluding questions afforded each participant the opportunity to provide additional comments or pose questions to the lead investigator (e.g., “Would you like to add anything else related to our interview?” and “Do you have any comments or questions?”).

Data Analysis

Interviews were audio recorded, transcribed verbatim, and stored using the NVivo 10 software package (QSR International Pty Ltd). The 18 interview transcriptions yielded 146 single-spaced typed pages of text. Data were analyzed using a hierarchical content analysis, a type of inductive (i.e., bottom-up) method that is used to identify patterns within and between the interviews. Sparkes and Smith (2014) noted that a hierarchical content analysis allows for data to be presented in a logical manner, which makes them “amenable for peer dissemination” (Sparkes & Smith, 2014, p. 117). Côté, Salmela, Baria, and Russell’s (1993) guidelines for conducting a hierarchical content analysis were followed. To begin, the lead investigator gained familiarity with the data by reading each transcript in its entirety several times while simultaneously listening to the audio recordings. Following this, the interview transcriptions were broken down into *meaning units*, which are blocks of text that represent a single concept, thought, or idea (Côté et al., 1993). This process yielded 472 meaning units. The second step involved assigning a *tag* to each meaning unit. A tag is a label that captures the essence of a meaning unit (Côté et al., 1993). Similar meaning units were assigned the same tag. Generating tags was an iterative process (see *critical friend* in the trustworthiness subsection for more information), and a final

list of 27 tags emerged from this process. The final stage of this hierarchical content analysis involved searching for patterns between the 27 tags. Those with similar characteristics were grouped into *properties*. Five properties emerged from this process and will be further explained in the results section.

Trustworthiness. Qualitative researchers are encouraged to be transparent throughout the research process and demonstrate the steps taken to ensure the quality and trustworthiness of their study (Creswell, 2013; Denzin & Lincoln, 2000; Sparkes & Smith, 2014). There has been much discussion on the best ways to establish trustworthiness in qualitative inquiry, with little consensus (see Smith, 2009; Sparkes & Smith, 2009 for a discussion). For example, Sparkes and Smith (2014) noted that *criteriological* approaches, such as Lincoln and Guba's (1985) parallel criteria, are among the most commonly used strategies in sport, exercise and health research to establish trustworthiness. However, Sparkes and Smith (2009) argued that Lincoln and Guba's parallel criteria are built on "very shaky philosophical 'foundations'" (p. 496) and cautioned researchers against using this approach. Consequently, the current study used a *relativist* approach (cf. Sparkes & Smith, 2009), which means that criteria were selected based on the context and purposes of our research.

Leaving an *audit trail* was one example of establishing trustworthiness in the current study (Sparkes & Smith, 2014). This involved articulating our rationale for decisions made throughout the research process by detailing background information about the participants and their setting, recruitment, consent/assent procedures, and data collection and analysis. A *critical friend* was used in the current study to ensure the data, interpretations, and outcomes of our study best represented the participants' insights, experiences, and meanings. The critical friend in this study was the third author of this paper, who acted as a theoretical sounding board throughout

data analysis to enhance the lead investigators' reflexive self-awareness (Sparkes & Smith, 2014). More precisely, the lead investigator initially assigned tags to each meaning unit and mapped the names of tags onto a master list. The critical friend reviewed all 18 tagged transcripts and the master list of tags to see if the tags initially assigned by the lead investigator accurately captured the essence of participants' experiences and perceptions. This process led to some changes in the labelling of tags (e.g., "feelings about returning to sports post-concussion" was changed to "returning to play – emotions"). Additionally, some meaning units were assigned different tags. This process was also repeated for step three of the analysis. Using a critical friend helped to ensure the lead investigator was reflexive throughout data analysis and to ensure data was appropriately categorized. *Researcher triangulation* was also used in the current study by having all of the authors independently review and agree on the data analysis, the results and their interpretations, as well as the conclusions drawn from this study. This process was conducted to help ensure we presented the most realistic representation of adolescent athletes' insights on the acquisition of concussion knowledge.

Results

Results from the inductive, hierarchical content analysis revealed five properties, which were labeled *Concussion Experiences*, *Returning to Sports after a Concussion*, *Personal Interactions about Concussions*, *Exposure to Concussion Information*, and *Suggestions to Improve Concussion Education*. These five properties will be detailed in this section and illustrated using quotes from all 18 participants. Participants' quotations will be identified using the pseudonyms outlined in Table 6

Concussion Experiences*: Concussions are not the same as other types of injuries*

All participants in this study reported having suffered various types of injuries while participating in sports. The adolescent athletes said the types of injuries they experienced directly (i.e., personally) or indirectly (i.e., peers, teammates, and family members) ranged from bruises and sprains to fractures and dislocations. Athletes also shared insights on concussions that stemmed from direct and/or indirect experiences with the injury. Perhaps not surprisingly, the six student-athletes who had not experienced a concussion did not talk about the injury in detail. Moreover, these student-athletes appeared hesitant to discuss concussions, even in relation to peers' and family members' experiences, which suggests they might have felt they were lacking knowledge about the injury. On the other hand, the 12 participants who had personally suffered a concussion described their experiences in detail, including the types of symptoms they encountered in the days and months afterwards. The following excerpt from Emmanuel's transcript provides an example of their comments:

> I've had two concussions. The first one was in grade five or six and I tripped while playing basketball and I smashed my head into the wall. Sensitivity to light and sound were the main symptoms I had. So, if I would stare straight into bright lights it would hurt. I would get headaches. I remember doing math homework and I couldn't get a simple question. It frustrated me to the point where I couldn't do anything. The headaches kept getting worse and then I just went to bed.

Although some participants reported experiencing protracted concussions symptoms, the majority said their concussion symptoms subsided within two weeks.

Based on their direct and indirect experiences, participants compared concussions to other types of injuries such as broken bones. All participants said they felt concussions were "worse" than other types of injuries. For example, Luke noted:

> Concussions are not the same as other types of injuries. I broke my leg last year and although it's possible my flexibility may not be the same ever again, that is still less severe than a head injury that stays with you for your entire life.

Despite feeling that concussions were worse than other types of injuries, some questioned whether they would report a concussion to a teacher, coach, or parent. This was especially true of participants who were playing in competitions that had great personal importance such as playoffs or championships or who wanted to demonstrate toughness to teammates or opponents:

> My concussion happened last year at rugby Nationals. It happened in our second or third to last game. I really wanted to play in the next game because it was being televised. So I lied to our athletic therapist. I said that I felt fine and that I was good. I really wanted to play in our next game but I didn't end up playing because she called my bluff (Elliot).
>
> It really wasn't smart for me to stay in the game after getting hit *that* hard. But I didn't want to let the other team think their player just destroyed me. And I didn't want to give the other player the pride of being able to say, 'Oh look at me I'm a beast I just took him out of the game' (Ethan).

In sum, the student-athletes experienced a variety of concussion symptoms, such as headaches and sensitivity to light. Based on their experiences, the participants felt that concussions were "worse" or more severe that other types of musculoskeletal injuries they had previously suffered such as sprains, tears, and broken bones. Despite having knowingly suffered a concussion, the student-athletes described instances where they purposely did not disclose their concussion symptoms in order to continue playing. Thus, knowledge of concussions may not be enough to improve adolescent athletes' concussion behaviors such as reporting possible injuries.

Returning to Sports after a Concussion: ***I was more cautious playing sports after my concussion***

Twelve participants described the process of being diagnosed with a concussion, recovery, and returning to play. According to the RTP protocol (cf. McCrory, Meeuwisse, Aubry et al., 2013), the first stage involves complete physical *and* cognitive rest until all concussion symptoms have subsided. The student-athletes who had previously experienced a concussion described their day-to-day experiences with a concussion. For example, James said, "I stayed in my room for the following few days. I slept a lot. But I didn't want to just sit there and do nothing… I would get bored. So I put sunglasses on and watched television". While James' concussion symptoms subsided within two weeks, Lauren and Holly indicated they experienced symptoms that persisted for longer than two weeks. They described their limited activities during this time:

> I went home, turned the lights out in my room, and went to sleep. When I woke up, I would just sit around. There's not much you can do. They say that it's good to stay away from the television and your phone. I think it was a couple weeks – maybe like 10 or 12 days – until I was able to get on my computer and phone (Lauren).
>
> I was out for about two months, give or take a week. One of the main things that happened because of my concussion was that I couldn't read, which was really frustrating. I really couldn't do anything. Television was out of the question. I started texting after the first week, which was not the best idea (Holly).

Eventually, all participants who experienced a concussion progressed through the RTP stages and returned to playing sports. RTP was designed to ensure that athletes are physically and cognitively prepared for a return to sport and thus does not account for psychological and

emotional aspects such as fear of reinjury. Several of the participants in this study described feeling uneasy about returning to sports. Walter noted, “It affected the way I played. I was already a careful person to begin with… but I would say that was a little more careful after the concussion”.

> I would say that I changed the way I played for a while because the fear of having to go through a concussion again. At first I was really fearful of getting injured again. Even when we’re in gym class at school, I remember someone accidentally kicked a ball right at the back of my head and I started freaking out. In terms of sports, I was trying to protect my head more. Eventually I was slowly able to get back to my normal game. Now I definitely don’t think about concussions when I play as much as I used to (Lauren).

These results suggest that athletes feared suffering a concussion when returning to sport. This was evidenced by some student-athletes who reported that they altered their playing styles to “play safe” upon their return to sports:

> I wasn’t taking any headers when I first returned to soccer after my concussion. I was just trying to take the ball off of my chest and put it down to my feet. So, I guess I was being very cautious. And as soon as someone would come close to me I would take a little extra step to be out of the way (Walter).

> I was more cautious playing sports after my concussion. Much more. I play center in hockey most of the time but there was a year or two when I played on the wing. And when a defense passes to you most of the time you get hit by a defenseman coming down the boards. That made me really nervous. I used to tip the puck off the boards and out of the zone (Luke).

In this property, the student-athletes described their (limited) daily activities while recovering from a concussion. Holly and Lauren described a particularly challenging recovery, as their concussion symptoms persisted for more than two weeks and inhibited their ability to engage in regular activities such as watching television and connecting with friends and peers using technology. In addition, some of the adolescent athletes felt their experiences with concussions caused them to modify their on-field behaviors when returning to sports by taking extra precaution to avoid contact and collisions.

Personal Interactions about Concussions: ***I've heard a whole lot about concussions because of my brother***

The adolescent student-athletes also discussed the types of interactions they had with people about concussions, which included peers, athletic therapists, and family members. For example, the student-athletes described the types of interactions they had with their friends and teammates about concussions: "My friends and I don't really ever talk about concussions. Maybe it will come up if we're talking about injuries in general" (Veronica).

> My teammates and I rarely talk about concussions. Maybe if we were watching a hockey highlight tape that involved a big [body check] or something. We might say, 'that guy is probably concussed' but that's about as much as we talk about concussions (Mark).

More than half of the student-athletes said they interacted with the school's athletic therapists about concussions. For example, Samantha noted, "Anytime I think I have a concussion I get checked out by our therapist". Throughout these interactions, participants said they were exposed to information about concussions:

> The athletic therapist did all these tests. I told her about how my vision and hearing was enhanced. She said that can happen after a concussion and that she would talk to my

> parents after the game. She had that whole *concussion talk* with them. You know, that I've been hit to the head and about the concussion protocol (Ethan).
>
> I don't know if it's true but the athletic therapist told me that if you play with a concussion and then you got another concussion then you could just collapse. Like, the brain will just shut down. I don't know if it's true or not – she might have just said that to scare me (Jordan).

Throughout the interviews, it was evident that a large number of participants were not confident when discussing aspects of concussions, which was evidenced by their voices trailing off when discussing aspects of the injury. For example, participants would often start by saying "I don't know if it's true or not but…", which suggests they were lacking knowledge about concussions.

Of all their interactions, it appeared that conversations with family members about concussions had the greatest impact on the adolescent athletes' knowledge and perceptions of the injury. For example, some of the student-athletes described their siblings' concussion experiences and how they impacted them, "I've heard a whole lot about concussions because of my brother. He got a pretty bad concussion from playing rugby. That concussion had a pretty big effect on my brother. He had a lot of migraines" (Ethan).

> I think that I knew a bit about concussions before I had my first concussion because of my sister. She got a really serious one playing basketball. She had serious symptoms for, like, a year. She was off of school. She wasn't able to go out with her friends anymore. Her lifestyle was totally changed. She was having a difficult time on day-to-day basis. That's pretty much how I have learned about concussions (Mark).

Participants whose siblings had suffered a concussion appeared to be quite knowledgeable about the injury, which may have resulted from observing the challenges their siblings encountered throughout their recovery.

Although a number of adolescent athletes said they interacted with their brothers and sisters, almost all of the participants described instances when they spoke about concussions with their parents:

> My mom talked to me about concussions when my brother got one. I remember my mom told me that I should tell someone right away if I ever get hit in the head. She also told me that I should get off the field and see how I feel later. My mom is really big on the saying, 'If you feel that you are injured, get off so you don't make it worse. Take a breather and see how you feel after' (Kelsey).
>
> My mom and dad sat me down and told me that if I ever I get hit to the head that I should tell them right away. That I should monitor how I feel. And if I have headaches I should tell them right away. If I have blurred vision or if I feel dizzy I should tell them right away so they said they can bring me to the hospital and get me checked out (Samantha).

Taken together, peers, athletic therapists, and family members were influential on the adolescent athletes' knowledge and perceptions of concussions. In particular, participants whose siblings suffered a concussion appeared to have gained knowledge about the injury by learning from their experiences.

Exposure to Concussion Information: ***Seeing what Crosby went through made me realize that concussions are serious***

The participants said that sports media reports were a popular method in which they were exposed to concussion information. Given that all of the participants lived in Canada, it was not

surprising the majority described examples from sports media reports involving professional ice hockey players. Although some described concussions involving professional soccer and basketball athletes, most of the participants highlighted National Hockey League (NHL) superstar player Sidney Crosby's well-documented concussion experiences (see McGannon, Cunningham, & Schinke, 2013):

> Sidney got [body checked to the head] during one game. And got hit along the boards in the next game. He bounced off the boards and just dropped. He was done. He was out for a long while after the second one. It was definitely a couple months (Aaron).
>
> Seeing what Crosby went through made me realize that concussions are serious. It's not something you want to joke around with. It made me realize that lying about having a concussion, like I did, is not the right thing to do. I was thinking, 'It's not a big deal, who cares.' But concussions are not something to be taken lightly (Elliot).

In addition to sports media reports, the adolescent athletes said that self-directed learning initiatives such as school projects were another way they were exposed to concussion information. More precisely, four participants said they conducted school projects on concussions or topics related to head injuries out of personal interest. Those who did a school project on concussions were primarily interested in learning about the long-term consequences of concussions:

> I actually did a presentation on concussions for one of my classes this year. When I was doing some of the research about the long-term effects of concussions… I didn't know that it could affect people that much in the future. I learned that your memory could really, really be affected (Holly).

> I just did an essay on concussions for school this year. I did some research about the long-term effects – like CTE and that kind of stuff. I researched a couple of hockey players like Derek Boogaard, how they suffered from it, and how it pretty much ruined their lives. Because he had concussion after concussion, his headaches basically didn't go away. After a while they started suffering from other diseases like dementia and all that (Jordan).

The majority of the participants who conducted school projects on concussions focused on the long-term consequences of concussions. Moreover, many said the content of their school projects were primarily based on sports media reports of professional athletes.

