EXAMINING SPORT-RELATED CONCUSSION ASSESSMENT AND MANAGEMENT TECHNIQUES AMONG ATHLETIC TRAINING PRECEPTORS VERSUS NON-PRECEPTORS.

By

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ABSTRACT

Background: Sport-related concussions (SRC) are common injuries that athletic trainers (ATs) often handle initially. They receive training through accredited programs, which follow specific standards set by organizations like CAATE and NATA. New CAATE standards in 2020 focus on SRC assessment and management. However, not all ATs, especially those not supervising students (non-preceptors), may be aware of these updates, leading to gaps in practice. SRC symptoms vary and require thorough assessments beyond just asking about symptoms. Despite guidelines, many ATs still rely on outdated tools and treatments. Preceptors, who guide student ATs, face challenges in staying updated on new standards, particularly with recent curriculum changes. By categorizing experience into 0-5 years and 6 or more years, we aim to understand how familiarity with standards evolves over time.

Purpose: The purpose of this study was to determine if certified ATs who are preceptors are using 2020 CAATE standards for concussion assessment and management. Secondarily, to examine if years of experience as an AT is associated with utilization of the new CAATE standards for concussion assessment and management.

Methods: A cross-sectional study investigated concussion assessment and management practices among certified ATs. A random sample of 1000 active NATA members was recruited, excluding those who didn't consent. The survey, adapted from previous research, included demographic questions and assessment of concussion practices aligned with 2020 CAATE standards. Face and content validity were established through expert review and pilot testing. Data was collected online and in paper format over four weeks. Descriptive statistics and regression analysis were used to analyze the data, testing hypotheses related to the utilization of CAATE standards for concussion assessment and management. Logistic and multinomial logistic regression were employed to assess associations between preceptor status, years of experience, and utilization to CAATE standards. Results provide insights into AT adherence to standards in concussion management.

Results: The pilot study, conducted on June 8-9, 2023, involved 24 certified athletic trainers (ATs), consisting of 58.3% females and 41.7% males. Among them, 79.2% were preceptors, and 20.8% were non-preceptors, with a mean age of 47.4 ± 13 years. The majority identified as white (87.5%), followed by black or African American (8.3%) and mixed race (4.2%). High school

athletics, DI college athletics, and DII college athletics were the primary places of employment. The pilot study focused on establishing face validity. In the main study, 298 certified ATs participated, with 61.7% females and 38.2% males. The mean age was 36.6 ± 11 years, with the majority identifying as white (90.5%). High school athletics, DI athletics, and academic settings were the top employment venues. Logistic regression analyses revealed significant associations between preceptor status and the utilization of CAATE standards for concussion assessment and management. Preceptors demonstrated higher odds of utilizing CAATE standards, particularly in diagnostic practices (standard 76), plan of care implementation (standard 76), and policy (standard 93) utilization for concussion management. The multivariable multinominal logistic regression results indicated significantly higher odds among preceptors for utilizing diagnostic and plan of care items compared to non-preceptors. Logistic regression analyses showed that ATs with 6+ years of experience had higher odds of utilizing CAATE standards for concussion assessment and management compared to those with 5 years or less of experience specifically with diagnosis, plan of care, and policy items. Overall, the final model results suggest that preceptorship and years of experience play significant roles in the utilization to CAATE standards for concussion assessment and management among certified ATs, highlighting the importance of mentorship and experience in promoting best practices within the athletic training field.

Conclusion: This study aimed to assess the utilization of 2020 CAATE standards for concussion assessment and management among ATs acting as preceptors, while also exploring the potential influence of years of experience on their adoption of these standards. The results indicate that preceptors have higher odds of utilizing CAATE standards compared to non-preceptors, demonstrating a higher utilization of diagnostic, plan of care, return-to-play, and policy items. Additionally, ATs with six or more years of clinical experience also showed higher odds to updated standards. These findings emphasize the crucial role of mentorship in promoting best practices within the athletic training profession, fostering excellence and accountability in concussion management. However, limitations such as potential response bias and the need for further research to explore mentorship dynamics and address potential barriers to utilization of CAATE standards should be acknowledged.

I dedicate this dissertation to my mom, Kelly McGrandy. Your strength, independence, and selflessness have been an inspiration to me throughout my life. I cannot express enough gratitude for everything you have done for me. I owe who I am and where I am today to you.

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CHAPTER 1: INTRODUCTION

1.1 Overview of the Problem

Sport-related concussion (SRC) is one of the most complex injuries that healthcare professionals must assess and manage. Each year 1.6-3.8 million SRCs occur in the United States.[1-3] Athletic trainers (AT) are usually the first licensed medical professional responsible for initial identification and management of SRCs.[4,5] ATs go through comprehensive training in a Commission on Accreditation of Athletic Training Education (CAATE) program with competencies set by the National Athletic Trainers' Association (NATA) Professional Education Council.[4-6] One requirement of athletic training educational programs is to complete hands-on clinical educational within athletic training and general medical populations.[7] The new 2020 CAATE standards include three standards (e.g., 71, 76, 93) that pertain to SRC assessment, management and treatment. Standard 71 covers various health conditions, including neurological issues like concussions and brain injuries, while standards 76 and 93 specifically address concussion assessment and management. More specific, CAATE standard 76 focuses on evaluation and management following guidelines, and CAATE standard 93 emphasizes policy development for concussion and brain injury cases.[7] However, ATs who are not preceptors (e.g., clinical supervisors) to students in a CAATE education program may not be aware of these updated standards. Moreover, ATs who do not keep up with the concussion literature may also not be aware of the new targeted treatment options and clinical profiles[8] now used to manage an SRC.

Following an SRC, a myriad of symptoms can arise including cognitive (e.g., difficulty concentrating, memory issues), physical (e.g., dizziness, headaches), emotional changes (e.g., anxiety, irritability), and sleep difficulties.[9] The uniqueness of SRC symptoms is that they includes both physical and psychological aspects, which can cause treatment and recovery to be variable resulting in ATs taking an individualized approach. ATs must utilize a comprehensive examination to be able to recognize the numerous domains that could affect an injured athlete. Moreover, a multimodal battery of tests has been supported and recommended by multiple international and domestic organizations.[10-12] The comprehensive examination of an SRC extends beyond the subjective symptom assessment and can include but is not limited to neurocognitive evaluation, assessment of the vestibular and vision systems, cervical spine involvement, mental health status, sleep assessment, exertional testing, nutritional status, and

clinical interview.[7,12,13] Although these recommendations should be used by ATs there is still a disconnect between best practice guidelines and actual clinical practice. Lempke and colleagues[14] found that ATs were still using outdated assessment tools such as the Sport Concussion Assessment Tool (SCAT) 2, which was released in 2009, while some were still using grading scales (e.g., Cantu released in 1980s, American Academy of Neurology). Notably, the SCAT has been revised throughout the years including the SCAT3 in 2013,[15] the SCAT5 (SCAT4 was skipped to align with the Consensus Statement) in 2017,[16] and the SCAT6 which was released in 2023 for use, representing a more updated tool for concussion assessment.[12] Not only are ATs using outdated assessment tools there is also a continuation of homogenous or one size fits all model with SRC (e.g., same return to play timeline for everyone with SRC). However, those models do not work as everyone will present with different signs and symptoms indicating an individualized targeted treatment approach. Treating all individuals with a one-size fits all approach could cause further harm than good.[12,13] Previous treatment for SRC consisted of strict brain rest (e.g., cocooning) until all symptoms were alleviated, which is now not the recommended protocol due to the possible negative effects (e.g., social isolation, anxiety, issues with self-esteem, loss of academic standing) on recovery.[10,17] Concussion management presently consists of 24 to 48 hours of cognitive and physical rest followed by active rehabilitation that could help improve symptom recovery.[13,18]

Previous studies have stated that ATs were not following the multi-faceted approach to SRCs due to their lack of self-efficacy in application of tools.[23-25] This could help explain research such as Lempke et. al.[26] who reported that ATs with more clinical experience had lower odds of using SRC assessment and management tools. Just because ATs have more years of clinical experience, does not mean they are keeping up to date on the most current literature regarding SRC assessment and management. Another study found that 10.5% of their participants from a variety of primary work settings (e.g., high school athletics, collegiate athletics, sports medicine clinic, industrial, professional sports) were still using outdated assessments such as the SCAT3,[27] and 42.8% were still using the Romberg test for balance and coordination suggesting ATs are not utilizing the best evidence for patient-centered practice.[27] Highlighting the importance of relying on outdated practices is essential, as it could impede accurate concussion assessment and management, ultimately resulting in inadequate care for athletes. Research[28] also suggests that high school ATs believed there was a lack of

standardization of SRC assessment and management which lead to uncertainties on their approach when evaluating a SRC. Moreover, this qualitative study found that inconsistencies among participants stemmed from confidence in using non-specified SRC assessment tools.[28] Understanding why ATs may not be applying recommended tools to their clinical practice is key for improvements within concussion assessment and management.

