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Understanding high school athletes' and coaches' experiences regarding concussion-related behaviours in their sports: A qualitative study using the COM-B model

By

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Thesis entitled

Understanding high school athletes' and coaches' experiences regarding concussion-related behaviours in their sports: A qualitative study using the COM-B model

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Résumé

Une commotion cérébrale liée au sport (CCS) est une lésion cérébrale traumatique dont les athlètes du secondaire sont susceptibles de présenter des symptômes graves en raison de la maturation cognitive pendant l'adolescence. En utilisant le modèle « Capability Opportunity Motivation-Behaviour » (Michie et al., 2011), nous cherchions à comprendre les expériences des étudiants-athlètes d'écoles secondaires et de leurs entraîneurs par rapport aux comportements liés aux CCS. Nous avons mené des entrevues semi-structurées (M = 72 min) avec des athlètes (n = 10), des entraîneurs (n = 4) et des enseignants-entraîneurs (n = 2) d'une école secondaire impliqués dans le hockey sur glace, le basket-ball, le volley-ball et le rugby. Nous avons effectué une analyse dirigée de contenu en utilisant le modèle COM-B. Les athlètes et les entraîneurs ont décrit des expériences ayant eu un impact sur leur *capacité* à divulguer les symptômes (athlètes) et à gérer correctement la CCS (athlètes et entraîneurs). De plus, les participants ont décrit des facteurs qui ont influencé les *opportunités à* améliorer les connaissances en matière de CCS (athlètes et entraîneurs), de les déclarer (athlètes), de les gérer correctement (athlètes) et de les identifier (enseignants-entraîneurs). Enfin, les participants ont indiqué leurs *motivations* pour les décisions concernant le signalement des CCS (athlètes), le retrait du jeu (entraîneurs) et la bonne gestion des CCS (athlètes et entraîneurs). Les résultats de cette étude pourraient aider les chercheurs à intégrer la théorie du changement de comportement pour créer des interventions d'éducation sur les CCS.

Mots-clés : traumatisme cranio-cérébral, recherche qualitative, enseignants-entraîneurs, étudiants-athlètes du secondaire, théorie de changement du comportement, psychologie du sport

Abstract

Sport-related concussion (SRC) is a traumatic brain injury that has regrettably become prevalent in many contact or collision sports. High school athletes are more vulnerable to experiencing more severe symptomatology compared to adults due to the cognitive maturation that occurs throughout adolescence. Using the Capability Opportunity Motivation-Behaviour (COM-B) model, the innermost ring of the Behaviour Change Wheel (Michie et al., 2011), we sought to understand the experiences of high school athletes and coaches with concussion-related behaviours in their sports. We conducted qualitative semi-structured interviews (M = 72 min) with high school athletes (n = 10), coaches (n= 4), and teacher-coaches (n= 2) from a rural high school in New Brunswick, who were involved in ice hockey, basketball, volleyball, and rugby. We performed a directed content analysis of the interview transcripts using the COM-B model as pre-determined codes. Athletes and coaches described experiences that we felt impacted their *capabilities* for symptom disclosure (athletes), and for both athletes and coaches to properly manage SRC. Similarly, we interpreted that *opportunities* to improve SRC knowledge (athletes and coaches), to report SRC (athletes), to properly manage SRC (athletes) and to identify SRC (teacher-coach) were impacted by factors described in participants' experiences. Lastly, participants described the *motivational* factors that impacted their SRC reporting (athletes), removal from play (coaches) and proper SRC management (athletes and coaches) behaviours. The findings from this study will ideally assist future researchers in designing more effective behavioural interventions to improve concussion safety among high school sport participants.
Keywords: traumatic brain injury, qualitative research, teacher-coaches, high school athletes, behaviour change theory, sport psychology

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List of Signs and Abbreviations

In the order that they appear in text:

COM-B model: Capability, Opportunity, Motivation-Behaviour model

CCS: Commotion cérébrale liée aux sports

SRC: Sport-related concussion

CISG: Concussion in Sport Group

ATs: Athletic Therapists

CAC: Coaching Association of Canada

NCCP: National Coaching Certification Program

TPB: Theory of Planned Behaviour

BCW: Behaviour Change Wheel

EB: Erin Brennan, 1st author

JC: Jeffrey Caron, 2nd author

Dedications

This thesis is dedicated in loving memory to my Grandparents: Marie & Ronald Chisholm, and Bill & Jeanne Brennan. I will miss you and love you forever. Thank you for watching over me and for instilling a love of learning in me at a young age.

This thesis is also dedicated to all athletes who have had or continue to suffer from experiences with concussion in sport. I hope that this research can be used to better understand high school athletes' and coaches' experiences with SRCs, which will ideally help make sport safer for all.

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Preface

This master's thesis consists of three chapters. Chapter 1 is a review of the sport-related concussion literature specific to the high school sport population. This chapter also includes a review of psychological theories used within the sport-related concussion literature. Chapter 2 is a manuscript that presents the objective, methods, results, and discussion of this research study. Chapter 3 is a summary and provides some suggestions for future research.

Chapter 1

Introduction and Literature Review

Chapter 1 is divided into three sections. First, we will elaborate on sport-related concussion (SRC) including the history, position statements, incidence, signs and symptoms, and proper assessment and management protocol of SRCs. Second, we will review concussions in high school sports, including the incidence, risk, lack of trained personnel and relevant research conducted on high school athletes and coaches in relation to SRCs. Third, we will discuss the use of psychological theories in concussion research, including the theory we selected to guide this study.

More than eight million Canadians over the age of 15 participate in sport each year (Canadian Center for Ethics in Sport, 2022). According to a survey conducted by ParticipAction Canada (2020), 77% of Canadians high school age and younger participate in organized sport each year, and 66% of this same population participate in individual or team sports. Sport participation throughout adolescence has been acclaimed for the various health and development benefits athletes receive as a result of their involvement (Wilson et al., 2022). Sport participation has been linked to positive physical and psychological well-being as well as positive social benefits, such as development in leadership and cooperation skills (Jewett et al., 2014; Kniffin et al., 2015). As such, many athletes become involved in sport through their school. However, as with any type of physical activity, sport participation also comes with an elevated risk of injury, with one study finding that 60% of student-athletes 12 to 15 years old report at least one sport-related injury each year (Emery & Pasanen, 2019; Emery & Tyreman, 2009). Of the different types of sports injuries, one study surveying Canadian high school athletes found that 12%

(232/1971) reported that they sustained one or more concussions in the past year (Black et al., 2021).

Sport-Related Concussion

A SRC is a mild traumatic brain injury that stems from direct biomechanical forces transmitted to the head, neck or body that often results in transient neurological impairment. SRC is observable through signs and symptoms (e.g., headache, dizziness, feeling in a fog) and potential axonal injury, brain inflammation and change in brain blood flow, which are not detectable using normal neuroimaging (Patricios et al., 2023; Silverberg et al., 2021). A biomechanical force could result from player-to-player contact or contact with equipment or with the playing surface (Patricios et al., 2023).

Dating back as far as the 16th century, clinicians and scientists have been interested in how brain trauma affects individual health (Harrison, 2014). Since the 2000s, there has been extensive research on SRCs, such as the physical, physiological, psychological, and social factors that influence the injury and recovery process (Schneider et al., 2022). Moreover, researchers have found that athletes present a higher risk of sustaining injury, including SRCs, than non-athletes due to the physicality and the unpredictable nature of gameplay that occurs during sport (Patricios et al., 2023; Sarmiento et al., 2023). As a result, it should not be surprising that researchers have become interested in studying SRCs (Patricios et al., 2023; Powell, 2001).

Over the past two decades, experts have developed position statements on the topic of SRCs to provide recommendations for prevention, identification, and management. For example, the National Athletic Trainers Association (Broglio et al., 2014), the American Medical Society for Sports Medicine (Harmon et al., 2019) and the Concussion in Sport Group (CISG; Patricios

et al., 2023) are some of the most cited position statements on SRC. The CISG statements have become particularly influential, which can be evidenced by their 5th position statement earning a score in the top five percent of all published research scored by Altmetric (Gasquoine, 2020; Pusateri et al., 2018). The Altmetric Attention Score automatically calculates all of the online attention that a published research article has received across a variety of web-based platforms, helping researchers to understand how it compares against other similar articles (Elmore, 2018). Since 2001, the CISG has held a meeting approximately every four years, where leading experts revise their position statements to incorporate new evidence and amend recommendations for best practice. The CISG held their 6th meeting in Amsterdam in October 2022, and the consensus statement was published in June 2023 (Patricios et al., 2023; Schneider et al., 2022). As such, the following sections of this paper are in line with the 6th CISG consensus statement.

SRCs are a prominent injury in sport today, with 1.6 to 3.8 million occurring each year (Daneshvar et al., 2011). In the United States, as many as 1.9 million SRC are sustained annually by youth athletes (≤ 18 years old; Bryan et al., 2016). SRCs occur frequently in contact, collision and combat sports such as ice hockey (1.20/1000 athlete exposures), American football (0.53/1000), rugby (4.18/1000), soccer (0.23/1000) and wrestling (0.17/1000; Pfister et al., 2016; Powell, 2001). Despite its prevalence in sport, many health care professionals consider SRC to be one of the most difficult injuries to diagnose and manage because it is an invisible injury (i.e., no identifiable signs like a sprain or fracture; King et al., 2014; Provvidenza & Johnston, 2009; Wan & Nasr, 2021). As such, health care professionals must rely, in part, on subjective assessments to diagnose SRC (Makdissi et al., 2015; Patricios et al., 2023; Silverberg et al., 2021, 2023).

SRCs are primarily detected through physical signs and symptoms such as headaches, nausea, vomiting, blurred vision, and, in some cases, a loss of consciousness. Athletes can also experience cognitive (i.e., poor memory and concentration), affective (i.e., stress, anxiety and depression) and behavioural (i.e., aggressiveness) impairments as well as sleep disturbances following SRC (Broglio et al., 2015; Patricios et al., 2023; Sheldrake et al., 2022; Silverberg et al., 2023). Additionally, SRC signs and symptoms do not always present themselves immediately following acute injury; some athletes only develop signs and symptoms in the hours following injury (Olson et al., 2020; Trbovich et al., 2022). Delayed SRC assessment places athletes at higher risk of sustaining protracted symptoms and recovery (Kontos et al., 2020). As a result, researchers and clinicians have underscored the need for prompt assessment to minimize the individuals' odds of sustaining adverse consequences that could negatively impact the athlete's quality of life (i.e. prolonged symptoms, risk of second more severe impact etc.; Kontos et al., 2020; Patricios et al., 2023).

Athletes suspected of SRC are assessed by a qualified health care professional, who can determine whether the athlete should be removed from the game. These assessments include testing athletes' cognitive functioning, attention, memory, and balance (Broglio et al., 2015; Patricios et al., 2023; Putukian, 2017). Once SRC has been diagnosed, the athlete should be immediately removed from play and is advised to rest for 24-48 hours and adhere to the six-step return to activity guidelines (See Appendix A; Patricios et al., 2023). Each step in the return to play guideline should take 24 hours to complete. However, if symptoms worsen, the athlete must revert back to the previous step (Patricios et al., 2023). Throughout this process, athletes and coaches are advised to continue monitoring athletes' signs and symptoms in the days following an impact, regardless of a negative assessment of SRC (Putukian, 2017). However, when athletes

and coaches are lacking knowledge of the injury, SRCs can go undiagnosed and athletes are at risk of returning to play prematurely, which can increases their chances for subsequent head trauma and sequelae (May et al., 2023).