The majority of participants said they had not previously been exposed to formal concussion education. However, some highlighted instances when they have received concussion education from health professionals. For example, two participants said they were informed about concussions by athletic therapists during baseline testing at the beginning of the season. Kelsey said, "Last year I did my first concussion test with [name of athletic therapist] and I guess that was the first time anyone talked to me about concussions", and Amanda noted, "Aside from when I got my concussion test, no one has really ever talked to me about concussions before". Only one of the 18 participants described having previously been exposed to a formal concussion information session. Specifically, Karen noted:

> One time a woman came in and spoke to my community hockey team about the neuroscience of concussions. She didn't really tell us what a concussion was. She told us more about how bad concussions could be. I don't remember everything. I definitely found the talk helpful because no one really ever told me how serious concussions were before that.

Results revealed these adolescent athletes were primarily exposed to informal concussion information through sports media reports on professional athletes and school projects. This suggests that formal concussion education initiatives are not a common way through which the adolescent athletes have acquired knowledge about the injury.

Suggestions to Improve Concussion Education: ***It would be good to use specific case studies about well-known athletes***

All 18 participants in this study said they felt it was important for athletes their age to be knowledgeable about concussions. For example, Sara noted, "A lot of people get concussions, like our classmates and stuff. But no one seems to think that it's that big of an issue". In particular, the participants felt it was important for athletes to be knowledgeable about concussions so they can "tell someone" if they potentially suffer a concussion, "It's important that athletes not be ashamed to tell someone right away if they get hit in the head (Ashley)". Additionally, Kelsey said:

> You use your brain for everything so you have to be very careful with it. It's important for athletes to know that they should not continue playing if they get hit in the head. A lot of people continue playing. When athletes are getting headaches or a lot of pain in their neck, they should tell someone and make sure that everything is okay.

Participants all expressed interest in learning more about concussions, which may not be surprising when considering that only one participant reported previous exposure to a formal concussion information session. The participants also forwarded some suggestions to improve concussion education efforts for adolescent athletes. For example, some of the participants felt that case studies would be an interesting and concrete way to learn about concussions:

> It would be helpful if someone came in and gave us relatable stories about athletes who have suffered a concussion… and then tell us what happened. That way, we could relate to the example and think, 'I play *that* sport so there's a chance I can get one'… (Veronica).
>
> It would be good to use specific case studies about well-known athletes. Because we know these athletes, their names, and we've probably been watching them on television. If you use professional athletes then we would probably be more interested in it. Like, 'If you were Paul George in that situation what would do?' – stuff like that (Emmanuel).

Participants also suggested that concussion education initiatives should be interactive. As an example, Karen noted, "An audiovisual lecture would be a good way to learn about concussions. Maybe group work, too". Additionally, Mark believed that interactive concussion education would be best for teaching adolescent athletes at their age about the injury:

> I don't think it would be great to teach athletes about concussions through lectures only. I think you would definitely want to make it interactive and include a visual aspect because that's just more interesting. Students my age would enjoy that more.

Collectively, the participants felt it was important for adolescent athletes to be knowledgeable about concussions so they could recognize potential symptoms and "tell someone" (i.e., report the concussion). The participants also suggested that interactive presentations involving case studies and audiovisual components would be preferred ways to learn about concussions.

Discussion

The purpose of the present study was to gather adolescent athletes' insights on the acquisition of concussion knowledge. Results from the hierarchical content analysis revealed five

properties, which will be discussed in relation to informing future concussion education efforts with adolescent athletes.

Adolescent athletes reported direct and/or indirect concussion experiences were the primary channel through which they acquired information about the injury. This is potentially troubling when considering participants in this study described instances when they knowingly hid concussion symptoms from coaches and health professionals in order to continue playing, a finding that is consistent with previous research on adolescent athletes (Chrisman et al., 2013; McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004; Register-Mihalik et al., 2013). Researchers have found that more than 50% of adolescent athletes have not reported a concussion because they did not think suffering a concussion was serious (McCrea et al., 2004; Register-Mihalik et al., 2013). Similarly, Chrisman and colleagues (2013) found that adolescent athletes said they would continue playing with a concussion despite "knowing a great deal about concussions" (p. 333). This finding suggests that it may be naïve to assume that concussion knowledge alone is sufficient to change adolescent athletes' concussion-related behaviors, such as reporting possible injuries (Caron et al., 2015; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Register-Mihalik et al., 2013). As a result, concussion education interventions may need to be framed within models of health behavior change that account for cognitive and socio-affective mechanisms that may underlie adolescent athletes' behaviors (DeSteno, Gross, & Kubzansky, 2013). Researchers have postulated that the Theory of Planned Behavior and Theory of Reasoned Action could be implemented to advance the research and practice of concussion education and concussion-reporting behaviors (Kroshus et al., 2014; Register-Mihalik et al., 2013). However, other models of health behavior change such as Self-Determination Theory (SDT; Ryan & Deci, 2000) and the Transtheoretical Model (Prochaska & DiClemente, 1983)

should also be explored. For example, researchers could use SDT and investigate the motives (i.e., competence, autonomy, and relatedness) underlying adolescent athletes' intentions to report or not report possible concussion injuries.

Upon their return to sport, participants said they tried to play safe by avoiding contact and collisions with opponents, the playing surface (i.e., ice rink boards), or objects (i.e., heading a soccer ball). Although participants did not articulate it explicitly, it appears they purposefully attempted to avoid contact and/or collisions for fear of suffering another concussion. Research on other types of athletic injuries (e.g., knees, ankles, shoulders) has found that athletes experience a range of emotions when returning to sport, including fears surrounding reinjury (Podlog, Dimmock, & Miller, 2011; Podlog et al., 2013; Tripp, Stanish, Ebel-Lam, Brewer, & Birchard, 2011). Podlog and colleagues (2013) conducted interviews with adolescent athletes and found they played with less tenacity when returning to sport after suffering serious shoulder and knee injuries, and reported they "hesitated when going for the ball" (p. 442) because they were concerned about reinjury. This finding is concerning because athletes who are fearful about reinjuring themselves might actually increase their risk of reinjury (Poglog et al., 2011). In the current study, the adolescent athletes said they modified their playing style to avoid contact or collisions, presumably for fear of suffering another concussion. However, they may have paradoxically increased their risk of suffering further injury and/or concussion. As a result, concussed athletes may benefit from psychological skills training to ensure they can cope with fear of reinjury upon their return to sport. For example, Podlog, Heil, and Schulte (2014) noted that psychological skills such as goal setting, self-talk, and relaxation and imagery have all been used to ameliorate athletes' return to sport from other types of injuries. Thus, incorporating

psychological skills training into concussion education initiatives could provide adolescent athletes with strategies to optimize their return to sport following a concussion.

Findings from the current study also revealed that siblings and parents influenced adolescent athletes' knowledge and perceptions of concussions. Research has found that family members supported adult athletes during their recovery from various injuries including concussions (Caron et al., 2013; Podlog et al., 2013; Udry, Gould, Bridges, & Tuffey, 1997). Udry and colleagues (1997) found that 81% of the adult athletes in their study who suffered serious injuries reported that family members were an important source of social support (e.g., "My parents were really there for me", p. 381). Specific to concussions, Caron and colleagues (2013) found that adult athletes said their families were an important source of social support throughout their recovery (e.g., "For at least three years, my wife was like a single mom to our kids. I was like an extra child for my wife and she took complete care of me", p. 174). While family members' supportive behaviors during concussion recovery was not the focus of the current study, the fact that adolescent athletes in this study said their family members influenced their knowledge and perceptions of the injury suggests that both athletes *and* family members should be involved in concussion education initiatives to enhance the recovery process.

Adolescent athletes also acquired information about concussions through sports media reports and school projects. In particular, participants said they chose school projects that focused on the long-term consequences of concussions, which, they said, included Chronic Traumatic Encephalopathy (CTE), a type of structural brain damage characterized by tau protein deposits in distinct areas of the brain, which are believed to accumulate over the course of multiple concussive or subconcussive head traumas (Gavett, Stern, & McKee, 2011). Although there are correlational data linking repeated concussions with CTE, the lack of long-term,

prospective data makes causal inferences about a concrete link between concussions and CTE premature (McCrory, Meeuwisse, Kutcher, Jordan, & Gardner, 2013). The current findings highlight the need to ensure that adolescent athletes are being exposed to information that is rooted in expert guidelines and/or peer-reviewed data (Caron et al., 2015) and presented by individuals who have expertise on concussions.

Participants also outlined a number of suggestions to improve concussion education efforts through interactive approaches and concrete examples. For instance, the adolescent athletes said they would prefer to be educated about concussions using interactive approaches such as audiovisual presentations. Interactive approaches to concussion education have scarcely been implemented (Caron et al., 2015). One example from Bagley and colleagues (2012) developed an interactive concussion education program for high school students, 9-18 years, which consisted primarily of an audiovisual presentation but also included video segments, discussions, and case studies of professional and high school athletes. Results from their study revealed an improvement in high school students' knowledge of concussions when comparing their pre- and post-intervention quiz scores. Given the methods employed by Bagley and colleagues did not allow participants to share their perceptions of their concussion education program, results from the current study build on their results and support the use of interactive oral presentations as a method of educating adolescent athletes about concussions.

In addition to interactive approaches, the participants suggested they acquired knowledge of concussions by observational learning of professional athletes, siblings, and peers who had experienced concussions. Bandura (1977) noted that behaviors may be learned through social interaction and by observing others (e.g., observational learning). The participants also suggested the use of concrete examples of concussed athletes (e.g., exemplars) would be a preferred way to

learn about concussions in education initiatives. Thus, as our data suggest, it may be beneficial to include exemplars of professional concussed athletes to capture the interests of adolescents and then follow-up with age- and gender-appropriate observational models of concussed adolescent athletes to improve knowledge of concussions.

Although the findings from the current study could be used to inform concussion education programs for adolescent athletes, the current results were bound within their specific environmental context (e.g., access to full-time athletic therapists) using an instrumental case study design (Stake, 2005). By its nature, qualitative research is not meant to be generalizable; rather, it is focused on providing detailed descriptions of participants' perceptions and experiences (Sparkes & Smith, 2014). Thus, while the findings could be used to inform concussion education programs in other contexts and locations, researchers are encouraged to adapt the content and delivery of concussion education initiatives to their intended audience(s), which is consistent with the practice of knowledge translation (Straus, Tetroe, & Graham, 2013) and recommendations to improve concussion education (Caron et al., 2015; Provvidenza & Johnston, 2009).

Conclusions and Future Directions

All 18 adolescent athletes in the present study reported that it was important for athletes their age to be educated about concussions. The adolescent athletes said they primarily acquired concussion information informally through direct and indirect experiences with the injury, interactions with peers and family members, sports media reports, and school projects. As such, the current findings have implications for future research and practice related to concussion education and prevention. For example, researchers should conduct studies on the incorporation of health behavior change models into concussion education initiatives. These types of initiatives

could improve adolescent athletes' knowledge of the injury and, perhaps, increase the likelihood of making appropriate concussion-related decisions. Future studies on concussion education initiatives may also consider the teaching of coping strategies and psychological skills training to optimize adolescent athlete recovery and minimize fear of reinjury (i.e., from concussions and other injuries) when returning to sports. Finally, researchers may consider incorporating family members in concussion education initiatives given that the participants in the present study reported siblings and parents were influential on their knowledge of concussions.

In sum, we may have just begun to learn about the multidimensional challenges inherent in educating adolescent populations about concussions. Results from the current study provide an initial understanding of adolescent athletes' insights on concussions and we hope these findings can be used to further develop concussion education initiatives to help make sport safer for adolescent athletes.

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Bridging Text

Chapter four was an original manuscript that explored high school athletes' perceptions of concussions, including how they acquired information about the injury. The results revealed that participants acquired concussion information via interactions with peers and family members, media reports involving professional athletes, and school projects. Furthermore, the athletes noted that their teammates and themselves attempted to deceive coaches and health professionals about concussions. The data gathered from a scoping review (chapter two) and interviews with coaches (chapter three) and athletes (chapter four) were combined to help create and implement our concussion education program. Chapter five is the final manuscript in this dissertation and presents the concussion education program that was developed for the high school student-athletes.

Chapter Five

Development and implementation of a concussion education program for high school student-athletes

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Abstract

Concussion education programs have been limited by the delivery of knowledge at one time-point and the nearly exclusive use of quantitative methods (Caron, Bloom, Falcão, & Sweet, 2015). Moreover, researchers have suggested that adopting principles of knowledge translation (KT) could improve the reach and effectiveness of these interventions (Mrazik et al., 2015). The purpose of this study was to develop and implement a concussion education program for high school student-athletes in Eastern Canada. More precisely, four interactive oral presentations were developed and implemented using principles of KT and were assessed using a mixed method design. The participants were male basketball (n =14) and ice hockey (n = 21) student-athletes (M_{age} = 15.94, SD = 0.34). Participants completed the Rosenbaum Concussion Knowledge and Attitudes Survey-Student Version (RoCKAS-ST) at three time-points during the season to measure changes in their knowledge (CK) and attitudes (CA) of concussions. Additionally, focus group interviews were conducted following the concussion education program to allow participants to articulate the types of knowledge they acquired, their attitudes towards concussions, and to describe their perceptions of the intervention. Results indicated that participants' post-intervention RoCKAS-ST scores for CK were higher than their pre-intervention scores. Specific to the focus group data, the student-athletes said they acquired CK about the role of protective equipment and symptom variability, and in terms of CA, they intended to avoid dangerous in-game collisions in the future. Finally, the participants enjoyed the interactive nature of the presentations as well as the use of case studies. The present findings are of interest to researchers, practitioners, and stakeholders in sport who are invested in improving the safety of the sporting environment through concussion education and awareness.

Keywords: Concussion Education; Knowledge Translation; Adolescent; Mixed Method

Development and implementation of a concussion education program for high school student-athletes

Approximately 54% of Canadians aged 15 to 19 participate in organized sports each year (Canadian Heritage, 2013). Sport participation has long been advocated as a way for youth and adolescents to acquire important life skills such as leadership and teamwork (Smith & Smoll, 2002), and to contribute to their physical and psychosocial well-being (Côté, Bruner, Erickson, Strachan, & Fraser-Thomas, 2010). However, adolescents who participate in high school athletics commonly suffer musculoskeletal injuries such as sprains, tears (Swenson et al., 2013), and fractures (Swenson, Henke, Collins, Fields, & Comstock, 2012). Concussions are another type of injury that has an elevated incidence rate in high school athletics (Marshall, Guskiewicz, Shankar, McCrea, & Cantu, 2015). In fact, researchers have found that concussions are particularly problematic for high school athletes, as they tend to underreport symptoms (McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004; Register-Mihalik, Guskiewicz et al., 2013) and because they are prone to suffering a more severe symptomatology that often persists for longer than older athletes (Carman et al., 2015; Williams, Puetz, Giza, & Broglio, 2015). Given that researchers have begun linking multiple concussive and subconcussive head impacts with dementia and chronic cognitive impairment (Godbolt et al., 2014; Stein, Alvarez, & McKee, 2015), there is a need to educate high school athletes about concussions in order to improve their safety and reduce the occurrence of this injury.

