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The Influence of Individual Factors and Specific Concussion Symptoms on College Athletes' Intentions to Report a Sport-Related Concussion

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A Thesis

THE INFLUENCE OF INDIVIDUAL FACTORS AND SPECIFIC CONCUSSION SYMPTOMS ON COLLEGE ATHLETES' INTENTIONS TO REPORT A SPORT-RELATED CONCUSSION

By

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ABSTRACT OF THESIS

THE INFLUENCE OF INDIVIDUAL FACTORS AND SPECIFIC CONCUSSION SYMPTOMS ON COLLEGE ATHLETES' INTENTIONS TO REPORT A SPORT-RELATED CONCUSSION

Background: The underreporting of sport-related concussion (SRC) is a barrier to connecting college athletes to medical and rehabilitation services needed for managing deficits associated with SRCs. Although the task of reporting a SRC symptom to a coach or an athletic trainer may appear simple, the factors associated with an athlete's willingness to report an injury are not fully understood. Most of the research on college athlete's reporting behaviors has focused on the impact of individual factors, such as an athlete's sex, sport contact level, previous history of concussion, and knowledge of signs and symptoms of SRCs. However, information about the influence of post-concussion cognitive-communication impairments on concussion reporting is limited, even though many individuals who have had a SRC experience changes in their cognitive-communication functions. Knowledge about athletes' concerns for changes to their cognitive-communication abilities is needed to better understand the reason for their choosing to report or conceal their SRC symptoms.

Purpose: The purpose of the study was to (1) replicate previous research examining the influence of individual factors on SRC reporting intentions and (2) expand on the current body of

research by examining the influence of perceived changes to cognitive-communication functions on college athletes' willingness to report a SRC symptom to a coach or athletic trainer.

Methods and Procedures: A 48-item questionnaire was developed and administered to 193 collegiate athletes. The questionnaire collected demographic information as well as information about the athletes' intentions to report a SRC in a variety of situations.

Results: The findings indicated that collegiate athletes' SRC reporting intentions did not change as a factor of their sex, year in college, the level of contact associated with their sport, or the number of previously diagnosed concussions they had. Furthermore, the study identified eight SRC symptoms that were most likely to be reported by college athletes and two SRC symptoms that were least likely to be reported.

Conclusion: The results from this study demonstrated that collegiate athletes would be more likely to report a future SRC if they were to experience changes to physical symptoms that are commonly taught in SRC education initiatives. The results also indicated that college athletes may be less concerned about cognitive-communication deficits that could impact their ability to function in school or at work. The findings support the need to include more information about the impact of SRC on cognitive-communication functions in concussion education initiatives.

KEYWORDS: Sport-Related Concussion, Concussion Prevention, Concussion Reporting, Concussion Symptom, Cognitive-Communication Impairment

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This thesis is dedicated to my family for their endless support and encouragement

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter One

Introduction

Over the past two decades, there has been an increase in public interest surrounding sport-related concussions (SRCs) as awareness and knowledge about the deleterious effects of these injuries have grown. SRCs are a subset of mild traumatic brain injuries (mTBI) that occur when a direct or indirect blow to an athlete's body or head results in complex neuropathological changes (McCrory et al., 2017). Following a concussion, athletes often experience short- and long-term effects including physical, emotional, and cognitive symptoms (Roth & Hardin, 2019). Due to the presence of multifactorial symptoms and their potential long-term consequences, the literature emphasizes the importance of a multidisciplinary approach to better identify, treat, and manage athletes with SRCs (Ketcham et al., 2017; Knollman-Porter et al. 2014; Mashima et al., 2021; Salvatore & Fjordbak, 2011). The unique perspectives provided by diverse medical professionals optimize recovery outcomes and abide by current best practice recommendations (Mashima et al., 2021).

Speech-language pathologists (SLPs) are one group of rehabilitation professionals who can provide valuable services in concussion management teams. Research in the field has outlined numerous benefits of incorporating SLPs into the multidisciplinary concussion management team. These benefits include: (a) reducing the impact of the potential sequalae of cognitive-communication deficits, (b) administering sensitive diagnostic tools, (c) assisting athletes in their return to the classroom, and (d) supporting other members of the concussion management team (Anjum et al., 2022; Brown & Knollman-Porter, 2020; Brown et al., 2019; Chessnut, 2021; Ketcham et al., 2017; Knollman-Porter et al., 2014; Lundine et al., 2019; Mashima et al., 2021; Salvatore & Fjordbak, 2011).

Statement of the Problem

Research estimates that between 1.6 to 3.8 million SRCs occur in the United States annually (Langlois et al., 2006). However, these figures underestimate the true occurrence, as nearly 50% of all SRCs go unreported (Harmon et al., 2013; Llewellyn et al., 2014; Milroy et al., 2019; Register-Mihalik, Guskiewicz et al., 2013). The underreporting of SRC is a substantial barrier to effectively managing athletes with SRCs. Low SRC reporting rates reduce athletes' access to necessary medical management including speech-language pathology services. Additionally, athletes who fail to seek necessary medical attention may continue to participate in sports thereby increasing their risk for further head injury, including second impact syndrome (Boden et al., 2007; Cantu, 1998).

Although the task of reporting a potential sport-related concussion may appear simple, the factors associated with an athlete's willingness to report an injury are still not fully understood. Researchers have investigated the influence of psychosocial determinants on college athletes' intentions to report a SRC (Kneavel et al., 2020). Some of the most commonly studied factors associated with SRC reporting are demographic variables, including sex, sport contact level, previous history of concussion, and athletes' knowledge of SRC signs and symptoms (Knollman-Porter et al., 2018; Kroshus et al., 2017; Miyashita et al., 2016; Wallace et al., 2017; Weber Rawlins et al., 2019). Currently, there are no known studies that have examined the potential influence of post-concussion cognitive-communication impairments on concussion reporting, even though many individuals who have a SRC experience changes in their cognitive-communication functions (Ackley & Brown, 2020, Ketcham et al., 2017; Roth & Hardin, 2019). Knowledge about athletes' concerns for cognitive-communication deficits is needed to fully understand why they choose to report or conceal their SRC symptoms.

Study Aims

The purpose of this study was to replicate previous findings that have investigated demographic variables associated with SRC reporting. Additionally, the study will expand on the current body of research by investigating the influence of perceived changes to cognitive-communication functions on athletes' willingness to report a SRC. Information about athletes' reporting intentions will help to inform future research and prevention efforts. Knowledge about the impact of cognitive-linguistic symptoms on concussion reporting may assist in expanding speech-language pathologists' role in the prevention and management of SRCs and increase service for concussed athletes.

Research Questions

The present study sought to answer the following research questions:

Question 1. Are there statistically significant differences in college athletes' intentions to report a SRC by:

a. *sex* (male vs. female),

b. *year in college* (freshman, vs. sophomore vs. junior vs. senior),

c. *level of sport contact* (noncontact vs. limited contact vs. contact vs. collision/combat),

d. *number of diagnosed SRCs* (0 vs. 1 vs. 2 vs. 3 vs. $\geq$ 4), and

e. *ratings on a novel symptom checklist*?

Question 2. What SRC symptoms are college athletes most likely to report if they were to experience a future concussion?

Question 3. What SRC symptoms are college athletes least likely to report if they were to experience a future concussion?

Significance of the Study

The findings of this study will increase knowledge related to athletes' willingness to report a potential concussion based on perceived changes to their cognitive-communication abilities. Understanding barriers to concussion reporting and why athletes report or conceal their symptoms is needed for developing efficacious prevention interventions and implementing long-term monitoring procedures post-concussion (Brown & Knollman-Porter, 2019; Kneavel et al., 2019). Well-designed multidisciplinary education and prevention initiatives can lead to increased reporting rates, thereby increasing athletes' access to speech-language pathology services (Knollman-Porter et al., 2018). This study has the potential to strengthen the role of SLPs in concussion management and prevention.

Chapter Two

Literature Review

This chapter provides background information on sport-related concussions and presents results from research that studied the influence of specific demographic variables on SRC reporting intentions. The chapter begins by defining traumatic brain injury and sport-related concussion. Next, details on the pathophysiology of SRC are provided to delineate the neurological basis for acute SRC symptomology. SRC recovery periods are then addressed including traditional and protracted recovery time frames. The chapter also describes three classifications of SRC symptoms, namely physical, emotional, and cognitive-communication symptoms. Finally, it concludes with a summary of the findings from the literature on the influence of demographic variables (i.e., athlete's sex , year in college, sport contact level, previous history of concussion, and athletes' knowledge of SRC signs and symptoms) on athletes' intentions to report a SRC.

Incidence and Definitions

Traumatic brain injuries are "alterations in brain function or other evidence of brain pathology caused by external force" (McCrory et al., 2017). According to a study by Taylor et al. (2017), an estimated 2.8 million people sustain a traumatic brain injury (TBI), with roughly 50,000 resulting in death. Additionally, in the United States between 3.2 and 5.3 million survivors of TBI are living with varying degrees of long-term disability (Selassie et al., 2008; Thurman et al., 1999). TBIs are classified on a continuum ranging from mild to severe to describe the severity of the head injury and the extent of the brain damaged. The Glascow Coma Scale (GCS) is a tool that is often used within a medical setting to determine the initial

classification of TBIs. Classifications on the GCS are as follows: mild (13-15 points), moderate (9-12 points), and severe (3-8 points) (Teasdale & Jennet, 1974).

Mild traumatic brain injuries are the most common brain injury as they account for nearly 80% to 90% of all traumatic brain injuries (Dewan et al., 2019; Skandsen et al., 2019). Researchers often use the term sport-related concussion interchangeably with mild traumatic brain injury, however, the two are not identical but overlap. That is, sport-related concussions are a subset of mTBI and therefore not all mTBIs are sport-related concussions, but all sport-related concussions are mTBIs.

There are slight variations in SRC definition in the literature, but many healthcare professionals, researchers, and experts rely on the most recent Concussion in Sport Group (CISG) definition of SRC. In 2016, the CISG met for the fifth international conference in Berlin, Germany where expert panelist provided a global summary of best practices in concussion prevention, diagnosis, and management (McCrory et al., 2017).

The CISG states that a SRC is a traumatic brain injury induced by a biomechanical force (McCrory et al., 2017). SRC involves the following criteria: (1) a direct or indirect trauma anywhere on the body with a force transmitted to the head; (2) athletes may or may not lose consciousness; (3) rapid (seconds to minutes) or delayed (minutes to hours) symptom presentation, typically with spontaneous resolution; and (4) negative standard neuroimaging (computerized tomography (CT) or magnetic resonance imaging (MRI)) findings (McKeithan et al., 2019). The negative neuroimaging results reflect a functional neuronal disturbance rather than a structural brain injury, which sets SRC and mTBI apart from more severe brain injuries.

SRC Pathophysiology

Classifying concussions as 'mild' traumatic brain injuries creates a misleading connotation as these head injuries are anything but mild. Giza & Hovda (2001; 2014) pioneered our current understanding of the pathophysiology of concussions and established that a single mTBI results in complex neuropathological changes in the brain. Included amongst these pathophysiological changes are altered white matter structure and function from diffuse axonal injury (DAI) and a 'neurometabolic cascade' characterized by altered neurotransmitter activity and subsequent altered levels of brain excitability (McInnes et al., 2017). DAI is a hallmark of closed-head injuries and have been observed in individuals post mTBI using diffuse tensor imaging (Aoki et al., 2012; Wallace et al., 2018). DAI is a phenomenon that occurs upon impact, when the white and grey matter of the brain stretches and shears due to rapid acceleration/deceleration or rotation of the brain. This axonal damage is likely the principal component of long-term deficits associated with mTBI, as it alters the athlete's central nervous system function (Browne et al., 2011). In addition to DAI, the neurometabolic cascade perpetuated by a concussion can cause neuronal dysfunction, membrane damage, altered blood brain barrier permeability, and cerebral swelling (Giza & Hovda, 2001). Thus, the description provided by Giza and Hovda (2001; 2014) of the pathophysiology of SRC is much more severe than what may come to mind when SRCs are categorized as 'mild' in nature. These complex neurometabolic events explain the presence of many concussion symptoms that can negatively impact an athlete's well-being and ability to participate in daily life activities.

Acute Symptomology

Knowledge regarding concussion and its symptomology has evolved with the advancement of SRC research. There is no uniform profile that defines the course of a

concussion, but there is an acute phase that occurs immediately post-injury. During this acute phase, the hallmark sign of a SRC used to be loss of consciousness; however, researchers now believe that loss of consciousness occurs in less than 10% of all SRCs (Mullally, 2017). Other observable signs of an athlete experiencing a SRC include loss in stability, moving clumsily when standing up from the injury, or looking dazed or stunned after the incident (Center for Disease Control and Prevention [CDC], 2019). Personal interaction may also reveal cognitive impairments following an injury. When talking with the athlete, they may not be able to recall events prior to or after a hit or fall, answer questions slowly, forget an instruction, or be confused about the game, a game assignment, or position (CDC, 2019).

SRC Recovery Period

Although initial observable signs may be missed or ignored, athletes will continue to experience a sequalae of symptoms in the hours and days following their injury. Traditional concussion recovery has been suggested to take between 10 to 14 days for adults (McCrory et al., 2017); however, recovery timelines are highly variable between individuals. For example, a recent prospective cohort study by Kara et al. (2020) analyzed 594 male and female athletes with SRCs from three different age cohorts (children, adolescent, and adult). The authors found that less than half of the study participants recovered from their SRC within two weeks post-injury, nearly 75% of participants were recovered within four weeks post-injury, and most participants (96%) were fully recovered at eight weeks post-injury. This study illustrates the variability in 'traditional' SRC recovery time frames.

Although most athletes experience a traditional SRC recovery trajectory, a subset of athletes may experience persistent symptoms. Estimates of the prevalence of a prolonged recovery vary from 10% to 20% depending on the cohort being studied and the time frames used

to define ‘prolonged’ (Barlow et al., 2010; Cooksley et al., 2018). A diagnosis of ‘post-concussion syndrome’ (PCS) may be given to individuals who experience persistent SRC symptoms; however, PCS remains highly controversial since there are no universally accepted criteria for diagnosis and the symptoms are individualized and nonspecific to concussion (Dwyer & Katz, 2018).

The Role of the Speech-Language Pathologist in Managing Cognitive-Communication Deficits in SRCs

Regardless of whether a diagnosis of PCS is given, both the acute and the persistent cognitive deficits associated with a SRC are of particular interest to SLPs. SLPs have unique knowledge and skill sets that can be used to evaluate, treat, and manage cognitive-linguistic deficits post-concussion (Ackley & Brown, 2020; Anjum, 2022; Brown, O’Brien et al., 2019; Dachtyl et al, 2017; Ketcham et al, 2017; Knollman-Porter et al., 2014; Salvatore & Fjordbak, 2011). Recent studies have outlined the value of incorporating SLPs into multidisciplinary concussion management teams as consultative team members. The literature provides support for SLPs to be involved during the acute phase of SRC recovery period by directly supporting athletes or athletic trainers in assisting athletes in their return to school (Anjum, 2022; Dachtyl et al, 2017; Ketcham et al, 2017; Salvatore & Fjordbak, 2011). Additionally, SLPs should continue to provide direct therapeutic services for any athlete who may experience persistent cognitive-linguistic deficits post-concussion (Ackley & Brown, 2020; Anjum, 2022; Dachtyl et al, 2017; Hardin & Kelly, 2019; Ketcham et al, 2017; Knollman-Porter et al., 2014).