Researchers have found that athletes can engage in improper SRC reporting and management behaviours. For example, some athletes are hesitant to report potential signs or symptoms of a concussion for fear of being withheld from playing or for fear of losing their roster position (Kroshus & Chrisman, 2019). Additionally, some athletes continue to play with SRC because they do not feel the impact was serious enough to report to a coach or health care professional (Kroshus &Chrisman, 2019; Register-Mihalik et al., 2013), which hints at a lack of knowledge about the injury. Taken together, there are a variety of factors that contribute to the identification and management of SRCs. Due to the mounting evidence that suggests SRCs can be particularly harmful for preadults, there is a specific need to explore reporting and management behaviours among high school sport populations.

SRC in High School Sport

The rate of SRCs in North American high school athletes is high. Approximately 1.5 million youth experience traumatic brain injury each year in North America, with 75% of those injuries reported as SRC (Moore et al., 2018). High school aged athletes have been identified as one of the highest risk groups of individuals for prolonged symptoms and recovery from an SRC, due to their developing postural stability, coordination, and reaction time, as well as brain maturation that often leads to engagement in risk-taking behaviours at this age (Fyffe et al., 2022; Patricios et al., 2023).

Researchers have found that high school aged athletes with SRC often take longer to recover than adults (Wilber et al., 2021; Kontos et al., 2020; Zemek et al., 2016). For example,

Williams and colleagues (2015) conducted a systematic review and meta-analysis of six studies that compared the SRC symptoms and cognitive recovery periods among high school and college athlete samples. The authors found that, on average, high school athletes experienced a longer recovery from symptoms (15 days), and a more severe regression in their cognitive functioning immediately following injury when compared to concussed college athletes (six days for symptom recovery; Williams et al., 2015). In another study, Charek and colleagues (2020) investigated the correlation between continuing to play despite experiencing SRC symptoms and recovery time for SRC in a sample of youth athletes (ages 11-19). The authors found that athletes who continued to play for less than 15 minutes were 5.43 times more likely to have protracted concussion symptoms than athletes who were removed from play immediately (Charek et al., 2020). Additionally, the authors found that athletes who continued to play for more than 15 minutes were 11.76 times more likely to have protracted concussion symptoms than the removed athletes (Charek et al., 2020). In sum, it is important that high school athletes suspected of concussion are assessed and removed from play immediately.

Most Canadian public high school athletes do not have access to on-site health care professionals, such as athletic trainers (ATs), for SRC identification, assessment, and management (Register-Mihalik et al., 2017; Yard et al., 2009). Moreover, rural high schools have less access to immediate healthcare professionals and services than urban high schools (Yue et al., 2020). Considering that 18% of all Canadians live in rural communities, only 8% of all practicing physicians in Canada practice in rural communities (Wilson et al., 2020). Further, 7% of rural Canadians live more than 25km away from a physician, as compared to the less than 2km distance for residents of urban communities (Ng et al., 1999). Researchers have found that high school athletes without access to health care professionals or ATs have lower levels of SRC

knowledge (i.e., identification, management protocols, severity, etc.) than athletes with access to health care professionals (Wallace, Covassin, Nogle, et al., 2017). As such, much of the responsibility for SRC identification and management falls on coaches.

Coaches are valuable mentors entrusted with developing athletes' physical, technical and tactical skills related to sport, but also to develop the athletes' psychological and social skills that can be transferred into other life domains (Gano-Overway et al., 2020; Super et al., 2018). Some of the most successful coaches have focused on developing the person before the athlete, and set process goals rather than outcome goals for their athletes, to reduce stress levels and promote a more positive team culture (Bissett et al., 2020).

The roles and responsibilities of sport coaches have been examined thoroughly for years (Gano-Overway et al., 2020; Gilbert & Trudel, 2004; Super et al., 2018). Additionally, organizations such as the Coaching Association of Canada (CAC), the National Coaching Certification Program (NCCP), and the International Coach Federation have published position papers (International Coach Federation, 2019) and created national coaching certification standards and certification processes to improve the quality of coaches based on best practices (Coaching Association of Canada, 2023). The NCCP, in particular, was developed by the CAC and was the first program of its kind internationally, where it offers specific training and online modules across 65 sports for coaches to complete to receive nationally and internationally recognized coaching certificates (Coaching Association of Canada, 2023).

Evidently, coaches carry considerable responsibility on a team beyond technical and tactical skill development. Some of these responsibilities include initiating medical care when an athlete is injured, identifying signs and symptoms of potential SRC, and following the recommended SRC management protocol as determined by the athlete's physician. Perhaps

unsurprisingly, researchers have become increasingly interested in investigating the role of high school coaches with respect to SRCs. In particular, researchers have started examining the influence that coaches have on athletes' reporting behaviours , factors that contribute to coaches' SRC knowledge (Beran & Scafide, 2022), and their understanding of best practices for athlete return-to-play procedures (McKeithan et al., 2019).

Behaviours refer to the way an individual acts in response to a situation or stimulus (Uher, 2016). Researchers have identified several SRC-related behaviours that have been examined such as SRC identification (i.e., recognizing signs and symptoms of a SRC; Beran & Scafide, 2022; Black et al., 2020), management (i.e., following the return to sport guidelines; Frémont et al., 2022; Kim et al., 2022), assessment (i.e., coaches or healthcare providers asking a series of questions to assess an athlete's cognitive functioning following a potentially concussive impact; Pratile et al., 2022), removing an athlete from play (i.e., the act of sitting an athlete out of a game or practice after they have sustained a potential SRC; Asken et al., 2018), and reporting (i.e., an athlete disclosing to a coach, parent or healthcare provider, the symtoms they are experiencing following a potentially concussive impact; Beran & Scafide, 2022; Brown et al., 2019). A list of SRC-related behaviours are summarized in Appendix B.

In an exploratory study on the effects of team culture and athletes' intentions to report SRCs in girls high school soccer, Brown and colleagues (2019) found that caring team environments, influenced by coaches, is related to increased athlete reporting behaviours and better SRC management. Similarly, Chrisman and colleagues (2013) found that poor coach approachability and poor communication between athletes and coaches about SRC management were notable factors in athletes' underreporting and pre-mature return to sport. In another study by Kim and colleagues (2022), the authors found that coaches with more knowledge (i.e., signs

and symptoms of SRCs, return to play guidelines) and positive attitudes (i.e., importance of reporting SRC) were more likely to employ SRC risk-management measures (i.e., instructing their athletes to report SRC). Overall, researchers have found that coaches play a critical role in the reporting, management, and prevention of SRCs in athletes.

Unfortunately, researchers have also noted that improvements in coach and athlete knowledge of SRCs do not always lead to improvements in safe behaviours in the sport environment (Beran & Scafide, 2022; Wallace, Covassin, & Beidler, 2017; Wallace, Covassin, Nogle, et al., 2017), which can be evidenced by the nearly 50% of SRCs that go unreported each year (Beran & Scafide, 2022). As a result, researchers have become interested in using psychological theories to help understand SRC-related behaviors (Michalovic et al., 2019), which could later be targeted in interventions.

Psychological Theory

As noted by renowned psychologist Sir Karl Popper (1962), psychological theories describe how interconnected constructs or variables explain the why, when, and how of a behaviour. Theories can help researchers organize observations and provide explanations of the person-environment relationship (Starovoytova et al., 2016), thus allowing for a better understanding of the many factors that influence behaviour (Davis et al., 2015).

To date, theories have been used to explore SRC-related behaviours such as athletes' symptom underreporting, athlete removal from play, and SRC prevention behaviours (Kroshus et al., 2015; Kroshus & Chrisman, 2019; Register-Mihalik et al., 2017). For example, Kroshus and colleagues (2015) used social norms theory to assess perceived team SRC reporting norms versus individual SRC reporting norms. Another example was the use of the socio-ecological framework to gain a better understanding of current SRC prevention and education strategies

(Register-Mihalik et al., 2017). The most popular psychological theory in SRC research, however, has been the theory of planned behaviour (TPB). Professor Icak Ajzen (1985) noted that TPB focuses on how an individual's attitudes, subjective norms, beliefs about behaviour, and perceived behavioural control contribute to behavioural intent. Relying heavily on the idea that a human's intentional behaviours are driven by an individual's perceived ability to control the behaviour and the individual's intent to carry out the behaviour (Ajzen, 1985), TPB has been used to gain insight on the associations between the components of the TPB and individuals' health-related behaviours (Sniehotta et al., 2014). Specific to the SRC literature, TPB has predominantly been used to better understand athletes' intentions to report SRC (Kroshus et al., 2014; Register-Mihalik, Linnan, et al., 2013).

Register-Mihalik and colleagues (2013) used the TPB to investigate concussion reporting behaviours and intentions among 167 high school athletes. Participants completed a survey with questions related to the various aspects of the TPB relating to SRC reporting, including their attitudes, subjective norms, perceived behavioural control and intention to report. Results indicated that 58% of variables affecting athletes' intentions to report SRC fit within the framework of the TPB (i.e., positive reporting attitudes, comfort levels with teammates and coaches, increased SRC understanding). Despite this, intentions to report SRC were not significantly affected by athletes' past actual reporting behaviours. In another study, Kroshus and colleagues (2014) used the TPB to gain a deeper understanding of male ice hockey athletes' (aged 18-21) past SRC reporting behaviours and intentions to report future SRCs. They conducted a survey with 256 of these hockey players to collect data related to their symptom reporting and intention to report, focusing on the athletes' concussion knowledge, perceived social norms, perceived outcomes, and self-efficacy. Results indicated that TPB explained that

participants' average self-efficacy scores regarding reporting behaviours accounted for 22% of the variance in SRC reporting intentions and accounted for the 10.5% of variance in athletes' non-SRC reporting behaviours.

Although TPB has been the most prominent psychological theory used in SRC research, researchers from a variety of disciplines have been critical of TPB (Sniehotta et al., 2014). TPB emphasizes logical reasoning, and its exclusion of the influences of habitual, emotional, and unconscious emotions on behaviour are one of its main limitations. Additionally, TPB concentrates on assessing behaviours at a particular moment of time which researchers argue may not be useful in predicting the influence that behaviour has on an individual's thoughts and beliefs over time and how that may affect future behaviours (Bloom et al., 2022; Michalovic et al., 2019; Sniehotta et al., 2014). Lastly, in a review of the rare instances when the TPB was tested in practical application, interventions that targeted one or all of the theory's cognitive predictors of behaviour were unsuccessful at modifying behaviour, and successful changes in an individual's thoughts and beliefs did not translate to changes in their behaviours (Sniehotta et al., 2014). As such, we believed it was necessary to explore other psychological theories that could help us to better understand athletes' and coaches' SRC-related behaviours.