Researchers have estimated that 1.6 to 3.8 million concussions occur annually in sports and recreation in the United States alone (Langlois, Rutland-Brown, & Wald, 2006). However, these statistics likely underestimate the true occurrence of concussions because signs of the injury (i.e., loss of transient consciousness) are rarely present after acute injury (McCrory et al.,

2013). As a result, many athletes are not evaluated for a concussion because they do not seek medical care. Reasons for not seeking medical attention after a potential concussion ranges from deliberately hiding symptoms from teammates, coaches, and/or medical professionals, to inadvertently not reporting concussion symptoms due to a lack of knowledge about the injury (e.g., Davies & Bird, 2015; Delaney, Lamfookon, Bloom, Al-Kashmiri, & Correa, 2015; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; McCrea et al., 2004; Register-Mihalik, Guskiewicz et al., 2013). For example, Delaney and colleagues (2015) found that student-athletes did not report concussion symptoms because they did not believe they had suffered a serious enough injury to warrant medical attention. These findings are disappointing considering that large-scale concussion education initiatives have existed for more than a decade, such as Canada's "ThinkFirst" programming (Parachute Canada, 2015) and the US Centers for Disease Control and Prevention's "HEADS UP to concussions" campaign (Sarmiento, Hoffman, Dmitrovski, & Lee, 2014). Perhaps most significantly, these findings underscore a need to improve high school athletes' knowledge of and attitudes towards concussions.

Experts have highlighted the importance of improving concussion education initiatives (Broglio et al., 2014; Harmon et al., 2013; McCrory et al., 2013). Despite this, little is known about the most effective ways to educate athletes about concussions (Caron, Bloom, Falcão, & Sweet, 2015). Large-scale concussion education initiatives have typically employed passive dissemination strategies, such as fact sheets and other printed materials (e.g., Sarmiento et al., 2014). Although these strategies are cost-effective and allow for information to be widely distributed to diverse populations, evidence suggests the general knowledge of concussions remains "substantially inaccurate" (McKinlay, Bishop, & McLellan, 2011, p. 761). As a result,

researchers should explore other strategies to improve the reach and effectiveness of concussion education initiatives.

Concussion education programs (i.e., initiatives beyond passive dissemination) are another strategy to educate adolescent athletes about concussions (Caron, Bloom, Falcão, & Sweet, 2015; Williamson et al, 2014). In their review, Caron, Bloom, Falcão and Sweet (2015) found that three types of concussion education programs have previously been used to educate a variety of populations about the injury: *interactive oral presentations* (e.g., Manasse-Cohick & Shapley, 2014), *educational videos* (e.g., Cusimano, Chipman, Donnelly, & Hutchinson, 2014), and *computer-based learning programs* (e.g., Glang, Koester, Beaver, Clay, & McLaughlin, 2010). Overall, these programs reported short-term improvements in participants' knowledge, attitudes, and behaviors about concussions (Caron, Bloom, Falcão, & Sweet, 2015). To date, concussion education programs have been limited by the delivery of education at just one time-point and the nearly exclusive use of quantitative methods to evaluate these interventions (Caron, Bloom, Falcão, & Sweet, 2015). Moreover, researchers have postulated that concussion education programs should be developed in line with principles of knowledge translation (KT) to improve their reach and effectiveness (Mrazik et al., 2015; Provvidenza & Johnston, 2009). KT is the science of bridging the gap between the scientific community and knowledge users by adapting knowledge to the local context (Graham et al., 2006; Straus, Tetroe, & Graham, 2013). Thus, adopting principles of KT and adapting the content and delivery of concussion education programs could improve their reach and effectiveness by making concussion information more accessible for non-scientific populations.

The purpose of this mixed method study was to build on research in this domain by developing and implementing a concussion education program for high school student-athletes in

Eastern Canada. More precisely, the concussion education program consisted of four interactive oral presentations that were developed in concert with principles of KT. Two hypotheses guided the quantitative aspect of this study. First, we hypothesized that high school student-athletes' knowledge of concussions would improve after exposure to the concussion education program. Second, we hypothesized that participants' attitudes regarding concussions would improve following the concussion education program. There were three research questions guiding the qualitative portion of this study. First, what types of knowledge did the student-athletes acquire through participation in the concussion education program? Second, in what ways did the concussion education program influence participants' attitudes towards concussions? Third, what were the student-athletes' impressions of the delivery of the concussion education program?

Methods

Design

Mixed method designs incorporate quantitative and qualitative research in the same report, which differs from multimethod designs that are restricted to either qualitative *or* quantitative traditions (Tachakkori & Teddlie, 2003). Tachakkori and Teddlie's (2003, 2010) guidelines for conducting a mixed method design were followed. Specific to the present study, the quantitative data provided an objective measure to test the effect of the concussion education program on student-athletes' Concussion Knowledge (CK) and Concussion Attitudes (CA), while the qualitative data allowed student-athletes to use their own words to describe their experiences in the intervention (Morse, 2010). A more detailed description of the mixed methods used in this study is provided later in this section.

Participants

Male and female athletes from a private (i.e., fee-paying) high school in a large urban Canadian city were invited to participate in the current study. The participants were thirty-five male student-athletes, aged 15-17 years (M_{age} = 15.94, *SD* = 0.34) in grades 10 and 11, who were members of the senior basketball (*n* = 14) or ice hockey team (*n* = 21). Athletes with a known concussion were excluded from participation. None of the athletes reported previous exposure to a concussion education program.

Procedures

Upon obtaining approval from our university research ethics council and permission from a local high school, the school's Athletic Director (AD) was contacted and agreed to serve as third party. The AD informed members of the school's senior athletic teams about the purpose of the study. Additionally, the AD notified the student-athletes they would not receive compensation and that participation would have no bearing on their athletic or academic standing. Student-athletes who were interested in participating in this study collected a sealed envelope from the AD's office, which contained parent/legal tutor consent (Appendix F) and athlete assent (Appendix G) forms, and returned them in the same sealed envelope to the AD's office. Student-athletes who did not return signed consent and assent forms prior to the first scheduled presentation of the concussion education program were excluded from participation.

Intervention

Fan and Sidani (2009) conducted a meta-analysis that included 50 diabetes educational interventions and found that more than 60% of studies used interactive oral presentation formats. The concussion education program in the present study consisted of four interactive oral presentations. Each presentation lasted approximately 30 minutes and was delivered to the basketball and hockey student-athletes (*n* = 35) by the first author in approximately one-week

intervals. The first three presentations were delivered to both teams concurrently whereas the final presentation occurred separately due to conflicting practice and game schedules. The concussion education program was developed in concert with principles of KT, whereby concussion information was combined and then adapted to meet the student-athletes' needs (Graham et al., 2006; Straus, Tetroe, & Graham, 2013). More precisely, knowledge, which included consensus concussion guidelines (McCrory et al., 2013), peer-reviewed concussion articles (e.g., Delaney et al., 2015), and literature on the psychology of injuries (e.g., Podlog, Dimmock, & Miller, 2011) was adapted and tailored to meet the participants' needs through a scoping review of concussion education programs (Caron, Bloom, Falcão, & Sweet, 2015), as well as interviews with athletes and coaches at the high school (e.g., Caron, Bloom, & Bennie, 2015).

The interactive oral presentations consisted of a slideshow, videos, pictures and animations, case studies, and group discussions. The content of the presentations is outlined briefly below. See Appendix H for the slideshows that were used during the presentations.

- Presentation #1 informed participants about the signs and symptoms of concussions, as well as the return to play protocol.
- Presentation #2 introduced student-athletes to the role of protective equipment, risk compensation, as well as underreporting and the long-term implications of concussions.
- Presentation #3 focused on the psychological aspects of athletic injuries and concussions, such as how emotions and behaviours can impact injuries and the rehabilitation process.
- Presentation #4 highlighted how student-athletes could create a safe and healthy sporting environment through the mutual respect of teammates, opponents, officials, and coaches.

Data Collection

Quantitative data. The Rosenbaum Concussion Knowledge and Attitudes Survey-Student Version (RoCKAS-ST; Rosenbaum & Arnett, 2010) was used in the current study. The RoCKAS-ST was developed to assess 13 to 20 years old students' knowledge (CK) and attitudes (CA) of concussions and has previously been used to assess the effectiveness of concussion education programs with high school athletes (e.g., Manasse-Cohick & Shapley, 2014). Rosenbaum and Arnett (2010) reported "satisfactory" test-retest reliability (CK items, $r = .67$; CA items, $r = .79$) and "adequate" internal consistency (Cohen's α range = .59–.72) of the instrument. The RoCKAS-ST contains 55 items and is divided into five sections (see Appendix I). Sections 1, 2, and 5 measure CK and consist of true and false questions, graded 1 (*correct*) or 0 (*incorrect*), for a possible total score of 37. Sections 3 and 4 measure CA and consist of 5-point Likert-style questions, graded on a scale from 1 (*most unsafe*) to 5 (*most safe*), for a possible total score of 90. High scores on CK (e.g., 33) and CA (e.g., 75) provide an indication of better knowledge of and attitudes towards concussions.

All 35 participants completed pen-and-paper versions of the RoCKAS-ST at three time-points: immediately prior to Presentation #1 (Time 1), immediately following Presentation #4 (Time 2), and two months after Presentation #4 (Time 3). The time-points selected to measure pre-post changes in CK and CA were consistent with previous concussion education programs (e.g., Cusimano et al., 2014).

Qualitative data. Focus group interviews have been used in the social sciences to gather group members' perceptions of an intervention (e.g., Kipping, Jago, & Lawlor, 2011). Group interviews are different than individual interviews because a moderator poses questions to all group members, who can then agree, disagree, or offer additional explanations based on the other participants' comments (Rubin & Rubin, 2012). A focus group interview guide (see Appendix J)

was created for the current study. Implementing focus group interviews allowed participants to use their own words to articulate the types of knowledge they acquired, their attitudes towards concussions, and describe their overall perceptions of the intervention.

Two focus group interviews were conducted with basketball (n = 6) and hockey (n = 5) athletes approximately two weeks following the conclusion of Presentation #4. Focus group participants were selected by the AD and included a mix of grade 10 and 11 student-athletes. The focus groups were audio recorded and lasted 27 min (basketball) and 33 min (hockey) respectively.

Data Analysis

Quantitative data. Participants were assigned a code (BB for basketball athletes and H for hockey athletes) to protect their anonymity and track their scores across the three time points (e.g., BB5, H5). Participants' RoCKAS-ST surveys were graded at each time point. CK and CA scores were entered into a Microsoft Excel file and then transferred to Version 22 of the SPSS software for Mac (IBM corp.). Prior to running the main analyses, a missing data analysis was performed. No data were missing. Visual inspection of histograms and descriptive statistics suggested the presence of a univariate outlier. Inspecting the z-scores for CK and CA confirmed a univariate outlier (i.e., $z > 3.29$) for BB15 at CK Time 3. Tabachnick and Fidell (2007) recommended changing the scores of univariate outliers "so they are deviant, but not as deviant as they were" (p. 77) in order to reduce the impact of the variable on the analysis. Accordingly, BB15's score of 10 at CK Time 3 was transformed to a score of 29, a value one unit larger than the next most extreme score (cf. Tabachnick & Fidell, 2007). Following this transformation, data were assessed for violations of normality, homogeneity of variance, and sphericity. No violations were found for homogeneity of variance or sphericity. Despite having values for skewness and

kurtosis within the normal range, Kolmogorov-Smirnov test results suggested violations of normality at CK Time 3 ($D = 0.27$, $p = .000$). Nonetheless, researchers have supported using analysis of variance (ANOVA) in the presence of non-normally distributed data because of the robustness of the test (cf. Schmider, Ziegler, Danay, Beyer, & Bühner, 2010). As a result, one-way repeated measures ANOVA's were conducted to compare the effect of a concussion education program on CK and CA.

Qualitative data. The audio recordings of the focus groups were transcribed verbatim and stored using Version 10 of the NVivo software package (QSR International Pty Ltd). The current study followed a modified version of Braun and Clarke's (2013) guidelines for conducting a thematic analysis. That is, the focus group data were analyzed abductively, which is a combination of deductive (top down) and inductive (bottom up) approaches (Tavory & Timmermans, 2014), and allows for compatibility between the quantitative and qualitative data. The first step of the analysis involved deductively organizing the focus group data into three higher-order themes: "Concussion Knowledge", "Concussion Attitudes", and "Perceptions of the Concussion Education Program", which were consistent with the research questions (and hypotheses) identified for this study. To organize the focus group data into these higher-order themes, the focus group interview transcripts were read several times to gain familiarity with the data. Next, data extracts, which are blocks of text that encapsulate a coherent idea or piece of information from a single focus group participant (Braun & Clarke, 2013), were organized into the abovementioned higher-order themes. Once all focus group data were separated into data extracts and organized into the three higher-order themes, an inductive analysis was performed to search for lower-order themes. That is, data extracts within each higher-order theme that had

similar meaning were grouped into two lower-order themes. Two lower-order themes emerged from each of the higher-order themes and will be described in more detail in the results section.

Results

Quantitative Data

Reliability analyses revealed that the subscales for CK (Cronbach's α = .713) and CA (Cronbach's α = .882) of the RoCKAS-ST were within the acceptable range. Mauchly's test indicated that the assumption of sphericity was not violated for CK, χ^2 (2) = 1.85, p = .397 or for CA, χ^2 (2) = 1.603, p = .449, therefore no corrections were made when reporting degrees of freedom. Results of a one-way repeated measures ANOVA indicated the aggregate mean scores for CK were significantly different F (2, 68) = 19.079, p = .000, η^2_p = .359. Pairwise comparisons revealed a significant difference in CK between Times 1 and 2 (t = -2.000, p = .000, d = -.884) and Times 1 and 3 (t = -1.971, p = .000, d = -.831), but no significant difference was found between Times 2 and 3 (t = .029, p = .931, d = .014). Specific to CA, aggregate mean scores did not differ significantly F (2, 68) = .540, p = .947, η^2_p = .002. Table 7 provides the aggregate mean scores as well as the Standard Error of the Mean for CK and CA across the three time points. Figures 2 and 3 illustrate the aggregate mean scores for CK and CA at each time point using histograms.

Qualitative Data

This section will describe the higher- and lower-order themes from the abductive analysis. Quotes from the focus group participants will be included to help explain and illustrate the meaning of each theme. Each participant is identified by a code (e.g., BB5, H12) to credit their comments and to protect their confidentiality.

Concussion knowledge. In this higher-order theme, the data were related to student-athletes' descriptions of the types of knowledge they acquired from the concussion education program. Two lower-order themes emerged and were labeled "protective equipment" and "symptom variability and severity".

Protective equipment. Participants discussed some of the misconceptions they had about the role of protective equipment. In particular, they said they were surprised to learn that helmets and mouthguards were not designed to prevent concussions:

> One of the main things that I learned was that both helmets and mouthguards do not prevent concussions – they were designed to prevent skull fractures and mouth injuries. I don't think anyone in the room would have known that before the presentations. Some guys wear mouth guards in practice but I'm sure they're not thinking about a stick coming through their cage and hitting their teeth. They're thinking about protecting themselves from a concussion. I think that demonstrates our lack of knowledge about concussions before the presentations (H6).

> As an athlete, you can develop a mentality or frame of mind where you think you're untouchable. It is important to be aware that helmets and mouthguards do not fully protect you from a concussion, and in fact, they could even have an opposite effect and make you feel untouchable (BB5).

***Symptom variability and severity*.** The student-athletes said they learned about the potential severity of concussions and how there is no finite timeline for recovery. For example, one participant noted, "I learned that each person can experience different symptoms. You're not necessarily going to feel like you're in a fog or feel sensitive to light. It's different for everyone"

(H2). Another participant said he learned that concussion symptoms can persist for different periods of time for each person:

> I didn't know there was such a variety in not only the type of concussion but in the length of time each concussion can take to heal. I used to think that if you get concussed and take 10 days off, you would be healed. But that's not always the case (BB6).