A general overview of the main categories of SRC symptoms are described below to address the gamut of potential symptoms experienced by athletes, and to describe the cognitive-linguistic symptoms that are relevant to the field of speech-language pathology. In general, both

persistent and acute SRC symptoms are classified into the following three categories: physical, emotional, and cognitive (Roth & Hardin, 2019). SRC's are not a homogenous injury; therefore, athletes with a concussion will experience a unique clinical profile characterized by individualized symptoms and deficits in each of the three categories.

Physical Symptoms

Headaches are the most reported concussion symptom and frequently persist the longest (Stillman et al., 2016). Meehan et al. (2010) collected concussion symptomology data from a large nationally represented sample (540 male and female athletes) using the High School Reporting Information Online injury surveillance system and found that 93% of high school athletes with sport-related concussions reported experiencing headaches after their injury. The findings from the study by Meehan et al. (2010) were further supported by Marshall et al. (2015), who found that nearly 90% of high school and college athletes across seven sports reported experiencing headaches post SRC.

Dizziness is the second most common reported acute concussion symptom and often used as a descriptor for three main sensations: vertigo, lightheadedness, and disequilibrium (Roth & Hardin, 2019; Reneker et al., 2015). A systematic review of studies consisting of male and female high school and college athletes found that between 67% and 77% of players with SRC reported dizziness post-concussion (Valovich McLeod & Hale, 2014). Further findings suggest that dizziness post mTBI is multifactorial and that individuals who experience initial dizziness symptoms post-concussion are more likely to experience a protracted recovery period (Valovich McLeod & Hale, 2014).

Other physical symptoms have been observed in athletes with a SRC, such as visual impairments, auditory disturbances, noise sensitivity, and sleep changes. Visual impairments are

a common symptom, as more than half of our brain's pathways are dedicated to vision and eye movement (Gunasekaran et al., 2019), and therefore neurologic pathways associated with the visual system can be compromised by a brain injury. Visual changes include hypersensitivity to light (photophobia), blurred vision, and double vision. One study found that visual disorders may occur in up to 69% of individuals following a mTBI (Master et al., 2016). Auditory disturbance is another common symptom reported after a concussion (Callahan et al., 2018; Roth & Hardin, 2019). Hypersensitivity to noise can be both an acute and persistent symptom following a mild head injury (Dischinger et al., 2009). Lastly, athletes with a SRC often experience changes in sleep patterns including increased fatigue, insomnia, hypersomnia, and daytime sleepiness (Mosti et al., 2016; Roth & Hardin, 2019). Although the exact incidence of sleep disturbance post SRC is unknown, estimates range from 30% to 70% of individuals (Ouellet & Morin, 2006). The identification of acute and persistent sleep pattern changes is important for athletes as it may impact their ability to participate in daily life activities including school and work.

Emotional Symptoms

Individuals with concussions exhibit transient mood symptoms including higher levels of anxiety, depression, irritability, anger, and impulsivity following a head injury (Byrd et al., 2021; Kontos et al., 2012; Mainwaring et al., 2004; Sandel et al., 2017). The literature indicates that mood symptomology can be difficult to differentiate from typical SRC symptomology, as there are many similarities in both symptom presentations (Byrd et al., 2021). Therefore, if mood symptoms persist past the point of a traditional SRC recovery period, it is important for a differential diagnosis to be made and for the athlete to receive necessary services to manage mood states.

Mainwaring et al. (2004) reported that acute and short term (< 1 month) mood disruptions were present in male and female college athletes post mTBI. The authors administered the Profile of Mood States (POMS) to a sample of concussed collegiate athletes, uninjured teammates of concussed athletes, and nonathlete college students. Each of the groups were given the shortened version of the POMS to determine a baseline score and both mTBI and undergraduate participant groups received serial emotional functioning tests. Participants baseline mood scores did not differ between the study groups; however, athletes with a SRC reported higher POMS scores for depression, confusion, and total mood disturbance after their injury. The mTBI group's mood disturbances returned to baseline around three weeks post injury, suggesting that athletes with a SRC typically experience only transient mood disturbances (Mainwaring et al., 2004).

A recent study by Byrd et al. (2021) provided additional information into the emotional states of collegiate athletes following a SRC. The authors examined feelings of anger, impulsivity, and anxiety using a mixed-method sequential design. In total, ten collegiate athletes were included in the sample. Results indicated that all 10 of the study participants reported feeling anxious after their concussion; however, consistent with the findings by Mainwaring and colleagues (2004), the participants' mood changes were usually transient, as 90% of the participants reported symptom reduction between eleven to twenty-one days post-concussion. Byrd and colleagues identified five common themes that emerged in the athlete's post-concussion reports. These themes included fear of the "unknown" and "not being about to play again;" anger and frustration towards "oneself" and "others;" and "impulsivity." (Byrd et al., 2021).

Cognitive-Communication Symptoms

Cognitive-communication symptoms occur in both the acute and persistent stages of SRC recovery (Dean & Sterr, 2013). Immediately following a SRC many athletes describe their brain as feeling "foggy," which is likely due to acute cognitive impairments affecting their concentration, processing speed, executive functions, and memory. While some athletes may only experience these deficits in the acute stages, other athletes may experience persistence of these symptoms. In fact, in two recent publications, the authors found that nearly half of individuals with a mTBI experienced long-term cognitive deficits (McInnes et al., 2017; Nelson et al., 2019). McInnes et al. (2017) performed a scoping review and found 45 articles that investigated short- and long-term cognitive functions in individuals with a single mTBI. Findings from their study indicated that approximately half of individuals with a single mTBI demonstrated long-term cognitive impairments. These findings were further supported by research conducted by Nelson and colleagues (2019) in which the authors examined 1,154 adults with mTBI and orthopedic traumatic injury up to a year post injury. At 12 months post-concussion, more than half (53%) of the mTBI participants reported difficulty with daily functioning on the Glasgow Outcome Scale–Extended Score Interview (GOSE) reflecting injury related functional limitations across broad life domains. Again, this study illustrated the presence of cognitive deficits in more than half of the participants a year after their concussion.

Before discussing the specific cognitive-linguistic deficits that athletes may experience post SRC, it is important to note that cognitive demands are rarely presented in isolation and therefore the use of multiple cognitive skills are required to function in daily life. When performing higher level cognitive activities such as completing homework, cooking, driving, and the like, individuals are required to integrate a variety of cognitive-linguistic skills to

successfully complete such tasks. Therefore, the cognitive symptoms described below are often interconnected and deficits are likely to present across various domains.

It is well documented in the literature that many individuals experience attention impairments following a mTBI (Shah et al., 2017; Villard, 2019). Attention is closely related to other cognitive processes and is a precondition for other cognitive-linguistic functions to be carried out (Villard, 2019). Concussed athletes have demonstrated deficits in direct attention including reduced attention span, attentional fatigue, increase distractibility, and/or failing to hear someone speaking to them (Dockree et al., 2005). The inability to focus for long periods of time may affect athletes' ability to engage in conversations, complete assignments on time, and/or prepare for examinations (Ackley & Brown, 2020; Anjum, 2022; Datchtyl et al., 2017).

Reduced processing speed has also been observed in individuals with mTBI (Bernstein, 2002; Johansson et al., 2009; Kinnunen et al., 2011; O'Jile et al., 2006). Bernstein (2002) conducted a study that illustrated reduced processing speed approximately eight years after individuals experienced a concussion. The study consisted of 23 college students who were divided into control and experimental groups. The study found that individuals with a mild head injury many years prior still performed poorer than the control on a digit symbol substitution task, a task that is widely used to measure processing speed (Bernstein, 2002).

Working memory is a cognitive skill that allows an individual to be able to hold and keep information accessible while actively manipulating or performing mental operations on the information (Cowan, 2008). Working memory enables individuals to perform everyday tasks such as driving, following multi-step directions, reading, taking a test, performing math equations, or writing a paper (Cowan, 2008). Impairments in working memory are common immediately following a concussion but have also been observed years after the injury

(Arciniega et al., 2019; Arciniega et al., 2021; Hudac et al., 2018). Arciniega and colleagues (2019) identified long-term working memory deficits on a visual working memory task when comparing collegiate undergraduate students with a history of mTBI and peers without a history of mTBI. The authors administered computerized working memory tests to four samples of participants and found that in each of the samples, individuals with a history of mTBI had deficits across all aspects of working memory including encoding, maintenance, and retrieval.

Executive functions comprise a set of interrelated cognitive skills that allow individuals to carry out goal directed and purposeful behavior (Lezak et al., 2012). Executive functions are high-level cognitive processes that control lower-level processes and are important for planning, organizing, initiating, and modifying behavior to complete a given task. Changes in executive function are among the most common and disabling aspects of cognitive impairment following a TBI (McDonald et al., 2002; Roth & Hardin, 2019). Individuals with executive dysfunction post-concussion will likely experience difficulties with tasks they were once very successful at, such as completing homework or taking notes in class. These subtle impairments can cause frustration and disrupt the athlete's success in the classroom or ability to complete daily tasks.

Summary of SRC Background Information

Sport-related concussions are mild traumatic brain injuries that occur due to biomechanical forces that result in functional brain disturbances (McCrory et al., 2017). Following a SRC injury, athletes experience complex neurometabolic changes and DAI, (Giza & Hovda, 2001; 2014) resulting in post-concussion physical, emotional, and cognitive symptoms. As previously described, physical concussion symptoms include headaches, dizziness, visual impairments, auditory disturbances, and changes in sleep patterns. Emotional symptoms include depression, anxiety, anger, irritability, and impulsivity. Cognitive-linguistic symptoms include

deficits in attention, processing speed, working memory, and executive functions. Although athletes experience a multitude of individualized symptoms, the presence of SRC symptoms alone does not indicate that the athletes will report their symptoms to a coach, athletic trainer other healthcare professional. Several studies have found that athletes underreport concussions and fail to seek medical and rehabilitation services post injury (Harmon et al., 2013; Milroy et al., 2019; Torres et al., 2013; Wallace et al., 2017).

Underreporting of SRCs

Torres et al. (2013) found that 43% of collegiate athletes with a history of a sport-related concussion knowingly hid their symptoms from a coach or an athletic trainer to stay in the game. Additionally, the study found that 22% were "unlikely" or "very unlikely" to report a future sport-related concussion (Torres et al., 2013). The findings from this study are consistent with previous research that estimates that nearly 50% of sport-related concussions go unreported (Harmon et al., 2013; Milroy et al., 2019; Wallace et al., 2017). The underreporting of SRCs is a barrier to effectively managing athletes' post-concussion and playing through these injuries puts players at risk for further injury and possible long-term consequences.

SRC underreporting has been observed across all age groups including adolescents (Ferdinand Pennock et al., 2020) and adults (Torres et al., 2013; Wallace et al. 2017). Most of the research on SRC symptom reporting has focused on high school and collegiate athlete populations. It is important to note that there are critical differences in these populations and that these differences can impact SRC reporting behaviors (Harmon et al., 2013; McGrath, 2010). One unique characteristic of collegiate athletes is the overwhelming majority are no longer dependents of their parents or guardians and they have autonomy over decisions such as SRC reporting. Collegiate athletes often live on campus and are typically not under the direct

supervision of their parents; therefore, the potential for a family member to recognize a collegiate athlete's SRC symptom is reduced. Additionally, college athletes may also have scholarship money at stake or a desire to go professional that could impact their likelihood of reporting a SRC (Register-Mihalik, Linnan et al., 2013). Thus, these factors make college athletes a unique population for research on SRC reporting behaviors.

As previously discussed, the identification, treatment, and management of SRC heavily rely on athletes' disclosure of concussion symptoms to an athletic trainer or coach. Many sport-related head injuries occur during games and practice and are often missed by athletic trainers, coaches, and teammates. Therefore, the responsibility of SRC reporting often falls on the athletes themself to seek out the appropriate professionals so that they can receive necessary medical intervention. To understand the factors that lead athletes to report a potential SRC, researchers have investigated demographic variables to determine their impact on an athlete's likelihood of reporting. Understanding the variables associated with athlete's reporting intentions can provide useful information for the development of future prevention initiatives that seek to increase the reporting behaviors of athletes. Some of the most widely studied demographic variables in SRC reporting include sex, year in college, sport contact level, and SRC education on athletes' concussion reporting intentions (Beran & Scafide, 2022; Chizuk et al., 2021; Knollman-Porter et al., 2018; Miyashita et al., 2016; Wallace et al., 2017; Weber Rawlins et al., 2019).

Impact of Sex on SRC Reporting Intentions

Sex is considered an important variable in describing differences in SRC reporting behavior among athletes. Epidemiologic research suggests that female athletes experience a higher rate of SRCs (Dick, 2009), but it is unknown if the incidence of SRC is higher in females

or if they are more willing to report compared to their male counter parts. Miyashita and colleagues (2016) investigated sex differences in SRC reporting as well as the impact of educational initiatives on SRC reporting intentions. The authors investigated a total of 454 male and female high school athletes from ten different sporting teams. The purpose of their study was to determine (i) if there is a difference in SRC reporting between the male and female athletes, (ii) who is more likely to report future concussions after educational intervention, and (iii) the reasons for not reporting a SRC. Survey data were collected from male and female participants at team meetings prior to receiving educational intervention and post-intervention. Interestingly, results from the study indicated that high school female athletes had greater reporting intentions compared to male athletes both before and after receiving educational intervention. However, the male and female athletes did not differ in terms of the rationales that they provided for not reporting a possible SRC. Both male and female athletes indicated feeling that their "injuries were not serious enough to report." Similar to the findings reported in Miyashita et al. (2016), other investigators have found that high school female athletes were more likely to report SRC symptoms than their male counterparts (e.g., Kurowski et al., 2014; Wallace et al., 2017; Weber Rawlins et al., 2019).

However, not all studies found that male and female athletes differed in their intentions to report a SRC. Chizuk and colleagues (2021) investigated multiple age cohorts including elementary, high school, and college athletes to determine the athletes' reporting intentions based on participants' sex and sport's contact level. Participants' reporting intentions were collected through a questionnaire that provided athletes with a variety of hypothetical scenarios. For example, the following hypothetical scenario were provided to participants: "If you were playing your sport and had a head injury that was not observed by others and started having symptoms

that might represent a concussion but felt like you could continue to play, would you or would you not tell your coach/ trainer knowing they would take you out for the entire game to rest?" The scenario was repeated for multiple conditions including practice, championship game, rival game, and a less important game. The results from the study demonstrated that both male and female athletes did not differ significantly in their SRC reporting intentions. Therefore, in contrast to the previous findings by Miyashita et al. (2016), this study demonstrated that the athlete's sex did not influence their SRC reporting intentions when comparing athletes within the same sport contact level. Additionally, reasons for not wanting to report a potential SRC were also provided by the athletes who asserted that they "did not want to miss a game" or "let their coach down" (Chizuk et al., 2021).