There is evidence that the Behaviour Change Wheel (BCW; Michie et al., 2011) could be a more appropriate psychological theory to understand SRC-related behaviours (Bloom et al., 2022; Michalovic et al., 2019). Michie et al. (2011) created the BCW by amalgamating the components of 19 existing theoretical frameworks (See Appendix C). Comprised of three rings that contribute to effective theory-based intervention design, the innermost ring of the BCW is the Capability Opportunity Motivation-Behaviour (COM-B) model of behaviour theory, used first to gain a better understanding of a targeted behaviour. The middle ring is comprised of nine

intervention functions (i.e., training, education, modelling) and the outermost ring is made up of seven policy categories (i.e., legislation, environmental planning), all targeted towards the development of effective, theory-based behaviour change interventions.

The COM-B model, at the core of the BCW, is used as a tool to understand which factors influence behaviour, so that interventions for behaviour change can be designed that target the main factors influencing behaviour (Michie et al., 2011). It is a dynamic model of behaviour that shows how an individual's capability, opportunity and motivation all interact to influence a certain behaviour (Michie et al., 2011). Each section of the COM-B model is further divided into sub-sections, physical and psychological capability, physical and social opportunity and lastly, automatic and reflective motivation (See appendix D for definitions). This model suggests that if any one section of the model does not positively influence a desired behaviour, that behaviour will not occur. For example, if a coach has received sufficient training on managing SRC (*physical opportunity*), is aware of the severity of SRC (*psychological capability*), does not feel pressured by others to keep the athlete in play (*social opportunity*), is *physically capable* of performing the sideline assessment, has a pre-determined plan in place for SRC management (*reflective motivation*) and wants to help the athlete in the best way they know how (*automatic motivation)*, theoretically there will be no barriers to that coach removing an athlete from play whom they suspect of having a SRC and assessing them for SRC.

The COM-B model has been used to gain a better understanding of health-related behaviours and informing the successful creation of behaviour change interventions (i.e., Barker et al., 2016; Lambe et al., 2020). Barker and colleagues (2016) have previously used the COM-B model to better understand audiologists' behaviour planning with regards to the development of a behaviour change intervention facilitated by the BCW to promote regular, long-term hearing

aid use by adults with hearing loss. They found that the COM-B model and BCW could be successfully used together to analyze the behaviours of people with hearing loss, and their audiologists, and supply information to be used in their intervention design (Barker et al., 2016).

Similarly, Lambe and colleagues (2020) implemented the use of the COM-B model and BCW to better understand nursing staffs' hand hygiene behaviours to inform the creation of a behaviour change intervention. They found that the COM-B model was successful at providing an in-depth understanding of the hand hygiene behaviours of participants, and that the results from that analysis were effective at informing the design of a behaviour change intervention targeted at improving the hand hygiene behaviours of the nursing staff (Lambe et al., 2020). Taken together, the studies from Barker et al. (2016) and Lambe et al. (2020) suggest that the COM-B model can help researchers gain a better understanding of health-related behaviours in other contexts, which could also be the case for SRC-related behaviours. Although the COM-B model has not yet been applied to SRC research, it appears to be a useful model to help explain athlete and coach SRC-related behaviours, which could provide insights for designing behaviour change interventions.

Chapter 2

Presentation of the Manuscript

Understanding high school athletes' and coaches' experiences regarding concussion-related behaviours in their sports: A qualitative study using the COM-B model

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Abstract

Sport-related concussion (SRC) is a traumatic brain injury that has unfortunately become commonplace in many contact or collision sports. High school athletes are particularly susceptible to sustaining more severe symptomatology compared to adults and young children due to the cognitive maturation that occurs throughout adolescence. Using the Capability Opportunity Motivation-Behaviour (COM-B) model, the innermost ring of the Behaviour Change Wheel (Michie et al., 2011), we sought to understand the experiences of high school athletes and coaches with concussion-related behaviours in their sports. We conducted qualitative semi-structured interviews (M = 72 min) with high school athletes (n = 10), coaches (n= 4), and teacher-coaches (n= 2) from a rural high school in New Brunswick, who were involved in ice hockey, basketball, volleyball, and rugby. We performed a directed content analysis of the interview transcripts using the COM-B model as pre-determined codes. Athletes and coaches described experiences that we felt impacted their *capabilities*, for symptom disclosure (athletes), and for both athletes and coaches to properly manage SRC. Similarly, we interpreted that *opportunities* to improve SRC knowledge (both), to report SRC (athletes), to properly manage SRC (athletes) and to identify SRC (teacher-coach) were impacted by factors described in participants' experiences. Lastly, participants described the *motivational* factors that impacted the decisions they made regarding SRC reporting (athletes), removal from play (coaches) and proper SRC management (both). The findings from this study will ideally assist future researchers in designing more effective behavioural interventions to improve concussion safety among high school sport participants.

Keywords: traumatic brain injury, qualitative research, teacher-coaches, high school athletes, behaviour change theory, sport psychology

Understanding high school athletes' and coaches' experiences regarding concussion related behaviours in their sports: A qualitative study using the COM-B model

Researchers have found that 77% of Canadians high school age and younger, participate in organized sport each year (ParticipAction Canada, 2020). Although sport participation has been associated with various physical, psychological and social benefits (Calcaterra & Zuccotti, 2022; Li & Shao, 2022; Vella et al., 2023), it also comes with an elevated risk of injury (Emery & Pasanen, 2019). One type of injury, concussion, has become increasingly prominent in sport, with an estimated 1.6 to 3.8 million occurring each year (Daneshvar et al., 2011).

A sport-related concussion (SRC) is defined as a traumatic brain injury that results from direct or indirect biomechanical forces that are transmitted to the head, neck, or body, which lead to impaired neurological functioning (Patricios et al., 2023). SRCs occur frequently in contact and collision sports such as ice hockey (1.20/1000 athlete exposures), American football (0.53/1000), rugby (4.18/1000), and soccer (0.23/1000; e.g., Pfister et al., 2015). In fact, the Canadian Community Health Survey (Champagne et al., 2019) reported that SRCs were the most reported injury in high school age students.

High school aged athletes have been identified as one of the highest risk groups for prolonged SRC symptoms and recovery (Patricios et al., 2023). This can be attributed to their developing postural stability, coordination, and reaction time, as well as brain maturation that occurs at this age (Fyffe et al., 2022; Patricios et al., 2023). Additionally, most public high schools, and particularly those in rural areas, do not have access to on-site health care professionals (Register-Mihalik et al., 2017; Yard et al., 2009; Yue et al., 2020). Researchers have found that a lack of access to health care professionals was associated with an increased

likelihood of high school athletes playing through SRC symptoms, and having lower levels of SRC knowledge (Register-Mihalik et al., 2017; Wallace et al., 2017).

Coaches play a significant role in the personal and athletic development of high school athletes, which includes injury management. Coaches are now expected to be able to identify signs and symptoms and remove athletes suspected of SRC from play (Patricios et al., 2023). Researchers have been interested in studying coach SRC identification and management behaviours in high school settings. A study by Daugherty and colleagues (2019) found that prior to receiving SRC education training, only 64.8% of high school coaches reported they could correctly manage a scenario regarding an athlete's safe return to play. Additionally, poor coach approachability and poor communication between athletes and coaches regarding SRC management have been found to contribute to athletes' SRC underreporting and pre-mature return to play (Chrisman et al., 2013). Taken together, coaches can play a critical role in the health and well-being of athletes suspected of SRC.

Unfortunately, researchers have also noted that improvements in coach and athlete knowledge of SRCs does not always lead to improvements in safe behaviours in the sport environment (Beran & Scafide, 2022; Wallace, Covassin, & Beidler, 2017), which can be evidenced by the nearly 50% of SRCs that go unreported each year (Beran & Scafide, 2022). Behaviours refer to the way an individual acts in response to a situation or stimulus (Uher, 2016). Researchers have identified several SRC-related behaviours that have been examined such as SRC identification (i.e., recognizing signs and symptoms of a SRC; Beran & Scafide, 2022; Black et al., 2020), management (i.e., following the return to sport guidelines; Frémont et al., 2022; Kim et al., 2022), assessment (i.e., coaches or healthcare providers asking a series of questions to assess an athlete's cognitive functioning following a potentially concussive impact;

Pratile et al., 2022), removing an athlete from play (i.e., the act of sitting an athlete out of a game or practice after they have sustained a potential SRC; Asken et al., 2018), and reporting (i.e., an athlete disclosing to a coach, parent or healthcare provider, the symtoms they are experiencing following a potentially concussive impact; Beran & Scafide, 2022; Brown et al., 2019). We created a table that summarizes SRC-related behaviours of interest to this study (see Appendix B), which was largely based on the four R's of concussion management: Recognize, Remove, Refer to a physician, Return to play (Sport Information Resource Centre, 2022).

Researchers have become interested in using psychological theories to help understand SRC-related behaviors (Michalovic et al., 2019). Popper (1962) noted that psychological theories describe how interconnected constructs or variables seek to explain the why, when, and how of a behaviour. Concussion researchers have previously used psychological theories to better understand SRC-related behaviours (Kroshus et al., 2014; Kroshus, 2015; Register-Mihalik, Linnan, et al., 2013a; Register-Mihalik et al., 2017). Ajzen's (1985) theory of planned behaviour, the most popular theory in SRC research, posits that how one's attitudes, subjective norms, and perceived behavioural control contribute to behavioural intent. TPB has mostly been used as a framework to better understand athletes' SRC symptom reporting intentions. For example, Kroshus and colleagues (2014) used the TPB to gain a deeper understanding of male ice hockey athletes' SRC reporting behaviours. The authors found that athletes' intentions to report did not necessarily lead to improved reporting behaviours (Kroshus et al., 2014). Indeed, TPB has received criticism from various disciplines regarding its effectiveness, with some even calling for TPB's "retirement" (Sniehotta et al., 2014). A key argument against TPB is the growing evidence of an intention-behaviour gap, which argues that an individual's intentions are not the best predictor of eventual engagement in a given behaviour (Rhodes & Dickau, 2012; Sniehotta

et al., 2005). As such, we believed it was necessary to explore other psychological theories that could help us to better understand athletes' and coaches' SRC-related behaviours.

Researchers have suggested that the Behaviour Change Wheel (BCW; Michie et al., 2011) might be a more effective psychological theory to understand concussion-related behaviours (Bloom et al., 2022; Michalovic et al., 2019). Michie and colleagues (2011) amalgamated the components of 19 existing theoretical frameworks to create the BCW (See Appendix C). The innermost ring of the BCW, known as the Capability Opportunity Motivation-Behaviour (COM-B) model, will be used to help guide the current study. The COM-B model developed by Michie and colleagues (2011) targets an individual's capabilities, opportunities, and motivations to perform a targeted behaviour. Each of these sections is further divided dichotomously to address one's physical capabilities (i.e., skills and abilities) and psychological capabilities (i.e., knowledge, decision making, memory); physical opportunities (i.e., environment and resources) and social opportunities (i.e., cultural norms, societal pressures); and automatic motivation (i.e., habits and emotional responses) and reflective motivations (i.e., planning and intentions; Michie et al., 2011). The COM-B model has been applied in areas of health research (Barker et al., 2016; Lambe et al., 2020), but not yet within SRC research. We believe the COM-B model could be useful in helping explain athlete and coach SRC-related behaviours, which could eventually provide insights for designing behaviour change interventions.