Clinical and immersive experiences can take place at a variety of clinical sites where ATs act as clinical supervisors known as preceptors to athletic training students. According to CAATE, preceptors are defined as "certified athletic trainers who supervise CAATE accredited program students in clinical education rotations. Preceptors must be licensed and credentialed by the state where they practice."[7] As a preceptor the goal is to serve as an AT in their respective clinical sites, however, they also have the responsibility of mentoring, teaching, and evaluating athletic training students to ensure they gain necessary hands-on experience throughout their clinical education rotations. However, many challenges have been faced when it comes to educational changes in the field of athletic training such as moving to an entry-level master's curriculum program. Therefore, it is imperative for preceptors to stay up to date on the newest CAATE standards and educational competencies.

With the shift to a master's level curriculum, it is unclear if preceptors are even of these modifications to the CAATE standards, and if they are do they feel confident in teaching these competencies to athletic training students. CAATE accreditation standards for athletic training programs have undergone revisions periodically to reflect advancements in the field, changes in best practices, and evolving educational requirements.[7] The frequency of these changes can vary depending on various factors such as emerging research, updates in healthcare regulations, and advancements in athletic training education. However, historically, revisions to CAATE accreditation standards have occurred approximately every five to seven years to ensure alignment with current practices and standards within the profession.[7] To-date there is no evidence that suggests that preceptors are fully understanding the changes that have been made to the CAATE standards and clinical competencies. As a result, there could be a disconnect between what is being taught in the classroom and a student's overall clinical experiences.

As of 2020, CAATE updated the standards for athletic training programs, expanding their scope for interpretation. Understanding these standards is crucial for enhancing the quality of care and fostering up-to-date practices in concussion management for future clinicians. For

example, standard 71 states that students should be able to "perform an examination to formulate diagnosis and plan of care for patients with health conditions".[7] Within standard 71 there is a multitude of conditions listed including neurological system that could include concussions and brain injury. While standard 71 is broader, both standards 76 and 93 are more specific to concussions. Standard 76 identifies if athletic training students are able to "evaluate and treat a patient who has sustained a concussion or other brain injury, with consideration of established guidelines".[7] The last standard related to concussion is standard 93 " develop and implement specific policies and procedures for individuals who sustained a concussion or other brain injuries".[7] Each of these standards represents the standard education that athletic training students are expected to undergo. However, there are intricacies within these standards, such as educating stakeholders, implementing targeted treatment, and managing SRC that may not be fully understood by all preceptors. Therefore, this lack of understanding may lead to inconsistent delivery of education or practice. As preceptors are teaching future ATs, it is imperative that they are knowledgeable and have confidence in these newer clinical skills being utilized for the assessment and management of SRCs. Over the years assessment and management of SRC has evolved creating challenges among ATs especially those with more years of clinical experience.[29] These barriers of implementation have been noted as lack of time and resources, and clinical practices have been found to use outdated information.[30,31] Therefore, it is critical for ATs to stay current with recommended practices and implementing those changes into clinical practice.

Years of clinical experience can play a pivotal role in the field of athletic training, where practical clinical expertise and real-world exposure are essential for ensuring the health, safety, and performance of athletes. While years of experience can provide numerous advantages in the field of athletic training, there are potential downsides as well. The key to experienced ATs is to strike a balance by staying current with best practices, continuously improving their skills, remaining open to new ideas and approaches to ensure they provide the best possible care for athletes. Since the release of the CAATE standards of 2020, years of clinical experience have gained particular significance due to the evolving landscape of athletic training education and practice. These standards introduced new protocols, techniques, and guidelines that seasoned athletic trainers need to adapt to and integrate into their practice. Therefore, their years of

experience become invaluable in navigating these changes while continuing to provide high-quality care to athletes.

In addition to determining if preceptors are knowledgeable on the 2020 CAATE Standards, it is imperative to also understand if years of experience relates to knowledge of CAATE standards. Examining years of experience, especially categorizing them into two 5 years, 6 or more years), is vital for assessing whether ATs have remained abreast of current guidelines. The 5th Berlin Consensus Statement on Concussion in Sport was published in 2017, representing a significant milestone in concussion management guidelines. This pivotal release represented a comprehensive overhaul of existing protocols, emphasizing the need to investigate whether years of experience correlate with familiarity with the updated protocols.[18,32] Considering that the current study was conducted six years after the release of these consensus guidelines, individuals with six or more years of experience would have had sufficient time to integrate and adapt to these updated standards into their clinical practice. Conversely, ATs with 0-5 years of experience would have entered the field post-2017, potentially aligning more closely with the newer consensus guidelines introduced during their clinical experience.[12,33]

Furthermore, the rationale behind utilizing a cutoff of 0-5 years of experience aligns with the timeframe of changes in concussion management guidelines, notably the shift towards the updated 2020 CAATE standards.[7] These individuals may have had exposure to evolving practices and updates within the field, including advancements in return-to-learn protocols, stepwise progression strategies, and changes to CAATE standards. Additionally, research is needed to capture a cohort that has experience with the transition from previous guidelines to the new consensus statements, which may influence their clinical decision-making processes. In essence, the rationale for categorizing ATs' years of experience into two distinct groups is grounded in the timing of guideline releases, changes in consensus statements, and the desire to capture the impact of evolving standards on clinical practice across varying experience levels within the athletic training profession.

Additionally, incorporating individuals with 6 or more years of experience enables the exploration of longer-term trends and adaptations in concussion management practices. This demographic may have encountered numerous iterations of guideline updates and observed shifts in clinical standards throughout their career, offering valuable insights into the evolution of concussion management protocols.

1.2 Purpose of the Study

The purpose of this study was to determine if certified ATs who are preceptors are using 2020 CAATE standards for concussion assessment and management. Secondarily, to examine if years of experience as an AT is associated with utilization of the new CAATE standards for concussion assessment and management.

Hypotheses

H1: ATs who are preceptors are more likely to utilize CAATE standards for concussion assessment and management compared to ATs who are not preceptors.

H2: ATs with 6+ years of experience are less likely to utilize CAATE standards for concussion assessment and management compared to ATs with 5 years or less of experience.