Other studies have also considered sex as a variable but have made an important distinction between athletes' biological sex and their gendered behaviors. For example, Kroshus et al. (2017) investigated concussion reporting intentions among a purely collegiate sample. The study consisted of 328 male and female collegiate athletes that competed across seven National Collegiate Athletic Association (NCAA) sports. Survey data was collected from participants and the results indicated that female collegiate athletes had greater symptom reporting intentions compared to their male counterparts. Although female athletes had greater reporting intentions, no significant differences were found between sexes regarding their likelihood of continuing to play when experiencing possible concussion symptoms. Therefore, even though female athletes had greater reporting intentions, this did not translate to actual reporting behaviors. Kroshus and colleagues (2017) suggest that a possible rationale for the sex differences in reporting intentions may be partially due to the function of athletes' gendered behavior and whether they conform to the traditional masculine norms (i.e., risk taking, avoiding help seeking, winning at all costs).

Female athletes who continued to play while symptomatic had a greater likelihood to conform to risk-taking behaviors, which may imply that the athletes' gendered behavior may be a more important consideration than the athlete's biological sex (Kroshus et al., 2017). These findings were consistent with research by Wallace et al. (2017) that indicated that sport ethos, masculinity, and social referents (i.e., coaches and teammates) significantly contributed to male athletes' unwillingness to report a sport-related concussion. The findings from both Kroshus et al. (2017) and Wallace et al. (2017) illustrate that masculine culture surrounding sports could be more impactful than an athlete's biological sex on athletes' concussion reporting behaviors.

Weber Rawlins et al. (2019) further investigated sex differences in athletes' willingness to report a concussion but also considered the athlete's year of sport eligibility and sport contact level as potential contributing variables that may impact reporting intentions and behaviors. Participants in this cross-sectional study were from one of twelve sport teams at the University of Georgia, Valdosta State University, or Emory University (n = 828). Data were collected from participants through a questionnaire which gathered demographic information, direct and indirect reporting intentions, and direct and indirect reporting behaviors. The results from this study found that female athletes had higher indirect reporting intentions than male collegiate athletes. However, there were no differences between male and female athletes on any of the following outcomes: direct intentions, direct behaviors, or associations between indirect behaviors. Thus, the results from this study were similar to Kroshus et al. (2017) and continued to show that although female athletes have greater reporting intentions, their intentions may not render a difference in actual reporting behaviors.

Impact of Year in College on SRC Reporting Intentions

Weber Rawlins et al. (2019) examined the influence of an athlete's year of sport eligibility on SRC reporting intentions. Sport eligibility is often the same as the athlete's year in college, however in some cases an athlete's sport eligibility year and year in college may differ by one year, as an athlete could have an academic status of a junior but an athletic status of a sophomore due to collegiate athlete's ability to 'red shirt' for an athletic season. The data from the study by Weber Rawlins and colleagues revealed that no statistically significant differences in SRC reporting intentions existed among athletes in various sport eligibility years. Although information about athletes SRC reporting intentions amongst different sport eligibility years is limited to only one collegiate study, a recent systematic review by Beran & Scafide (2022) revealed two studies that looked at high school athletes SRC reporting intentions based on their year in high school. The findings from those studies differed, as one study found no differences in SRC reporting intentions amongst grade levels, and the other study found a difference between reporting intentions of freshman and junior high school athletes. Further research in this area is needed to gain a better understanding of the impact of SRC reporting intentions based on the athlete's year in college.

Impact of Sport Contact Level on SRC Reporting Intentions

In addition to investigating athletes reporting intentions based on sex and year in college, two of the studies discussed above examined the impact of sport contact level on athletes reporting intentions (Chizuk et al., 2021; Weber Rawlins et al., 2019). Researchers have examined if sport contact level is a predictor of SRC reporting because athletes who participate in high contact sports experience an increased likelihood of sustaining a SRC (Daneshvar et al., 2011). Therefore, it is important to determine if athletes who participate in high contact sports

also report potential SRCs at higher rates. Chizuk et al. (2021) investigated sport contact level on athletes' reporting intentions. Each of the sports in their study were classified based on the NCAA's contact level classification system (i.e., collision/combat sports, contact sport, limited contact sports, and non-contact sports). Examples of collision/combat sports include football, hockey, lacrosse, and wrestling. Contact sports included basketball, field hockey, and soccer. Limited contact sports included baseball, softball, and volleyball, and non-contact sports were cross country, golf, swimming, tennis, etc. Results from the study indicated that even though athletes who participated in higher contact sports received more education about concussions, non-contact sport athletes were more likely to report a possible concussion. Thus, athletes who were more at risk for obtaining a concussion, were also less likely to report a potential concussion. Consequently, the authors suggested that athletes who participate in collision/combat and contact sports may benefit from more informational awareness about the detrimental and potentially fatal consequences of sustaining subsequent head injuries while they are still suffering from a previous concussion (Chizuk et al., 2021).

Weber Rawlins et al. (2019) also investigated the influence of sport contact level on athletes' intention to report a potential SRC. Athletes in this study were divided into two groups either a collision/contact or a limited/non-contact sport. Similar to the results in Chizuk et al. (2021), the authors found that athletes in the limited/noncontact group had higher indirect and direct SRC reporting intentions. However, no statistically significant relationships were found between sport contact level and SRC reporting behaviors, indicating that the increase in reporting intentions by athletes who played limited contact sports did not transfer to increases in actual reporting behaviors (Weber Rawlins et al., 2019).

Impact of a Previous Concussion on SRC Reporting Intentions

Although limited information has been recorded on previous history of concussion and future SRC reporting behaviors, this is an important variable to consider as repeated head injuries can lead to an increase in potential long-term deficits. One study that considered the impact of previous history of concussion on college athletes future SRC reporting intentions was Kroshus and colleagues (2020). The authors sought to determine whether college athletes with a prior concussion would be more or less likely to play with a future concussion. To determine athletes SRC reporting behaviors, a questionnaire was administered to 328 collegiate athletes which asked them if they had a previous SRC diagnosis, instances of having SRC symptoms following the diagnosis, and whether they reported those symptoms. Findings from this study revealed that athletes who had a previous SRC diagnosis had a significantly greater risk of continuing to play while experiencing symptoms of a possible SRC. Thus, the results of this study illustrate that even after sustaining a single concussion, collegiate athletes did not view this injury as being serious enough to change their attitudes and perceptions about it. This is concerning as repeated head injuries may increase the duration and severity of cognitive-linguistic deficits post-concussion.

Impact of Athletes' Knowledge of Concussion Symptoms on SRC Reporting Intentions

While previous studies have investigated concussion reporting intentions based on sex, year in school, sport contact level, and previous SRC history, these variables alone are not sufficient for determining reporting behaviors. The influence of concussion symptom knowledge on athlete's SRC reporting intentions has also been examined by researchers (e.g., Wallace et al., 2017). Recognition of the signs and symptoms of a potential concussion is necessary to identify a possible SRC. In 2010, the NCAA enacted its Concussion Policy and Legislation which

mandated member institutions to instate a concussion management program (NCAA Bylaw: 3.2.4.17). Included in the mandate was yearly concussion education for all athletes. Although education among varsity athletes is mandated, there is no standardization regarding the content or delivery of the information because the NCAA does not regulate it (Knollman-Porter et al., 2018). Therefore, the effectiveness of educational programs has been questioned and research has sought to understand athlete's knowledge of concussion signs and symptoms.

Wallace et al. (2017) utilized a survey measure adapted from Register-Mihalik, Guskiewicz, et al. (2013) to investigate sex differences in athletes' knowledge of the signs and symptoms associated with SRC. To measure symptom knowledge, participants were provided a list of 21 possible concussion symptoms, 10 of which were actual SRC-related signs and symptoms, and 11 were foils. Scores were generated based on the number of correct and incorrect responses. Data from a sample of 288 high school athletes were analyzed. Results from the study revealed a significant difference between male and female athletes' SRC symptom knowledge. High school female athletes had greater symptom knowledge compared to their male counterparts.

Although the study by Wallace and colleagues (2017) investigated some of the most common concussion symptoms, it did not incorporate the full gamut of concussion symptoms. For example, only two vague cognitive deficits associated with SRC were examined: "fogginess" and "memory loss." Interestingly, the study findings indicated that "fogginess" was the least recognized symptom, demonstrating a gap in knowledge on potential cognitive impairments associated with concussion.

Knollman-Porter et al. (2018) added to the current body of SRC symptom knowledge research by investigating the knowledge of varsity athletes, recreational athletes, and non-

athletes regarding concussion definition, symptoms, and support services available. A total of 306 male and female collegiate athletes from two different sports responded to the survey and were included in data analysis. To identify study groups SRC knowledge, each of the participants were asked to provide a SRC definition in their own words, freely recall SRC symptoms, and identify SRC symptoms when given choices. Findings from their study indicated that all groups (collegiate athletes, recreational athletes, and non-athletes) had incomplete knowledge of concussion symptoms (Knollman-Porter et al., 2018). Analysis of participants' SRC definitions revealed that nearly 70% of the respondents indicated that a SRC is a brain injury, but only 21% of the respondents listed relevant symptoms associated with concussions as part of their definition. Furthermore, less than 70% of respondents recognized symptoms that may negatively impact them in the classroom (Knollman-Porter et al., 2018). Although participants were able to identify hallmark professionals involved in concussion management, such as physicians and athletic trainers, the authors found that athlete's knowledge of support personnel remains incomplete (Knollman-Porter et al., 2018).

A recent publication by McAllister-Deitrick et al. (2020) further supports the need for educational interventions that inform athletes on the potential long-term impacts of SRCs. The authors investigated collegiate athletes SRC knowledge and reporting behaviors from 6 institutions. Participants included 986 male and female NCAA division I and II athletes across a variety of geographic regions including Pennsylvania, Ohio, Michigan, and South Carolina. Participants represented 17 different sports including football, lacrosse, soccer, basketball, wrestling, etc. Football players had the highest response rate and accounted for nearly one fourth (23.4%) of the study participants. To gather qualitative data the authors developed a survey which included questions about athletes' previous SRC reporting behaviors. Study findings were

similar to Wallace et al. (2017), which indicated that female athletes had greater SRC symptom knowledge and reporting intentions than male athletes. However, the authors suggested that SRC knowledge may have little implication on actual SRC reporting behaviors and that increased education regarding the potential long-term impacts of SRC may be necessary to increase athletes reporting behaviors.

To recap, the findings by Knollman-Porter et al. (2018) suggested that athletes have an incomplete knowledge regarding SRC signs and symptoms and that most athletes fail to recognize symptoms that may impact them in the classroom. The conclusions from Wallace et al (2017) indicated that female athletes have greater SRC symptom knowledge than male athletes, but that both groups have a limited understanding of the cognitive-linguistic deficits associated with concussion. Lastly, McAllister-Deitrick et al. (2020) emphasized the importance of educating athletes on the potential long-term impacts of SRC to facilitate changes in athletes reporting behaviors.

Summary of Demographic Variables of SRC Reporting Intentions

In summary, research has sought to describe some of the factors associated with sport-related concussion reporting, but gaps in the literature remain. The present review of the literature revealed that variables contributing to concussion reporting behaviors are multifactorial. First, Miyashita et al. (2016), Kroshus et al. (2017), and Weber Rawlins et al. (2019) all found that female athletes have greater reporting intentions. This finding, however, was not supported by Chizuk and colleagues (2021) who found no differences in SRC reporting intentions between males and females. Further investigation on the potential influence of biological sex on SRC symptom reporting would be beneficial due to conflicting evidence in the existing literature. Second, Weber Rawlins et al. (2019) found that athletes' SRC reporting

intentions did not change as a factor of their sport eligibility year. However, in a recent systematic review on factors related to concussion reporting (Beran & Scafide, 2022), the authors found conflicting results between two studies that examined the influence of year in high school on SRC symptom reporting behaviors. Therefore, further research is needed to determine if collegiate athletes' year in education impacts their SRC reporting intentions. Next, Chizuk et al. (2021) and Weber Rawlins et al. (2019) found that athletes who participated in low contact sports had greater SRC reporting intentions, and Kroshus et al. (2020) found that collegiate athletes did not experience a change in attitudes following a diagnosed SRC. Due to the limited number of studies that have looked at SRC reporting as a factor of sport-contact level and previous SRC history, additional examination of these variables is warranted. Lastly, Wallace et al. (2017) and Knollman-Porter et al. (2018) found that athletes' knowledge of concussion signs and symptoms remains incomplete and that cognitive-communication symptoms such as fogginess and memory loss were barely recognized by high school athletes. In a recent study, McAllister-Deitrick and colleagues (2020) concluded that more education regarding the long-term effects of SRC, including cognitive-linguistic deficits, is needed to increase SRC symptom reporting. Together, these studies provide support for additional research on athletes' likelihood to disclose a potential concussion based on changes to their cognitive-communication abilities. Research findings related to this topic are critical for advancing knowledge necessary for developing effective SRC educational initiatives in the future.

Chapter Three

Methodology

Human Subject Review

La Salle University's Institutional Review Board (IRB) approved all procedures involved in this project prior to beginning athlete recruitment (IRB no. 20-10-045). Permission from all participating institutions was obtained and included in the IRB application. Athletes' participation in this study was voluntary and informed consent was obtained prior to questionnaire completion. See Appendix A for the informed consent form.

Recruitment

Collegiate athletes from three universities were invited to participate in this study. Individuals were eligible to volunteer for this study if they were a collegiate athlete who participated in at least one NCAA organized sport. Athletes were actively recruited from one private university and two private colleges in the greater Philadelphia region of the United States. Recruitment of participants occurred across all three NCAA divisions.

Athletic directors from three of the participating institutions assisted in student-athlete recruitment by distributing a questionnaire link directly to the target population and/or to coaches who distributed the questionnaire link to their players. Recruitment efforts occurred for a total of 4 months, from December 1, 2020 to March 31, 2021.

Procedure

A digital copy of the questionnaire was created using Qualtrics Core XM, a platform which allows users to create, distribute, and collect anonymous questionnaire responses. The questionnaire was built using a blank template and display logic was implemented to eliminate extraneous data from the results. A script was developed and included in the email sent out to

the athletes inviting them to participate in the study and provided them with access to the questionnaire link (see Appendix B for recruitment script). Upon clicking the link, prospective participants were redirected to the informed consent page, which allowed them to voluntarily decline or agree to participate in the study. The informed consent educated potential participants about the purpose of the study, what would be expected of them if they chose to participate in the research, and any potential risks or advantages to completing the study. Individuals who elected to participate in the study were given access to complete the questionnaire. Athletes who did not agree to participate in the study were redirected to a new internet page that thanked them for their time and allowed them to exit the platform.

All questionnaire responses were recorded and stored in Qualtrics Core XM. Participant responses were imported into Microsoft Excel and then later into IBM Statistical Package for the Social Sciences (SPSS), version 24, for data analysis.

Instrument

Survey research can provide quantitative information about the attitudes and opinions of a population by studying a smaller sample of that population (Fowler, 2009). A 48-item questionnaire was developed for the present study (see Appendix C). The questionnaire consisted of three domains: (1) participant demographic profile (Items 1-16), (2) participants' intention-to-report a sport-related concussion (Items 17-22) (Kneavel et al., 2020), and (3) participants' likelihood of reporting a sport-related concussion if they experience a specific post-concussion symptom (Items 23-48). To fully understand participants' reporting intentions, the questionnaire included mixed question types such as multiple-choice, fill in the blank, and a Likert rating scale. The questionnaire took participants approximately 15 minutes to complete.