The purpose of this study was to gain a deeper understanding of the experiences of high school athletes and coaches regarding concussion-related behaviours. Specifically, we used the COM-B model to explore concussion-related behaviours in high school sports.

Methodology and Methods

Philosophical Positioning

Qualitative researchers are encouraged to explicitly state their views on the nature of reality (ontology) and the nature of knowledge (epistemology), so readers can better understand and assess the research questions, methods, data collection techniques, analyses, and results of a particular study (Guba & Lincoln, 1994; Poucher et al., 2020; Sparkes & Smith, 2013). This study was situated within a critical realist paradigm. We adopted a *critical realist* ontology, meaning that we believe there exists a universal, apprehendable truth that exists independent of the individual (Bhaskar, 2020; Fletcher, 2017; Price & Martin, 2018; Ryba et al., 2022). We also adopted a *modified dualist/objectivist* epistemological position, which attempts to limit or minimize the influence of the researcher on the knowledge produced in the study. Consistent with our philosophical positioning, we used the COM-B model to guide all aspects of this study, which was done in an attempt to situate participants' experiences within a behaviour change framework.

Participants and Sampling

We received ethical approval from three different sources prior to engaging in participant recruitment. Specifically, we received approvals from (a) our university ethics council, (b) the superintendent of the schoolboard, and (c) the principal of the participating high school. We used both passive (i.e., posters at the high school and local arena; and social media posts on Twitter, Facebook, and Instagram) and interactive (i.e., in-person and virtual presentations) methods of participant recruitment.

We used criterion purposeful sampling (Moser & Korstjens, 2018) to recruit athlete, coach, and teacher-coach participants from a rural high school in New Brunswick. As defined by

Camiré and colleagues (2016), a teacher-coach is a teacher who volunteers as the coach of a sports team affiliated with their school. For the high school athlete participants, they were required to be between 15 and 18 years and participate in a sport where concussions occur frequently (i.e., Pfister et al., 2016). Sports where concussions occur frequently were determined based off those listed in a systematic review and meta-analysis of the incidence of SRCs in youth sports (athletes ≤ 18 years of age) conducted by Pfister et al. (2016). Athletes had to have either sustained an SRC themselves or witnessed a teammate sustain an SRC in the context of high school sport participation. We decided to include athletes who witnessed a teammate or opponent suffer SRC, which we think provided us with a different perspective on SRC experience.

Additionally, if athletes experienced SRC, it was required that they were no longer symptomatic of a SRC. For the coach participants, they were required to be a coach or a teacher-coach of a high school sports team where SRCs occur frequently. They must have also had experience witnessing or interacting with athletes with SRCs. Sixteen individuals, including athletes (n = 10), coaches (n = 4) and teacher-coaches (n = 2), met the eligibility criteria described above and provided informed consent to participate in this study (see Appendix E for participant demographics). Participants were compensated 20$ for their involvement in this research.

In qualitative research, it is challenging to "quantify" the number of participants needed to provide rich insight into a given phenomenon (Dworkin, 2012; Hennink & Kaiser, 2022; Sim et al., 2018). It depends on the research question(s) and methods used to collect and analyze the data. In many qualitative studies researchers aim for data saturation to validate the number of participants used in their study (Braun & Clarke, 2021; Francis et al., 2010). Data saturation is when no new themes or ideas are collected from new participants pertaining to the research

question in a study, thus signifying that the researcher has collected sufficient data (Braun & Clarke, 2021; Francis et al., 2010).

Our sample size of 16 participants is consistent with similar studies that examined the lived experiences of participants post-concussion using semi-structured interviews for data collection (e.g., Francis et al., 2010; Kemp et al., 2022; Kita et al., 2020). Furthermore, in a systematic review of 23 qualitative studies from Hennink & Kaiser (2022), the authors noted that participant samples varied greatly—from one single participant to as many as 132 participants. Hennink and Kaiser (2022) determined that most of the studies in their review obtained sufficient data to address their research questions after collecting data with nine to 17 participants. Following interviews 12 and 13, we realized that we were beginning to obtain repetitive responses (i.e., automatic motivations regarding SRC reporting and management, physical and social opportunities regarding concussion education opportunities and team culture). As such, we feel confident that our sample size of 16 was sufficient to address the goals of this research.

Data Collection

All participants were emailed an information and consent form prior to engaging in data collection. At the beginning of each meeting, Erin Brennan (EB) reviewed the consent form with participants and provided them the opportunity to clarify any of the information in the document. To collect data, we used semi-structured interviews to allow participants the freedom to share stories of their concussion experiences using their own words (Moser & Korstjens, 2018). Interviewing allows researchers to gain a detailed understanding of participants' experiences, including by assessing non-verbal cues and emotional reactions, which provides another layer of depth to the data (Rinaldo & Guhin, 2022). Semi-structured interviews, in particular, have been

used in previous research that explored participants' lived experiences through the lens of behaviour theory (e.g., Chemtob, 2018; Lambe et al., 2020; Ojo et al., 2019).

We developed a semi-structured interview guide for this study (see Appendix F). The first section attempted to understand scenarios in which athletes and coaches observed unsafe behaviours or practices related to gameplay or concussion management. An example of a question in this section was "describe a time where you dealt with or witnessed another coach deal with an athlete who sustained a SRC". The questions in the second section were aligned with the COM-B model of the BCW (See Appendix C). Specifically, we asked participants about the degree to which they believed they had the capability, opportunity, and motivation to engage in safe behaviours relating to the situations described in the first part of the interview. An example of a question about motivation was "Describe why you think the athlete or coach made [decision] in the situation(s) described above." The third and final section afforded participants an opportunity to ask questions or add any other relevant information to the conversation.

All interviews occurred virtually, using the video conferencing platform Zoom, due to the physical distancing mandates associated with the COVID-19 pandemic. It is noteworthy that no sports were played at the participating high school between March 2020 and September 2021 because of the pandemic. As a result, most participants in this study reflected on concussion experiences that occurred prior to the pandemic.

Researchers

Within qualitative research, it is accepted that the researchers have a certain extent of knowledge (experiential, educational) on the topic. This knowledge influences all aspects of a study; the creation of the interview guide (See Appendix F), the way questions are asked and the researchers' interpretations of the data (Caelli et al., 2003). The lead researcher, EB is presently a

competitive athlete and was both a student-athlete and coach at the high school where participants were recruited from for this study. She has experienced SRCs and has acquired knowledge about concussions as an emerging scholar in this domain. EB's supervisor Dr. Jeff Caron (JC) is a former athlete who has sustained multiple SRCs and has a research program on SRCs. Our previous experiences have undoubtedly influenced all aspects of this project. We were aware of these biases and consistent with our philosophical positioning, we attempted to ensure that the knowledge produced in this study was representative of participants' experiences and consistent with the COM-B model.

Data Analysis

The interviews lasted, on average, 72 minutes and resulted in a total of 560 pages of transcription. We followed Hsieh & Shannon's (2005) guidelines for directed content analysis, a strategy that allowed us to use pre-determined codes (i.e., the COM-B model) to examine the interview data (Hsieh & Shannon, 2005; Kyngäs, 2020; Kyngäs & Kaakinen, 2020).

Step one involves becoming familiar with the data and writing down initial impressions (Hsieh & Shannon, 2005). An initial transcription of the interviews was automatically generated by Zoom. EB then transferred the text to Word files and reviewed the transcriptions while listening to the audio recordings to ensure consistency. Each participant was attributed a pseudonym to preserve their confidentiality. EB uploaded the Word files into NVivo 12 qualitative coding software. EB read each transcript several times to gain familiarity with the data and wrote field notes to record initial impressions.

Second, Hseih & Shannon (2005) note that researchers must choose and define the themes before commencing analysis. EB and JC selected the main themes from the COM-B model (Capability, Opportunity, and Motivation) for data analysis. Consistent with Michie et al.

(2011), the three main themes were then further divided into second level themes: Capability (physical and psychological), Opportunity (physical and social), and Motivation (automatic and reflective). See Appendix D for an overview of how these themes were divided.

Third, coding begins where researchers highlight and organize data relevant to their research question into the pre-selected themes (Hsieh & Shannon, 2005). For the coding process, EB began by highlighting sections of text that matched Michie and colleagues' (2014) definitions for Capability, Opportunity, and Motivation. Next, EB further coded data into a second level theme (Michie et al., 2011). For example, EB coded participants' comments about *knowing how to identify SRCs* under the second level theme Psychological Capability, as it encompasses an individual's knowledge, memory, and decision-making processes (Michie et al., 2014). Therefore, using this example, we interpreted that participants' memories of previously learned information about SRCs would have impacted their decision-making skills when attempting to identify a potential SRC.

Fourth, Hsieh and Shannon (2005) noted that relevant data that does not fit into the pre-determined themes could later be analyzed into new themes that support or contradict the framework guiding the analysis. After reflection, we believe that our relevant data fit within the COM-B model, so we did not create any new themes.

Fifth and finally, Hsieh and Shannon (2005) noted that researchers must review their data to ensure that all coded data has been correctly categorized. After reviewing the data, we (EB and JC) were in agreement that the data coded into each category matched the definitions and categorizations provided by Michie et al. (2011, 2014).

Rigor

Qualitative researchers are encouraged to demonstrate to the reader how their study is rigorous, trustworthy, or valid (Morse et al., 2002; Smith & McGannon, 2018). Ronkainen & Wiltshire (2021) noted that critical realist researchers should respond to three main questions to demonstrate rigor: (1) Is the research sufficiently empirical? 2) How credible is the research ontologically? and 3) What is the practicality of the research in the real world? (Ronkainen & Wiltshire, 2021).

First, we believe that we demonstrated that this study is sufficiently empirical by describing in detail the methods we used to gather and analyze data (Ronkainen & Wiltshire, 2021). We interviewed several high school athletes and coaches, who had experience with SRCs, to provide a more detailed understanding of these individuals' view on concussion-related behaviours in their sports. Second, we believe we demonstrated the ontological plausibility on this work, which, when situated within a critical realist paradigm, refers to our ability to merge theory and empirical data within this study. We used Michie and colleagues' (2014) definitions for each aspect of the COM-B model and attempted to situate participants' comments into the appropriate categories. Moreover, I (EB) took field notes before, during, and after interviews to help process participants' comments as well as reflect on how my past experiences were shaping my interpretations of the comments. JC acted as a critical friend to help ensure that the interpretations from this study were consistent with the COM-B model and reflected participants' experiences. Third, we believe that the results from this study could have practical applications for concussion education. Specifically, these results could be used to help researchers incorporate behaviour change components within concussion education initiatives delivered to high school sport participants. In sum, we hope that presenting our attempts to conduct a rigorous qualitative study can help readers make a judgement about the quality of the work that was undertaken.

Results

The three main themes, Capability (physical and psychological), Opportunity (physical and social), and Motivation (automatic and reflective), will be presented in this section. We present the results of this study using direct quotes from both the athlete and coach participants. Each participant is assigned a pseudonym to credit their quotes as well as protect their confidentiality (See Appendix E).