1.3 Operational Definitions

Accreditation: The process in which institutions, colleges, universities, and programs of higher education are evaluated for validation.[7,34]

Athletic Trainer (AT): A healthcare provider who provides services such as emergency response, primary care, injury and illness prevention, wellness promotion and education, examination and clinical diagnosis, therapeutic intervention, and rehabilitation of injuries and medical conditions. An AT is part of a healthcare team in which they are under the direction of a physician, in compliance with their state, statues, and regulations.[7,34]

Athletic Training Student: A student currently enrolled in a CAATE accredited program.[7,34]

Commission on Accreditation of Athletic Training Education (CAATE): CAATE is a non-profit organization that ensures compliance with accreditation standards to enhance athletic training education. CAATE is the only program accreditor in athletic training.[7,34]

Clinical Education: Incorporates three different learning opportunities to prepare students in a CAATE accredited program including athletic training clinical experiences, independent clinical practical, simulation, and supplemental clinical experiences.[7,34]

Concussion: A TBI caused by a direct blow to the head, neck, or body resulting in an impulsive force being transmitted to the brain.[12] The definition proceeds to talk about the initiation of neurotransmitters and metabolic cascade with possible axonal injury, blood flow change, and inflammation affecting the brain.[12]

Sport-related Concussion: Arise as a direct consequence of biomechanical forces exerted on the body or head, resulting in the acceleration, deceleration, and rotational forces acting upon the brain.[12,35]

Preceptor: Certified ATs who supervise CAATE accredited program students in clinical education rotations. Preceptors must be licensed and credentialed by the state where they practice and attend preceptor training.[7,34]

Non-Preceptor: Certified ATs who do not supervise students in a CAATE accredited program during their clinical education rotations.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Introduction

This review of literature provides a comprehensive summary of the research on sport-related concussions (SRC), particularly in assessment and management. The definition of concussion is discussed first, followed by an overview of pathophysiology, along with an in-depth look at the epidemiology of SRC. Next, the evaluation and assessment will be reviewed followed by return to play protocols. Early studies that have shaped our understanding of SRC assessment and management are thoroughly reviewed. Furthermore, the role of AT as preceptors, in line with CAATE concussion standards, will be discussed. Finally, this chapter concludes with a summary of relevant gaps in the literature and the purposes of the present study.

2.2 Sport-related Concussion Definition

Over the years there has been much debate over the definition of SRC. The debate began in the early 1960s with defining concussion due to the usage of a mechanical incident of the head and using it as a state of the injured person.[36] Continuing with the differing opinions many of those used loss of consciousness to determine if one had a concussion.[36] However, in more recent times it has been noted that loss of consciousness is not the main determining factor in diagnosis. In 1966, the Committee on Head Injury Nomenclature of the Congress of Neurological Surgeons defined concussion as a clinical syndrome characterized by immediate and transient impairment of neural function, such as alteration of consciousness, disturbance of vision, and equilibrium, due to mechanical forces.[37] The Quality Standards Subcommittee of the American Academy of Neurology and the National Athletic Trainers Association (NATA) have a more similar definition which is a trauma-induced alteration in mental status that may or may not involve loss of consciousness.[11,38] The Concussion in Sport Group (CISG) modified their previous definition in 2017 to SRC is a traumatic brain injury (TBI) induced by biomechanical forces.[18] In 2022, the CISG group again modified their definition to align with recent evidence in the understanding the pathophysiology of SRC.[12] The definition now states a SRC is a TBI caused by a direct blow to the head, neck, or body resulting in an impulsive force being transmitted to the brain.[12] The definition proceeds to talk about the initiation of neurotransmitters and metabolic cascade with possible axonal injury, blood flow change, and inflammation affecting the brain.[12] The American Medical Society for Sports Medicine (AMSSM) defines concussion as a traumatically induced transient disturbance of brain function that involves

pathophysiological process.[10,13] The Center of Disease Control (CDC) and Brain Injury Association of America states that concussion is a type of TBI, caused by a bump, jolt, blow to the head that ranges in severity from mild to severe and can change the way your brain typically works.[3,39]

Although there are resemblances among the definitions there are limitations that come from not having a gold standard definition for SRC. For example, with the constant use of the internet by athletes and their parents can create confusion with the multiple definitions of an SRC. Having one gold standard definition will allow those internet searches to be less overwhelming and confusion to the layperson. This will also help healthcare providers educate their patients when discussing SRC. Therefore, validation of a gold standard should be key for experts in the field of SRC research.

2.3 Pathophysiology of Concussion

Immediately following a concussion injury, the brain suffers a major disruption of homeostasis. Concussion is considered a functional injury that causes distress of cellular or physiological functions resulting in a neurometabolic cascade.[40,41] The neurometabolic cascade of events following an SRC involves cytoskeletal and axonal alterations, impairments in neurotransmission, bioenergetic chances, and vulnerability to delayed cell death and possible chronic dysfunction.[40,41] The neurometabolic cascade is said to be most distinct within the first few hours and days following an SRC.[21,40,41] Essentially before a concussion the cell membrane is intact with calcium on the outside and potassium inside of the cell membrane. Immediately following the injury, there is a temporary neuronal dysfunction when the cell membrane is disrupted and both the calcium and potassium shift together.[21,40,41] This neuronal dysfunction causes both sodium and potassium pumps to work harder by needing gradual amounts of adenosine triphosphate (ATP) to restore the neuronal membrane to normal potential.[40,41] Typically during this time there is an increase in glucose metabolism[40,41] which can be considered the most vulnerable time for the brain to get subsequent injuries.[21,40,41] After hypermetabolism, there is a slowing of glucose and metabolism, but levels of calcium can increase leading to impairment of mitochondrial oxidative metabolism.[21,40,41] The access calcium has been shown to lead to cell death, disruption of neurofilaments, microtubules, impairing posttraumatic neural connectivity.[21,40,41] Figure 1 below is a visualization of the neurometabolic cascade.

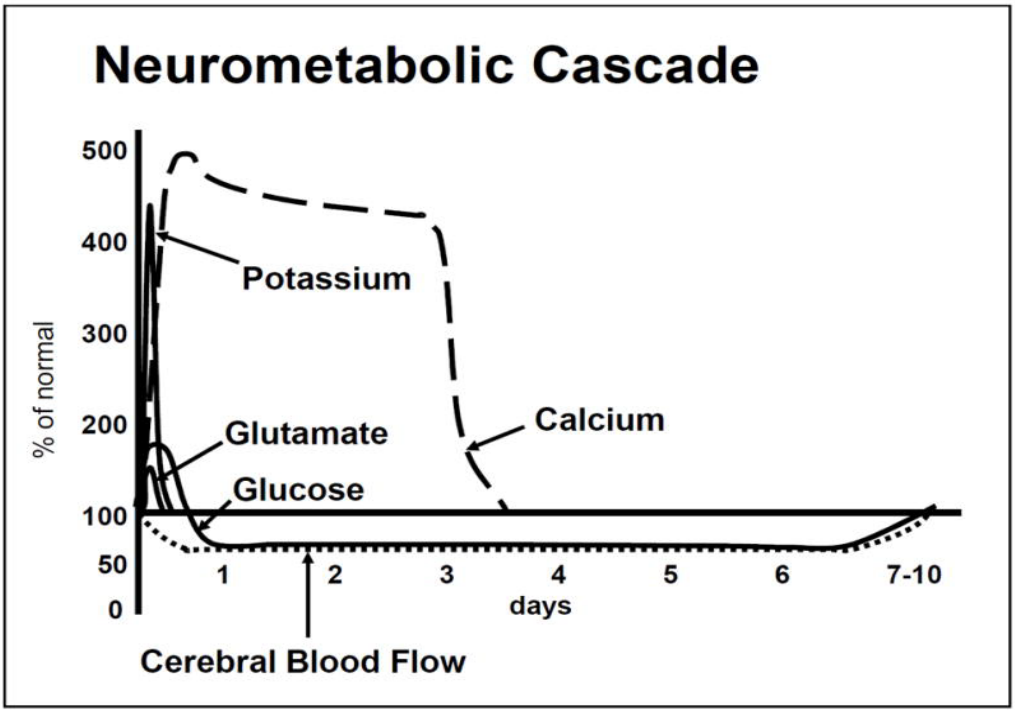

Figure 1. *The time course of the neurometabolic cascade following experimental concussion. From "The New Neurometabolic Cascade of Concussion," by C. Giza and Hovda, 2014*