Concussion attitudes. In this higher-order theme, data were related to the student-athletes' attitudes towards concussions. Two lower-order subthemes emerged and were labeled "hiding concussion symptoms" and "in-game behaviors".

***Hiding concussion symptoms*.** The participants discussed their attitudes towards hiding concussion symptoms. In particular, they noted it was common for their teammates to hide symptoms from coaches and health professionals:

> If someone gets a concussion, they will be taken off. But at half time if you ask any player they will say, 'Yeah I'm fully better. It's okay to go in now. I want to go back in and help the team. I don't want to be sitting on the sidelines watching'. As players we don't feel like we're part of the team if we're on the sidelines. Sometimes players go back in when they're obviously concussed (BB11).

> I guess people feel as if they should continue playing because they don't want to be that guy who's "soft" sitting on the sidelines because he's got a concussion. I think that a lot of time athletes aren't honest about concussions because they don't want to be *that* guy sitting on the bench and not playing. They want to be in there and making a difference in the game (BB2).

Furthermore, the participants did not feel that the interactive oral presentations would impact their teammates' attitudes and influence them to report a possible concussion in the future:

> I remember [during the presentations] when we talked about whether or not you should tell a coach or therapist if you think you have a concussion. When I heard that people would choose not to tell their coach I was surprised – but the more I think about it, I guess it's reasonable. I never thought I would do that [not report a concussion] until I got one and had to sit out. Watching your team lose and knowing you can't do anything about it is hard. You feel helpless (H1).
>
> I think we all realize that players don't tell their coaches about concussions pretty often. It happens more often than it should. Even this year between football and hockey, I'm sure there has been more than one player who's done that. By now, we all know that it's not right to hide a concussion. I don't think we're necessarily scared to admit having a concussion – it's more that we don't want to. Even now, after the presentations, if a player sustained a concussion while we were in playoffs, I wouldn't be surprised if 90% of the guys would not admit to having a concussion (H3).

In-game behaviors. The basketball and hockey focus groups had differing opinions regarding the effect of the concussion education program on their attitudes towards in-game behaviors. More precisely, the basketball student-athletes did not feel the interactive oral presentations would impact future in-game behaviors (e.g., reaching for a 50/50 ball or rebounding, plays that often involve contact/collisions with opponents). However, they said the presentations might influence their decisions to return to play after being diagnosed with a concussion. One basketball student-athlete said, "I don't think the presentations will influence *how* I play as much as they will influence my decision to return to play after getting a concussion" (BB6).

> I think all sports have a physical aspect to them. What I learned from the presentations is that we can get a concussion in a lot of different ways. There is a risk of getting a concussion in most sports. Even knowing that hasn't changed the way I play in games or my decision regarding the types of sports I would play. But I think I would change my decisions after getting a concussion because now I know the impact of them (BB5).

Somewhat different than the basketball student-athletes, the hockey players felt the information they learned from the concussion education program might impact the way they approach collisions with opponents in the future:

> We have gained a greater appreciation of concussions and head injuries in general. Our eyes have really been opened up to the long-term consequences of concussions. I think having that knowledge in the back of your mind when you're on the ice might make you think twice about cutting into the middle with your head down or even body checking a bigger player. So even if you're not consciously deciding not to hit someone to avoid a concussion, it's in the back of your mind (H6).
>
> You're thinking about yourself and your own head when you're playing. But at the same time, you always have to be thinking about your opponent. Let's say you're going to body check a guy in the corner. Obviously you're not going to be focusing on this, but in the back of your mind, you know that it's possible to impact his life and sports career. You don't want to be too aggressive and throw dangerous hits that could put your opponent's life in jeopardy (H17).

Perceptions of the concussion education program. In this higher-order theme, the participants' shared their perceptions of the delivery of the concussion education program. Two

lower-order themes emerged and were labeled “videos and interactive presentation style” and “case studies of athletes with concussions”.

Videos and interactive presentation style. The participants in both focus groups said they enjoyed the interactive nature of the concussion education program, which included videos and encouraging the student-athletes to participate during the presentations:

> I don’t think it would be good if you showed us a video the whole time. I think you would lose people because there would be too much information. I think it was good how you spoke, then showed us videos, and explained them in more detail afterwards (BB9).
>
> I liked the visual aspect to your presentations – using PowerPoint. It was nice to be able to see what we were learning. I also liked how it was kind of laid back and we were able to interact and ask questions. I thought those teaching methods were beneficial and I think most people got a lot out of the presentations (H17).
>
> I really liked you didn’t make it super formal. You kept it interactive. Even when you were speaking, you would ask questions or invite people to ask questions. You made us feel free to ask questions and engage you in discussions during your presentation so it created a comfortable environment where we were able to participate and learn (H6).

Case studies of athletes with concussions. The interactive oral presentations included case studies and examples of high school and professional athletes who had concussions. Both the basketball and hockey focus group participants said they enjoyed learning about National Hockey League (NHL) players’ experiences with multiple concussions:

> I liked the real-life examples. Like when you talked about those NHL hockey players… It hit close to home… and makes you realize that it’s actually bad what happens if you get

> too many concussions. It's better than just spitting facts. The facts are good too, but the examples made the presentations more real (BB6).
>
> If we were to sustain a concussion during a play, the long-term repercussions would not usually be our first concern. We're not thinking about what might happen to us 30 years down the road. So, listing to the examples of the NHL players put things into context, and essentially, what could happen to us (H3).
>
> I really enjoyed the examples of NHL players. Obviously I didn't *like* the stories because their stories were so severe, but it was nice to get real information. That made a big impact on me and, I think, all of us (H2).

Discussion

The purpose of this study was to develop and implement a concussion education program for high school student-athletes. The first subsection will discuss the findings that stemmed from the hypotheses and research questions from our mixed-methods design. The second will discuss how the concussion education program contributes to the development, assessment, and dissemination of research and practice. The third will outline limitations and recommendations to improve future concussion education programs.

Hypotheses and Research Questions

Results from this study supported the first hypothesis, whereby the participants' RoCKAS-ST scores for CK were higher post-intervention compared to pre-intervention. These findings were reinforced by the qualitative data, which found the participants acquired CK regarding the role of protective equipment and symptom variability. Researchers have previously reported short-term improvements in athletes' CK after exposure to a concussion education program (e.g., Bagley et al., 2012; Hunt, 2015; Kurowski et al., 2015; Miyashita, Timpson, Frye,

& Gloeckner, 2013). However, researchers have rarely measured CK beyond immediate post-intervention assessment (i.e., CK retention) and have not used standardized measures to assess participants' CK (Cook, Cusimano, Tator, Chipman, & Macarthur, 2003; Cusimano et al., 2014). Consequently, results from the present study build on existing research, as the participants appeared to retain CK for two months following the intervention (i.e., no significant difference between Time 2 and Time 3), as measured by a standardized instrument (i.e., RoCKAS-ST). Nonetheless, more research is needed to understand the impact of concussion education programs on CK retention. Randomized controlled designs and assessment strategies that involve standardized instruments, measured across longer periods of time (i.e., 6- and 12-months post-intervention) should be used to guide future research and intervention in this area.

Researchers have suggested that improved CK does not automatically lead to improvements in athletes' CA (Kroshus, Baugh, et al., 2014; Kroshus, Kubzansky, Goldman, & Austin, 2014; Register-Mihalik, Linnan et al., 2013). As a result, it was not surprising there were no significant differences in participants' RoCKAS-ST scores for CA. Moreover, student-athletes in the focus groups also felt their teammates would continue to underreport concussions following the intervention. Previous research has found the most common reason for underreporting concussion symptoms was due to a lack of CK (Davies & Bird, 2015; Delaney et al., 2015). Because participants in the present study demonstrated improved CK, it is more likely their unwillingness to report future concussions stemmed from other factors. For example, concerns over the perceived negative consequences associated with reporting a concussion, such as losing their status on the team (Delaney et al., 2015), might have concerned the participants. Researchers have postulated that concussion education programs could include content to help mitigate athletes' perceived negative consequences associated with concussions reporting

(Kroshus, Baugh et al., 2014; Register-Mihalik, Linnan et al., 2013). For example, Kroshus, Baugh et al. (2014) suggested that part of concussion education could involve encouraging teams to develop a protocol for concussed athletes to ensure they have an opportunity to re-establish their position on the team after returning from a concussion. Taken together, our results highlight a need for concussion education programs to specifically target athletes' CA during interventions, which may involve working with coaches and athletes to develop strategies to help diminish the negative perceptions associated with accurately reporting concussion symptoms.

Although the findings suggested our concussion education program did not improve the participants' CA towards post-concussion behaviors (i.e., concussion reporting), results from the focus group interviews indicated that some of the participants' intended to protect themselves from future concussions by modifying their in-game behaviors. Intention to modify future behaviors has been theorized to be the most important predictor of future behaviors (Ajzen, 1991), however the present study was not designed to measure athletes' in-game behaviors. Future concussion education programs are therefore encouraged to evaluate athletes' in-game behaviors following a concussion education program (e.g., Cook et al., 2003), which appears to be a particularly important suggestion given that behavior change is a primary objective of health-related interventions (Rickert, Ockne, & Pbert, 2014). Additionally, researchers have postulated that concussion education programs could help prevent concussions and reduce athletes' risk-taking behaviors (Caron, Bloom, Falcão, & Sweet, 2015; Provvidenza et al., 2013). Our results suggest that future concussion education programs should maximize concussion prevention messaging by providing athletes with sport-specific strategies to avoid dangerous collisions or unnecessary risk-taking behaviors.

Concussion Education Program

Principles of KT informed the development of our concussion education program. To date, concussion education initiatives have minimally applied principles of KT (Mrazik et al., 2015), which is disappointing given that KT is a common practice in health-related fields (Straus, Tetroe, & Graham, 2013) and because developing interventions in concert with KT has been recommended as a strategy to make concussion information more accessible to non-scientific populations (Caron, Bloom, Falcão, & Sweet, 2015; McCrory et al., 2013; Provvidenza & Johnston, 2009). Findings from the present study reinforce the value of using principles of KT to develop and implement a concussion education program for a specific audience. However, researchers have noted that KT should be viewed as an ongoing process that involves continued dialogue and interaction between knowledge creators and users (Provvidenza & Johnston, 2009; Mrazik et al., 2015). As a result, researchers are encouraged to continuously refine the content of their concussion education programs so it is up-to-date with contemporary evidence (e.g., McCrory et al., 2013) and to work collaboratively with knowledge users to ensure that the delivery of knowledge is appropriately adapted to meet audiences' ever-evolving needs.

Previous concussion education programs have rarely assessed their interventions using qualitative methods (Caron, Bloom, Falcão, & Sweet, 2015). This is disappointing because focus groups, a type of qualitative method, have been implemented to assess interventions in the social sciences (Kipping et al., 2011; Krueger & Casey, 2000) and have been recommended as a strategy to evaluate KT interventions (Straus, Tetroe, Bhattacharyya, Zwarenstein, & Graham, 2013). Participants in the focus group interviews said they enjoyed the interactive nature of the presentations and the use of case study examples, which are insights that could be used to inform future research and intervention in this domain (Caron, Bloom, Falcão, & Sweet, 2015). Given that researchers have reported few benefits of didactic (i.e., lecture only) concussion education

(Kurowski et al., 2015), results from our focus group interviews contribute to a body of research that supports the use of interactive forms of concussion education. Moreover, the findings demonstrate the types of insights that can be gleaned from using qualitative methods to evaluate concussion education programs.

The use of four interactive oral presentations in the present study differed from previous concussion education programs, which have disseminated knowledge at one time-point only (Bagley et al., 2012; Hunt, 2015; Kurowski et al., 2015; Manasse-Cohick & Shapley, 2014; Miyashita et al., 2013). Given that the present study did not compare different types of concussion education programs (e.g., interactive oral presentations vs. educational videos), it would be premature to conclude that interactive oral presentations are *more* effective than other interventions. However, disseminating information across multiple educational sessions may be a beneficial strategy to help reduce feelings of being overwhelmed with content, which might occur in single-session educational interventions. Additionally, implementing multiple educational sessions allowed for information to be presented that is unique from previous concussion education programs (Caron, Bloom, Falcão, & Sweet, 2015). More precisely, information about psychosocial aspects of injuries and concussions as well as creating a safe sporting environment through respect was disseminated to the student-athletes. Taken together, our results suggest that multiple educational sessions are an effective strategy to disseminate and acquire information about concussions.

Limitations and Recommendations

The present study offered one of the first attempts to systematically develop and implement a concussion education program. However, as with any study, there were limitations that must be acknowledged. First, all participants attended the same private high school in a large

urban Canadian city, which might have hindered the generalizability of the present findings to student-athletes in other socioeconomic contexts and geographical locations. Second, the present study did not have a control condition. As a result, it is possible that improvements in CK might have resulted from the concussion education program *and* external factors. Future studies are encouraged to implement a control and/or attentional control condition. Third, the present sample consisted of all males. Given that researchers have found that female athletes tend to report more concussion symptoms than males of the same age (e.g., Covassin, Elbin, Harris, Parker, & Kontos, 2012), future concussion education programs should include female athletes, which would also improve the generalizability of the findings. Future research should also investigate other types of interactive concussion education strategies. For example, web-based applications Twitter and Facebook (e.g., Ahmed et al., 2013; Sullivan et al., 2012) may be particularly effective concussion education strategies for younger generations, as they may enjoy (or even prefer) learning through these mediums. Researchers have also suggested that teammates could play an important role in improving athletes' concussion-reporting behaviors (Kroshus, Garnett, Baugh, & Calzo, 2015). As such, concussion education programs may consider developing segments within interventions that teach athletes specific strategies to facilitate or encourage teammates to report suspected concussions. Finally, researchers should investigate participants' preferred facilitator of concussion education, which may include a researcher, health professional, or other. It is possible the individual who delivers the concussion education program can influence both the participants' perceptions of the intervention as well as their acquisition of concussion information. Taken together, the following recommendations could be used to further improve research in this domain:

- Utilize theories of KT throughout the development and implementation of concussion education programs
- Implement randomized controlled designs to concurrently test several types of concussion education programs
- Develop and empirically test the effectiveness of concussion education programs that are primarily web-based (e.g., Facebook, Twitter, YouTube)
- Measure behavioral outcomes of interventions
- Develop concussion education programs that include participants of varying age, socioeconomic status, and geographical location
- Integrate case studies of professional athletes who experienced concussions, and then follow up with age, sport, and gender appropriate examples

In sum, improving the dissemination of concussion information will require continuous collaboration between researchers, clinicians, and knowledge users. The present findings highlight the multitude of factors that should be considered when developing and implementing a concussion education program. Results from this study are of interest to researchers, practitioners, and stakeholders in sport who are invested in athletes' short- and long-term health of athletes of all ages.

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Chapter Six

Summary

This doctoral dissertation consisted of six chapters. Chapter one provided an overview of the contemporary knowledge and understanding of concussions, including the influence and contributions of the Concussion in Sport (CIS) group. In particular, the CIS group has called for improvements in concussion education to help prevent the injury and make sport safer (McCrory et al., 2013). Despite this, there is no consensus regarding *how* concussion information should be disseminated. Therefore, the purpose of this dissertation was to develop and implement a concussion education program for high school student-athletes. The specific objectives of this research were to (a) determine the extent of research that has been conducted on concussion education programs and (b) tailor a concussion education program to student-athletes at a high school in Eastern Canada. These objectives were accomplished through a cohesive series of four manuscripts that were presented in chapters two through five.