Physical Capability

Participants described situations that we interpreted as reflecting their physical capabilities to deal with SRC in high school sport in several ways. This included athletes' and coaches' previous SRC experiences which impacted their capabilities to manage SRC, and athletes' skills practiced in contact and collision sports (i.e., proper body checking techniques) which impacted their capability to reduce risk of injury. Michie and colleagues (2014) defined *physical capability* as an individual's physical capacity to engage in an action based on their acquired skills, strengths, and stamina obtained through practice. We interpreted participants' comments, such as an athlete's or coach's capability to manage a potential SRC (or lack thereof) to be consistent with the definition provided by Michie et al. (2014). In this subsection, we present data related to coaches' and athletes' capabilities to manage SRCs based on their lived experience.

Athletes and coaches in this study described situations regarding their lived experiences with SRCs which we felt greatly influenced their physical capabilities to manage SRC in high school sport. In line with Michie and colleagues' (2014) definition of physical capability, we inferred that athletes and coaches who had prior experiences dealing with SRCs could use the skills they acquired through those experiences to improve the management of their more recent

exposures to SRCs. For example, when asked if she felt she had the opportunity to report her SRC symptoms to her coach and parents, grade twelve basketball player Stella instead focused on telling us about how she felt more capable of managing her second and third SRCs based on her prior experience with this injury.

> *Stella:* When we finished that game, and we got in the car I handed my mom the cell phone. I said, "Okay, this is what I need [indicating that she would need to call her doctor for a SRC assessment], and I probably will need Monday off [from school]." After my second and third [concussion]…I knew. I had gone through it all. So, I was able to say after those ones what I needed.

We interpreted that Stella's past experiences with SRCs equipped her with the skills she needed to be physically capable of communicating her needs for proper SRC management, starting with telling her mom that she would need to get checked over by a doctor and would need to take time off from school. We found that athletes who had previously experienced a SRC described how they felt more confident managing their subsequent SRCs as compared to athletes with no prior SRC experience who described finding it more challenging to communicate and assert their needs to ensure proper management of their SRC.

Similar to the athletes' experiences, coaches recounted scenarios where they felt more capable of managing an athlete's SRC due to their previous experiences dealing with this injury. Experienced coaches dealing with SRCs indicated feeling more capable of delegating other coaching tasks to an assistant coach or team captain so they could take the time to properly manage sideline SRC assessments. For example, when we asked Ryan, a basketball coach with over 20 years of coaching experience, what some of the challenges might be for a newer coach

regarding SRC management, he explained how some coaches prioritize other coaching aspects and neglect the seriousness of sideline SRC assessments.

> *Ryan:* I take [SRC assessments] very seriously. I can delegate the coaching duties during a game to the assistant. I would prefer to think that I'm trained a little more [in SRC management] because I have more experience and there were other incidents that I [have dealt with].

Ryan described how his prior experiences dealing with concussed athletes made him feel as though he was trained more in proper SRC management. We felt that his described capabilities for delegating coaching tasks and performing proper sideline assessments reflected his physical capability to manage SRCs through skills and abilities he had gained from his previous SRC experiences. Athletes and coaches in this study who had lived experiences with SRCs reported feeling confident in their skills and abilities to properly manage subsequent SRC scenarios, whereas athletes and coaches with no prior SRC experience found it challenging to manage the SRC in their scenario. In sum, we felt that these examples reflected how lived experiences with SRCs positively impacted these athletes' and coaches' physical capabilities to manage SRCs properly.

Psychological Capability

Participants provided a number of responses that we interpreted as reflecting their psychological capabilities to deal with SRC in high school sport. This included athletes and coaches feeling confident in their capabilities to identify SRC based on prior SRC experiences, as well as athletes' capabilities to report SRC symptoms and coaches' and athletes' capabilities to manage SRC properly due to their knowledge of the severity of SRC. Additionally, we interpreted that athletes' and coaches' knowledge (or lack thereof) of their team's SRC reporting

and management protocols impacted their capability to properly report or manage SRCs. We felt that these responses were consistent with Michie and colleagues' (2014) definition of *psychological capability* (i.e., an individual's cognitive abilities and psychological skills, such as decision making, memory retention, reasoning, and comprehension). This section will feature quotes from athletes that we believe reflect their psychological capability to make informed decisions about symptom reporting, SRC management, and removal from play, based on their perceived knowledge of the severity of SRCs.

Many athletes described situations in which we felt their described lack of knowledge regarding the severity of SRCs impacted their psychological capability to properly manage a SRC. For example, when asked how she had managed her first SRC, grade twelve basketball athlete Stella indicated that she and her mother were not aware of the severity of SRCs nor the recommended management process she should have taken for recovery. As a result, they had to figure it out through trial and error.

> *Stella:* We were like "Okay, it's just a concussion, blow it off." … Really, this was the first [SRC] for all of us. So, we didn't know what the options were [for return to school and sport resources], what state I really was in, and we were just so lost in knowing what was going on, that we just kind of went with it. And I was pushed and suffered through.

Stella states that it was "just a concussion" and decided to "blow it off" and continue with her life like normal. She only later realized the severity of her injury and the importance of proper SRC management after experiencing prolonged SRC symptoms and failing exams due to attempting to return to school and sports too soon. We felt that Stella's apparent lack of knowledge on SRC severity and proper management protocols negatively influenced her decision-making skills regarding proper SRC management.

Similarly, we inferred that athletes' perceptions about the severity of their SRC symptoms impacted their psychological capability to disclose their SRC symptoms and remove themselves from play. Consistent with Michie and colleagues' (2014) definition of psychological capability, we felt that this was a clear reflection of the impact that athletes' knowledge of SRC severity had on their decision-making skills regarding SRC symptom disclosure and removal from play. Certain athletes described scenarios to us in which they believed they could keep playing despite experiencing symptoms of a possible SRC, stating that the impact didn't seem that severe, and they felt the symptoms would not affect their athletic performance. For instance, when asked if she knew she shouldn't have kept playing after a concussive impact in a hockey game, grade twelve athlete Michelle responded with:

> *Michelle*: I think I kind of figured… I was just like, "Nah, I'm just gonna pretend that it's fine." Because I do get headaches quite often. I don't know why—I just do. Like, as I said, I get migraines. So, I was like, "Well, I can endure it, so I might as well."

Michelle indicated that she suspected she might have sustained a SRC, however because she did not feel the injury was that serious, she decided to continue playing as though nothing was wrong. We interpreted that Michelle's disregard of the severity of this injury reflected her knowledge on SRC severity which negatively impacted her decision to hide her SRC symptoms and continue playing. Athletes in this study who described situations that we felt reflected a minimal understanding of the severity of SRCs decided to continue to play and conceal their symptoms, while athletes who felt they should not continue to play due to their understanding of the severity of the SRCs withdrew from competition and reported their symptoms. In closing, we found that athletes' knowledge of SRC severity (or lack thereof) impacted their psychological capabilities to report SRC symptoms, withdraw from play and properly manage SRCs.

Physical Opportunity

Participants described various factors that we felt affected the physical opportunities they had for dealing with their SRC experience in high school sport. This included insufficient concussion education training available for coaches and athletes which we felt negatively impacted their SRC identification and management behaviours, a lack of trained personnel (i.e., athletic trainers) present during games and practices for SRC identification and management on most teams, and lastly, teacher-coaches' opportunities to recognize delayed onset SRC symptoms in student-athletes in the classroom. We interpreted these experiences as being in line with Michie et al., (2014) definition of physical opportunity which is defined as the environmental and contextual resources available for an individual to perform a behaviour, such as time, location and resources (Michie et al., 2014). In this subsection, we highlight the insufficient concussion education training available (or not available) to coaches and athletes for improving SRC identification and management knowledge and behaviours, and the unique opportunity teacher-coaches indicated having for identifying delayed onset SRC symptoms in athletes at school.

First, coaches described how the mandatory training they received through the school for their sport provided them with an adequate opportunity to learn the basics of what constitutes a SRC, however they felt that the training was not in-depth enough to prepare them to deal with SRCs on their own and wished that there were opportunities to refresh their SRC training annually. We felt this reflected how these coaches' lack of access to sufficient contextual resources influenced their SRC identification and management behaviours. The majority of coaches indicated that the SRC training they received was only offered once with no opportunity to refresh their knowledge each year. In response to our question regarding the type of SRC

training he had received, basketball coach for over two decades, Ryan, described how he is aware that the literature on concussions has evolved since he first started coaching, and extensive research is being done to learn more about this injury. He believes that the SRC training they take as coaches through the school should reflect this advancement in knowledge, and coaches should be afforded the opportunity to update their training each year saying, "I think [we] should take it every year. Not just, you know, do it once and then you never see it for 10 years again." Additionally, many of the coaches stated that while they felt the online training program they took was sufficient for providing basic information regarding SRCs, many coaches indicated that SRC specific information was only a small portion of the mandatory coaching course. For example, when asked about the SRC training they receive as coaches, first year teacher-coach Megan expressed feeling inadequately informed on SRC management protocols despite taking the mandatory coaching course. She suggested that the course should have allocated more time to address SRCs and SRC management.

> *Megan:* We do have a little bit of training…But you know, it's a weekend clinic and it was not all concussion specific. That was like a 30-minute part of the entire weekend for the course I had to take. So, yeah. I definitely didn't feel like I was adequately prepared to know when to move … or not move [the athlete] after she hit the [ice hockey] boards.

We inferred that the lack of time and resources allocated to sufficient SRC training for Megan, was indicative of the lack of physical opportunity she had for receiving proper SRC identification and management training, thus influencing her SRC management behaviours in the scenario she described. In sum, although all of the coaches received mandatory basic SRC training through the high school, we felt that the described lack of time spent specifically on SRCs and lack of opportunity to refresh their knowledge annually was an evident gap in the

physical opportunity that coaches had for improving their SRC knowledge, negatively influencing their SRC identification and management behaviours.

Moreover, most athletes reported not receiving any formal SRC training or education through their sport. The few who did receive SRC information, indicated that it consisted of a few sentences printed on a one-page consent form for parents to sign allowing their child to participate in sport that season. Additionally, athletes who had received formal training on SRC's indicated that this opportunity for learning about SRCs was offered through other activities they were involved with outside of their sport. For example, when we asked grade ten rugby player Lucy what type of training she and her teammates received on SRCs, she stated "We don't really have like lessons on concussions. I've never had a lesson on concussions, other than first aid training [for cadets]." In sum, the athletes in this study described not having received sufficient formal SRC education or training through their sport which we felt negatively impacted their opportunities to improve their SRC knowledge and identification and management skills.

Lastly, teacher-coach participants reported a unique opportunity to observe athletes with a potential SRC in the classroom setting after a practice or game. This allowed them to detect delayed onset SRC signs and symptoms, as well as athletes attempting to conceal their symptoms, which we noted as being in line with Michie and colleagues' definitions of physical opportunity. For example, when we asked teacher-coach Logan what some of the advantages to being a teacher and coach affiliated with the high school might be when dealing with SRCs, he described how the calmer atmosphere in a classroom environment makes it easier to detect if a student-athlete is displaying signs and symptoms of a SRC.

> *Logan:* Certainly, like your classroom environment is-- it's a little easier [to identify athletes showing signs of SRCs] because it's just a quiet setting. You know what I mean?

> And when you do have a concussion, it is hard to focus and concentrate, and you are off and it's a little bit harder to hide.