2.4 Epidemiology of Concussion

SRC is a major public health concern[42,43] that affect millions of individuals each year in the United States (US).[4] More specifically 3.8 million SRCs occur annually[1,11] with the CDC estimating that 5-10% of athletes will experience an SRC in any given sports season.[3] An estimated 238,000 children younger than 18 years of age sought care at an emergency department (ED) for sport or recreation-related concussions between 2010-2016.[44] A study in 2015 compared concussion rates between youth, high school, and collegiate levels.[45] Among all three levels the concussion rate was higher in games compared to practice.[45] It was also found that college athletes had the highest incidence rate of 3.74 per 1,000 athletic exposures (AE), followed by high school athletes at 1.86 per 1,000 AE, and youth athletes at 1.57 per 1,000 AE.[45] However, it is important to note that the numbers could be under represented as many SRCs go unreported, misdiagnosed, or that individual might not have the access to the correct medical follow up.[3,46]

2.4.1 Youth Athletes

Among children in the US aged between 6 to 12 years old 56% played a team sport with 38% participating on a regular basis.[47] However, with sport participation comes the risk of

incurring an SRC. One study examined US children visits to the ED for a concussion and found that 8- to 13-year-olds sustained 40% of all concussions.[48] Moreover, in the same study 25% of those visits among the 8-to 13- year old group occurred during organized team sport.[48] Two other studies from 2016, estimated that 33-54% youth athletes who have sustained an SRC are treated annually by a healthcare provider, more specifically seen in ED settings.[49,50] Sarmiento et al.,[51] reviewed 23 articles that examined the incidence of concussion among sports and found that the lowest incidence was among sports with less physical contact (e.g., cheerleading), where the highest were sports with a high degree of physical contact (e.g., rugby).[52] Research also suggests that concussion incidence is higher in games compared to practice.[1,18,45,52-56]

A study focused specifically on middle school athletes found that the overall concussion rate of 0.75 per 1,000 AEs in games and practices.[57] Sports with the highest concussion rate were boys football with 2.61 per 1,000 AEs and girls soccer with 1.30 per 1,000 AEs.[57] Another study focusing on SRC in youth football players aged 8 to 12 found that combined concussion incidence rate for practices and games was 1.76 per 1,000 AEs.[58] However, this study [58] only examined youth football athletes resulting in a higher incidence rate compare to an incidence rate of 0.75 per 1,000 AE which examined multiple sports .[26] Moreover, when breaking up the age groups it was found that 11-12 year old youth football players were 2.9 times more likely to have a concussion compared to those 8-10 years old players.[58] The older athletes being faster, stronger, and bigger than the younger football players is attributed to the higher likelihood of concussion.[58]

2.4.2 High School Athletes

In 2017, the CDC analyzed data from the Youth Risk Behavior Survey (YRBS) which resulted in about 2.5 million high school students reported having at least one concussion related to physical activity or sports.[59] Moreover, an estimated 1 million students reported having two or more concussions 12 months prior in the YRBS.[59] It is estimated that 8-13% of all high school athletic injuries are concussions.[33,60]

An earlier study such as Marar and colleagues[55] investigated epidemiology of concussion in high school athletes among 20 sports between 2008-2009 academic years.[55] The overall injury rate of concussions was 2.5 per 10,000 AEs.[55] The study also found that injury rate was greater in competition than in practice.[55] Concussion incidence rates having a greater rate in game/competition compared to practice is highly documented and supported in the

literature.[52,54,57,61] Pfister and colleagues[52] in 2016 conducted a systematic and meta-analysis of studies looking at youth athletes incidence of concussions. The literature that was involved in the systematic review and meta-analysis ranged from 1999-2011.[52] The findings from this study found that in 23 articles there was an overall risk of concussion at 0.23 per 1,000 AEs.[52] Sports with the highest incidence rates were rugby at 4.18 per 1,000 AEs, hockey at 1.20 per 1,000 AEs, and American football 0.53 per 1,000 AEs.[52] The lowest incidence rates occurred in volleyball at 0.03 per 1,000 AEs, baseball at 0.06 per 1,000 AEs, and cheerleading at 0.07 per 1,000 AEs.[52]

Kerr and colleagues[54] examined epidemiology of concussions in 20 high school sports during 2013-2014 and 2017-2018 school years. The study found that there was an overall concussion rate of 4.17 per 10,000 AEs.[54] Football was the highest in overall concussion rate at 10.4 per 10,000 AEs, followed by girls soccer at 8.19 per 10,000 AEs, and boys ice hockey at 7.69 per 10,000 AEs.[54] Findings from competition were similar to overall rates, however there were differences when examining concussion incidence in practice. The highest rate in practice was still football at 5.01 per 10,000 AEs, followed by cheerleading at 3.60 per 10,000 AEs, and boys wrestling at 3.12 per 10,000 AEs.[54] However, this study is significantly higher than earlier studies among concussion incidence rates in high school athletes.

Sex differences have been noted among high school athletes' concussion incidence rates in epidemiological literature.[1,52,54,55,57-59,61] A study by Gessel et. al.,[61] found that in sex-comparable sports girls sustained a higher rate of concussions. Similarly, Marar et. al.,[55] revealed that girls had a higher concussion rate of 1.7 per 10,000 AEs than boys concussion rate of 1.0 per 10,000 AEs in sex-comparable sports. Moreover, recently an epidemiological study found that in sex-comparable sports, concussion rates were higher in girls (3.35 per 10,000 AEs) than in boys (1.52 per 10,000 AEs).[54]

2.4.3 Collegiate Athletes

Most studies utilize the National Collegiate Athletic Association Injury Surveillance System (NCAA ISS) and now the NCAA Injury Surveillance Program to record concussions and AEs. Specifically for the NCAA it is estimated that 10,500 SRCs are documented in collegiate athletes.[62,63] Previous research has found that collegiate athletes had higher incidence rates of a concussion compared to high school athletes.[52,55,56,59,64,65] Kerr et al.,[65] found that concussion rates were higher among collegiate athletes (7.29 per 1,000 AEs) than high school (4.01 per 1,000 AEs) during the years of 2005-2006 and 2013-2014. Gessel and colleagues[61] utilized the

NCCA ISS and the High School Reporting Information Online (RIO) to compare 100 US high schools and 180 US colleges to determine the incidence of concussions. The findings reveled that collegiate athletes had higher rates of concussions compared to high school athletes.[61] Kerr et al.,[64] examined data from the NCAA ISS in 13 sports from 2011-2012 to 2014-2015 academic years. Men's wrestling had a higher concussion rate and risk (7.9%) however, football athletes had the largest average number of concussion per AEs (5.63±5.36).[64]

Sex differences in SRC are evident across both high school and collegiate athletes. Research indicates that female collegiate athletes, particularly those in soccer and basketball, face an elevated risk of SRCs compared to their male counterparts, who exhibit greater susceptibility in sports like lacrosse. [62,63] This divergence is partly ascribed to variations in game rules, such as the allowance of body checking in lacrosse for males but not females.[66] While SRC occurrence tends to be higher in women, the distribution of SRCs by injury mechanism varies. In men's sports, SRCs often arise from player-to-player contact, with equipment contact more prevalent in baseball.[62,63] Conversely, SRCs in women's sports are mainly caused by equipment, except in women's basketball, where player contact accounts for over 50% of cases.[62] These disparities underscore the impact of sport-specific rules and gameplay dynamics on SRC occurrence and emphasize the necessity for tailored prevention and management strategies. Master et al.[67] found that females in contact sports experienced longer recovery times than their male counterparts; however, males in limited contact sports also had extended recovery periods compared to females. This epidemiological study further examined sex differences by analyzing the proportion of SRCs sustained during practice and competition.[67] The results revealed that females sustained a higher proportion of SRCs in practice, while males experienced more SRCs during competition.[67] This research highlights the prevalence of SRCs among athletic participants, who are typically treated by ATs, emphasizing the need to investigate the utilization of current CAATE educational standards among practicing ATs.

2.5 Assessment of Concussion

The clinical evaluation of SRC is a multi-faceted approach that helps with the heterogeneity nature of the injury. SRC is a complex injury and key indicators of this injury come from the myriad of symptoms that can present. The unique symptom presentation of SRC can be both physical and psychological which can cause treatment and recovery to be variable.