Chapter two, an original manuscript, was a scoping review of literature on concussion education programs (Caron, Bloom, Falcão, & Sweet, 2015). The study investigated the existing literature and found nine concussion education programs, which have been delivered as an interactive oral presentation, educational video, or computer-based learning program. Additionally, the results revealed these programs delivered knowledge at one time-point only and primarily used quantitative measures to assess their effectiveness. In sum, chapter two provided a number of important insights from previous research in this domain. These findings also informed the subsequent three chapters of this dissertation.

Chapter three was a qualitative study that explored high school coaches' insights and perceptions of concussions (Caron, Bloom, & Bennie, 2015). The coaches said they taught their

athletes sport-specific skills and strategies to help protect them from concussions during practices and games. Additionally, coaches mentioned that some athletes attempted to hide or exaggerate their concussion symptoms. The findings from chapter three offer one of the first empirical accounts of coaches' perceived knowledge of and roles with concussions. The results also indicated that it would be important to include information about the potential dangers of inaccurately reporting concussion symptoms in our education program.

Chapter four contained information that investigated high school athletes' insights on concussions, including the mediums through which they have acquired information about the injury. The student-athletes said they primarily learned about concussions *informally*, through interactions with peers and family members, media reports involving professional athletes, and school projects. Participants noted that their teammates and themselves attempted to deceive coaches and health professionals about concussions. The results from this study further highlight a need to educate adolescent athletes about the dangers of being disingenuous when reporting concussion symptoms.

Results from chapters two, three, and four were used to create a concussion education program for high school student-athletes, which formed the purpose of the study of this dissertation. The concussion education program itself consisted of four interactive oral presentations that were evaluated using mixed methods. The results from chapter five revealed improvements in participants' knowledge of concussions after exposure to the concussion education program. Additionally, some of the participants said they intended to modify future in-game behaviors after exposure to the concussion education program. Finally, the student-athletes said they enjoyed the interactive nature of the presentations and the use of case study examples.

In sum, results from chapter five indicated that multiple interactive oral presentations were an effective strategy to disseminate concussion information to high school athletes.

The remainder of information in this chapter will outline recommendations for future research in this emerging area of inquiry. Results from this dissertation suggest that theories from knowledge translation (KT) should continue to be used to guide concussion education programs. It was noted in chapter five that KT should be viewed as an ongoing process that involves continued dialogue and interaction between knowledge creators and users (Provvidenza & Johnston, 2009; Mrazik et al., 2015). One theoretical framework from KT, the knowledge to action cycle, highlights a cyclical process of knowledge dissemination that has been forwarded as a way to improve concussion education initiatives (Provvidenza et al., 2013). However, researchers have yet to incorporate the knowledge to action cycle into a concussion education program. To develop concussion education programs using the knowledge to action cycle, longitudinal designs (i.e., > 12 months) should be incorporated to detail the types of interactions between knowledge creators and users, including *how* interventions were refined based on these interactions. Qualitative research methods, such as individual and focus group interviews, would be particularly useful to collect these data.

Other theories may also be incorporated to improve concussion education initiatives. In particular, results from this dissertation were in line with previous research that found that improved knowledge of concussions might not lead to improved attitudes and behaviors towards concussions (Chrisman, Quitiquit, & Rivara, 2013; Kroshus, Baugh, Daneshvar, & Viswanath, 2014; Register-Mihalik et al., 2013). This highlights a need to better understand the mechanisms that underlie athletes' concussion-related attitudes and behaviors. Researchers have suggested that theories of behavior change, such as the Theory of Planned Behavior (TPB) and Theory of

Reasoned Action, could be used to guide these efforts (Kroshus, Baugh et al., 2014; Register-Mihalik et al., 2013). For example, TPB posits that intention to modify future behaviors is the most important predictor of future behaviors (Ajzen, 1991), which suggests that researchers would need to determine how best to deliver content or messaging to influence athletes' *intentions* to modify future concussion-related attitudes and behaviors. However, theories have been minimally incorporated into contemporary concussion research and have not yet been used to inform a concussion education program. Moreover, given that research is in its early stages of development, other theories of health behavior change such as Self-Determination Theory (Ryan & Deci, 2000) or the Transtheoretical Model (Prochaska & DiClemente, 1983) should also be investigated. Evidently, there are numerous opportunities for researchers to integrate theory into concussion education programs as a way of improving athletes' behaviors and attitudes towards concussions.

Results from this dissertation indicated that adolescent athletes preferred interactive forms of concussion education. Researchers have postulated that web-based applications Facebook, Twitter, and YouTube could be used to disseminate concussion information (Ahmed et al., 2010; Sullivan et al., 2012; Williams et al., 2014), however no empirical studies have reported using the mediums specifically for concussion education. As a result, researchers are encouraged to develop and empirically test the effectiveness of concussion education programs that are primarily based on web-based applications. Implementing interactive, web-based applications would allow researchers to connect with athletes without requiring a face-to-face meeting and may help to increase the reach of concussion education programs. Furthermore, younger generations may prefer learning about concussions through web-based mediums as opposed to existing interventions (e.g., educational videos). It would be interesting if researchers

used randomized controlled designs to concurrently test several types of interventions to provide an indication of the most effective concussion education program.

The findings also revealed that coaches, peers, and family members were influential on adolescent athletes' perceptions and knowledge of concussions. This highlights the importance of ensuring all individuals in the sports environment are knowledgeable about concussions. In particular, improving the concussion knowledge of coaches, peers, and family members might enhance their ability to identify concussion symptoms and initiate athletes' removal from play, which are central to improving concussion safety in sport. As a result, researchers should consider how coaches, peers, and family members could be taught these types of skills and strategies. One suggestion might be to incorporate segments (e.g., case studies, discussions) into concussion education programs that would allow the participants to develop sport- and situation-specific strategies that best fit their needs. For example, facilitators of concussion education programs could generate discussion among peers and family members and help them develop strategies to support and encourage athletes to report possible concussion symptoms (Kroshus, Garnett, Baugh, & Calzo, 2015). Additionally, facilitators could work collaboratively with coaches and athletes to improve the accuracy of concussion reporting, which may involve developing a team protocol that would provide athletes returning to play from a concussion with a fair opportunity to re-gain their position on the team (Kroshus, Baugh et al., 2015).

Researchers should also begin investigating how fear of reinjury might impact athletes' return to sport following a concussion. Researchers have previously highlighted that athletes often encounter feelings of fear after suffering other types of musculoskeletal injuries (Podlog, Dimmock, & Miller, 2011) and that psychological skills interventions involving topics such as, goal setting, self-talk, and relaxation and imagery, have helped to diminish these feelings during

their return to sport (Podlog, Heil, & Schulte, 2014). These results suggest that sport psychology professionals, who are trained to provide services and deliver interventions aimed at improving athletes' recovery from injuries (Canadian Sport Psychology Association, 2015), could also teach psychological skills to athletes recovering from concussion to help mitigate fears of reinjury. More research is needed to elucidate how sport psychology services could be provided during the recovery of concussed individuals, including how the delivery of psychological skills could be implemented without exacerbating the cognitive deficits that stem from a concussion. Nonetheless, results from this dissertation concur with the CIS group's recommendation that sport psychology approaches have application to concussions (cf. McCrory et al., 2005), and highlight exciting possibilities for professional growth within the area of sport-related concussions.

Additionally, researchers have previously discussed the role of the sport psychology professional as part of the sports medicine team (Bloom, Horton, McCrory, & Johnston, 2004; Johnston et al., 2004; Kontos, Collins, & Russo, 2004). Results from this dissertation suggest that sport psychology professionals can assist in the dissemination of concussion education programs to athletes, coaches, as well as other members of the sport environment. Given that sport psychology professionals routinely conduct educational interventions on topics related to psychosocial aspects of injury recovery (Evans & Hardy, 2002; Schwab Reese, Pittsinger, & Yang, 2012) as well as issues related to health and well-being (Williams, 2010), it seems reasonable that the profession becomes more involved in the delivery of educational interventions on concussions.

In sum, this dissertation presented a cohesive series of manuscripts that improved our understanding of concussion education. Chapter six presented a number of ways to advance

research in this domain and improve athletes' knowledge, attitudes, and behaviors of concussions. Results from this dissertation indicate that multidisciplinary collaboration will be important for future research on concussion education and to help maximize athletes' safety and enjoyment of sport.

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Appendices

Appendix A
Informed Consent Form

This study is in partial fulfillment of the requirements for the degree of Doctor of Philosophy for Jeff Caron, a Ph.D. Candidate in Sport Psychology, in the Department of Kinesiology and Physical Education at McGill University. You are invited to participate in our research on high school coaches' perceptions on concussions, safety, and injury prevention. If you choose to participate in this study you will be requested, without payment, to partake in a 45 to 60 minute audiotaped interview where you will be asked to discuss your perceptions on concussions and the ways in which they have influenced your coaching practice. If more information is necessary, then a follow-up telephone interview may occur.

Once the interview is complete, you will have to opportunity to edit any comments you made during the interview at your discretion. You will also receive a typed transcription of the interview, which may be edited at your discretion. Prior to publication, you will receive copies of the results and conclusions of the study. The information you provide will **remain confidential**. The principle investigator (Jeff Caron) and the faculty supervisor (Dr. Gordon Bloom) will be the only individuals to have access to identifiable data. All data, including audio files of the recorded interview(s) and digital copies of the demographic questionnaire and consent form, will be securely stored in encrypted folders on a password-protected computer for a period of seven years. Any paper copies will be converted to digital files and, promptly, destroyed. Pseudonyms will be used to label all digital files. All data will be destroyed seven years after the study ends. The information disclosed during the interview will remain confidential and will be used for publication purposes and scholarly journals or for presentations at conferences. The researchers will not disclose names or identify the study participants at any time. The McGill Research Ethics Board has reviewed this study for compliance with its ethical standards.

Your participation in this study is voluntary and not mandatory. You are free to refuse to answer any questions or withdraw from participation at any time, for any reason, without penalty.

After reading the above statement and having had the directions verbally explained, it is now possible for you to provide consent and voluntarily agree to participate in this research project based on the terms outlined in this consent form. You will be provided with a signed copy of this consent form for your records. You may refuse to continue participation at any time, without penalty, and all information gathered will remain confidential. Please contact the Research Ethics Officer at 514-398-6831, or lynda.mcneil@mcgill.ca if you have any questions or concerns regarding your rights and welfare as a participant in this research study. Please sign below if you agree to participate in this study.

_____ _____
Signature Date

_____ _____
Researcher's Signature Date

I agree to the audiotaping of the interviews with the understanding that these recordings will be used solely for the purpose of transcribing these sessions. Yes□ No□ _____ Initials

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Appendix B
Coach Interview Guide

Opening Questions:

1. Briefly describe your athletic career.
    - Sport(s) you competed in
    - Highest level of competition
    - Detail all head injuries experienced as an athlete

2. Briefly describe your coaching evolution.

3. Describe the most often-occurring injuries in the sport you coach.
    - Most serious ones

Key Questions:

4. Describe the policies, procedures, and protocols that your school has in place for dealing with serious sports injuries.

5. In what ways do your school's injury protocols, procedures, and policies differ when an athlete suffers a head injury such as a concussion?
    - Coach's role/involvement throughout athlete recovery (i.e., physically and psychologically)
    - Communication with athletic therapist, athletic director, parents, principal/headmaster, physician
    - Most serious cases

6. How has the media's portrayal of concussions influenced your perceptions of the injury?
    - Outline some of the most surprising things you have learned
    - Athlete and parental awareness

7. In what ways have concussions impacted the way you coach?
    - Importance of providing information to athletes about concussions
    - Unsettling aspects about concussions for young athletes
    - Assistant coaches

8. How important is it for coaches to be exposed to information on head injuries and concussions?
    - Formal education and training
        - Mandatory or not? If yes, what and where?
    - Informal education
        - Most helpful resources
        - Challenges/barriers to accessing information/resources

Concluding Questions

9. Would you like to add anything else to our interview?

10. Do you have any other comments or questions?

Appendix C
Parent/Legal Guardian Consent Form

This study is in partial fulfillment of the requirements for the degree of Doctor of Philosophy for Jeff Caron, a Ph.D. Candidate in Sport Psychology, in the Department of Kinesiology and Physical Education at McGill University. The purpose of this letter is to inform you about the purpose, procedures, and conditions of the research we are conducting at Lower Canada College (LCC) as well as to invite your child to participate in our study. The McGill Research Ethics Board has reviewed and approved this study for ethical acceptability.

The purpose of our research is to understand high school athletes' awareness, knowledge, and perceptions of concussions. Being an athlete at LCC, we believe that your son/daughter possesses valuable insights and perceptions about concussions that could ultimately help our research team design and implement a concussion education program for high-school athletes. Should you consent and allow your son/daughter to participate in this study, they will be requested – without payment or reward – to partake in a 30 to 45 minute audiotaped interview in a classroom at their high school. The interview will take place outside of class time. They will be asked questions related to concussions, including their perceptions, knowledge and understanding of the injury, and the ways in which the growing media attention and awareness has influenced their sport participation. They do not have to prepare or study for this meeting.

All information provided during the interview will **remain confidential**. Mr. Christian Viau, Director of Athletics at LCC, is helping us with this research by identifying participants, collecting consent forms, and arranging interview times. Thus, he will know who is participating in the research but he will not have access to the interview materials or data. The principle investigator (Jeff Caron) and the faculty supervisor (Dr. Gordon Bloom) will be the only individuals to have access to identifiable data. All data, including audio files of the recorded interview(s) and digital copies of the consent and assent forms, will be securely stored in encrypted folders on a password-protected computer for a period of seven years. Any paper copies will be converted to digital files and promptly destroyed. Pseudonyms will be used to label all digital files. All data will be destroyed seven years after the study ends. The information disclosed during the interview will remain confidential and will be used for publication purposes and scholarly journals or for presentations at conferences. The researchers will not disclose names or identify the study participants at any time.

Your child's participation in this study is voluntary and not mandatory. They are free to refuse to answer any questions or withdraw from participation at any time, for any reason, without penalty or prejudice.

After reading the above statement, I (print name) _____ consent and voluntarily allow to my child to participate in this research project based on the terms outlined in this consent form.

I agree to that the interview involving my child may be audiotaped with the understanding that these recordings will be used solely for the purpose of transcribing these sessions.
Yes□ No□ _____ (Initials).

Child's Name (print): _____

_____ _____
(Parent's signature) (Date)

You will be provided with a signed copy of this consent form for your records. Please contact the Research Ethics Officer at 514-398-6831, or lynda.mcneil@mcgill.ca if you have any questions or concerns regarding your child's rights and welfare as a research participant in this study. In addition, you can contact my supervisor or myself using the information provided at the bottom of the page.

The McGill Sport Psychology Research Laboratory has a history of producing influential research on both concussions and youth sport participation. Please visit our website if you would like to learn more about our research: http://sportpsych.mcgill.ca.

Thank you for considering participating in this research project.

Sincerely,

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Appendix D
Athlete Assent Form

The McGill Research Ethics Board has reviewed and approved this study for ethical acceptability. The purpose of this research study is to help us understand high school athletes' awareness, knowledge, and perceptions about concussions. This document is to provide you with the knowledge to knowingly and willingly participate in our research study. Participation in this study involves a 30 to 45 minute interview that will take place outside of class time.

What if you don't want to participate?
You may choose not to participate in this study at any time and for any reason.

What do you get if you participate in the study?
You will not receive any rewards for participating in this study.