Questionnaire Items

Questionnaire demographic items gathered relevant information to describe the participant population and aimed to reflect inclusivity and sensitivity to all groups of people. As previously discussed in the literature review (Chapter 2), differences in concussion reporting intentions have been observed based on the student-athlete's sex (Chizuk et al., 2021; Kurowski et al., 2014; Miyashita et al., 2016; Wallace et al., 2017; Weber Rawlins et al., 2019), sport eligibility year (Kroshus et al., 2020), sport contact level (Chizuk et al., 2021; Weber Rawlins et al., 2019), and previous SRC education (Knollman-Porter et al., 2018; McAllister-Deitrick et al., 2020; Wallace et al., 2017). To compare our research findings to the results of previous studies, we asked demographic questions related to the athlete's sex, year in college, sport contact level, and previous concussion history. Multiple-choice questions were provided in the demographic section so that participants could quickly and easily respond to questions. If the athlete selected 'other' as a response, they were prompted to type their answer to gather more specific information.

Questionnaire items 17 to 22 were adapted from a validated instrument (McCarthy et al., 2021) and used in previous concussion research (e.g, Kneavel et al., 2020) for evaluating collegiate student-athletes' intentions to report a sport-related concussion for themselves. These items provided a variety of scenarios to the student-athlete to understand if their reporting intentions changed based on a given situation (e.g., "*I plan to report even if I am not sure it is serious*;" "*I will report if it happens in a playoff or championship game*."). Participants responded to these items on a 7-point Likert scale, in which they rated their willingness to report a sport-related concussion to a coach or an athletic trainer, as follows: 1 = strongly disagree, 2 =

disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, and 7 = strongly agree.

A review of the literature on sport-related concussion symptomology informed the construction of questionnaire items 23-48, referred to as the novel symptom checklist (Eisenberg et al., 2014; Hardin & Kelly, 2019; Knollman-Porter et al., 2018; McCrory et al., 2017; Roth & Hardin, 2019). These items asked participants to rate the likelihood of reporting a sport-related concussion if they were to experience a specific post-concussion symptom. Statements in this section provided participants with functional examples of how physiological symptoms (e.g., daytime sleepiness) or cognitive-communication impairments (e.g., difficulty telling a story in the correct sequence) may manifest in their daily lives after a concussion. Participant responses were obtained using the same 7-point Likert scale described above (i.e., 1 = strongly disagree, 7 = strongly agree).

Research Questions

Question 1. Are there statistically significant differences in college athletes' intentions to report a SRC by:

a. *sex* (male vs. female),

b. *year in college* (freshman, vs. sophomore vs. junior vs. senior),

c. *level of sport contact* (noncontact vs. limited contact vs. contact vs. collision/combat),

d. *number of diagnosed SRCs* (0 vs. 1 vs. 2 vs. 3 vs. $\geq$ 4), and

e. *ratings on a novel symptom checklist*?

Question 2. What SRC symptoms are college athletes most likely to report if they were to experience a future concussion?

Question 3. What SRC symptoms are college athletes least likely to report if they were to experience a future concussion?

Data Analysis

Responses to the questionnaire items 17 to 22 were summed for each participant to derive an intention to report *total score*, ranging from 6 (least likely to report) to 42 (most likely to report). Mean total scores were computed for the groups of interest in Question 1(a) through Question 1(e). An independent samples t-test was conducted for comparing the mean scores between the male and female participants in Question 1(a). One-way analyses of variance (ANOVAs) were conducted for comparing the variables of interest in Questions 1(b) to (d). Question 1(b) was answered by comparing the mean scores among the freshman, sophomore, junior, and senior participants. Data from participants who reported being in their 5th year of college were omitted from the analyses addressing this question because of limited data (n =2). Question 1(c) asked whether the mean scores differed significantly among participants who played sports with higher and lower levels of contact. To address this question, four groups were formed based on the level of contact associated with the sports that the participants played (i.e., non-contact, limited contact, contact and collision/combat), as described by Chizuk et al. (2021). Any participant who reported playing more than one sport was classified using the sport they played with the highest level of contact. Question 1(d) was addressed by comparing the intention to report mean scores among groups based on the number of diagnosed SRC(s) (i.e., 0, 1, 2, 3, or $\geq$ 4). Question 1(e) was addressed using an independent samples t test. Means from the novel symptom checklist were compared for groups of athletes who were classified as 'likely' to report (based on a total score of 36 or above on the intention to report survey) and 'less likely' to report (designated by a total score of 35 or below).

Research Questions 2 and 3 were addressed by computing the median scores for each of the SRC symptom questionnaire items (23 to 48) to identify symptoms that were most and least likely to be reported if experienced in a future concussion. The scores for the questionnaire items ranged from 1 (least likely to report) to 7 (most likely to report). For the purpose of this study, the symptoms described in items with a median score of 6 or above were considered to be symptoms that college athletes would most likely report, since half of the participants *agreed* or *strongly agreed* that they would report a concussion if they experienced these symptoms. These findings contributed data for addressing Question 2. Symptoms described in the items with a median score of 4 or below were identified as items that were least likely to be reported and provided data for addressing Question 3. All statistical analyses were conducted in IBM SPSS version 24. For tests of significance, the alpha level was set at $p = .05$.

Chapter Four

Results

Participants

A total of 193 native English-speaking athletes (130 female; 63 male) from 3 universities/colleges in the Philadelphia area participated in the study. The participant characteristics are described in Table 4.1.

In the sample, 67% of participants were female. The mean age of the participants was 19.84 years (SD = 1.27) and approximately 76% of participants indicated their ethnicity as White, 9% as Black/African American, and 6% as Hispanic/Latinx. Other ethnicities reported by the participants are shown in Table 4.1.

Table 4.1

Participant Characteristics

Demographic Variables	
Sex	
Male (%)	63 (32.6)
Female (%)	130 (67.4)
Ethnicity	
White (%)	146 (75.6)
Hispanic/Latino (%)	12 (6.2)
Black or African American (%)	17 (8.8)
Native American or American Indian (%)	4 (2.1)
Asian/ Pacific Islander (%)	6 (3.1)
Mixed (%)	7 (3.6)
Nigerian (%)	1 (0.5)
Year in College [a]	
Freshmen (%)	54 (28.1)
Sophomore (%)	44 (22.9)
Junior (%)	48 (25.0)
Senior (%)	44 (22.8)
Fifth year (%)	2 (1.0)
NCAA Division	
I (%)	54 (28.0)
II (%)	50 (25.9)
III (%)	89 (46.1)

Table 4.1. (Continued)

Number of Hours Spent Practicing and Competing Each Week [a]	
1-5 hours (%)	5 (2.6)
6-10 hours (%)	30 (15.6)
11-15 hours (%)	54 (28.1)
16-20 hours (%)	72 (37.5)
Over 20 hours (%)	31 (16.1)
Received Education on SRC [a]	
Yes (%)	151 (78.6)
No (%)	41 (21.4)
Yearly Hours of SRC Education	
1-2 hours (%)	109 (72.2)
3-4 hours (%)	25 (16.6)
5-6 hours (%)	6 (4.0)
More than 6 hours (%)	11 (7.3)
Previous SRC Diagnosis	
Yes (%)	75 (38.9)
No (%)	118 (61.1)
Previous number of SRC Diagnosis	
0 (%)	119 (61.7)
1 (%)	40 (20.7)
2 (%)	20 (10.4)
3 (%)	8 (4.1)
More than 3 (%)	6 (3.1)
Suspected SRC not Diagnosed [a]	
Yes (%)	64 (33.3)
No (%)	128 (66.7)

Note. [a] The frequencies shown for those items do not reflect (n= 193), as one participant did not respond to each of those questionnaire items.

Aside from 5th year athletes, participants were almost equally represented by their year in college with 28% of participants identifying as freshmen, 23% of participants as sophomores, 25% as juniors, 23% as seniors, and 1% as fifth-year students. Each NCAA division was represented in the sample. Most participants (46%) indicated that they competed at NCAA division III level, 28% of participants competed at the NCAA division I level, and 26% of participants competed at NCAA division II level. Nearly 38% of participants indicated that they spent 16 to 20 hours practicing and competing in their respective sport(s) each week. This was

followed by 28% of participants that indicated that they spent 11 to 15 hours participating or competing each week.

Table 4.2 shows the different sports played by the participants and the frequencies of the sports played by sex. Soccer (19.2%) was the most represented sport, followed by lacrosse (17.1%), and softball (15.5%).

Table 4.2

Frequencies of Males and Females Participating by Sport

Sport	Female (n=130)	Male (n=63)
Baseball	N/A	8
Basketball	7	12
Football	N/A	15
Lacrosse	29	4
Soccer	27	10
Softball	30	N/A
Field Hockey	18	N/A
Tennis	1	2
Track and Field	8	6
Wrestling	N/A	3
Volleyball	9	0
Golf	0	3

Note. In addition to the frequencies represented in this table, 6 participants indicated that they play a second NCAA sport (see Table 4.3 for second sport participation).

As depicted in Table 4.3, 6 of the 193 participants indicated that they played a second NCAA sport.

Table 4.3

Frequencies of Males and Females Participating in a Second Sport

Sport	Female (n=4)	Male (n=2)
Basketball	1	0
Cross Country	1	1
Field Hockey	1	N/A
Track and Field	1	0
Golf	0	1

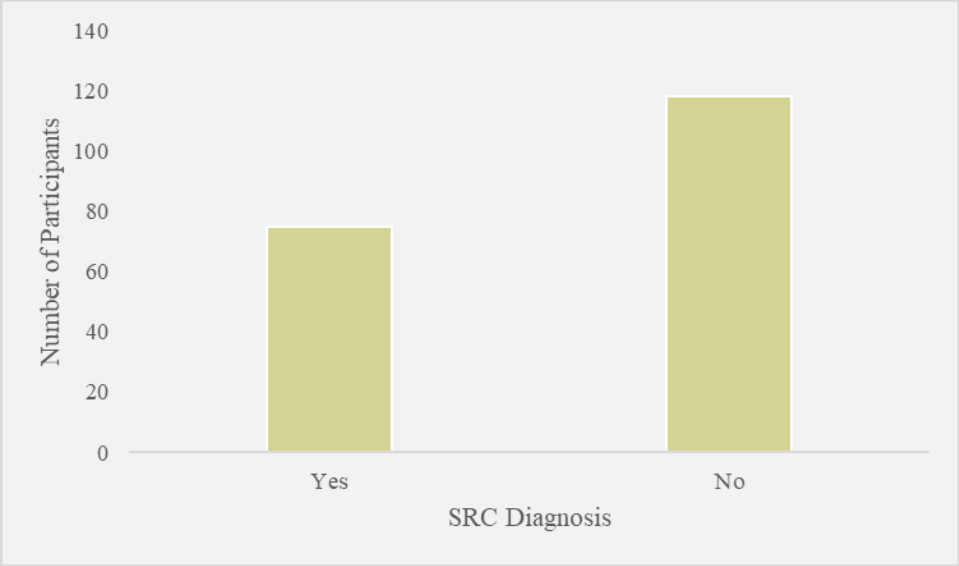
Although yearly concussion education is mandated, surprisingly, 21% of participants reported that they did not receive yearly SRC education. Of the 79% of participants that reported

receiving SRC education, 72% of participants indicated that they received 1 to 2 hours of SRC education, 17% received 3 to 4 hours of education, 4% received 5 to 6 hours of education, and 7% received more than 6 hours of education.

The final demographic questionnaire items asked participants about previous SRC diagnosis and if they suspected that they had an SRCs that went undiagnosed. Seventy-five (39%) of athletes reported that they have received a previous SRC diagnosis (see Figure 4.1) with the majority of those athletes indicating that they have previously received only one SRC diagnosis. Of note, nearly one third of the participants indicated that they suspected that they had a SRC that went undiagnosed.

Figure 4.1

Number of Participants' With or Without a Previous Diagnosed SRC



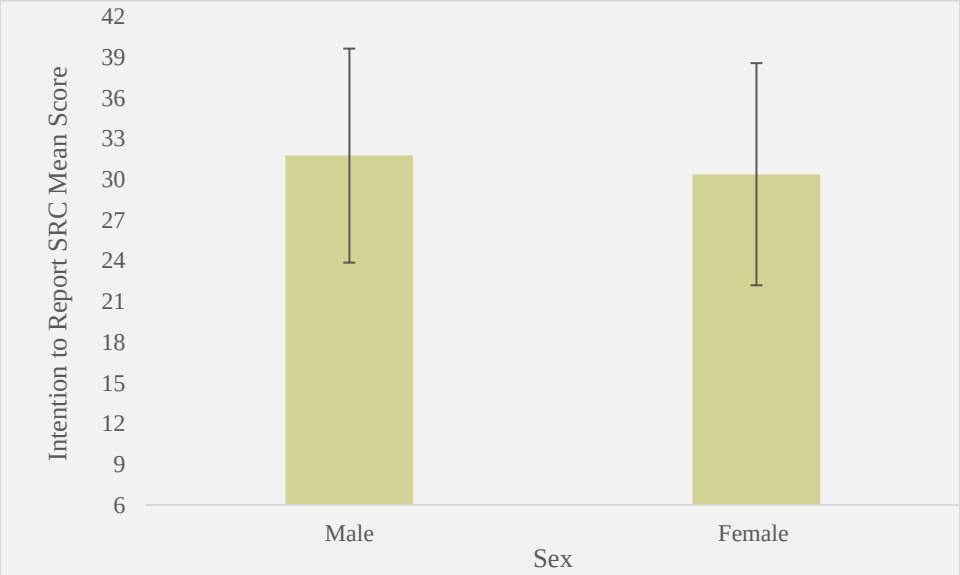
Research Question 1(a)

This question asks whether intentions to report a sport-related concussion differed between male and female college athletes. An independent samples t-test was conducted to compare the mean total scores for questionnaire items 17 to 22 between the male and female participants. The mean scores between the male (M = 31.75, SD = 7.886) and female (M =

30.38, *SD* = 8.186) participants did not differ significantly, *t*(186) = 1.096, *p* = .274, indicating that SRC reporting intention was not impacted by the participants' sex (see Figure 4.2).

Figure 4.2

Male and Female SRC Reporting Intentions

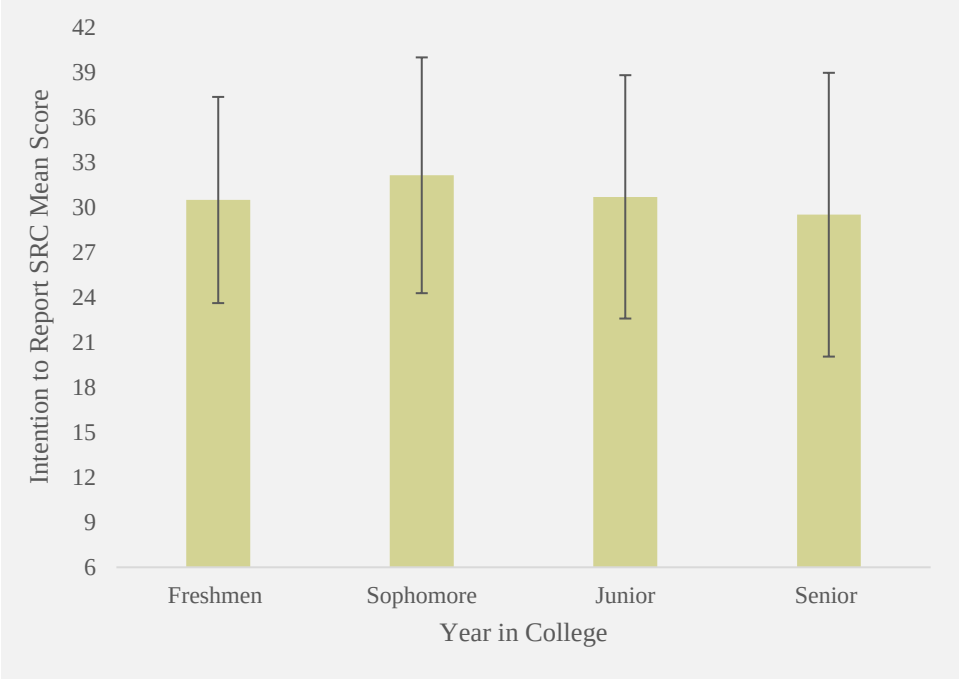


Research Question 1(b)

This question is concerned with whether student-athletes' intention to report a SRC differed among the freshman, sophomore, junior, and senior participants. A one-way ANOVA indicated that there were no significant group differences on the intention to report SRC total scores for years in college, *F*(3,182) = .779, *p* = .507. The participants' mean total scores and standard deviations for freshman (*M* = 30.51, *SD* = 6.880) sophomore (*M* =32.16, *SD* = 7.868) junior (*M* = 30.72, *SD* = 8.121) and seniors (*M* = 29.53, *SD* = 9.470) are illustrated in Figure 4.3.