Therefore, a multi-faceted approach and evidence-based management should be used following a concussion by all healthcare providers on the management team.[11,13,68]

Baseline testing should be completed on all contact and collision athletes prior to a sport season.[13] Baseline testing helps decipher individuals level of cognitive performance prior to sustaining a SRC.[21] Following a SRC, clinicians will be able to compare an individual's baseline scores to their post-concussion cognitive scores. This will allow for the clinician to determine the level of impairments or deficits the individual has following their SRC.

2.5.1 Signs and Symptoms

SRC can impact various clinical aspects, including physical, cognitive, as well as emotional or behavioral domains. SRC is not homogenous therefore, everyone can present differently after sustaining a SRC. Some individuals present signs and symptoms immediately following a concussive incident whereas, others can have delayed onset (e.g., evolve over minutes to hours). In the past, loss of consciousness was a prominent indicator of SRC, but as our understanding has evolved, typical symptoms now encompass confusion, amnesia, diminished concentration, cognitive difficulties, exacerbated or new headaches, dizziness, sensitivity to light and sound, and emotional disturbances.[1,3,11,18,36,39,69] Indications necessitating immediate removal from the field encompass actual or suspected loss of consciousness, seizures, tonic posturing, ataxia, impaired balance, confusions, alterations in behavior, and amnesia.[32,70]

Symptoms serve as crucial indicators in the evaluation and management of SRCs offering valuable insights into an individual's post-injury experience. The subjective reporting of symptoms following a SRC stands as one of the earliest and fundamental elements within the comprehensive framework for evaluating concussions. Symptom checklists, such as those integrated into tools like the Sport Concussion Assessment Tool-6 (SCAT6)[71] and Child SCAT6[72], enable clinicians to comprehensively assess an individual's symptomatology. These checklists typically encompass a wide range of symptoms, including headache, dizziness, and nausea, each graded on a severity scale. By documenting the severity and duration of symptoms, clinicians can better understand the trajectory of recovery and tailor management strategies accordingly. These assessments are recommended by all consensus and position statements and commonly used to assess individuals following an SRC. [10,11,13,18,73] Self-report is the most utilized symptom type of assessments such as inventory, scales, or checklists. Some of the most common symptom inventories that have been utilized are the Post-Concussion Symptom Scale,[74]

Graded Symptom Checklist,[75] and the Rivermead-Post Concussion Symptom Scale.[76] Many of these can be on their own and typically completed on paper and pencil, although currently several of these symptom scales have been incorporated into other test batteries (e.g., ImPACT, SCAT6).

The SCAT6 symptom checklist, for instance, consists of 22 symptoms graded on a severity scale 0-6 (e.g., 0 being none, 1 representing mild symptoms and 6 representing severe symptoms)[71], providing a standardized framework for symptom assessment. Additionally, the Child SCAT6 adapts symptom descriptions to facilitate understanding for pediatric populations, ensuring accurate reporting even among younger individuals.[72] The Child SCAT6 consists of 21 symptoms graded on a severity scale 0-4 (e.g., 0 being none, 1 representing a little, and 4 represent the symptom is a lot).[72] Furthermore, the inclusion of a parent symptom checklist allows caregivers to contribute valuable observations, enhancing the holistic assessment process.[72] Another widely utilized tool, the Post-Concussion Symptom Scale (PCSS), features 22 symptoms graded on severity, offering an alternative approach to symptom assessment in concussion management.[74,77,78] The PCSS is a symptom inventory designed for SRC, comprising 22 items that assess physical, cognitive, affective, and sleep-related symptoms associated with concussion.[74,77,78] Participants use a Likert-type scale ranging from 0 (no symptom) to 6 (severe symptom) to rate the presence and severity of each symptom. This yields a total symptom severity score ranging from 0 to 132.[74,77,78]

2.5.3 Sport Concussion Assessment Tool 6th Edition (SCAT6)

The Sport Concussion Assessment Tool 6 (SCAT6) is a standardized tool used by healthcare professionals to assess and evaluate athletes suspected of sustaining a concussion. It is designed to aid in the diagnosis and management of SRCs by providing a structured framework for evaluating various aspects of symptoms, cognitive function, balance, and other relevant clinical indicators.[32,71] The SCAT6 builds upon previous versions, incorporating updated research findings and best practices in SRC assessment and management.[12,17,18,32,70,71,79] It includes a combination of subjective symptom reporting, cognitive assessments, balance testing, and clinical examination components to provide a comprehensive evaluation of concussion-related impairments. The SCAT6 is the fifth version of the SCAT from the CISG.[71] The SCAT6 aims to facilitate more accurate and timely identification of SRCs, ensuring appropriate management and care for athletes to promote safe return-to-play decisions. The SCAT6 should

only be used for individuals who are 13 years or older and for any younger individuals (8-12 years old) the child SCAT6 should be used.[71]

The SCAT6 includes detailed instructions for the clinician to perform and appropriately administer the test. The SCAT6 has been revised from the previous SCAT5 with major changes including:

- improved athlete demographic information section,
- enhanced recognition and removal section,
- revised immediate evaluation and neurological screening,
- incorporating a new coordination and ocular/motor screening
- enhanced red flags section.
- elimination of the read aloud symptom scale instructions.
- exclusion of the immediate memory 5-word list
- introduction of a timed element in the months in reverse subtest
- redesigned coordination and balance assessment, complete with an optional dual-task tandem gait

The rapid memory and neurological screening comprises six sequential steps, including (1) heightened observation of physical signs, (2) utilization of the Glasgow Coma Scale, (3) an evaluation of the cervical spine, (4) a modified assessment of coordination and ocular/motor functions, (5) a memory assessment using Maddocks questions, and (6) an expanded section focused on identifying potential red flags.[71]

The transition from the SCAT5 to the SCAT6 is beneficial for ATs as it equips them with updated and refined tools for concussion assessment. By incorporating the latest research findings and clinical practices,[12,70-72] the SCAT6 enables clinicians to more accurately and comprehensively evaluate athletes suspected of sustaining a concussion. This improvement in assessment protocols enhances the ability of ATs to detect and diagnose concussions promptly, allowing for timely and appropriate management strategies to be implemented. Additionally, the SCAT6 may provide clinicians with a broader range of assessment metrics and tools (e.g., timed 10-word list, months in reverse, tandem gait), offering greater flexibility and customization in tailoring assessments to individual athletes' needs. As previous literature had found that subsets of the SCAT5 concentration tests and 5-word memory lists were exhibiting significant ceiling

effects.[70,79-82] Ultimately, the SCAT6 empowers clinicians to deliver more effective and evidence-based care to athletes, ensuring optimal outcomes in concussion management.

According to Echemendia et. al.,[71] the SCAT shows its highest effectiveness in distinguishing between athletes with concussions and those without for a period of up to seven days following the injury, with reduced clinical utility beyond the initial 72-hour window.[71] Asken and colleagues[83] compared SCAT5 versus SCAT3 symptom reporting differences and convergent validity in collegiate athletes. The findings from the study found that there was adequate convergent validity between SCAT5 and SCAT3 symptom severity.[83] Petit et al.,[84] examined baseline values of the SCAT5 in NCAA Division I collegiate athletes and factors that could influence scores. This study found that collegiate athletes who had depression/anxiety, ADD/ADHD, and those who participated in contact sports were found to report more baseline symptoms.[84] The results Petit et al., also adds to the normative values which clinicians could utilize if there were no available individualized baseline testing values.[84]

2.5.4 Balance Error Scoring System (BESS)

The balance error scoring system (BESS) was created to assess concussed individuals as an objective measure.[85] The BESS is a cost-effective way for clinicians to test postural stability on their athletes whether it be baseline testing or following a SRC. The BESS takes approximately 10 minutes for a clinician to perform. The three stances included in the BESS are double-leg stance (feet together), single-leg stance (standing on the non-dominant leg), and a tandem stance (non-dominant leg behind the dominant) in a heel to toe manner. When performing the three stances the individual must place hands on their hips with their eyes closed. Each stance is performed on a hard surface then it is followed by all three stances performed again on a foam service. A 20 second trial is done for each stance counting possible errors by the individual. Errors can be defined as lifting hands off hips, opening of the eyes, stepping, or stumbling out of position, abducting hip more than 30°, or failing to return to test position in more than five seconds.[85-87] Scoring for the BESS counts errors for each of the single stances with the maximum score allowed is 10 and then all three stances are totaled for a maximum of 30 errors. Both the firm and foam surfaces should be scored separately to be able to assess differences in balance deficiencies.