Are there any dangers if you participate in the study?
There are no dangers associated with participating in this study. Participation in this research study has no bearing on your grades or position on a Lower Canada College athletic team or club.

Who will know what you said?
A fake name will be attached to your comments so no one at the school will ever know what you said during the interview. Only my supervisor (Dr. Gordon Bloom) and I (Jeff Caron) will know what you said. Digital copies of the interview and any other identifying information will be stored in encrypted folders on a password-protected computer for a period of seven years. All files will be destroyed seven years after the study ends.

What if you have questions?
If you have any questions about this study, please contact:

Jeff Caron OR Dr. Gordon Bloom
Email: jeffrey.caron@mail.mcgill.ca Email: gordon.bloom@mcgill.ca

I, (please print your name)_____, understand that my Mom, Dad, or Guardian have/has given me permission to participate in a research study titled "High school athletes' awareness, knowledge, and perceptions of concussions".

I agree to the audio recording of this interview. The recording will be used solely for the purpose of transcribing these sessions. Check either: Yes□ No□ _____(Write your initials).

My participation in this project is voluntary and I have been told that I may stop participating in this study at any time and for any reason. You will be provided a copy of this form for your records.

Participant: _____
Name Signature Date

Lead Researcher: _____
Name Signature Date

Appendix E
Athlete Interview Guide

Pre-interview Routine

Introduction ☐
Consent Form ☐
Assent Form ☐

Demographic Questions

1. What is your date of birth? What grade are you in?

2. What is/are your favourite organized sport(s) to play?
    - How many years have you been playing that/those sport(s)?

3. Which high school team(s) did you play on this past year?
    - What position did you play?
    - Do you also play on a team in your community?
    - How many hours per week do you play sports?

4. How would you describe yourself as a player?
    - What is your favourite part about playing sports?
    - What type of role do you play on the team (i.e., captain, scorer)?

Interview Guide

Opening Questions:

1. Can you describe the injuries happen most often in the sports you play?

2. Not including concussions, have you ever been injured playing sports?
    a. If yes, what happened (recovery, missed time, underreporting)
        i. School team
        ii. Community team
    b. If no, have any of your teammates or friends been injured playing sports?
        i. Tell me about what happened.

Key Questions: We are going to focus on concussions for the next set of questions.

3. Have you ever suffered a concussion?
    a. If yes, describe what happened (school protocol, medical personnel, coach, parents)
        i. Describe the symptoms (physical, psychological such as fear, anxiety about RTP)
        ii. Did you tell anyone about your concussion? (length of time, underreporting)

   b. If no, have you ever played in a game where a teammate or opponent suffered a concussion?
      i. Describe what happened

4. Has anyone ever talked to you about concussions?
   a. If yes, who, and what kind of things did you talk about?
   b. Do you and your friends ever talk about concussion or head injuries?

5. Now let's talk about concussions that are not related to you or your teammates. Tell me some of the things you hear about concussions in the media (Twitter, Facebook, Sports Networks, TV)?
   a. How do concussions compare to other types of injuries?

6. Can you think about any professional athletes that have suffered a concussion?
   a. Describe what happened.

7. For the last question, could you tell me if you think it's important for athletes your age to learn about concussions?
   a. Why?

Concluding Questions

8. Would you like to add anything else related to our interview?

9. Do you have any comments or questions?

Appendix F
Parent/Legal Tutor Consent Form

This study is in partial fulfillment of the requirements for the degree of Doctor of Philosophy for Jeff Caron, a Ph.D. Candidate at McGill University. The purpose of this letter is to inform you about the purpose, procedures, and conditions of the research we are conducting at Lower Canada College (LCC) as well as to invite your child to participate in our study. The McGill Research Ethics Board has reviewed and approved this study for ethical acceptability.

The purpose of this study is to deliver a concussion education program to your child's team at LCC. The concussion education program will consist of four, 30-minute seminars that will occur immediately before (or after) regularly scheduled practices. The dates and times of these seminars will be determined by Mr. Christian Viau, Director of Athletics at LCC, and your son/daughter's senior team coach. Should you consent and allow your son/daughter to participate in this study, they will be requested – without payment or reward – to participate in the four concussion education seminars and complete questionnaires. Additionally, your child may be selected to partake in a 30 to 45 minute audiotaped focus group interview, which would also occur before or after a regularly scheduled practice. **Each aspect of this study will take place outside of class time. Your son/daughter does not have to prepare or study for the concussion education seminars, questionnaires, or focus group interview.**

Mr. Christian Viau, Director of Athletics at LCC, is helping us with this research by identifying participants, collecting consent forms, and arranging times for the concussion education seminars and focus group interviews. Thus, he will know who is participating in the research but he will not have access to the interview materials, questionnaires, and post-intervention forms. Apart from the other student-athletes present for the focus group interview, the principle investigator, Jeff Caron, and the faculty supervisor, Dr. Gordon Bloom, will be the only individuals to have access to identifiable data. Audio recordings and hard copies of the consent and assent forms will be converted to digital files and securely stored in encrypted folders on a password-protected computer for a period of seven years. Once the transcription is complete, the audio recording will be destroyed. Paper copies of consent/assent forms will be converted to digital files and promptly destroyed. Pseudonyms will be used to label all digital files. Paper copies of all questionnaires and post-intervention forms will be stored in a locked filing cabinet located in Dr. Bloom's office at McGill. All data will be destroyed seven years after the study ends. **The information disclosed on questionnaires or during interviews will remain confidential and will be used solely for the purposes of publications in scholarly journals or for presentations at conferences.** The researchers will not disclose names or identify the study participants at any time.

Your child's participation in this study is voluntary and not mandatory. They are free to withdraw from this study at any time, for any reason, without penalty or prejudice.

After reading the above statement, **I (*print name*) _____** consent and voluntarily allow to my child to participate in this research project based on the terms outlined in this consent form.

I agree **YES□ NO□ _____(*Check YES or NO and write initials*)** that my son/daughter may participate in a audiotaped focus group interview with the understanding that these recordings will be used solely for the purpose of transcribing these seminars.

Child's Name (print): _____

_____ _____
(Parent's signature) **(Date)**

You will be provided with a signed copy of this consent form for your records. Please contact the Research Ethics Officer at 514-398-6831, or lynda.mcneil@mcgill.ca if you have any questions or concerns regarding your child's rights and welfare as a research participant in this study. In addition, you can contact my supervisor or myself using the information provided at the bottom of the page.

The McGill Sport Psychology Research Laboratory has a history of producing influential research on both concussions and youth sport participation. Please visit our website if you would like to learn more about our research: http://sportpsych.mcgill.ca.

Sincerely,

Jeff Caron

Jeff Caron, M.A.
Ph.D. Candidate in Sport Psychology
Dept. of Kinesiology & PE
McGill University, Montreal, Quebec
jeffrey.caron@mail.mcgill.ca

Gordon Bloom, Ph.D.
Associate Professor
Dept. of Kinesiology & PE
McGill University, Montreal, Quebec
gordon.bloom@mcgill.ca

Appendix G
Athlete Informed Assent

The McGill Research Ethics Board has reviewed and approved this study for ethical acceptability. The purpose of this research study is to deliver a concussion education program to you and your teammates. This document will provide you with information so you can knowingly and willingly participate in our research study. Participation in this study involves four, 30-minute concussion education seminars and completing questionnaires. Also, you may be invited to participate in a 30 to 45 minute focus group interview. All of these activities will take place outside of class time. A copy of this form will be provided for your records.

What if you don't want to participate?
You may choose not to participate in this study at any time and for any reason.

What do you get if you participate in the study?
You will not receive any rewards for participating in this study.

Are there any dangers if you participate in the study?
There are no dangers associated with participating in this study. Participation in this research study has no bearing on your grades or position on a Lower Canada College athletic team or club.

Who will know what you answered on the questionnaires or in the interview?
Your answers on the questionnaires will be kept confidential by assigning you a unique code. Your code will be used to identify your questionnaire (instead of using your name). The master key that links your unique code to your identity will only be accessible by Jeff Caron and Dr. Gordon Bloom. Also, a fake name will be attached to the comments you make in the interviews. Only your teammates in the focus group interview, my supervisor (Dr. Gordon Bloom), and me (Jeff Caron) will know what you said. Digital copies of the interview and any other identifying information will be stored in encrypted folders on a password-protected computer for a period of seven years. All files will be destroyed seven years after the study ends.

What if you have questions?
If you have any questions about this study, please contact:

Jeff Caron
Email: jeffrey.caron@mail.mcgill.ca

OR

Dr. Gordon Bloom
Email: gordon.bloom@mcgill.ca

By signing here, I **(*please print your name*)_____,** agree to voluntarily participate in a research study titled "The effect of a concussion education program on high school athletes' knowledge and attitudes".

I agree **YES□ NO□ _____(*please check YES or NO and write your initials*)** to the audio recording of the focus group interview based on the understanding that it will be used solely for the purpose of transcribing the seminars.

My participation in this project is voluntary and I have been told that I may stop participating in this study at any time and for any reason. Please contact the Research Ethics Officer at 514-398-6831, or lynda.mcneil@mcgill.ca if you have any questions or concerns regarding about your rights and welfare as a research participant in this study.

Participant: _____
Name Signature Date

Appendix H
Slideshows used in the Concussion Education Program

Presentation #1: Introduction to Concussions

Jeff Caron
McGill University

January, 2015

1

Today's Topics

- What is a Concussion?
  - Common Symptoms
- Video
- What if you think you have a Concussion?
- Return to Play Protocol

2

What is a Concussion?

- A concussion is a brain injury.
- Occurs when the brain moves violently in the skull.
  - Caused by direct (i.e., head) or indirect (i.e., neck, body) impacts to the brain.
- In other words, it's possible to get a concussion without ever hitting your head against something.

3

What is a Concussion?

- A concussion is an "invisible injury"
  - Not like other injuries because you cannot see bruising, swelling, or broken bones.
  - Does not show up on X-Ray, MRI, CAT scans
- You do not need to be knocked unconscious to have a concussion.

How do you know if you have suffered a concussion?

4

What is a Concussion?

Common Symptoms

Headaches	Dizziness
Difficulty concentrating	Sensitivity to sound
Sensitivity to light	Feeling in a "fog"
Difficulty remembering	Feeling slowed down
Drowsiness	

What is a Concussion?

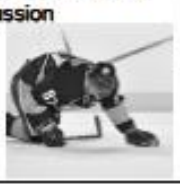
- According to experts, 80% to 90% of concussions get better within 10 days.
- Several factors can make your symptoms worse or last for longer periods of time:
  - Age
  - History of concussions
  - Getting a 2nd concussion before your 1st one is fully healed (e.g., Sidney Crosby)

Video

- Sidney Crosby's concussion experience
- Video from Sidney Crosby's doctor
  - Describes what happens when you get a concussion

Sidney Crosby (Center) and Micky Collins (Right)

Micky Collins video



What if you think you have a concussion?

- STOP PLAYING!
- TELL SOMEONE!
- GET EVALUATED!
  - By an expert who is trained to deal with concussions (e.g., Athletic Therapists at LCC)
- Then what?

Return to Play Protocol

Table 2 – Graduated return-to-play protocol after a concussion

Rehabilitation stage	Functional exercise at each stage
1. No activity	Complete physical and cognitive rest
2. Light aerobic activity	Walking, swimming, stationary cycling, keeping intensity less than 70% of maximum predicted heart rate; no resistance training
3. Sport-specific exercise	For example, skating drills in ice hockey, running drills in soccer; no head impact activities
4. Noncontact training drills	Progression to more complex training drills (eg, passing drills in football and ice hockey); may start resistance training
5. Full-contact practice	After medical clearance, participate in normal training activities
6. Return to play	Normal game play

Comments and Questions?

Please fill out evaluation forms

Presentation #2: Long-Term Effects of Concussions

Jeff Caron
McGill University

January, 2015

Today's Topics

- **Does Equipment Prevent Concussions?**
- **Reporting Concussion Symptoms**
- **Long-Term Effects**

Does Equipment Prevent Concussions?

- Protective Equipment


Does Equipment Prevent Concussions?

- Mouthguards



Does Equipment Prevent Concussions?

- Helmets






Does Equipment Prevent Concussions?

- Do you think it's possible that wearing more advanced and protective equipment (e.g., helmets, shoulder pads) could actually cause **more** concussions?



Reporting Concussion Symptoms

- Doctors, therapists, and coaches are aware that athletes are occasionally not truthful about concussion symptoms.
- Researchers from McGill University studied this topic in more detail:

Why University Athletes Choose Not to Reveal Their Concussion Symptoms During a Practice or Game

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Reporting Concussion Symptoms

- Why did athletes not report concussions?

1. Did not feel the concussion was serious/severe
2. Did not want to be removed from the game
3. Might miss future games if diagnosed with a concussion
4. Had similar symptoms in the past so felt there was no danger
5. Being diagnosed with a concussion might affect place on team

So why is it important to report concussion symptoms?

Long-Term Effects

Effects of Multiple Concussions on Retired National Hockey League Players

"I think I get tired more often than other people. There are days when I just don't want to get up because I'm exhausted. I go through those lulls where I'm a little more tired than the normal person."

19

Long-Term Effects

"Sometimes I still have trouble retaining information. I find that I can't remember phone numbers. You can tell me a phone number five times and I can repeat it five times, yet I'll still have trouble remembering it."

"The first time I went through a really deep depression. It was a very scary time. . . . People don't understand going from, in their eyes, a hockey celebrity to the point where you can't walk out of your house. You can't shave. You have no desire to do anything. You're depressed."

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Long-Term Effects

"I was at the point where I'd be driving along and would think about going full speed and hitting the wall. Just end my life. The pain was unbelievable. I had headaches every day for a minimum of three and a half years. Not just a little headache where you want to take an aspirin. I almost wanted to scream."

Long-Term Effects

- Former NHL players did not manage their concussions properly.
  - Did not report
  - Continued to play many times throughout their careers
  - Have long-term brain damage that affects all parts of their lives

If you manage concussions properly, there is no reason to believe you will not make a full recovery

Comments and Questions?

Please fill out evaluation forms

Presentation #3: Psychology of Concussions

Jeff Caron
McGill University

January, 2015

Today's Topics

- **Athletic Injuries**
- **Concussions**
- **Supporting a Teammate who has a Concussion**

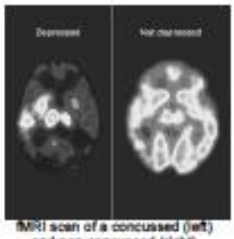
Athletic Injuries

1. **Fear and Anxiety**
   - **Many athletes worry that:**
     - **They will never recover**
     - **They will get reinjured**
     - **Someone will replace them in the line-up**
2. **Identity Loss**
   - **Some athletes base all of their identity on playing sports.**

Athletic Injuries

3. **Lack of Confidence**
   - **Unable to practice or compete**
   - **May decrease performance**

Concussions



fMRI scan of a concussed (left) and non-concussed (right) patient

Concussions

- Psychological (emotional) symptoms can also include:
  - Irritability
  - Anxiety
  - Fatigue

Emotional symptoms typically occur for those who experience symptoms for longer than 10 days

Bob McKenzie Concussion Video

Concussions

Brianna Scurry

- Goalkeeper for Team USA
- 2 time Olympic gold medallist (1996, 2004)
- World Cup of Soccer (1999) Brianna Scurry Concussion Video
- Retired because of concussions

Concussions

- Athletes often experience isolation during their recovery from a concussion.
  - Unique recovery process (i.e., physical and cognitive rest; no electronics; absences from school and sports)
  - Away from the team environment
  - No timeline for recovery

Supporting a Teammate who has a Concussion

1. Because athletes tend to feel isolated while recovering from a concussion…
   - Try to include teammates in team activities as much as possible.
   - Make sure they continue to feel part of the team!