Figure 4.3

Participants' SRC Reporting Intentions Based on Their Year in College

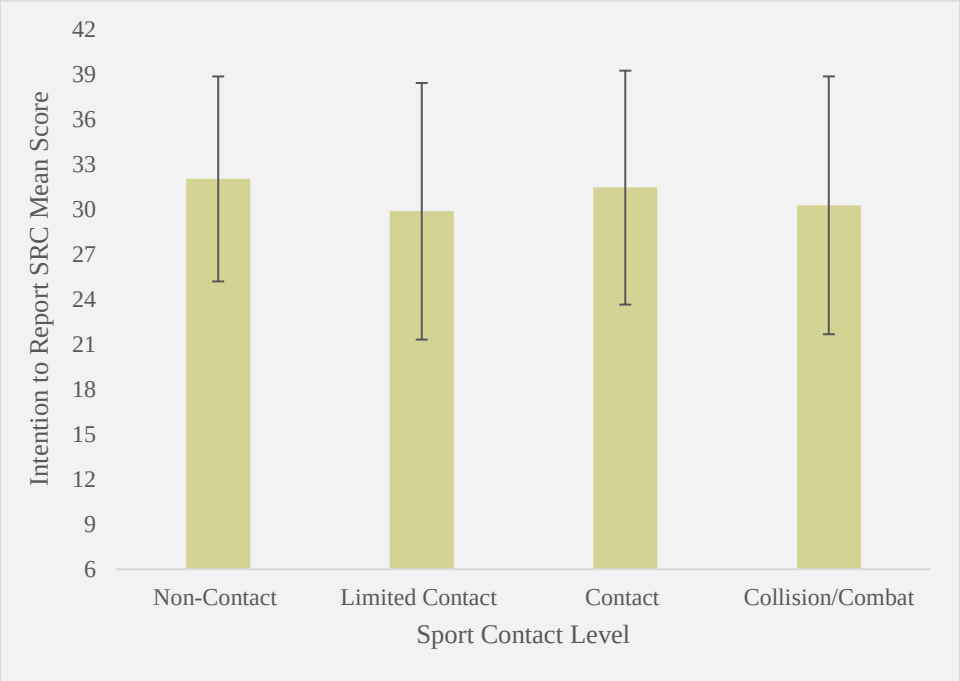


Research Question 1(c)

As shown in Table 4.2, a total of twelve sports were represented in the study. Each of the sports were classified into one of four groups based on the level of contact (no contact, limited contact, contact, combat/collision) associated with playing the sport. A one-way ANOVA was conducted to compare the levels of sport contact on the intention to report SRC total scores. No significant between-group differences were found, $F(3, 184) = .578$, $p = .630$, indicating that different levels of sport contact did not influence participants' SRC reporting behavior (see Figure 4.4).

Figure 4.4

Participants' SRC Reporting Intentions Based on Their Sport Contact Level

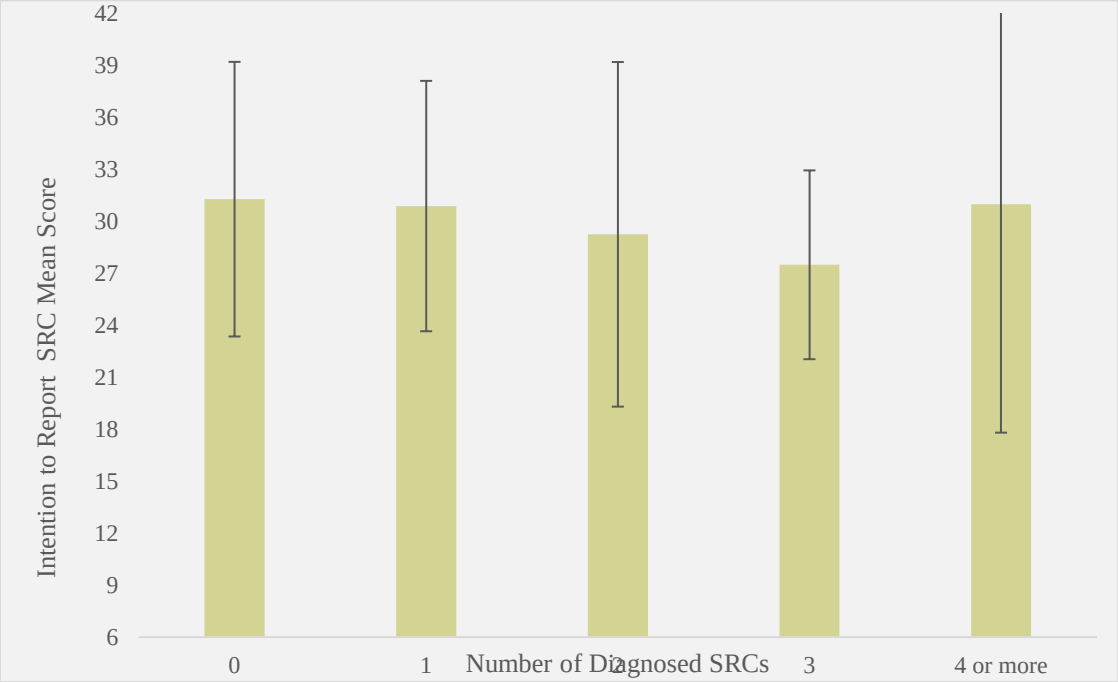


Research Question 1(d)

College athletes with varying number of prior SRCs (from none to four or more) were compared using a one-way ANOVA with total intent to self-report a suspected SRC as the dependent variable. Results indicated that no significant differences were found $F(4, 183) = .608$, $p = .658$) (see figure 4.5). Athletes without any prior SRCs had a mean of 31.29 ($SD = 7.928$); those with 1 prior SRC had a mean of 30.89 ($SD = 7.229$); those with two SRCs had a mean of 29.26 ($SD = 9.949$); those with three SRCs had a mean of 27.50 ($SD = 5.451$); and those with four or more SRCs had a mean of 31.00 ($SD = 13.191$) in their intent to self-report. Overall, the number of concussions an athlete experienced did not impact their intent to self-report a suspected concussion.

Figure 4.5

Participants' SRC Reporting Intentions Based on the Number of Diagnosed SRCs

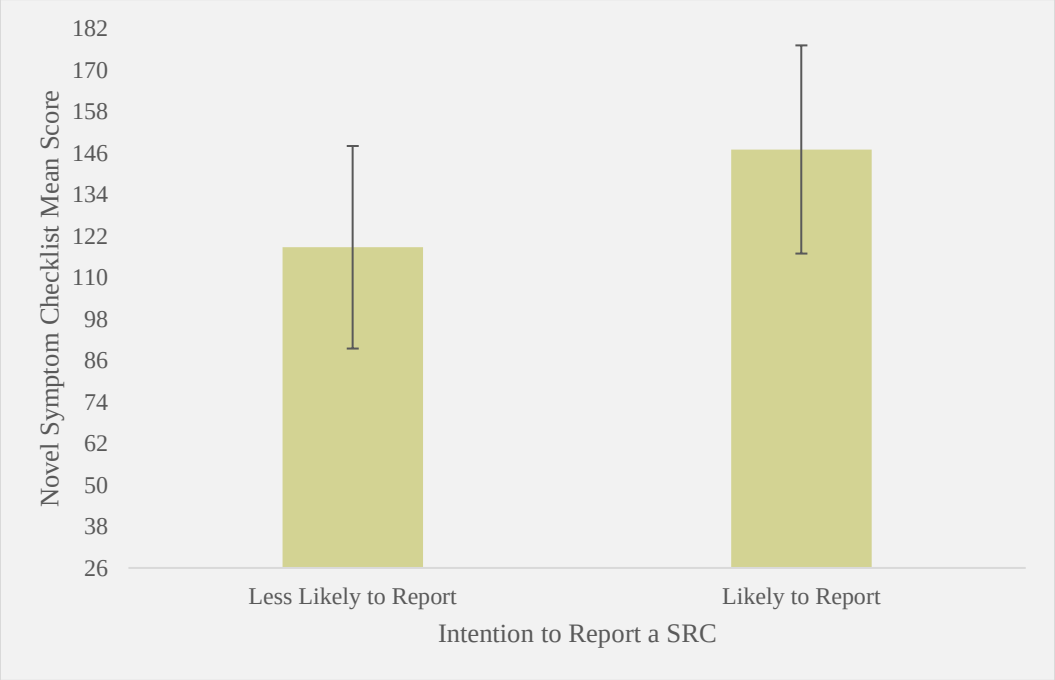


Research Question 1(e)

This question is concerned with whether athletes' intention to report a SRC differed according to mean scores on the novel symptom checklist (i.e., questionnaire items 23-48). An independent samples t test was calculated comparing the mean score of college athletes who identified themselves as likely to report a SRC and those less likely to report based upon scores on a novel symptom checklist. A statistically significant difference was found between the two groups $t(173) = 5.757$, $p < .001$). The mean of the likely to report a concussion group was significantly higher ($M = 147.02$; SD 30.104) than the less likely to report group ($M = 118.74$; SD 29.289).

Figure 4.6

Participants' SRC Reporting Intentions Based on Novel Symptom Checklist Mean Score

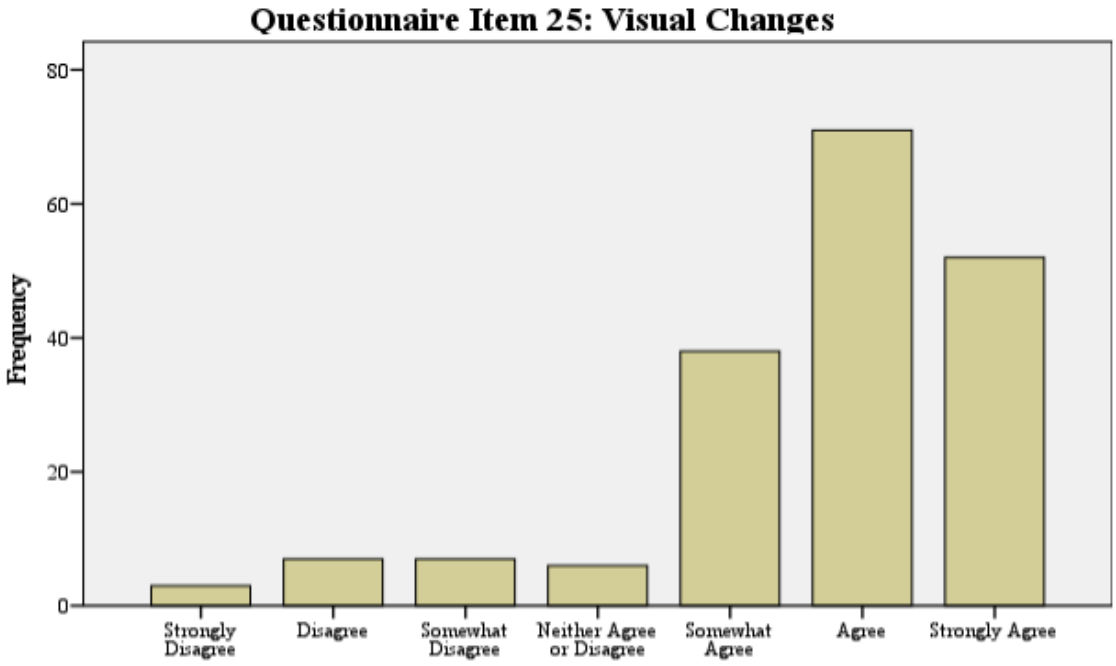


Research Question 2

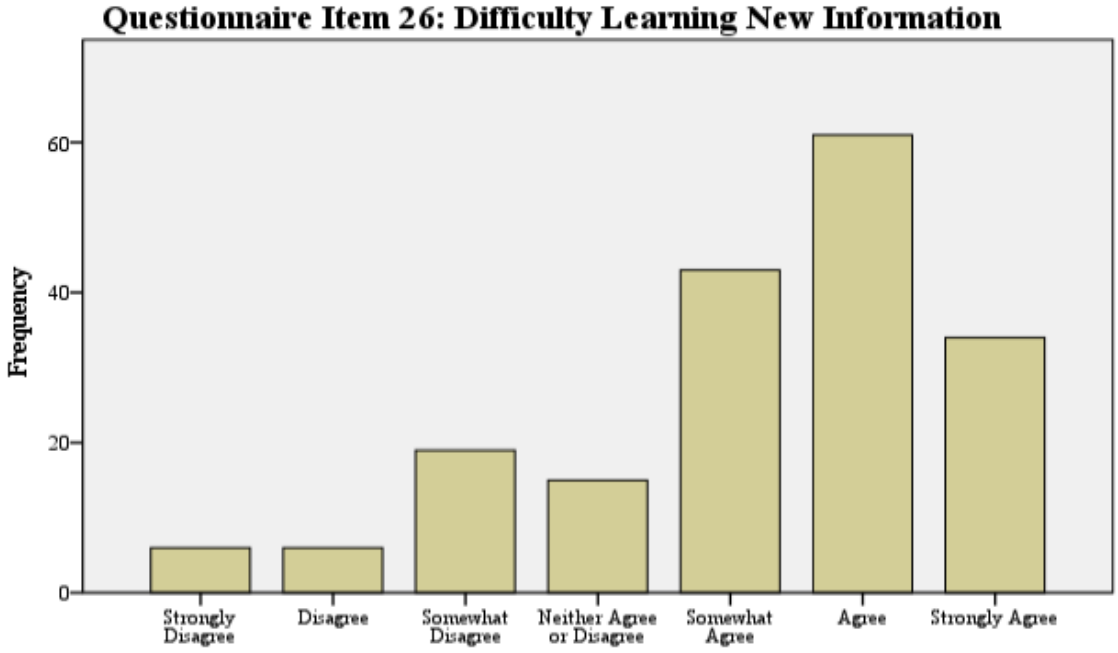
This question asks what symptoms college athletes are most likely to report if they were to experience a future concussion. Median scores for items 23 to 48 were calculated to determine the symptoms that would have the greatest impact on college athletes' future concussion reporting behaviors. Depicted in Figure 4.6 are the eight SRC symptom questionnaire items that athletes were most concerned about, as indicated by at least half of the participants reporting that they *agreed* or *strongly agreed* to report a concussion (i.e., item median score $\geq$ 6) if they were to experience the symptoms. These symptoms included *visual changes, difficulty learning new information, increased headaches, sensitivity to noise, feeling slowed down, confusion in a sports game, nausea/vomiting, and changes in sleep patterns.* The median score for each of these items was a 6.