One study found that between the BESS and Sensory Organization Test (SOT) which utilizes a force plate had a significant relationship between the scores in a group of concussed

athletes.[87] Bell et. al.,[86] systematically reviewed the literature to assess the BESS which found that the it had moderate to good reliability when assessing static balance. Overall, it seems that the BESS has been deemed as a valid and cost-effective method for assessing postural stability following an SRC. [86,87]

2.5.5 Vestibular/Ocular Motor Screening (VOMS)

The VOMS was developed to assess vestibular and ocular motor impairments via patient-reported symptom provocation after different assessments.[88] The VOMS consists of brief assessments in the following seven domains: (1) smooth pursuits, (2) horizontal saccades, (3) vertical saccades, (4) near-point convergence (NPC), (5) horizontal vestibular ocular reflex (VOR, (6) vertical VOR, and (7) visual motion sensitivity (VMS. Before the initiation of testing, individuals are asked to rate their current levels of headache, dizziness, nausea, and fogginess symptoms on a scale of 0 to 10, where 0 indicates no presence and 10 indicates maximum severity. Following each of the 7 VOMS items, symptoms are reassessed to determine the degree of symptom provocation and impairment. Convergence is measured both by symptom provocation and by objectively measuring NPC and performed three times. The VOMs take five to seven minutes to administer.

Mucha et al.,[88] provided initial data for internal consistency and validity for VOMS following a SRC. The VOMS demonstrated high internal consistency with a Cronbach alpha of 0.92.[88] The study also found that VOMS was able to distinguish between SRC athletes and controls.[88] Kontos and colleagues[89] examined the reliability of VOMS across a 6-month period in uninjured US Army Special Operations Command personnel. Similar to Mucha et al.,[88] there was excellent internal consistency with a Cronbach alpha of 0.99.[89] The test-retest reliability for VOMS items were considered moderate-to-good with intra-correlation coefficients ranging from 0.60 to 0.81.[89]

2.5.6 Neuropsychological Assessment

The Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) is a neuropsychological screening tool that evaluates attention, memory, visual motor speed, reaction time, and concentration. ImPACT is a computerized neurocognitive test assessment. Scoring for ImPACT is based off five composite scores including verbal memory, visual memory, process speed, reaction time, and total symptoms. The ImPACT test takes 25 to 30 minutes to complete.

Schatz and colleagues[90] examined the diagnostic utility of ImPACT in concussed high school athletes and found that the sensitivity was 81.9% and the specificity was 89.4%. Schatz and Sandel[91] also examined sensitivity and specificity of the online version of ImPACT among high school and collegiate athletes. The results revealed that the online version was 91.4% sensitive and specificity was 97.3%.[91] ImPACT convergency and discriminant validity has also been tested by Koehl and colleagues who compared SRC athletes to non-concussed controls.[92] The study indicated that all five ImPACT domains were able to differentiate between SRC athletes and controls.[92]

2.5.7 King-Devick

The King-Devick (K-D) is considered a vision-based test that measures the speed of rapid number naming.[93,94] The test is only two minutes long which is a quick way to be able to assess someone. The K-D requires the use of eye movements such as saccades, convergence, and accommodation.[94] Previously, the K-D test consists of four cards: one demonstration card, and three test cards. Currently the test is only administered on an iPad.[95] To perform the K-D, participants are asked to read the numbers from left to right as quickly as they can without making any errors.[94] Although participants are told not to make any errors there is always a chance for mix up of the numbers. However, if the participant does immediately correct their mistake before moving forward it will not be recorded as an error.[94] The demonstration card is the first card that the participants read and then they are asked to read the next three test cards in the same manner. Each trial is timed and recorded using a stopwatch. After all test cards are completed the three times are summed which acts as the summary score for the K-D.[95]

As with each assessment tool for SRC it is critical that there is a baseline assessment of the K-D test which will allow to compare worsening test times after a SRC has incurred. A meta-analysis from 2015[94] found that the K-D for detecting concussion had 86% sensitivity and 90% specificity. The study also reported that it was reliable when administered between trained personnel and the layperson.[94]

2.6 Clinical Profiles

Clinical profiles are considered a heterogenous approach to concussion management, which allows individuals to receive more patient-centered care.[8,20,21] Utilizing a clinical model with a heterogenous approach characterizes similar risk factors, symptoms, impairments, and clinical outcomes in athletes.[8,20,21] Originally, the clinical profiles had six different trajectories

but are now reduced to five along with two modifiers.[20] The clinical profiles includes vestibular, ocular, cognitive/fatigue, posttraumatic migraine, and anxiety/mood with modifiers being sleep and cervical spine.[8,20] Each of the these clinical profiles are determined by symptom clusters which allows for prioritizing problems with targeted treatments for concussions.[8,20,96] Individuals who incur a concussion can be classified under one primary clinical profile, however there could also be a secondary or tertiary clinical profile. When multiple clinical profiles are associated with one individual, clinicians will determine the primary, secondary, and tertiary which will allow for focus on different targeted treatments. Figure 2 demonstrates the overlapping of clinical profile characteristics in post-concussion participants.[97] Sections 2.5.1 to 2.5.5. describe the five individual clinical profiles.

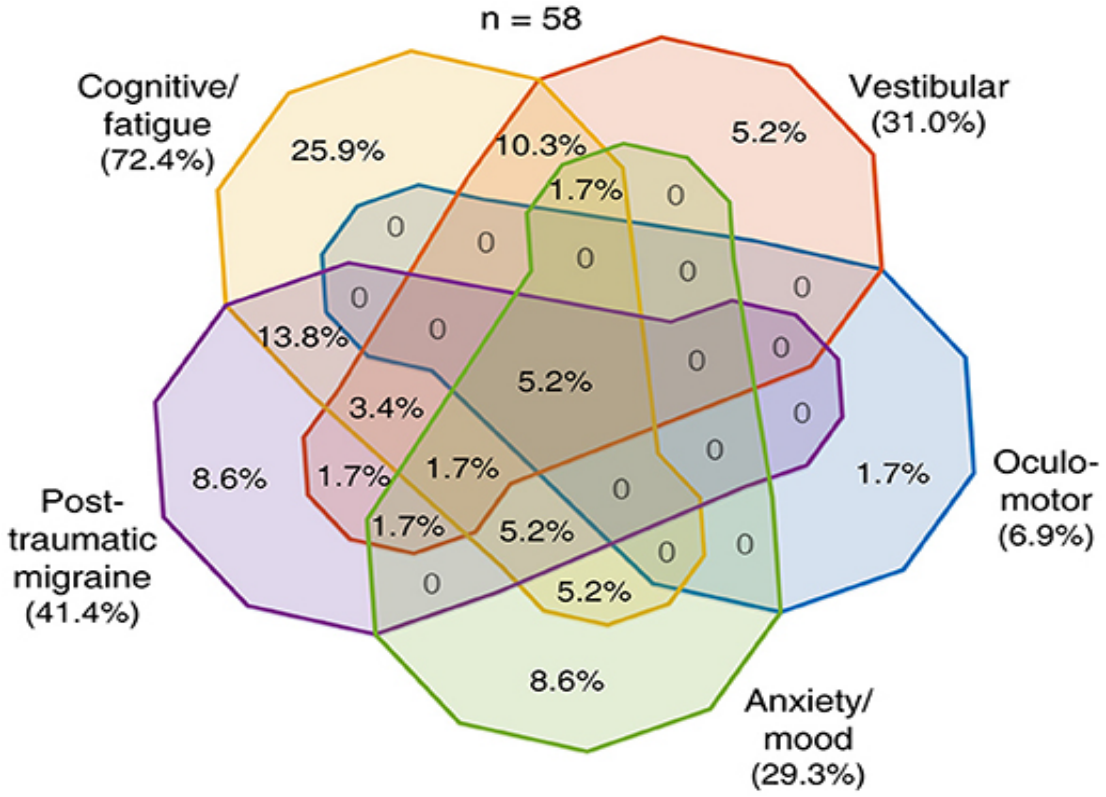

Figure 2. *Overlapping clinical profiles: Distribution of subjects among various combinations of five clinical profiles with percentages.97 From "American Medical Society for Sports Medicine position statement on concussion in sport" By Harmon et al., 2019*