Supporting a Teammate who has a Concussion

2. It's possible that athletes experience setbacks while recovering from a concussion.

- When this occurs, teammates are in need of greatest amount of support from peers.
- Encourage concussed friends/ teammates to talk to you about their setbacks.

Comments and Questions?

Please fill out evaluation forms

Presentation #4: Creating a Safe Sports Environment

Jeff Caron
McGill University

January, 2015

Today's Topics

- **Case Study**
- **Summary of Concussion Seminars**
- **Playing with Respect**
- **Concussion Resources**

Case Study - Basketball

- During the second half, Kevin, who is one of the team's top players, is hit in the head while trying to get a rebound.
- Kevin immediately sees "stars" but is able to get back into the play.
- All his teammates saw the hit but the coach and therapist were tending to other players and missed it.
- Kevin had a concussion earlier this year so is reluctant to tell anyone about how he feels.

Case Study – Hockey

- During the second period of a game, Kevin, who is one of the team's top players, is hit in the head while carrying the puck.
- Kevin immediately sees "stars" but is able to get back into the play.
- All his teammates saw the hit but the coach and therapist were tending to other players and missed it.
- Kevin had a concussion earlier this year so he is reluctant to tell anyone about how he feels.

Case Study

- What should Kevin do?
  - Playoff or Championship game
- As Kevin's teammate, what should you do?

Summary of Concussion Seminars

- A concussion is a brain injury that can impact your short- and long-term health.
  - You only have one brain – take care of it!
- Helmets and mouthguards do not prevent concussions.
- Athletes who have a concussion for more than 10 days are at risk of experiencing psychological symptoms.
  - Support teammates and friends who have a concussion.

"When in doubt, Sit them out!"

Playing with Respect

- Respect Opponents: Do not fight or purposely try to injure other players.
  - Almost always results in a penalty that negatively affects your team.

Playing with Respect

- Respect Yourself: Concussions are an "invisible" injury.
  - Be honest with your symptoms.
  - You are not helping your team by playing at less than 100% health.
  - "Playing up" or "downplaying" symptoms could lead to more serious health problems in the future.
    - Recall the former NHL players we spoke about

Playing with Respect

- Being a high school athlete is a great experience:
  - Represent your school
  - Develop leadership skills
  - Make lifelong friendships

Playing with Respect

- Competitive sports are a small part of our lives.
  - Represent family, school, and team with integrity and pride
- Long-term health and well being is most important.
  - Make smart decisions

McGill University

Charline Labonté

Playing with Respect

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Concussion Resources

Websites:

- http://www.cdc.gov/concussion/
- http://www.thinkfirst.org/concussion

Apps:

- "Hockey Canada Concussion Awareness"

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Comments and Questions?

Please fill out evaluation forms

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Appendix I
Rosenbaum Concussion Knowledge and Attitudes Survey-Student Version

SECTION 1

DIRECTIONS: Please read each of the following statements and circle TRUE or FALSE for each question.

Number	Statement	TRUE	FALSE
1.	There is a risk of possible death if a second concussion occurs before the first one has healed.	TRUE	FALSE
2.	Running everyday does little to improve cardiovascular health.	TRUE	FALSE
3.	People who have had one concussion are more likely to have another concussion.	TRUE	FALSE
4.	Cleats help athletes' feet grip the playing surface.	TRUE	FALSE
5.	In order to be diagnosed with a concussion, you have to be knocked out.	TRUE	FALSE
6.	A concussion can only occur if there is a direct hit to the head.	TRUE	FALSE
7.	Being knocked unconscious always causes permanent damage to the brain.	TRUE	FALSE
8.	Symptoms of a concussion can last for several weeks.	TRUE	FALSE
9.	Sometimes a second concussion can help a person remember things that were forgotten after the first concussion.	TRUE	FALSE
10.	Weightlifting helps tone and/or build muscle.	TRUE	FALSE
11.	After a concussion occurs, brain imaging (i.e., CAT Scan, MRI, X-Ray) typically shows visible damage (e.g., bruise, blood clot) to the brain.	TRUE	FALSE
12.	If you receive one concussion and you never had a concussion before, you will become less intelligent.	TRUE	FALSE
13.	After 10 days, symptoms of a concussion are usually completely gone.	TRUE	FALSE
14.	After a concussion, people can forget who they are and not recognize others but be perfect in every other way.	TRUE	FALSE
15.	High school freshman and college freshman tend to be the same age.	TRUE	FALSE
16.	Concussions can sometimes lead to emotional disruptions.	TRUE	FALSE
17.	An athlete who gets knocked out after getting a concussion is experiencing a coma.	TRUE	FALSE
18.	There is rarely a risk to long-term health and well-being from multiple concussions.	TRUE	FALSE

SECTION 2

DIRECTIONS: Please read each of the following scenarios and circle TRUE or FALSE for each statement that follows the scenarios.

Scenario 1

While playing in a game, Player Q and Player X collide with each other and each suffers a concussion. Player Q has never had a concussion in the past. Player X has had 4 concussions in the past.

1.	It is likely that player Q's concussion will affect his long-term health and well-being.	TRUE	FALSE
2.	It is likely that player X's concussion will affect his long-term health and well-being.	TRUE	FALSE

Scenario 2

Player F suffered a concussion in a game. She continued to play in the same game despite the fact that she continued to feel the effects of the concussion.

3.	Even though player F is still experiencing the effects of the concussion, her performance will be the same as it would be had she not suffered a concussion.	TRUE	FALSE

SECTION 3

DIRECTIONS: For each question, circle the number that best describes how you feel about each statement.

Number	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I would continue playing a sport while also having a headache that resulted from a minor concussion.	1	2	3	4	5
2.	I feel that coaches need to be extremely cautious when determining whether an athlete should return to play.	1	2	3	4	5
3.	I feel that mouthguards protect teeth from being damaged or knocked out.	1	2	3	4	5
4.	I feel that professional athletes are more skilled at their sport than high-school athletes.	1	2	3	4	5
5.	I feel that concussions are less important than other injuries.	1	2	3	4	5
6.	I feel that an athlete has a responsibility to return to a game even if it means playing while still experiencing symptoms of a concussion.	1	2	3	4	5
7.	I feel that an athlete who is knocked unconscious should be taken to the emergency room.	1	2	3	4	5
8.	I feel that most high school athletes play professional sports in the future.	1	2	3	4	5

SECTION 4

DIRECTIONS: For each question read the scenarios and circle the number that best describes your view. (For the questions that ask you what *most athletes* feel, base your answers on how you think MOST athletes would feel.)

Scenario 1

Player R suffers a concussion during a game. Coach A decides to keep player R out of the game.

Number	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I feel that Coach A made the right decision to keep Player R out of the game.	1	2	3	4	5
2.	Most athletes would feel that Coach A made the right decision to keep Player R out of the game.	1	2	3	4	5

Scenario 2

Athlete M suffered a concussion during the first game of the season. Athlete O suffered a concussion of the same severity during the semifinal playoff game. Both athletes had persisting symptoms.

Number	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3.	I feel that Athlete M should have returned to play during the first game of the season.	1	2	3	4	5
4.	Most athletes would feel that Athlete M should have returned to play during the first game of the season.	1	2	3	4	5
5.	I feel that Athlete O should have returned to play during the semifinal playoff game.	1	2	3	4	5
6.	Most athletes feel that Athlete O should have returned during the semifinal playoff game.	1	2	3	4	5

Scenario 3

Athlete R suffered a concussion. Athlete R's team has an athletic trainer on staff.

Number	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7.	I feel that the athletic trainer, rather than Athlete R, should make the decision about returning Athlete R to play.	1	2	3	4	5
8.	Most athletes would feel that the athletic trainer, rather than Athlete R, should make the decision about returning Athlete R to play.	1	2	3	4	5

Scenario 4

Athlete H suffered a concussion and he has a game in two hours. He is still experiencing symptoms of a concussion. However, he knows that if he tells his coach about the symptoms, he knows his coach will keep him out of the game.

Number	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9.	I feel that Athlete H should tell his coach about the symptoms.	1	2	3	4	5
10.	Most athletes would feel that Athlete H should tell his coach about the symptoms.	1	2	3	4	5

SECTION 5

DIRECTIONS: Think about someone who has a concussion. Check off the following signs and symptoms that you believe someone may be likely to experience AFTER a concussion.

Signs and Symptoms	✓	Signs and Symptoms	✓
Hives		Feeling in a "Fog"	
Headache		Weight Gain	
Difficulty Speaking		Feeling Slowed Down	
Arthritis		Reduced Breathing Rate	
Sensitivity to Light		Excessive Studying	
Difficulty Remembering		Difficulty Concentrating	
Panic Attacks		Dizziness	
Drowsiness		Hair Loss	

Appendix J
Focus Group Interview Guide

Opening Questions

1. Tell me about some of your favourite aspects of the presentations.
    - Content
    - Delivery
    - Delivery method
2. How could the presentations be improved?
    - Content
    - Delivery
    - Delivery method

Key Questions

3. Describe some of the things you learned from the presentations.
    - Signs and symptoms (i.e., short- and long-term)
    - Underreporting
    - Psychological aspects
    - Prevention, playing safe
4. Tell me how the presentations changed the way you now think about concussions.
    - Teammates
    - Opponents
    - Professional sports
5. Do you think the presentations changed the way you play sports?
    - On-field behaviours
    - Aggression, risk-taking
6. Have you noticed any changes in your teammates and coaches throughout the season that you think might be a result of our presentations?
7. If a friend or family member suffered a concussion and asked you for advice, what would you say to them?

Concluding Questions

8. Would you like to add any other information related to the concussion education program?

9. Do you have any other comments or questions?

Tables

Table 1

Clinical, pathologic, and biomechanical constructs of a concussion

Number	Construct
1	Concussion may be caused either by a direct blow to the head, face, neck or 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 neuropathologic changes but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.
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; however it is important to note that in some cases symptoms may be prolonged

(McCrory et al., 2013)

Table 2

Factors that can predispose athletes to protracted concussion symptoms

Factors	**Modifier**
Symptoms	Number Duration (>10 days) Severity
Signs	Prolonged loss of consciousness (>1min), amnesia
Sequelae	Concussive convulsions
Temporal	Frequency – repeated concussions over time Timing – injuries close together in time 'Recency' – recent concussion or traumatic brain injury (TBI)
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion
Age	Child and adolescent (<18 years old)
Co- and pre morbidities	Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), sleep disorders
Medication	Psychoactive drugs, anticoagulants
Behaviour	Dangerous style of play
Sport	High risk activity, contact and collision sport, high sporting level

(McCrory et al., 2013)

Table 3

Description of the included studies

Studies	**Methodology**	**Participants**	**Program**	**Instruments**	**Main Outcomes**
Bagley et al. (2012)	Non-randomized, pre-post study without a control group.	599 male (n=309) and female (n=290) students were grouped into three age categories: 9–12 (n=104), 13–15 (n=310), and 16–18 (n=148) (n=37 age unknown).	*Content:* Signs and symptoms, short- and long-term consequences, and strategies for responding to concussions. *Delivery:* 40 to 60 minute audiovisual presentation that contained video segments, demonstrations, case studies of professional and high school athletes, personal testimonies, and question/answer period.	Identical pre- and post-program quizzes containing free-response, T/F, and MC questions.	Pre- and post-quiz mean scores of all participants significantly increased from 43% (SD = 16%) to 65% (SD = 20%), respectively (P<.0001, ES = 1.2147). More athletes 13 and older passed the post-presentation quiz (84%) compared to 12 and younger (73%) (P<.0001). More females passed the post-quiz (94%) than males (70%) (P<.0001).
Cook et al. (2003)	Randomized controlled, post-only study. Two groups: experimental (n=45) and control (n=30).	75 male ice hockey players 11 to 12 years old.	*Content:* Medical information, training lessons, and personal statements. *Delivery:* Experimental group watched 'Smart Hockey' video. Control group received no intervention.	Two methods of assessment: two "player questions" assessed concussion knowledge, and game-by-game penalty analysis to determine video's effect on behavior.	Experimental group showed improvements in knowledge (number of correct answers) that were maintained at three months (P<.05). In the experimental group, a significant change was observed in cross checking and checking from behind, from mean (SEM) 23.7 (1.3) to 13.0 (3.4) and 38.4 (3.7) to 7.6 (0.69) penalties per 1000 player hours, respectively (P<.05).

Cusimano et al. (2014)	Cluster randomized controlled, pre-post study. Two groups: video (n=61) and no-video (n=74).	135 youth ice hockey players 10 years old (n=89) and 14 years old, (n=46). Gender was not reported.	*Content:* Mechanisms of concussion, in-game tactics to reduce high-risk maneuvers, and return to play guidelines. *Delivery:* Video group watched the ThinkFirst's 'Smart Hockey: More Safety, More Fun'.	Two questionnaires were developed to assess athletes' knowledge, and attitudes and behaviors. They were administered at three time points: immediately before and after video, and two months later.	Increase in players' knowledge immediately following the video from M=7.36, SD=2.12 to M=9.05, SD=2.01 (P<.001, ES = .8181). 10-year old group showed concussion knowledge post-video improvement (+1.93) but decreased average scores at two months from baseline (-0.32) (measure of significance were not provided). The 14-year old group showed concussion knowledge post-video improvement (+1.73) and retention at two months (+1.86). No significant differences in players' attitudes and behaviors were found between the groups (P=.507).
Echlin et al. (2010)	Randomized controlled, pre-post study. Three groups: DVD (n=16), Interactive Computer Module (ICM) (n=20), and control (n=22).	58 male ice hockey players 16 to 21 years old.	*Content:* Not explicitly stated. *Delivery:* Experimental groups received either the ThinkFirst DVD or ICM intervention. Control group received no intervention.	26 MC and T/F questions on injury knowledge and treatment protocol. Questions were re-administered immediately after intervention, and at two and four months.	No significant differences in knowledge acquisition between groups, across the times measured (P>.05).

Glang et al. (2010)	Randomized controlled, post-only study. Two groups: experimental (n=40) and control (n=35).	75 male (n=52) and female (n=23) youth sport coaches. 75% self-identified as being between 30 to 49 years old.	*Content:* Prevention, recognition, and management based on expert guidelines,[29, 30] *Delivery:* Experimental group completed computer modules designed to deliver concussion education. Control spent 15–20 min reviewing CDC materials.	Questionnaire assessed general knowledge, symptoms, misconceptions, self-efficacy and behavior intention, and program satisfaction and acceptability	Experimental group scored higher in: general knowledge (η^2 = .37), symptoms (η^2 = .46), misconceptions (η^2 = .12), self-efficacy (η^2 = 0.29), and intention to take appropriate actions (η^2 = 0.17).