Figure 4.7

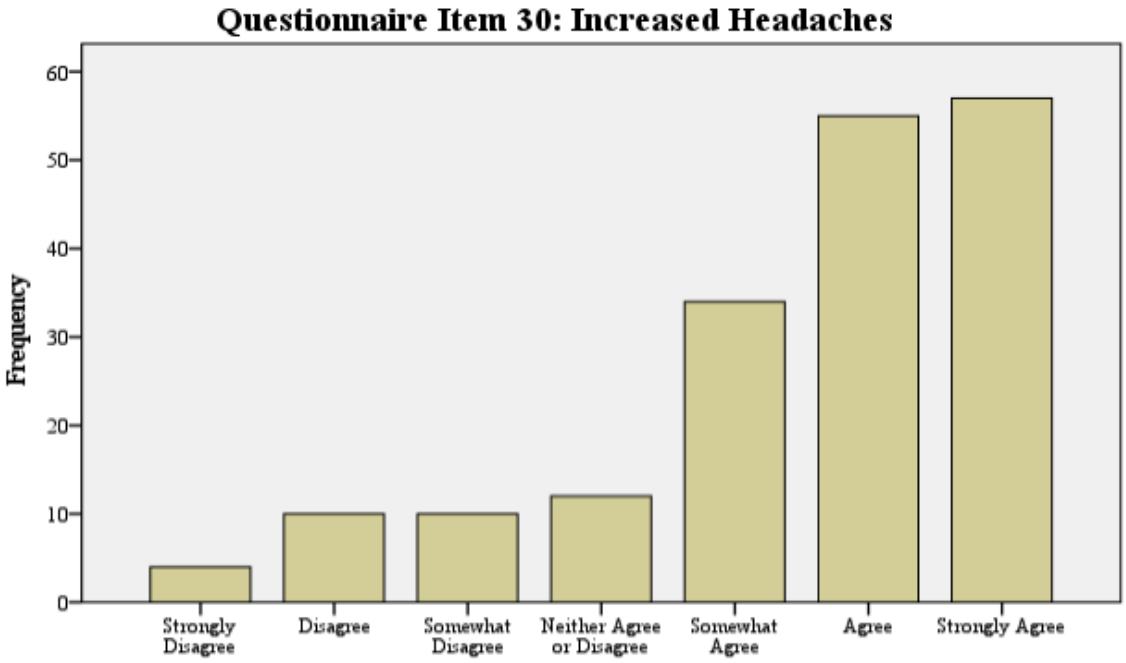
Eight Symptoms Most Likely to be Reported if Experienced a Future SRC



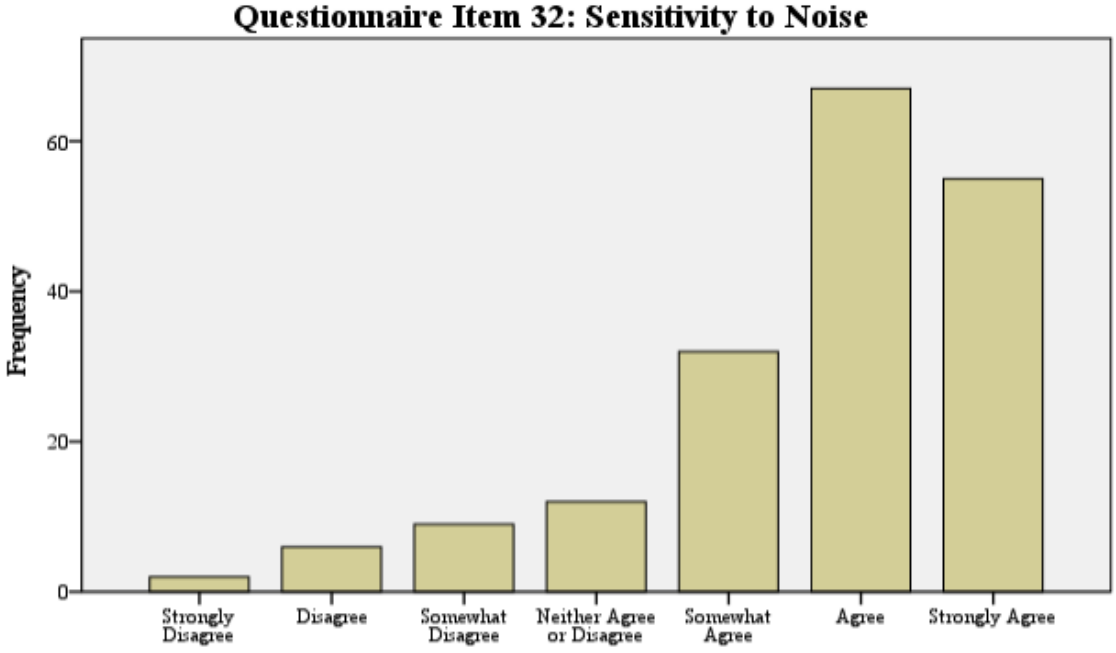
Mean: 5.66; Median: 6.00; SD: 1.369; Skewness: -1.489



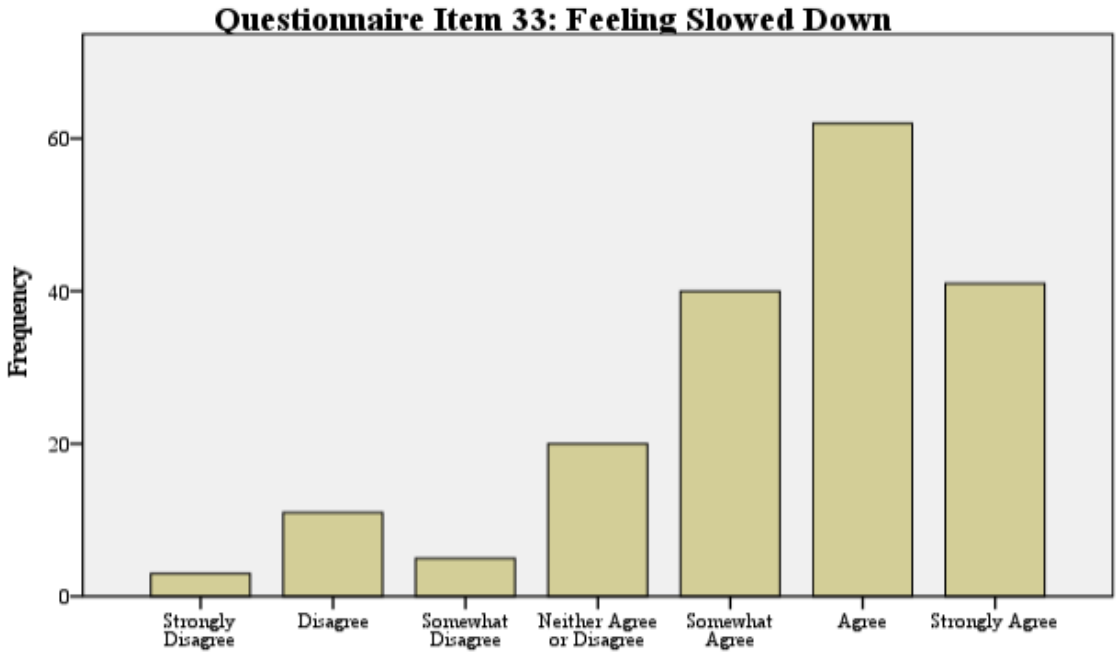
Mean: 5.18; Median: 6.00; SD: 1.536; Skewness: -0.946



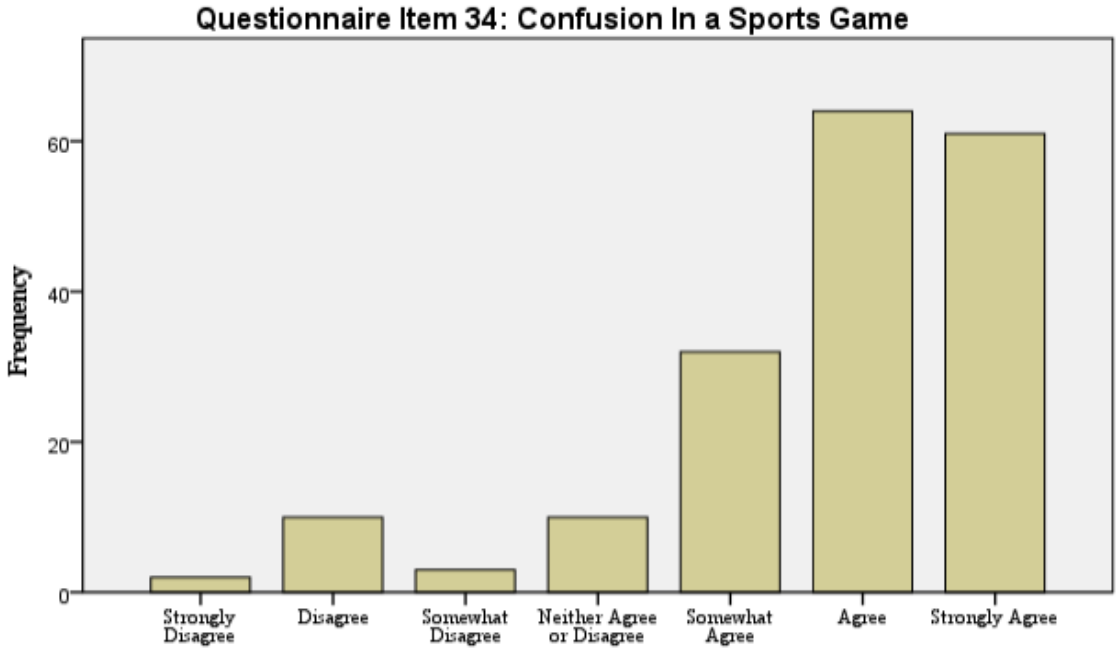
Mean: 5.50; Median: 6.00; SD: 1.565; Skewness: -1.158



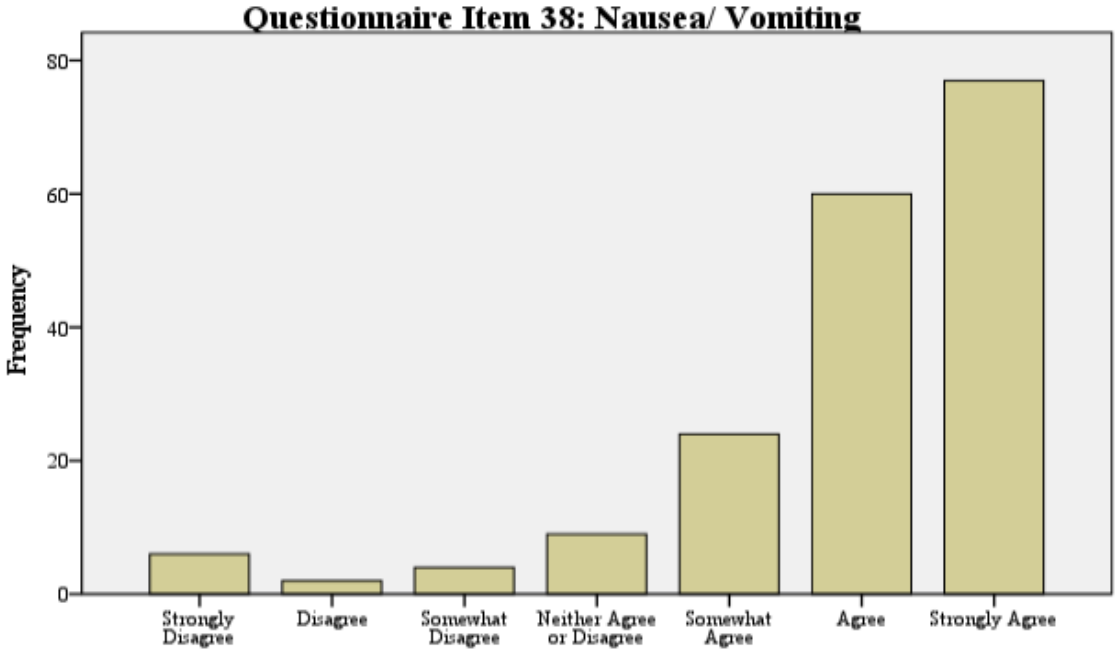
Mean: 5.66; Median: 6.00; SD: 1.369; Skewness: -1.292



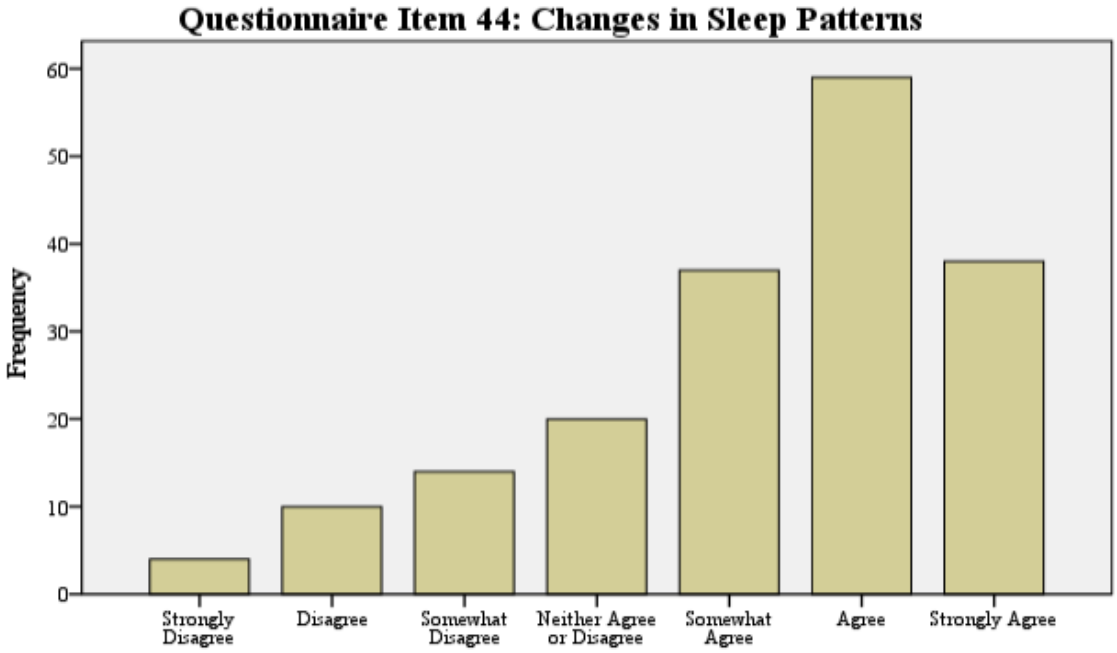
Mean: 5.38; Median: 6.00; SD: 1.462; Skewness: -1.089