2.6.1 Vestibular

The vestibular profile is described as interference of the central vestibular system (e.g., imbalance, dizziness, nausea, fogginess).[8,20,21] The vestibular system is a sensory network that

delivers information to the brain about equilibrium, motion, and spatial orientation to maintain balance. Interruptions to the system of vestibular function can result in symptoms such as dizziness, balance issues, nausea, and fogginess. Within the vestibular clinical profile there may be different impairments such as slowed reaction time, processing speed, possible balance problems, visual motion sensitivity or holding gaze while moving the head up and down or side to side. Individuals that could be at a greater risk to be classified with a vestibular clinical profile would be those who have a history of motion sickness or other vestibular disorders, migraine headaches, and dizziness at the time of their injury. Concussed individuals with the vestibular profile could also be categorized in another simultaneous clinical profile such as posttraumatic migraine, anxiety/, and ocular.[8,20,21]

2.6.2 Ocular

Ocular profile is defined as posttraumatic vision impairments such as double vision, frontal headache, and fatigue with visual activities.[8,20,21] Following an SRC an individual may present with symptoms such as frontal headache or pressure, trouble focusing, blurred or double vision, and fatigue with visual activities (e.g., reading or screen time). An individual could be more at risk if there is a history of vision problems prior to an SRC. Concussed individuals with the ocular profile could also fall under the cognitive-fatigue or posttraumatic migraine profile.[8,20,21]

2.6.3 Cognitive Fatigue

Cognitive fatigue is characterized by difficulty with cognitive skills and fatigue with mental activities such as difficulty concentrating, memory issues, and low energy.[8,20,21] Within this clinical profile there are a chance that symptoms can get worse throughout the day with more cognitive activity. Risk factors that could be associated with the cognitive fatigue clinical profile include history of attention or learning disorder, and poor quality of sleep. Pita et al. found that cognitive fatigue profiles were commonly associated with mood and ocular clinical profiles, with cervical involvement as a modifier among patients with persistent post-concussion symptoms (PPCS). Furthermore, cognitive fatigue profiles predominated among PPCS patients across all ages and sexes.[98]

2.6.4 Posttraumatic Migraine

Posttraumatic migraine (PTM) is defined as a pulsating headache after head trauma in which severity can be classified as moderate or severe (e.g., worsening headache under stress,

persistent headache).[8,20,21,99] Classic symptoms that are seen with this profile includes nausea, headache, and photosensitivity.[8,20,21] Impairments for individuals that fall under this category can include memory deficits specially on visual tasks which can also be related to vestibular or ocular provocation.[8,20,21] Risk factors for individuals who could be categorized with the PTM profile includes history of motion sickness, migraine headaches, or other vestibular distorders.[8,20,21] If an individual is classified with the PTM profile they may also fall under vestibular, anxiety/mood, or ocular profiles.[8,20,21]

2.6.5 Anxiety/Mood

Anxiety/ mood profile can be described as behavioral and emotional changes following an SRC.[8,20,21] Individuals with this profile can present with anxiety, reports of depression, feeling more emotional, irritability, sleep disruption, overwhelmed and mood changes.[8,20,21] Individuals that could be more at risk for the anxiety/mood clinical profile includes a history of mood disorder.[8,20,21] These individuals could also could be classified with the vestibular or PTM clinical profile.

2.6.6 Clinical Profile Modifiers

Clinical profile modifiers are components that could exist with the five clinical profiles that were mentioned above. Sleep and cervical spine could affect individuals with a SRC however, they are not distinct enough to be their own profile. These modifiers can simultaneously happen with other symptoms or issues that are affecting individuals that incurred an SRC. Although these modifiers are an additional component, they still must be considered when treating an individual with an SRC.

2.6.6.1 Sleep

Sleep disruption (e.g., sleep frequency, sleep quality) is considered a common symptom following SRC but can coincide with other clinical profiles.[8,20,21] Kontos and colleagues[8,20,21] explained that sleep disruptions could involve changes in frequency (e.g., insomnia or hypersomnia) or the quality of sleep (e.g., completion of sleep cycles, sleep initiation). As healthcare providers it is important to consider how sleep disruptions affect athletes and recovery from SRC.

2.6.6.2 Cervical Spine

Originally the cervical spine started as its own trajectory but progressed to a modifier. Researchers suggest that there should always be evaluation of the cervical spine in management

of a concussion, however, it is not distinctive enough to have its own profile.[8,22] Symptoms that could arise from this modifier include neck pain, stiffness, headache stemming in the back of the head, numbers or tingling, and limited range of motion.[8,20,21] Individuals may have underlying cervicogenic component from neck involvement in the mechanism of injury or a pre-existing cervical susceptibility.[8,20,21]

2.7 Clinical Profiles Research

A study examined participants between the ages of 11-40 years old following a concussion and found that distribution for primary profiles were as follows: 26% migraine, 24% anxiety/mood, 19% vestibular, 16% ocular, 11 % cognitive/fatigue, and 4% had no clear primary profile.[8] Pita et.al,[98] did a retrospective chart review from a concussion center and found that the most common clinical profiles and modifiers among their participants was cognitive (34%), neck (17.8%), and mood (16.8%). Another study examining blast related TBI found that the most prominent clinical profile was migraine/headache. However, among the 38 participants in the study was vestibular, cognitive, and mood/anxiety were also common.[100] Kontos et.al, found that anxiety/mood was a primary profile for 24% of their participants. Moreover, the results from this study identified anxiety/mood being the second most prevalent primary profile among athletes. Mood profiles was most common among females with persistent post-concussion symptoms.[98]

2.8 Management of Concussion

When a SRC is suspected, the individual should be immediately removed from play and not return to play until cleared by a licensed healthcare provider (e.g., physician, doctor of osteopathic medicine, nurse practitioner).[11,13,18,21,32,75] There is no gold standard recovery time for SRC due to the heterogeneity nature of SRC. Previous literature has stated that the majority of athletes can recover from an SRC in 7-10[13,18] days, however, recent research suggests the timeline to recover is 10-14 days.[3,11,13,39,101] Moreover, some athletes could experience prolonged recovery times.[3,11,13,39,101] SRC is treatable, however there are many clinicians still utilize a more homogenous approach rather than a more updated heterogenous approach.

2.8.1 Homogenous Treatment

Clinical approaches for treatment of SRC have been homogenous or “one size fits all,” however that does not fit how unique the presentation of this injury can be for individuals. Treating all individuals who sustain a SRC the same way could cause further harm for those individuals. Previous treatment for SRC consisted of strict brain rest (e.g., cocooning) until all

symptoms are alleviated, which is now not the recommended protocol due to the possible negative effects (e.g., social isolation, anxiety, issues with self-esteem, loss of academic standing) on recovery.[10,17,102] Treatment recommendations presently consist of 24 to 48 hours of cognitive and physical rest followed by active rehabilitation that could help improve symptom recovery.[13,18] These recommendations also include a monitored stepwise return-to-play (RTP) prior to individuals fully returning to their sport or activity.[13,18]

2.8.2 Clinical Profile Targeted Treatment

SRC is treatable, however, treatment options are not widely available as they are mostly utilized in concussion clinics and research. For example, a high school AT may not be integrating targeted treatments into the SRC management plan due to lack of resources (e.g., time and funding) and the concussed patients only point of care. Utilizing clinical profiles is more evidence-based along with incorporating a more biopsychosocial approach with an athlete taking an active role in their recovery and treatment following an SRC.[96] Thus, it is important that different athletic training environments (e.g., high school, university, ATEP) implement this heterogenous approach to improve diagnosis and treatment of SRC. However, not all ATs, particularly preceptors, may be versed in these new clinical profiles and approaches to targeted treatment for SRCs.