Logan described how being able to observe his athletes in a quieter classroom environment positively impacted his opportunity to identify delayed onset SRC symptoms or SRC symptoms in athletes who decide to conceal their symptoms in sport. Overall, the need for better SRC training opportunities for all participants is evident, however, having teachers as coaches of high school sports teams provides a unique physical opportunity for identifying delayed onset of symptoms in athletes, or signs and symptoms of SRC in athletes trying to hide their injury.

Social Opportunity

Participants described various experiences dealing with SRCs that we felt reflected their social opportunity to deal with SRC in high school sport. Athletes and coaches reported a positive team and sport culture surrounding SRCs which we felt positively impacted their SRC management behaviours. One athlete described a scenario in which their teammates openly doubted the validity of another teammate's SRC, due to a prolonged recovery period, which negatively influenced that athlete's premature return to sport. And lastly, a couple of athletes described feeling pressure from their coaches to keep playing even after disclosing symptoms of a SRC which we felt impacted their opportunity to report and properly manage their SRCs. We felt that these scenarios were consistent with the definition of social opportunity provided by Michie and colleagues (i.e., opportunities afforded through social and cultural norms and conformity; 2011). In this sub-section we will highlight the supportive culture (or lack of support) that athletes felt from teammates and coaches regarding their SRC management and reporting behaviours.

The consensus from participants' responses was that there was generally a positive culture surrounding injuries on their teams, with athletes and coaches both expressing concern for the injured athlete's health and safety. We interpreted that most athletes, such as John, felt that they had sufficient support from coaches and teammates and that there was a positive culture around injuries which allowed them the opportunity to take the necessary time needed for their recovery. When we asked John how his teammates and coaches acted when he was out with a SRC, he elaborated on how supportive everyone was of him, especially his coach.

> *John:* Everybody was making sure I was all right. They were all saying "Take the necessary time that it's going to take for you to get better. We'd rather you be at 100% than like out [on the ice at] 50% and then receive another injury and be out for the rest of your life" … Having that good bond with my previous coach, it made a big difference, knowing that I wasn't rushed to go back in, it really, it helps. I can just, I can take my own time and pace it out.

We inferred from this response that John's described support from his teammates and coaches indicated a positive social culture and norms regarding SRC management behaviours on his team. Similarly, many of the athletes indicated that their teammates were always very supportive of them in their return to sport and wanted them to get better as soon as possible because they were concerned for their friend. Those athletes indicated how this made a positive difference for them regarding taking the necessary time off from sport for their SRC recovery. We interpreted from these responses that a positive team culture was reflective of sufficient social opportunity for athletes to engage in proper SRC management behaviours as opposed to rushing back into sport due to social pressures.

Unfortunately, other athletes such as Celine, described scenarios where their coach appeared to prioritize winning over the health and safety of their athlete, describing what we inferred to be a negative culture of pushing through injuries instead of properly managing them. When asked to describe her experience dealing with a SRC, basketball athlete Celine explained how despite displaying obvious signs and symptoms of a SRC, her coach said she wanted her back in the game. Celine then described a scenario that we interpreted as her feeling pressured to do as her coach said, thus influencing her social opportunity to properly manage her SRC. She stated, "my coach didn't really want me to go off. It was a championship game too. So, she really wanted me out there I guess." When asked to elaborate on that point, Celine remarks that she had disclosed her feeling of dizziness to her coach while simultaneously wiping away blood from her nose, but ultimately her coach wanted her to push through the injury.

> *Celine:* As soon as [my coach] wiped [the blood] up, she was like, "alright, go get back out there." And I was like, "Are you sure?" She's like, "do you feel Okay?" And I'm like, "well I'm a little dizzy." So she was like, "there's really not much time left, you can do it." So, she just sort of sent me out there.

We interpreted from Celine's described experience of dealing with a SRC, that the social opportunity for her to properly manage her SRC was negatively impacted by the apparent pressure from her coach to play through her SRC symptoms in order to win. Overall, within social opportunity, we found that teams with a positive social culture of SRC management behaviours appeared to improve athletes' social opportunities to properly manage SRCs, whereas what we interpreted to be a negative "push through the injury" culture, fostered by coaches, appeared to have a negative impact on athletes' social opportunities to properly manage SRCs.

Automatic Motivation

Participants described several scenarios regarding dealing with SRCs in high school sport, that we felt reflected their automatic motivations for engaging in SRC reporting, removal from play, and SRC management behaviours. Michie and colleagues (2011) define automatic motivation as emotional reactions and impulses, emotions, habits, and reinforcements such as rewards, incentives, and punishment. Specifically, athletes described scenarios where they chose not to report their SRC symptoms to avoid missing playing time, they didn't think it was serious enough to be a SRC, they wanted to support their teammates, and because their team was finally winning. Additionally, coaches described scenarios where they felt uncertain on whether to remove an athlete from play due to athletes and parents declaring that the athlete was fine, and them wanting to hope that the athlete was not seriously injured. We felt that these experiences described by participants reflected athletes' automatic motivations to report SRCs, and coaches' and athletes' motivations to properly manage SRC. In this subsection we will highlight scenarios described by athletes where their motivation to conceal SRC symptoms was influenced by their desire to not miss out on playing time and to help their team win. Additionally, we will focus on coaches' motivations for allowing concussed athletes to continue playing due to the athlete not accurately reporting their SRC symptoms.

We understood from participants' responses that athletes who did not report their SRC symptoms or did not remove themselves from play despite sustaining a potential SRC were often motivated by their desire to avoid missing playing time and the desire to help their team win. Consistent with the definition of automatic motivation (Michie et al., 2011), we felt that these scenarios reflected these athletes' incentives and emotional responses in relation to SRC symptom reporting and removal from play behaviours. For example, when we asked grade

twelve hockey player John why he chose to continue playing, despite experiencing a concussive impact in a hockey tournament, he stated:

> *John:* Even if there was anything wrong, I completely ignored it because it was the first game of an entire tournament, and we were doing good. We were winning for the first time, the whole year, so I was getting excited.

We felt that John's emotional reaction to being a part of a game where their team was finally winning after a long losing streak and his excitement at being part of this game undoubtedly influenced his decision to not report his SRC symptoms to his coach or remove himself from play. Additionally, we interpreted that not only was there incentive and reward associated with winning the game, but with this being the first game in an entire weekend tournament away from home, it reflected John's incentive to conceal his SRC symptoms so that he would not have to sit and watch for the remainder of the tournament.

Some coaches described scenarios that we felt reflected their automatic motivations for not removing an athlete from play following a potentially concussive impact. Many indicated that the athlete repeatedly told them they felt fine, and that during a sideline assessment the athlete answered all of their questions correctly. For example, when we asked volleyball coach Scarlett why she had decided to let an athlete continue playing after sustaining a concussive hit in practice, she responded by saying that the athlete insisted that they felt fine and weren't displaying any obvious signs of SRC in the moment.

> *Scarlett:* We asked him "How are you feeling? Are you okay?" And he said "yes." And we asked him if he was okay to continue [practicing] and he seemed okay to continue, so he kind of, you know, he took a few seconds [to rest] and then he came back to the court and continued.

Scarlett described how in the moment she felt that the athlete was telling the truth and he was not displaying any obvious signs of SRC, as such she decided to allow the athlete to continue practicing. We felt that Scarlett's described experience reflected how her impulsivity to assume that the athlete was fine without performing an extensive sideline assessment and her emotional reaction of simply trusting that the athlete was accurately disclosing his health status, were indicative of her automatic motivation for choosing to not remove a concussed athlete from play.

Lastly, one of the athletes described a scenario where their coaches allowed a teammate with a SRC to continue playing due to the athlete not accurately reporting their health status and the athlete's unaltered athletic performance which helped their team win. Grade eleven hockey player Ross, recounted a scenario where one of his teammates had sustained a SRC, and when we asked about how it was managed by their coaches, he responded with:

> *Ross:* Our coaches tried to talk him out [of playing] and said like, "you can sit on the bench but I'm not going to play you." And then [my teammate] kept saying "no, I have to play, I have to play." And stuff like that. So, they sent him out for probably 15 seconds, and he actually generated a couple [of] opportunities in that span of 15 seconds. So, the [coaches were] like, "he's playing good, let's just keep them rolling." [meaning they would put the players out on the ice in the same order as usual].

We interpreted from Ross's description of how his coaches managed the SRC of his teammate, that their emotional responses to his teammate's insistence on playing, coupled with the reward of winning, were influential in the coaches' decision to let him continue playing. Because the athlete was playing well and was repeatedly insisting that he needed to play, we felt that this impacted their automatic motivation to let this athlete play for the remainder of the game instead of removing and assessing for a SRC. In conclusion, athletes' automatic motivations regarding

concealing SRC symptoms appeared to be affected by incentives and rewards related to winning, incentives to not miss playing time and emotional responses such as excitement about winning. Additionally, coaches' automatic motivations for not removing an athlete from play were affected by impulsivity in assuming a player was fine without assessing for SRC, emotional reactions (i.e., trusting the athlete's inaccurate symptom disclosure), and lastly, incentives and rewards related to winning.

Reflective Motivation

Participants described various scenarios that we felt demonstrated the factors impacting the reflective motivations athletes had for reporting SRC symptoms, athletes returning to sport pre-maturely, and athletes' and coaches' motivations for not removing an athlete from play. Athletes described situations that we felt were influential towards their motivation to report or conceal SRC symptoms and their motivation for returning to sport pre-maturely during recovery (i.e., they wanted to win, they felt indispensable to the team, it was their grade twelve year, they wanted to prove their leadership, they did not want to be isolated during recovery and they did not want to miss too much time in school). Additionally, coaches stated that they addressed team SRC management and reporting protocols with athletes and parents early in the season to negate potential disputes regarding their SRC management decisions, and one teacher coach indicated how her role as a teacher influenced her desire to learn more about SRC. Lastly athletes and coaches described how if they could change the way they had managed the SRC in question, they would have erred on the side of caution regarding SRC management. We interpreted that all of these scenarios were consistent with Michie and colleagues' (2011) definition of reflective motivation (i.e., an individual's beliefs about capabilities and consequences, roles, identity, intentions, goals, optimism, plans and evaluations). In this section we highlight reflective

motivational factors regarding athletes returning to sport pre-maturely in order to help their team win and not miss playing time, and athletes' motivations for concealing SRC symptoms due to their beliefs about the recovery process for SRC. Lastly, we highlight athletes' motivations for returning to sport pre-maturely due to misconception regarding SRC severity.

Athletes stated that one of their main motivations for returning to sport pre-maturely would be to not miss out on playing time or to help their team win. When asked what might motivate him to return to sport before being fully recovered from a SRC, grade eleven volleyball player Dean stated that he would return pre-maturely if his team required a complete roster to play, or if he was uniquely skilled in a specific role that would help his team win.

> *Dean:* Maybe if, like your team doesn't have enough people to play, so you have to play to keep the team like afloat. Or if you're uniquely good at something like that no one else can do, and then you have to play to like make the team win.

We felt that this response reflected Dean's belief about consequences associated with him not playing and his role on the team, which he described feeling would impact his team's chances at winning. We interpreted from his response that these beliefs would influence his reflective motivation for returning to sport pre-maturely following a SRC.