Mean: 5.73; Median: 6.00 ; SD: 1.403; Skewness: -1.466



Mean: 5.92; Median: 6.00; SD: 1.398; Skewness: -1.876



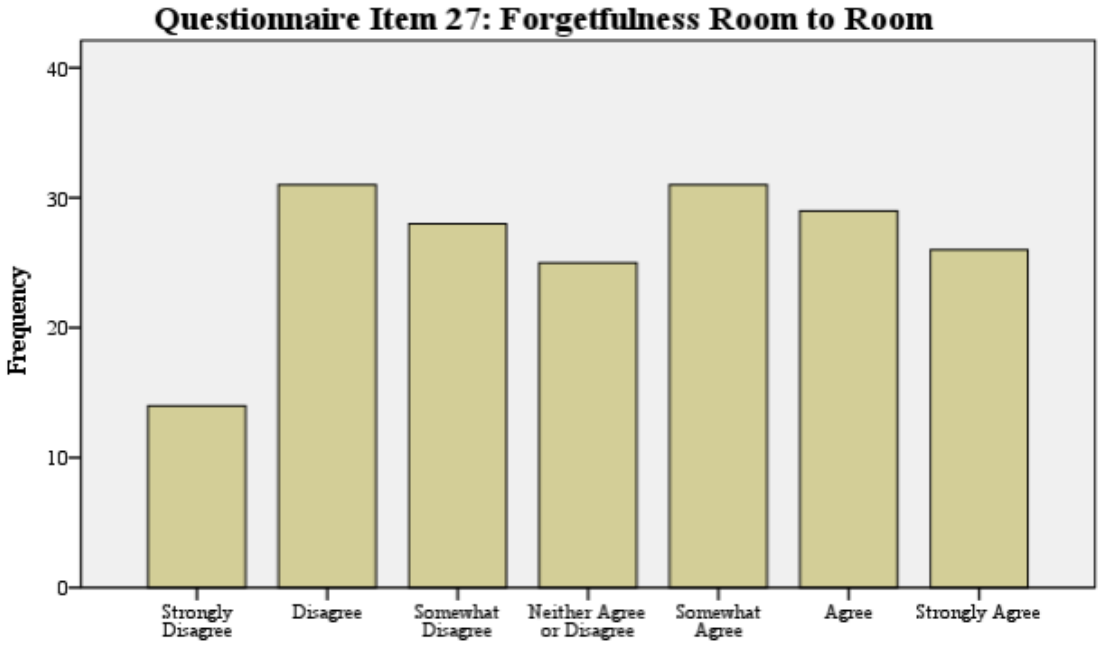
Mean: 5.23; Median: 6.00; SD: 1.544; Skewness: -0.893

Research Question 3

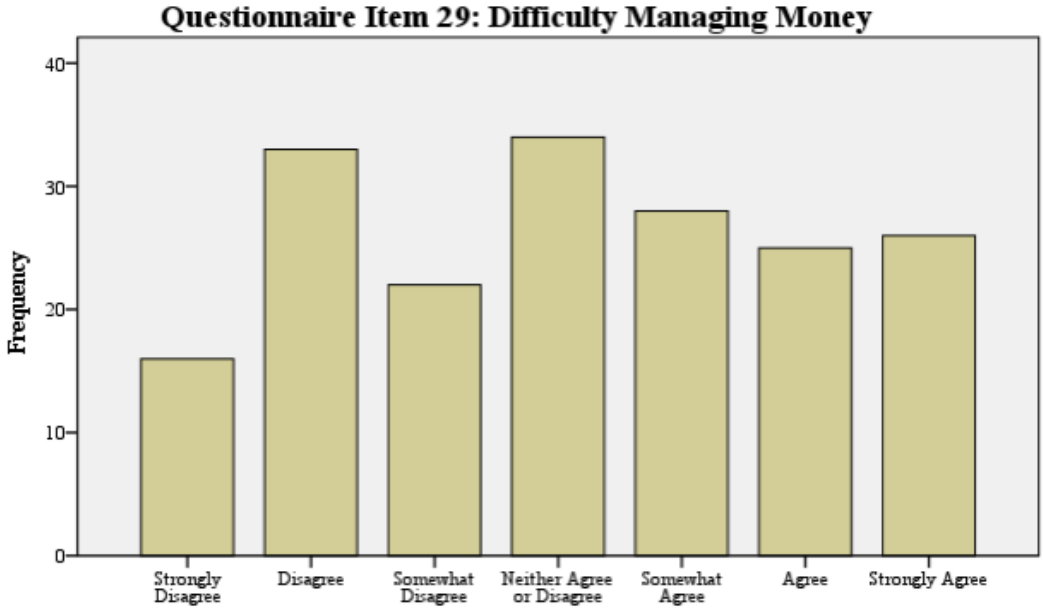
This question asked what symptoms college athletes would be least likely to report if they were to experience a future concussion. Median scores for items 23 to 48 were calculated to determine the symptoms that would least likely impact athletes' future concussion reporting behaviors. A median score of 4 or below for the questionnaire items were used to identify items for answering Research Question 3, because a median score of 4 indicated that participants *neither agreed nor disagreed* to report the symptom to a coach or athletic trainer following a suspected SRC. As shown in Figure 4.7, there were two symptoms that college athletes were least concerned about if were to experience in a future concussion. These symptoms were *forgetting why you went into a room* and *difficulty managing money*. The median scores for the two items associated with these symptoms were both 4.

Figure 4.8

Two Symptoms Least Likely to be Reported if Experienced a Future SRC



Mean: 4.19; Median: 4.00; SD: 1.88; Skewness: -0.051



Mean: 4.11; Median: 4.00; SD: 1.896; Skewness: -0.002

Summary

The findings for the Research Questions 1(a) to 1(d) suggested that participant characteristics did not significantly influence college athletes' intentions to report a SRC to a coach or athletic trainer. That is, college athletes' intentions to report a SRC did not differ as a function of the participants' sex, year in college, sports contact level, number of hours of SRC education received, or number of diagnosed SRCs. The findings for Research Question 2 identified eight SRC symptoms that college athletes were most likely to report if they were to experience in a future sport-related head injury. These symptoms were visual changes, difficulty learning new information, increased headaches, sensitivity to noise, feeling slowed down, confusion in a sports game, nausea/vomiting, and changes in sleep patterns. Results for Research Question 3 showed that problems with forgetfulness from room to room and managing money were the least likely symptoms to be reported if experienced in a suspected SRC.

Chapter Five

Discussion

A substantial barrier to effectively managing individuals with SRCs is the underreporting of SRC symptoms to athletic trainers, coaches, and/or medical professionals. Due to the potential long-term negative effects associated with SRCs, increased reporting behaviors and proper medical management of these injuries have been at the forefront of ongoing multidisciplinary research efforts. Specifically, the studies summarized in the literature review examined athletes' SRC reporting intentions based on demographic variables, namely the athletes' sex, year of sport eligibility, sport contact level, and number of previously diagnosed SRCs. Due to inconclusive findings and a lack of research regarding the impact that these variables have on college athletes, further research was warranted to better understand the impact that these variables have on college athletes SRC reporting intentions. Additionally, findings from the literature review revealed that collegiate athletes have a limited understanding of cognitive-linguistic deficits associated with SRCs (Knollman-Porter et al., 2018), which bolstered the need for research questions that addressed athletes' concern regarding SRC symptoms.

A total of 193 male and female collegiate athletes from the Philadelphia area were represented in the present study. Participants were administered a 48-item questionnaire to answer three research questions. Research question 1 was divided into five parts (research question 1(a) to 1(e) and sought to replicate the findings from previous research which investigated the impact of specific individual variables on college athletes' SRC reporting intentions. Research questions 2 and 3 expanded on the current body of research by investigating the concussion symptoms that collegiate athletes regarded as the most and least

important in influencing their future SRC reporting behaviors. The findings from research questions 1(a) through 1(d) revealed that collegiate athletes SRC reporting intentions were not impacted by any of the demographic variables of interest including the athlete's sex (1a), year in college (1b), sport contact level (1c), or number of diagnosed SRC (1d). Research Q1(e) demonstrated that the 'novel symptom checklist' develop for this study could discriminate between participants who were 'likely' and 'less likely' to report SRC symptoms in the future. The results for research questions 2 revealed eight SRC symptoms that college athletes felt were the most important to report if they experienced a future SRC. Research question 3 identified two SRC symptoms that college athletes felt they would be less likely to report if they were to experience a future SRC. The results of each of the research questions are discussed below and interpreted in the context of previous research findings. Suggestions for future research are also provided throughout these sections.

Research Question 1(a)

The present study found that male and female athletes did not differ in their SRC reporting intentions. This finding was consistent with research by Chizuk et al. (2021). However, the result of the present study differed from several other previous works including Kroshus et al. (2017), Kurowski et al. (2014), Miyashita et al. (2016), Wallace et al. (2017), and Weber Rawlins et al. (2019), all of which found a difference in SRC reporting intentions based on the athlete's sex.

Although the present study examined the athlete's biological sex in relationship to athletes' SRC reporting intentions, a closely related construct, *gender*, may be a more useful variable to consider for understanding athletes' SRC reporting behaviors. In a study by Kroshus and colleagues (2017), the authors made an important distinction between biological sex and

gender. Biological sex can be defined as the different biological and psychological characteristics of males and females, whereas gender refers to the socially constructed characteristics between men and women including norms and roles (World Health Organization [WHO], 2019). Traditional masculine norms including risk-taking behaviors, playing through pain, and self-reliance are highly valued amongst both male and female collegiate athletes as they support 'winning' and characteristics of a 'good athlete' (Kroshus et al., 2017). Therefore, the differences in SRC reporting behaviors may be a function of how much a particular athlete conforms to traditional masculine norms of sport culture, rather than the athlete's biological sex. This concept, along with the idea that social referents (i.e., coaches and teammates) impact athletes reporting behavior, has been applied to recent educational interventions that have incorporated the Theory of Planned Behavior (TPB) and Theory of Reasoned Action (TRA) to shift the culture of athletics and increase SRC reporting behaviors (Wallace et al., 2017; Kneavel et al., 2020).

Research Question 1(b)

This study found that athletes reporting intentions did not differ based on participants' year in college for freshman, sophomore, junior, and senior athletes. This finding was consistent with the results reported by Weber Rawlins et al. (2019) showing that college athletes' sport eligibility year did not impact their SRC reporting intentions. Although year in college and sport eligibility year may be different, these variables are closely related and suggest that athletes reporting intentions remain relatively unaffected by their class standing. Perhaps considering the athletes' status on the team (1st string, 2nd string, 3rd string) may be a more important consideration than their year in college when investigating athletes' SRC reporting behaviors. Athletes who make up the 1st string or the starting lineup may be less inclined to

report a potential SRC due to pressure from coaches or teammates to continue to play. Social referents including coaches and teammates have a substantial impact on SRC reporting behaviors as discussed by Wallace et al. (2017). This theory may also hold true for 2nd string athletes who may only receive a few minutes of playing time each game. These athletes may want to conceal a possible SRC for fear of losing the little playing time they already receive and the potential to advance their status on the team. In contrast, 3rd string athletes may be more likely to report a SRC than members of the 1st and 2nd string as these athletes may feel that they have little to lose if they report an injury as their status on the team will remain the same. Thus, future research may consider the impact of team status on an athlete's SRC reporting behavior.

Research Question 1(c)

The study found that participants' sport level of contact did not impact athletes' SRC reporting intentions. Athletes who participated in no contact, limited contact, contact, and combat/collision did not differ in their SRC reporting intentions. These findings are in contrast with the results from Chizuk et al. (2021) and Weber Rawlins et al. (2019) that showed that athletes who participated in limited contact or no-contact sports had higher SRC reporting intentions compared to athletes who participated in sports with higher levels of contact. Differences in the study population between the present study findings and Chizuk et al. (2021) may account for the variations in the researchers' findings. For example, Chizuk and colleagues (2021) investigated a wide range of age groups including elementary, high school, and college athletes. This population differed from the present study's sample which consisted of collegiate athletes only. Furthermore, the differences in findings between the present study and Weber Rawlins et al. (2019) may be due to differences in the sport contact level classification used in the research. In the present study, we classified sport level of contact into four groups (no

contact, limited contact, contact, and combat/collision), whereas Weber Rawlins et al. (2019) classified participants' sport level of contact into two groups (collision/contact and limited/non-contact). It is possible that these differences may have impacted the study findings. Further research considering the impact of sport contact level on SRC reporting is warranted, as findings remain inconclusive.

Research Question 1(d)

The present study found that the number of previously diagnosed SRCs did not impact athletes' reporting intentions. Specifically, the results showed that there were no statistically significant differences in SRC reporting intentions between college athletes with no previous SRC diagnosis, 1 diagnosed SRC, 2 diagnosed SRCs, 3 diagnosed SRCs, and 4 or more diagnosed SRCs. Intuitively, it may seem that an athlete with a previous SRC diagnosis would be more likely to report a future SRC; however, the findings from both our study and a study by Kroshus et al. (2020) do not support this idea. The results from Kroshus et al. (2020) showed that athletes with a previous SRC diagnosis had a significantly greater risk of continuing to play while experiencing symptoms of a possible SRC compared to athletes who did not have a diagnosed SRC. These findings illustrate that athletes may minimize the potential long-term effect of a concussion, suggesting the need for improved education regarding the potential long-term impact of SRCs. Athletes with multiple SRCs have an increased risk for long-term cognitive deficits and potentially serious brain diseases such as chronic traumatic encephalophagy (CTE) that occurs as a result of repetitive mTBIs (Fesharaki-Zadeh, 2019).

Research Question 1(e)

Research question 1(e) considers the cognitive, physical, and emotional symptoms of a SRC. This question was formulated to determine if college athletes would be more likely to

report a suspected concussion if they experienced symptoms listed on the novel symptom checklist. Of the 175 athletes who completed this checklist, 51 were considered 'likely reporters.' The results from the present study indicate that only 29% of college athletes would be willing to report a future SRC. The findings continue to show that most college athletes will not report a potential SRC to their coach, athletic trainer, or medical professional (Harmon et al., 2013; Milroy et al., 2019; Torres et al., 2013; Wallace et al., 2017). College athletes who fail to report these injuries may not receive needed SRC management services, including speech-language pathology services.

Research Question 2

Research question 2 was formulated to determine the SRC symptoms that college athletes would most likely report if they were to experience a future concussion. A total of eight symptoms were identified. These symptoms included visual changes, difficulty learning new information, increased headaches, noise sensitivity, feeling slowed down, confusion in a sports game, nausea/vomiting, and changes in sleep patterns. When considering the symptoms together, it appears that college athletes may be concerned most about the immediate physical changes that occur following a SRC and less concerned about the potential long-term effect. Of note, these eight SRC symptoms are ones that are commonly described by public health organizations (e.g., CDC, 2019; Mayo Clinic, 2022) and are therefore likely to be highlighted in SRC education initiatives. Thus, athletes may regard these symptoms as most important because of the nature of the SRC education they receive.

Research Question 3

Research question 3 was formulated to determine which SRC symptoms college athletes were least likely to report if they were to experience a future concussion. The findings from the

present study identified two symptoms that participants were least likely to report, namely walking into a room to get something and forgetting what it was you wanted and difficulty managing money. When considering the results from research questions 2 and 3 together, it appears that athletes may be less willing to report symptoms that could impact their ability to function at school or at work. That is, forgetting what item to get from a room indicates that the person may have problems with short-term memory, which is an important function for successfully completing many school- and work-related projects. It is also important to note that these two symptoms are seldom included in SRC education initiatives. Thus, the findings from research questions 2 and 3 raise questions about whether SRC education could be improved by explicitly including more meaningful and functionally related information about the detrimental impact of cognitive impairments post-concussion.