Goodman et al. (2006)	*Study 1* Randomized controlled, post-only study. Two groups: experimental (n=65) and control (n=65). *Study 2* Randomized controlled, post-only study. Two groups: experimental (n=16) and control (n=17).	*Study 1* 130 ice hockey players aged 11 to 12 (n=44), 13 to 14 (n=38), and 15 to 17 years old (n=48). Gender was not reported. *Study 2* 39 ice hockey players 13 to 14 years old. Gender was not reported.	*Content:* Concussion symptoms. *Delivery:* Experimental group played a computer game where they stacked icons that represented concussion symptoms and non-symptoms. Control group played the same game but icons were not related to concussion.	A 36-item questionnaire was developed and administered after playing the game. Time to complete the questionnaire was also recorded. Computerized feedback questionnaire provided to assess game attributes.	*Study 1* Experimental group answered more questions correctly (M = 11.2, SD = 1.5) and faster (M = 143.7, SD = 33.5) than control (M = 10.5, SD = 2.5 and M = 158.3, SD = 44.9, respectively) (P < .05, ES = .3395 for questions, and ES = -.3685 for time). The game "held the interest" of 90% of 11 to 12 year olds, 75% of 13 to 14 year olds, and 60% of 15 to 17 year olds. *Study 2* Experimental group completed questionnaire faster (M = 89.81, SD = 25.87) than control group (M = 115.41, SD = 31.18) (P=.015, ES = -.8909). Compared to study 1, less 13 and 14 year olds thought the game was difficult to play (12% in study 2 compared to less than 33% in study 1). No differences were found in symptom recognition (P=.055).

Koh (2011)	Incidence cohort, pre-post study without a control group.	208 male (n=136) and female (n=72) university students from 18 to 32 years old registered in a snowboarding class.	*Content:* Concussion definition, mechanism of injury, signs and symptoms, post-concussion management, and return-to-play. *Delivery:* 30-minute concussion safety session using slides, videos, and oral presentation.	A 20-item quiz was developed. Identical quizzes were administered pre- and post-educational intervention.	After exposed to the concussion safety session significant increase were observed in snowboard-related concussion knowledge from M = 15.3, SD = 1.82 to M = 17.6, SD = 1.7 (P = 0.00, ES = 1.3060).
Manasse-Cohick & Shapley (2013)	Non-randomized pre-post study without a control group.	160 high school football players. Information on athletes' age and gender were not provided.	*Content:* General information about concussions, causes and symptoms, management, short- and long-term, and underreporting. Based on Rosenbaum and Arnett's [31] survey. *Delivery:* A five-minute modified video of CDC's "Heads Up: Concussion in High School Sports – Information for Coaches" followed by a 20-minute PowerPoint presentation, and a question and answer period.	Participants answered identical pre- and post-questionnaires. The Rosenbaum Concussion Knowledge and Attitudes Survey was used. Developed for students aged 13 to 20 years, it contains three indices: Concussion Knowledge Index, Concussion Attitude Index, and Validity Scale.	Significant increase found in post-intervention Concussion Knowledge Index from M = 18.2, SD = 3.5 to M = 21.3, SD = 2.3 (P<.000, ES = 1.0467) but not with respect to the Concussion Attitude Index (P=.508).

Miyashita et al. (2013)	Cross-sectional, pre-post study without a control group. Pre-intervention surveys were completed during pre-participation physical tests. Post-intervention surveys were completed 5 months (soccer) and 7 months (basketball) months after the intervention.	50 male (n=27) and female (n=23) NCAA Division II basketball and soccer players average 19.68 years old.	*Content:* Definition of concussion, signs and symptoms, reporting process, "take-home guide", return-to-play protocol, and long-term sequelae. Based on "athletic Training Education" courses taught by lead investigator. *Delivery:* 20-minute PowerPoint presentation with 10 slides.	Pre- and post-intervention surveys contained four quantitative questions to obtain athletes' previous medical history and six qualitative questions to ascertain athletes' concussion knowledge.	Athletes scored significantly fewer incorrect scores between the pre-intervention survey M = 3.6 and the post-intervention survey M = 1.22 (P<.0001).

Table 4

Coaches' characteristics

Pseudonym	Age Range	Gender	Current Team	Years Coaching at the High School Level	Highest Level of Athletic Competition
Thomas	30–34	M	Girls Flag Football	5	University Football
Victoria	30–34	F	Girls Basketball	9	University Track and Field
Mark	35–39	M	Boys Basketball	10	High School Basketball/Ice Hockey
Kevin	40–44	M	Boys Hockey	11	Professional Ice Hockey
Martin	40–44	M	Boys Football	13	University Football
Charles	45–49	M	Girls Hockey	6	Recreational Ice Hockey/Baseball
Jessica	45–49	F	Girls Soccer	16	Professional Soccer
Richard	50+	M	Boys Soccer	33	University Soccer

Table 5

Overview of results

Categories	1. Coach Concussion Knowledge and Training	2. Coaches' Roles with Concussed Athletes	3. Recommendations for Concussion Education
Properties	- Coach Concussion Knowledge - Coaching High School Sports - Personal Injuries and Concussions	- Athlete Interaction - High School Concussion Procedures	- Concussion Prevention
Tags	- Awareness (9) - Coaching evolution (11) - Coaching credentials (8) - Coaching style (16) - Concussions – coaching style (15) - Knowledge (18) - Knowledge through experience (19) - Higher education experiences (2) - Parents – general (6) - Parents – concussions (19) - Personal athletic experiences (12) - Personal injury experiences (4) - Personal concussion experiences (13) - Personal concussion rehabilitation (7) - Physical signs (5) - Prevalence (6) - Sports in general (4) - Sports injuries – general (21)	- Athlete concussion deception (15) - Athlete concussion education (4) - Athlete injury deception (3) - Athlete interactions – concussions (13) - Athletic Director (7) - Athletic Therapists – general (20) - Athletic Therapists – treatment (9) - Concussions – school protocol (30) - Injuries – school protocol (13) - Knowing your athletes (5)	- Coach concussion education (27) - Equipment (7) - Media (10) - Teaching prevention strategies (12)

Note. Numbers in parentheses represent the frequency of each tag

Table 6

Athletes' characteristics

Pseudonym	Age	Gender	Current Sports Team(s)	Previous Concussion History (Yes/No)	Grade
Ethan	16	M	Hockey, Football	Yes	10
Walter	15	M	Basketball, Tennis	Yes	9
Sara	16	F	Basketball, Flag Football	No	11
Samantha	17	F	Soccer	No	11
Aaron	16	M	Hockey, Football	No	11
Holly	17	F	Soccer, Basketball	Yes	11
Mark	16	M	Hockey	Yes	11
Jordan	16	M	Hockey, Football	Yes	10
Emmanuel	17	M	Basketball, Football	Yes	11
Lauren	16	F	Soccer, Basketball	Yes	10
Elliot	17	M	Rugby, Hockey	Yes	11
James	15	M	Hockey	Yes	10
Karen	18	F	Hockey, Flag Football	No	12
Luke	15	M	Hockey, Football	Yes	10
Ashley	15	F	Soccer, Basketball	No	9
Veronica	15	F	Soccer	Yes	9
Kelsey	15	F	Soccer, Football	No	10
Amanda	15	F	Hockey, Soccer, Tennis	Yes	10
	M_{age}=15.94 years	F=9; M=9		Yes=12; No=6	

Table 7

Aggregate mean scores and values for the standard error of the mean for each time

Time	1	2	3
Concussion Knowledge	30.80 (0.312)	32.80 (0.280)	32.77 (0.281)
Concussion Attitudes	75.40 (1.423)	75.57 (1.118)	75.20 (1.077)

Note. The aggregate mean scores for Concussion Knowledge and Concussion Attitudes are presented for each time point. Values for the Standard Error of the Mean are presented in parentheses.

Figures

Figure 1

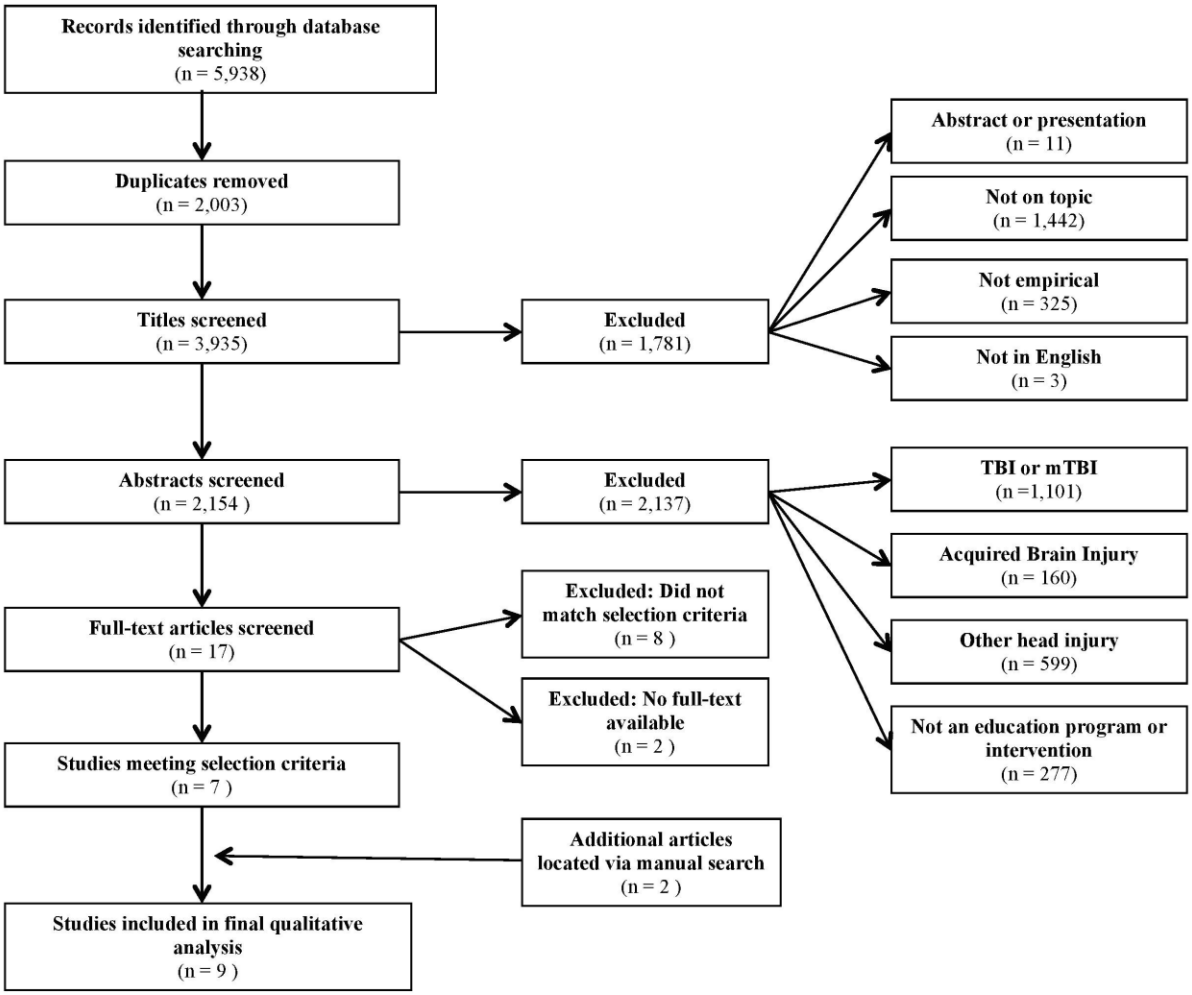

Figure 1. Illustration of the Research Process. The figure presents the articles included and excluded at each stage of analysis.

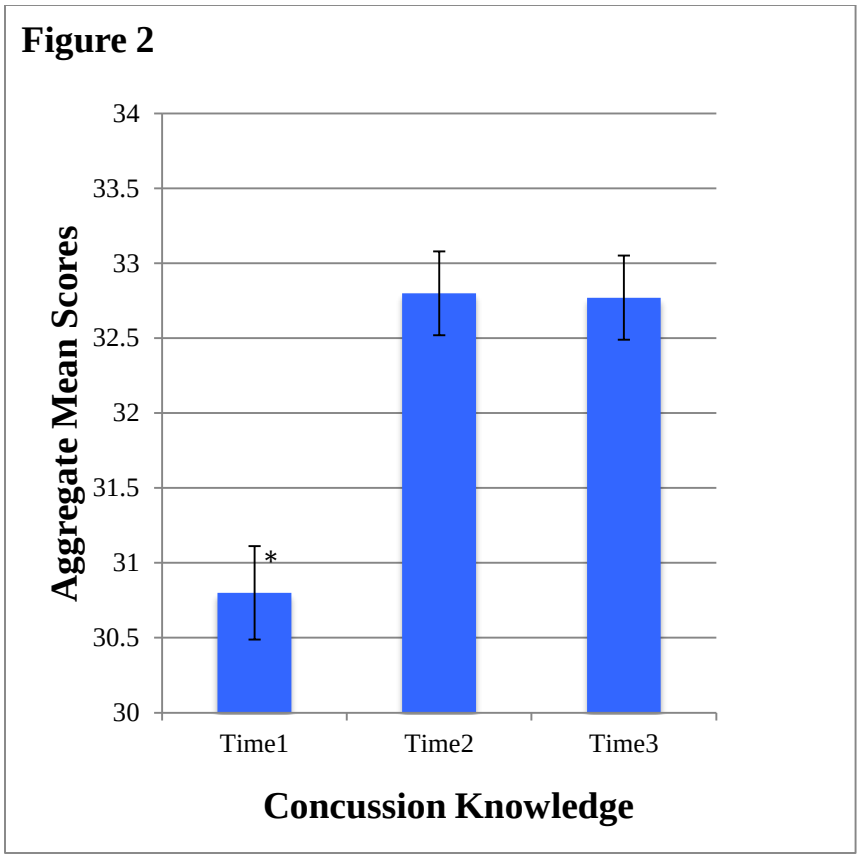

Figure 2. Aggregate Mean Scores for Concussion Knowledge. Error bars represent the 95% confidence interval around the Standard Error of the Mean. Aggregate mean scores in Time 1 are significantly lower than Times 2 and 3.

Figure 3

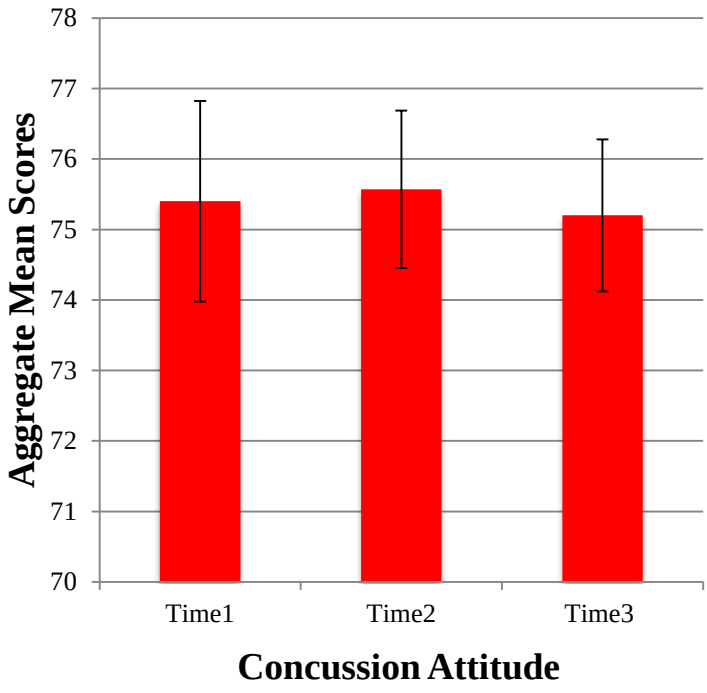

Figure 3. Aggregate Mean Scores for Concussion Attitudes. Error bars represent the 95% confidence interval around the Standard Error of the Mean. The aggregate mean scores at Times 1, 2, 3 did not differ significantly.