Particularly interesting was athletes' perceptions of what the recovery period looked like for their teammates which they stated would negatively influence their motivation to report a SRC to their coach. Many of the athletes stated that because of what they heard regarding how isolating their teammates found their recoveries to be from a SRC, they would be hesitant to report a potential SRC to their coaches or parents for fear of being socially isolated and missing so much playing time. When we asked grade twelve hockey player Adam what some of the

reasons might be for why he might choose not to report SRC symptoms to his coach he indicated how he would be reluctant to be so isolated during recovery.

> *Adam:* And I know that like you're supposed to [not have] electronics and [you're sensitive to] light. So, like, you sit in a dark room and basically do nothing. It sounded really bad. Like something that I didn't want to do.

Adam proceeded to say how he would not want to miss so much playing time or end up being cut off socially from his friends while being forced to sit in a dark room for recovery. Although current SRC recovery recommendations do not require athletes to be alone in the dark, we interpreted that Adam's belief about the consequences of reporting a SRC resulting in an isolating recovery period would impact his decision to conceal his SRC symptoms.

Some athletes stated how if they had known more about the severity of SRCs they would have been more motivated to take the necessary time for their recovery. For example, grade twelve basketball and rugby player Alicia, who has suffered from three SRCs and two concussions not affiliated with sport, responded to our question regarding what she wished she had done differently when dealing with her SRC experiences. She stated that she wished she had known more about what would happen to her if she didn't manage her SRC properly.

> *Alicia:* I feel like if I would have known like, more of like the long term effects and, like the side effects of going back to a sport so soon, I feel like I would have stayed away from that just so I wouldn't have ended up at the point where I can't play sports anymore, and [I'm] like in fear of hitting my head so… [trails off and looks away sadly].

Alicia explains how, had she known about the consequences she would end up suffering from because of returning to play prematurely (i.e., protracted SRC symptoms and doctors advising her to stay away from contact and collision sports based on her extensive history with

concussions) she would have taken the necessary time for proper SRC recovery. She felt that having more knowledge on the severity and long-term effects that could result from SRC would have motivated her to take the necessary time off from sport for proper SRC recovery. We felt that this displayed how her beliefs about consequences would have impacted her reflective motivation to take the necessary time off from sport for proper SRC recovery. In brief, within reflective motivation we found that athletes' reflective motivations for returning to sport prematurely were influenced by their beliefs about consequences (i.e., the team losing or forfeiting without them) and their belief about their role on the team (i.e., uniquely talented at a certain position) and athletes' reflective motivations for taking necessary recovery time were also influenced by their beliefs about consequences (i.e., knowing the severity and long-term effects associated with SRC).

Discussion

We interviewed sixteen participants (10 athletes and 6 coaches) to better understand their experiences with concussion-related behaviour in high school sports. Our results show how we perceived athletes' and coaches' experiences with SRC-related behaviours (i.e., management, reporting, identification) to be influenced by various factors associated with the themes of the COM-B model. This section will discuss how these themes relate to literature on SRC.

Consistent with previous research, our findings within the theme of capability (physical and psychological) indicate that the athletes and coaches in this study with knowledge or lived experiences with SRCs described feeling confident in their capabilities to properly manage subsequent SRCs (Kim et al., 2022; Weber Rawlins et al., 2021) and SRC reporting behaviours (Chinn & Porter, 2016; O'Connor et al., 2020). For example, Chinn and Porter (2016) found that athletes with prior SRC experiences had an increased likelihood of 63% corelated with intent to

report future SRCs. Additionally, a study from Kim and colleagues (2022) found that coaches with knowledge of SRCs reported feeling more likely to engage in preventative SRC management behaviours. Our findings add to the literature by demonstrating how knowledge and lived experiences seemed to positively affect participants' perceived capabilities to manage SRCs. Future research may consider targeting athletes' and coaches' capability (physical and psychological) within behaviour change interventions to improve SRC management and reporting behaviours. Researchers could integrate vicarious learning opportunities into current concussion education initiatives, such as case studies or narrative accounts that depict athlete or coach experiences with SRC.

Despite the availability of free, reliable, online concussion education resources to Canadian athletes and coaches (e.g., Sport Information Resource Center website, the Concussion Awareness Training Tool), most participants in this study said they did not have the physical opportunity to learn about proper identification and management of SRCs. In a systematic review conducted by Mallory and colleagues (2019), researchers found that only 32 out of 456 identified online concussion resources were suitable for Canadian high school students, based on the current CISG recommendations. Further, researchers found that although there are several free online SRC training resources available for athletes and coaches, the quality and accuracy of many online resources is unknown (Mallory et al., 2022; Robins et al., 2023). Our results suggest there is a need to increase awareness and accessibility of reliable online SRC resources, which could help ensure that high school sport participants feel they have the physical opportunity to acquire knowledge of SRCs. There is a need to make concussion education resources more accessible to athletes and coaches to improve their SRC-related behaviours (i.e., identification,

management), since healthcare providers are not always readily accessible for high school sports teams—particularly in rural settings.

Athletes with a positive team culture of injuries (e.g., teammates and coaches expressing concern and understanding regarding SRC reporting and the athlete's SRC management process) appeared to demonstrate more social opportunities to report or properly manage SRCs. Researchers have previously explored team culture of SRCs in relation to reporting and management (i.e., Brown et al., 2019; Wallace, Covassin, & Beidler, 2017). Brown and colleagues (2019) found that positive team cultures were associated with increased intent to report SRC (Brown et al., 2019), whereas negative team cultures led some male athletes to feel hesitant about reporting SRC due to others' perceptions of them (Wallace, Covassin, & Beidler, 2017). Brown and colleagues (2019) suggested that researchers should implement interventions where coaches are taught communication skills regarding SRC management with an emphasis on player safety could be an appropriate solution for improving positive team culture. Based on our results, we concur with the suggestion from Brown and colleagues' (2019), and we would add that the BCW could be a useful framework to improve the social opportunities and improve team culture with respect to SRCs. Specifically, the *intervention functions* and *policy category* rings of the BCW in line with our findings on social opportunities could be used to target improving high school team cultures to positively impact athlete's SRC reporting and management behaviours.

We interpreted from participants' responses that their beliefs about consequences (i.e., their team losing or forfeiting without them, having an isolating recovery period) influenced athletes' reflective motivations for concealing SRC symptoms or for properly managing SRCs in the future. Additionally, incentives (i.e., winning), emotional reactions (i.e., not wanting to miss playing time) and impulsivity (i.e., coach assuming athlete was fine) influenced athletes'

automatic motivations for improper SRC management, or concealing SRC symptoms. Kroshus and colleagues' (2014) conducted a study on hockey players' intention to report SRC using TPB and found that athletes' SRC reporting intentions were impacted by their concussion knowledge, perceived social norms, perceived outcomes, and self-efficacy. Register-Mihalik and colleagues (2013) have also previously used the TPB to guide a survey focused on better understanding athletes' motivations regarding SRC underreporting. The authors found that athletes' intentions to report did not necessarily lead to improved reporting behaviours, and that positive attitudes about reporting were most impactful influence on athletes' intentions to report SRC symptoms (Register-Mihalik, Linnan, et al., 2013). Our findings support previous research and underscore the importance of considering not only their reflective motivations (i.e., intentions and planning), but their automatic motivations (i.e., emotions and impulses) that influence their SRC-related behaviours. The results from this study suggest that the BCW is a framework that can be used to better understand athlete and coach motivations regarding SRC-related behaviours, which could also be targeted in behaviour change interventions. By identifying and better understanding some of the motivational factors that influenced the SRC-related behaviours of athletes and coaches in this study, these findings could be used in collaboration with the outer two rings of the BCW to help future researchers effectively target athletes' problematic SRC reporting and management behaviours in future behaviour change interventions.

Participants described various scenarios that we interpreted through the lens of the COM-B model of the BCW (Michie et al., 2011). Few studies have used theories to examine SRCs, and those that have primarily used TPB to study athletes' intentions to report SRCs (Kroshus et al., 2014, 2015; Register-Mihalik et al., 2013). For example, using TPB, Kroshus and colleagues (2014) found that increased SRC knowledge, perceived social norms, perceived outcomes, and

self-efficacy of SRC reporting are all important factors to consider when analyzing SRC under-reporting (Kroshus et al., 2014). If examined through the lens of the COM-B model, we believe these factors would fall into psychological capability, social opportunity, reflective motivation, and physical capability respectively. By using the COM-B model as the theoretical framework guiding our study, we were able to gain a broader understanding of the subsidiary levels of capability (physical, psychological), opportunity (physical, social) and motivation (automatic, reflective) that athletes and coaches had regarding several SRC-related behaviours. Thus, the COM-B model and the BCW could help future researchers determine which behaviours to target in their interventions.

Coaches in this study described having insufficient physical opportunities to improve their SRC knowledge and management skills, and those with prior SRC experiences felt more capable of dealing with SRCs. Researchers have typically examined coaches' experiences with SRCs quantitatively using questionnaires (e.g., Abel et al., 2022; Black et al., 2020; Kim et al., 2022; Kroshus et al., 2023). For example, Black et al., (2020) conducted a study to assess the correlation between concussion education and concussion knowledge, beliefs, and behaviours among youth hockey coaches and parents. They distributed questionnaires to 796 participants, and found there was not a significant difference in beliefs or intended behaviours related to concussion management, and as such they recommended that future researchers target motivational factors using behaviour change theory (Black et al., 2020). In this study, using semi-structured interviews, we were able to gain a more in-depth perspective of coaches' perceptions of how they have dealt with SRCs in the past, which could be used to better inform future SRC education initiatives.

Another notable aspect of this study was that the sample of athletes and coaches in this study were from a rural high school, and they indicated a lack of physical opportunities for proper SRC identification and management behaviours. Only one study to our knowledge has examined health care considerations for athletes with concussions in rural areas (Yue et al., 2020). The authors noted that athletes from rural areas need to travel longer distances to seek medical attention, schools in these areas typically have a lower socioeconomic status than urban schools, and there are decreased availabilities of healthcare providers qualified to conduct neuroimaging tests (Yue et al., 2020). Our results complement the findings of Yue and colleagues (2020), as our sample of athletes and coaches also reported a lack of physical opportunity (access to healthcare providers and reliable SRC training resources) and ability to acquire knowledge (i.e., identifying, assessing, and managing SRC). This suggests a need to improve knowledge translation to athletes and coaches at rural Canadian high schools, as they may experience additional barriers to engaging in safe SRC-behaviours than those living in urban areas.

Strengths and Limitations

One strength of this study is that it is the first to our knowledge to use the COM-B model within SRC research. A second strength is that we collected data from a sample of athletes, coaches, and teacher-coaches, which provided us with multiple perspectives in the high school sport context. A third and final strength is that the results from this study could be useful in informing behaviour change interventions using the BCW framework.

One significant limitation of this project was that participants reflected on SRC experiences that occurred several years ago because data collection occurred amid the Covid-19 pandemic. A second limitation is that we only conducted one interview with each participant.