In light of the findings from the present study and the results from previous research, it may be beneficial to incorporate more information about cognitive-communication impairments into future SRC education initiatives. Previous findings from Knollman-Porter et al. (2018) revealed that SRC symptoms that had a direct impact on school performance were recognized by less than 70% of college students. Additionally, the findings from Wallace et al. (2017) demonstrated a gap in college athletes' knowledge of potential cognitive impairments associated with concussion. The results from the present study indicated that athletes may be less concerned about cognitive-communication deficits that could impact their ability to function in school or at work than physical symptoms associated with SRC. These findings raise concerns, as the NCAA recently reported that less than 2% of NCAA athletes make it into professional athletics (National Collegiate Athletic Association [NCAA], 2020). Consequently,

after college, most athletes will have to rely on high-level cognitive abilities to function in society and maintain employment.

Clinical Implications

Over the past decade, increased evidence has emerged regarding the benefit of speech-language pathology services for people with a mTBI (Anjum et al., 2022; Brown & Knollman-Porter, 2020; Brown et al., 2019; Chessnut, 2021; Ketcham et al., 2017; Knollman-Porter et al., 2014; Lundine et al., 2019; Mashima et al., 2021). Although SLPs' expertise may be valued in the management and treatment of athletes experiencing persistent SRC symptoms, SLPs have largely been left out of education efforts aimed at increasing SRC reporting rates. Increasing SRC reporting rates should be a concern to the field, as improving reporting will increase athletes' access to speech-language pathology services. SLPs' extensive knowledge of cognitive-linguistic impairments could be useful in the development of SRC educational initiatives. The American Speech-Language-Hearing Association (ASHA) Scope of Practice document identifies cognition, including attention, memory, problem-solving and executive functioning, as one of the "big nine" areas that are within SLPs' scope of practice (ASHA, 2016). The document also delineates 'education' as one of the five domains of professional practice for SLPs (ASHA, 2016). Additionally, incorporating SLPs into the administration of SRC education models may increase their visibility to the student-athlete body. If SLPs become a familiar face, athletes may be more willing to report a potential SRC to them, as they are objective members of the concussion management teams with no direct ties to the sport team.

Limitations

This investigation has limitations to consider in the interpretation of the study findings. Although the primary investigator made several attempts to obtain a diverse group of

participants by repeated recruitment efforts, some groups were disproportionately represented in the sample. That is, most participants indicated that they were female (67.4%) and 75.6% of the participants described their ethnicity as being 'white.' Additionally, participants came from three NCAA institutions all located in the Philadelphia region. These demographic factors may limit the generalizability of the results of the study to other populations. A second limitation of this study is that it relied on participant self-report of a future event. Therefore, we cannot be certain if the athlete's reporting intention would match their actual SRC reporting behavior.

Directions for Future Research

As highlighted above, future research should consider examining the impact that an athlete's status on the sport team has on SRC reporting behaviors. It is possible that athletes, who are a part of the first string, could be less inclined to report a potential SRC due to their prominence on the team. A similar variable to be investigated in future SRC reporting research is the athlete's belief that they may make it into professional athletics. The NCAA recently disclosed that roughly 98% of collegiate athletes do not make it 'pro;' however, this statistic may not match athletes' perceptions. Athletes who aspire to make it into professional athletes may exhibit less concern regarding the potential long-term impacts of a SRC and may be less willing to report SRC symptoms. Therefore, future research should investigate athletes' perceptions and beliefs surrounding making it 'pro' and the overall impact that this has on SRC reporting behaviors.

The present study supports the need for research examining the efficacy of SRC education models that explicitly provides information on the everyday, functional impact of persistent cognitive deficits associated with SRC. Incorporating SLPs' expertise into SRC educational initiatives may help to facilitate a greater understanding of the potential long-term

impacts of SRCs. Comprehensive SRC education models should include information about the cognitive-linguistic deficits that athletes may experience post-concussion, describe how those deficits may manifest in athletes' school day, when completing homework, or participating in their sport. Increasing athletes' overall knowledge regarding cognitive-linguistic deficits may make identification of a possible SRC easier. Educational initiatives should also increase athletes' knowledge regarding long-term cognitive-linguistic deficits associated with SRC, and the role of SLPs in managing those deficits. Increasing athletes' awareness of potential long-term effects that a concussion or repeated head injuries can have on their life may be another faucet that helps to shift the culture of athletics and increase SRC reporting behaviors.

Appendix A
Informed Consent Document To Participate In Research

Exploring the Variables Associated with Reporting Sport-Related Concussions in College Athletes

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PROCESS OF INFORMED CONSENT

You are being asked to participate in a research study. For you to decide if you want to volunteer for this project, you should make an informed decision based on an understanding of what this research is about and the possible risks and benefits. This process is known as informed consent. This document describes the purpose, procedures, possible benefits, and risks, as well as how your personal information will be used and protected. Once you have read this form and your questions about the study are answered, you will be asked if you want to take part in the study; if so, you will be asked to sign this electronic consent form. This will allow your participation in this study. You may print a copy of this informed consent for your records.

RESEARCH PURPOSE

We invite you to participate in a research study. The purpose of this study is to better understand the variables associated with college athletes' intentions to report a sport related concussion. We anticipate that about 200-1,000 male and female college athletes at La Salle University and Chestnut Hill College in Philadelphia, PA and Muhlenberg College in Allentown, PA will complete this study. To participate, you must be at least 18 years old and be able to read and write in English.

PARTICIPATION

If you agree to participate in this study, we will provide you with a link that will bring you to an anonymous online questionnaire. The 10-15-minute questionnaire will involve answering basic

questions about yourself (age, gender, ethnicity, year in college, and sport you play). Additionally, there will be questions concerning your intention to report sport-related concussions to a coach or athletic trainer for yourself and for a teammate. You may complete the questionnaire using your computer, smart phone, tablet, or other personal device, in a location of your choosing at any time that is convenient for you. If you choose to complete the questionnaire in public, please be aware of your surroundings. In order to protect your confidentiality, we recommend that your personal device cannot be viewed by others.

ANTICIPATED BENEFITS OF PARTICIPATION

Although there may be no direct benefit to you, understanding the factors associated with reporting sport-related concussions may guide future educational programs for athletes, parents, and interdisciplinary professionals. Additionally, this research may lead to more effective management of sport-related concussions by medical professionals, improving post injury care and outcomes.

ANTICIPATED RISKS AND DISCOMFORTS OF PARTICIPATION

There are no more than minimal risks involved in participating in this study. Please note that if you do experience any discomfort while completing the study, you may skip any question that you do not want to answer. You may also stop participating at any time with no penalty. If you want to discuss any issues that concerned you about the study, you may contact the principal investigator, Karle Linden at lindenk2@lasalle.edu or (814) 602-1345. You may also seek counseling services at your University's Counseling Center (La Salle University: (215) 9511355, Chestnut Hill College: (215) 233-1914, Muhlenberg College: (484) 664-3178).

RISKS TO CONFIDENTIALITY AND DATA SECURITY

Any information obtained about you as a result of your participation in this research will be kept as confidential as legally possible. Specifically, the responses to questionnaires will be in a secure, password-protected file in a locked file cabinet. All data and materials will be kept for seven years after completion of the study, and then will be permanently erased by Dr. Ryan S. Husak, Ph.D. CCC-SLP.

DISSEMINATION OF RESULTS

If you would like to know the overall findings of this study, you may contact Karle Linden at lindenk2@lasalle.edu; otherwise, you will not be informed of the results.

VOLUNTARY NATURE OF PARTICIPATION

Your participation in this study is completely voluntary. You do not have to participate. If you do decide to participate, you are free to withdraw your consent and remove yourself from participation in this study at any time without penalty.

COMPENSATION
It will not cost you to participate in this study, and you will not be compensated for your participation.

RESEARCHER CONTACT INFORMATION
If you have questions, concerns, or complaints; or would like to know the results of the study, please contact the Primary Investigator: Karle Linden, Master's Student, Department of Communication Sciences and Disorders, (814) 602-1345, lindenk2@lasalle.edu.

IRB CONTACT INFORMATION
The Institutional Review Board (IRB) of La Salle University is responsible for protecting individuals participating in this research project. If you have any questions or concerns regarding your rights as a research participant or any complaints about the research, please contact Ariel McAnulty, IRB Administrative Assistant at (215) 991-2728 or mcanulty@lasalle.edu. You may also write to the IRB Chair, Dr. Susan Borkowski, Ph.D., at the Department of Accounting, La Salle University, 1900 W. Olney Avenue, Philadelphia, PA 19141.

CONSENT STATEMENT
I have read and understand the statements about this study and have received a copy of the consent form. By providing my signature electronically here indicates that the procedure has been explained to me and that I agree to participate in this research. I understand that I may withdraw my permission and may discontinue participation at any time without penalty. I understand that I will receive no compensation for this study.

Participant's Name (Please print) _____

Participant's Signature _____ Date _____

Investigator's Name (Please print) _____

Appendix B

Recruitment Script

Hello, my name is Karle Linden and I am a graduate student in the Speech-Language Pathology program at La Salle University. I am conducting a research study to investigate the factors associated with college student athletes' intentions to report a sport-related concussion. I became interested in this topic throughout my academic coursework, and because I am a college student athlete. I understand the impact that a sport-related concussion can have on a person and a sports team. This study requires participants to complete a short questionnaire. Participation is voluntary. If you were to participate in this study, it would provide me with the information needed to complete a master's thesis. I would greatly appreciate your support in this project. If you have any questions you can email me at lindenk2@lasalle.edu. If you choose to participate, you will be asked to sign an electronic informed consent. The questionnaire will take approximately 10-15 minutes of your time. Thank you.

Appendix C
Sport-Related Concussion Questionnaire for College Athletes

Demographic Profile

1) What is your gender?
___ Female
___ Male
___ Non-binary

2) Please specify your ethnicity.
___ White
___ Hispanic/Latino
___ Black or African American
___ Native American or American Indian
___ Asian/Pacific Islander
___ Other (please specify) _____
___
3) What is your primary language (the language you currently use most of the time)?
___ English
___ Spanish
___ Other (please specify) _____

4) What is your age in years?
___ 18
___ 19
___ 20
___ 21
___ 22
___ 23
___ 24

5) What year of college are you currently in?
___ Freshmen
___ Sophomore
___ Junior
___ Senior
___ Fifth year

6) What is your athletic eligibility year?
___ Freshmen
___ Redshirt Freshmen
___ Sophomore
___ Redshirt sophomore
___ Junior
___ Redshirt junior

___Senior
___ Fifth year

7) How many NCAA sports do you currently participate in?
___ 1
___ 2
___ 3
___ More than 3

8) Please select all of the NCAA sports that you currently participate in.
___ Football
___ Sprint football
___ Lacrosse
___ Soccer
___ Baseball
___ Softball
___ Field hockey
___ Basketball
___ Other (please specify) _____

9) What NCAA division does your sport's team compete in?
___ Division 1
___ Division 2
___ Division 3
___ Other (please specify)

10) On average, how many hours a week do you participate in your NCAA sport during the competitive season (including practice time and games)?
___ 1-5 hours
___ 6-10 hours
___ 11-15 hours
___ 16-20 hours
___ Over 20 hours

11) Have you ever been diagnosed with a sport-related concussion?
___ Yes
___ No

12) If yes to the previous question, please indicate the number of sport-related concussions you've been diagnosed with.
___ 1
___ 2
___ 3
___ More than 3 (please specify number) _____

13) Do you feel that you have ever had a sport-related concussion that was undiagnosed?
___ Yes
___ No

14) Have you previously been educated on mild head injury/concussion?
___ Yes
___ No

15) If yes to the previous question, approximately how many hours of education have you received on mild head injury/concussion during each athletic season?
___ 1-2 hours
___ 3-4 hours
___ 5-6 hours
___ More than 6

16) On average, how many hours of sleep do you get every night?
___ 0-3 hours
___ 4-7 hours
___ 8-11 hours
___ More than 11 hours

Intention to report a sport-related concussion to an athletic trainer or coach

For each of the questions below, circle the response that best characterizes how you feel about the statement, where: 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = Neither agree or disagree, 5 = Somewhat agree, 6 = Agree, 7 = Strongly agree

When I myself experiences possible concussion symptoms:	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
17. I intend to report under most circumstances.	1	2	3	4	5	6	7
18. I plan to report even if I am not sure it is serious.	1	2	3	4	5	6	7
19. I will make an effort to report.	1	2	3	4	5	6	7

20. I plan to report when I notice symptoms.	1	2	3	4	5	6	7
21. I will report if it happens in a playoff or championship game.	1	2	3	4	5	6	7
22. I intend to report in a practice.	1	2	3	4	5	6	7

Intention to report a sport-related concussion to an athletic trainer or coach

For each of the questions below, circle the response that best characterizes how you feel about the statement, where: 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = Neither agree or disagree, 5 = Somewhat agree, 6 = Agree, 7 = Strongly agree

How likely are you to report a sport-related concussion if you were to experience a change in the following:	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
23. Poor concentration while watching a movie	1	2	3	4	5	6	7
24. Poor concentration while reading	1	2	3	4	5	6	7
25. Visual changes, such as sensitivity to light	1	2	3	4	5	6	7
26. Difficulty learning new information at school	1	2	3	4	5	6	7
27. Walking into another room to get	1	2	3	4	5	6	7

something and forgetting what to get							
28. Decreased reading speed when reading silently	1	2	3	4	5	6	7
29. Difficulty managing money	1	2	3	4	5	6	7
30. Increased headaches	1	2	3	4	5	6	7
31. Forgetting personal items at home such as a wallet or cellphone	1	2	3	4	5	6	7
32. Sensitivity to noise	1	2	3	4	5	6	7
33. Feeling slowed down or foggy consistently throughout the day	1	2	3	4	5	6	7
34. Confusion while participating in a sports game such as remembering the score of the game, opponent, or assigned position	1	2	3	4	5	6	7
35. Difficulty completing daily tasks within the time limits you set	1	2	3	4	5	6	7
36. Difficulty thinking of the right word to say in a conversation	1	2	3	4	5	6	7
37. Feeling more overwhelmed when having to complete tasks throughout the day	1	2	3	4	5	6	7

38. Nausea or vomiting	1	2	3	4	5	6	7
39. Needing more time to complete a class assignment	1	2	3	4	5	6	7
40. Difficulty managing everyday chores, such as doing laundry or a cooking meal	1	2	3	4	5	6	7
41. Needing more time to understand what others are saying while having a conversation	1	2	3	4	5	6	7
42. Frequently forgetting to turn in assignments for class	1	2	3	4	5	6	7
43. Difficulty working on more than one task at a time	1	2	3	4	5	6	7
44. Changes in sleep patterns such as fatigue, insomnia, or daytime sleepiness	1	2	3	4	5	6	7
45. Difficulty with telling a story in the correct sequence	1	2	3	4	5	6	7
46. Difficulty finishing a project	1	2	3	4	5	6	7
47. Frequently forgetting items you need to purchase from the store	1	2	3	4	5	6	7
48. Difficulties setting objectives and	1	2	3	4	5	6	7

determining a course of action to achieve the objectives							

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