Qualitative researchers have highlighted the benefits of using multiple interviews with participants as a way to gather richer information about their lived experiences (Sparkes & Smith, 2013). Upon reflection, we agree that conducting a follow-up interview with participants could have been useful for gaining a deeper understanding of their experiences. Finally, some researchers have noted distinct differences in SRC-related behaviours between male and female participants (Malcolm et al., 2023; Wallace et al., 2017). Wallace and colleagues (2017) found that females in their study scored higher on SRC knowledge assessments, and males in their study were more hesitant to report SRCs due to perceptions of others. Additionally, researchers have found that there is a toxic masculinity culture often associated with SRC underreporting in male sports (Malcolm et al., 2023). We could have potentially gained a more detailed understanding of participants' experiences by exploring sex differences.

Chapter 3

Conclusion

Guided by the COM-B model (Michie et al., 2011), we explored athlete (n = 10) and coach (n = 6) experiences with SRC in high school sport, in an attempt to better understand their experiences with SRC related behaviours. One of the main findings from this study suggests that athletes' and coaches' prior experiences with SRCs positively influenced their *capabilities* to manage and identify subsequent SRCs. The results from this study supported previous literature (Brown et al., 2019; Kim et al., 2022) by showing that a positive team culture can enhance athletes' *opportunities* for engaging in favourable SRC reporting and management behaviours. Specifically, the results demonstrate that a positive team culture can create favorable opportunities for SRC reporting and management behaviors among athletes. The results from this study supported and contributed to the literature on *motivational* factors affecting athletes' SRC behaviours (Beran & Scafide, 2022; Kroshus & Chrisman, 2019). We found that participants' automatic motivations for concealing SRC symptoms, and coaches' motivations for allowing an athlete to continue playing following a SRC, appeared to be affected by their emotional reactions, impulsivity, and incentives. Lastly, adding to the literature regarding SRC reporting intentions (Kroshus et al., 2014), athletes' reflective motivations (intentions and planning) regarding pre-mature return to sport and concealing SRC symptoms were linked to their pre-conceived beliefs about consequences associated with that behaviour.

Understanding high school sport participants' SRC-related experiences is only the first step in making sport safer. Based on our findings, we suggest a few possible directions for future research. First, researchers could use the current results to inform behaviour change interventions to change high school athletes' and coaches' problematic SRC-related behaviours. For example,

using the BCW framework, researchers could target high school coaches' impulsivity, emotional reactions, and incentives and rewards to influence their automatic motivations for not removing an athlete suspected of SRC from play. Second, athletes and coaches in this study with lived experience with SRCs mentioned they felt more capable to properly manage subsequent SRCs. As such, researchers could consider integrating vicarious learning opportunities (e.g., video analysis of concussions, role-playing exercises, or case studies) within their educational interventions. These opportunities could help athletes and coaches practice identifying and managing SRCs, leading to improved knowledge and capability. Our hope is that some of these suggestions could be used in future interventions to modify problematic SRC-related behaviors in high school sports and help contribute to a safer sport environment.

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Appendix A

Table 1

Six-Step Graduated Return to Sport (RTS) strategy

Step	Aim	Goal
1	Symptom-limited activity	Gradual re-introduction of work/school activities
2	Aerobic exercise light, then moderate.	Increase heart rate
3	Individual sport-specific exercise	Add movement, change of direction
4	Non-contact training drills	Resume usual intensity of exercise, coordination, and increased thinking
5	Full contact practice	Restore confidence and assess functional skills by coaching staff
6	Return to sport	

Note. Adapted from Patricios et al. (2023) Amsterdam Consensus Statement

Appendix B

Table 2

Definitions used for classifying SRC-related behaviours

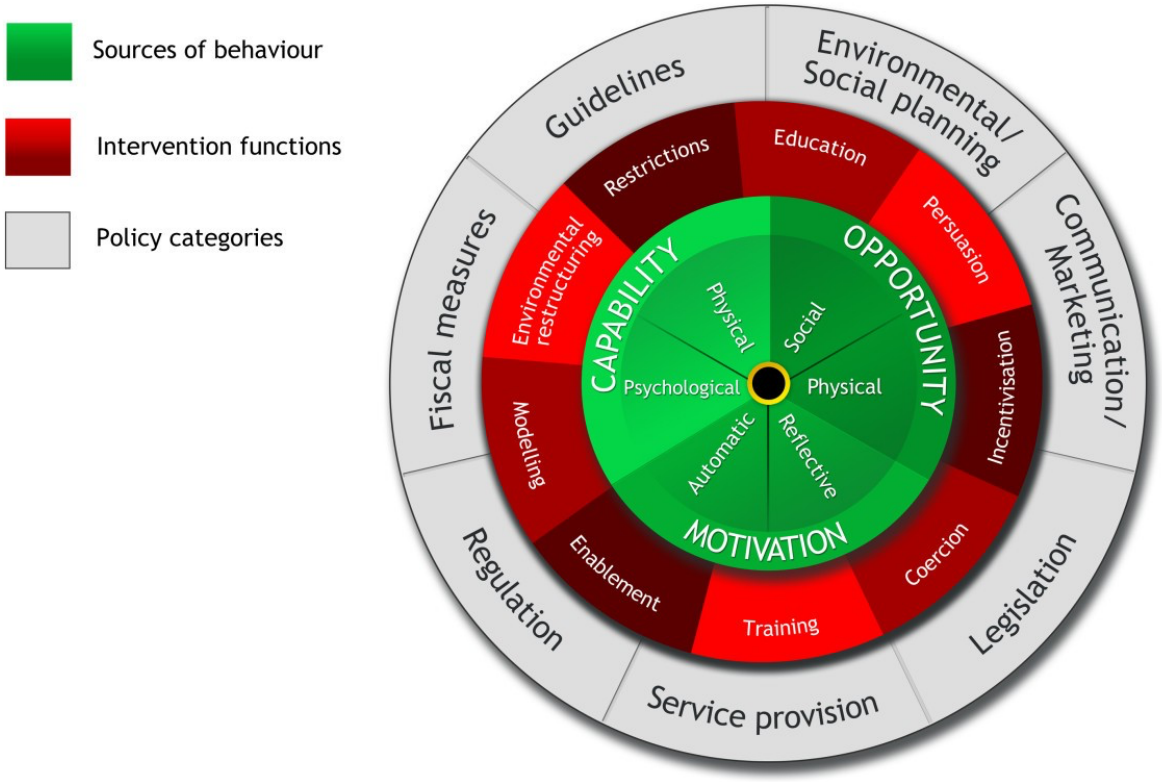
SRC-related behaviours	Definition
Reporting SRC Symptoms	The action of an athlete telling a teacher, coach, parent, or healthcare provider about the symptoms they are experiencing following a concussive impact *(Beran & Scafide, 2022; Brown et al., 2019; Kroshus et al., 2014; Register-Mihalik et al., 2013).*
Identifying the SRC	The action of recognizing and naming which signs and symptoms are indicative of a SRC and being able to recognize and name these signs and symptoms when faced with a practice or game situation *(Beran & Scafide, 2022; Black et al., 2020).*
Assessing/Managing the SRC	The action of removing an athlete from play (athlete or coach), performing a sideline assessment (coach), and seeking medical assessment (athlete) *(Asken et al., 2018; Davis et al., 2017; Echemendia et al., 2017; Frémont et al., 2022; Kim et al., 2022; Pratile et al., 2022).*
Returning to Sport	The action of following RTS guidelines (athlete) and adapting training for athletes returning to sport (coach) *(Patricios et al., 2023).*

Note. The development of this table was informed by the Sport Information Resource Centre of Canada's *4 R's: Steps to a Safe Recovery* https://sirc.ca/concussion/the-4-rs-steps-to-a-safe-recovery/

Appendix C

Figure 1

The Behaviour Change Wheel.



Appendix D

Table 3

Definitions used for directed content analysis using the COM-B model (Michie et al., 2014)

1st Level Themes & Description	2nd Level Themes & Description
Capability "An individual's physical and psychological abilities to engage in a behaviour"	**Physical Capability** "Skills, abilities or proficiencies acquired through practice"
	Psychological Capability "Knowledge, memory, attention, decision processes, behavioural regulation"
Opportunity "Factors that lie outside the individual that make the behaviour possible"	**Physical Opportunity** "Environmental and contextual resources"
	Social Opportunity "Social influences such as social pressures, norms, conformity and social comparisons"
Motivation "The brain processes that energize and direct behaviour"	**Automatic Motivation** "Emotions, reinforcement such as rewards, incentives, punishment. Emotional reactions, impulses"
	Reflective Motivation "Beliefs about capabilities and consequences, roles, identity, intentions, goals, optimism, plans and evaluations"

Appendix E
Participant Demographics

Table 4

Participant demographics

Pseudonym	Athlete, Coach, or Teacher-Coach	Sex	Age	Sport	SRC experience (MD, S, W)
Stella	Athlete	F	18	Basketball	MD, S
Alicia	Athlete	F	18	Basketball, Rugby	MD
Adam	Athlete	M	18	Ice Hockey	S, W
Ross	Athlete	M	16	Ice Hockey	W
Charlotte	Athlete	F	16	Ice Hockey	MD
Michelle	Athlete	F	18	Ice Hockey	MD, W
Lucy	Athlete	F	17	Rugby	S
Dean	Athlete	M	17	Volleyball	W
Celine	Athlete	F	18	Basketball	MD, S
John	Athlete	M	17	Ice Hockey	MD, S
Scarlett	Coach	F	49	Volleyball	MD
Joe	Coach	M	48	Rugby	MD, S
Anthony	Coach	M	42	Basketball	MD, S
Ryan	Coach	M	52	Basketball	MD, S
Megan	Teacher - Coach	F	26	Ice Hockey	MD, S
Logan	Teacher - Coach	M	37	Ice Hockey	MD, S

Note. MD = Medically Diagnosed, S = Suspected, W = Witness

Appendix F
Interview Guide

Introduction & Pre-Interview routine:
Introduce study & build rapport
Review Consent Form

Main Interview Questions:

- Tell me about your experience with sport-related concussions. (Describe a time when you sustained or witnessed another athlete sustain an SRC; Describe a time where you dealt with or witnessed another coach deal with an athlete with an SRC or suspected SRC)
- Describe some situations when you [or an athlete or coach that you know] did not properly manage a possible concussion, or care for a concussed individual.

Next Questions relate to the situation(s) described above:

- *Motivation – (the brain processes that energize and direct behaviour; Michie et al., 2011)*
  - Describe why you think the athlete or coach made those decisions in the situation(s) described above.
  - What needs to be done in order to modify that behaviour in the future?

- *Capability – (an individual's psychological and physical capability to engage in the behaviour; Michie et al., 2011)*
  - Do you [or members of your team/league/sport] believe that you have the capability to properly manage and care for concussed athletes?
  - Describe what needs to be done to ensure that you [or members of your team/league/sport] have the necessary skills to manage and care for concussed athletes.

- *Opportunity – (Factors that lie outside the individual that make the behaviour possible; Michie et al., 2011)*
  - How would you describe the culture around concussions on this team/league/sport?
  - Which changes or what type of support would need to be in place to better manage the situations(s) described above in the future?

Summary Questions:

- Would you like to add any other information to our conversation?
- Do you have any other comments or questions for me? (Pertaining to this study, what we plan to do with this data… etc.)