The American Medical Society's stance on concussions emphasizes the importance of proactively engaging in interventions during the initial phases of recovery.[10] This approach is recommended to help reduce the potential long-term impairments that may arise after a SRC.[13] Kontos, et.al,[103] performed an intervention design with military and civilian patients with chronic mTBI. Over the six month intervention the participants improved in cognitive, symptom, vestibular, and oculomotor domains by the use of targeted interventions.[103] Researchers have advocated for a targeted approach for interventions following an SRC and interventions supporting it may be used.[19,104,105] A recent study found AT participants utilized and acknowledged the necessity of implementing treatments, however, over 50 percent of them opted to defer the responsibility for treatment interventions to other healthcare professionals.[106] The percentage of ATs who reported employing treatment for particular symptoms was as follows: 82.4% for emotional symptoms, 55.5% for cervical impairments, 49.0% for vestibular impairments, 43.7% for ocular impairments, and 32.0% for migraine symptoms.

2.9 Return to Play (RTP)

Individuals who incurred a SRC go through a period of gradual stepwise progression to RTP. As mentioned before the first 24-48 hours should be a period of initial rest. The stages of RTP have been revised over the years by position and consensus statements[3,11,13,39,101] and now recommended the following 6 stages. The first stage of RTP is having the individual complete daily activities, however the activities should not provoke symptoms.[3,11,13,39,101] The second stage of RTP is considered light aerobic exercise where an individual can walk or ride a stationary bicycle. The third stage is sport-specific where running drills can be incorporated, however no head impact activities can be incorporated in this stage. The fourth stage is non-contact training drills where harder drills are incorporated and progressive resistance training. The fifth stage is full contact practice which is following medical clearance from a medical professional and the individual can participate in normal training activities. The final stage is returning to sport which is considered normal game play. Each one of these stages should take at least 24 hours which is about a week of RTP protocol. If at any point in time the individual experiences symptoms, they should move forward in the RTP progression. The individual will move back to the asymptomatic level and begin progression through RTP after being symptom free for 24 hours.[3,11,13,39,101] There is no standard time frame that can be given to an individual who has incurred a SRC however, this is allows for a gradual safe progression to RTP.

2.9.1 Return to School

Return to sport is one aspect of SRC management, however return to school which is used interchangeably with return to learn also needs to be considered for an athlete. As mentioned previously, post-SRC can cause cognitive issues such as memory impairment, difficulty focusing, diminished attention-span along with physical symptoms such as headache, dizziness, and fatigue which can potentially hinder a student's ability to reintegrate into the school environment. Although, in SRC cases where there is rapid recovery, return to school might only need minimal assistance. Whereas students starting return to school with more severe symptoms, the process could exacerbate and extend their symptoms.[107,108]

Incorporating homogenous treatment into return to school is critical as not all students will have the same timeline. Recent literature has found that students miss an average number of 2-5 school days following an SRC.[109,110]A prospective cohort study by Vaughan, et. al,[110] found that older children took longer to return to school compared to younger children.[110] There is

inconsistences about early return to school as studies have found that more time at school was associated with higher symptom levels.[111,112] But others suggest more time away from school was associated with longer recovery time.[110,113-115] Although there is no guaranteed timeline for return to school consensus statements have given recommendations to assist clinicians.[11,13,18,116,117]

Similar to RTP following an SRC return to school/learn recommendations are in stages. During Stage 1, children are advised to go through a brief period of cognitive and physical rest, engaging in symptom-guided activities, and they should remain at home from school for a minimum of 24 hours. Progressing to Stage 2, involves gradually reintroducing cognitive activities, with each session lasting for 30 minutes, while ensuring that symptoms do not worsen. Stages 3 and 4 are primarily focused on the gradual return to school/learn process, which may involve adjustments in academic tasks, environmental accommodations, and certain activity restrictions. If symptoms are exacerbated at any point in time during the return to school/learn the individual should repeat the stage before moving forward.

DeMatteo and colleagues[117] completed a three year prospective cohort study incorporating return to school and RTP simultaneously. The study found that both children and youth return to school faster than they RTP even though they have school related symptoms moving through the protocol.[117] The researchers suggest that RTP stage 6 should not be completed prior to full integration back into school.[117] While recovery can be variable among individuals, recommendations should still be followed. ATs should be familiarized with the possibility of incorporating return to school in an individual's SRC management. Collaboration between different medical professionals (e.g., AT, PCP, school nurse) should be in agreement to provide the best evidence-based care to an athlete suffering an SRC.

2.10 Commission on Accreditation of Athletic Training Education

The Commission on Accreditation of Athletic Training Education (CAATE) sets the standard for athletic training education in the United States. Their rigorous standards ensure the highest quality of education and training for aspiring ATs. By adhering to CAATE standards, institutions not only guarantee comprehensive and up-to-date curricula but also contribute significantly to the development of skilled professionals who play a crucial role in the healthcare and sports industries.[7] As of June 2020, CAATE implemented new standards for the professional education of students at the master's degree level. Per CAATE, preceptors should be updated if

there are revisions to the standards to the program through communication from leaders of the program and preceptor training.[7] The 2020 professional standards brought about substantial alterations to the accreditation requirements. These changes, implemented by CAATE, aimed to enhance both the theoretical and clinical aspects of students' learning experiences.[7]

2.10.1 Preceptors

The influence of athletic training preceptors within CAATE holds a profound impact on the development and preparation of future athletic training professionals. These dedicated mentors serve as the guiding force for athletic training students on their journey towards becoming skilled and knowledgeable practitioners in the field. Through their wisdom, experience, and commitment to the education and growth of athletic training students, CAATE preceptors are instrumental in ensuring that the next generation of ATs is well-equipped to meet the evolving demands of this dynamic profession.

According to CAATE standards preceptors have responsibilities they must fulfill to supervise athletic training students.

- **CAATE Standard 32**: The program maintains a consistent and continuous flow of communication with every preceptor, ensuring that all parties are well-informed about the program's structure, the unique requirements of individual students, student advancement, and assessment methods. The program establishes the frequency and character of this communication.
- **CAATE Standard 45**: a preceptor is a healthcare provide who possess qualifications and experience including licensure in the state they practice as well as credentials, board of certification is in good standing, national provider identifier number, contemporary exercise, and planned/ongoing education for their role as a preceptor.
- **CAATE Standard 46:** Preceptors serve the role of overseeing, guiding, and providing mentorship to students during their clinical education, adhering to the program's established policies and procedures. AT or physicians who act as preceptors evaluate students' capabilities in meeting the curricular content standards.
- **CAATE Standard 66:** Deliver healthcare services in accordance with the BOC Standards of Professional Practice and pertinent institutional, local, state, and federal laws, regulations, rules, and guidelines. These encompass, among others:
    - Necessities concerning physician oversight and cooperative efforts.

- Obligations for mandatory reporting.

Athletic training preceptors initially serve in a supervisory capacity during athletic training students' clinical rotations, gradually transitioning into more of a mentorship role. [14,118,119] The practice of mentoring is now universally recognized as a means to guide students during their socialization into their forthcoming professional responsibilities, facilitating their growth and development.[120-122] Previous studies have demonstrated how influential preceptors can be on the development of athletic trainings students in a professional manner.[123-125] Mazzerolle and colleagues[126] found that preceptors who exemplify their passion for the profession and offer an authentic portrayal of the duties and obligations of ATs can inspire a sense of professional enthusiasm and dedication in athletic training students.

The influence preceptors have over athletic training students can also create barriers if an AT is unaware of the updated CAATE standards. The lack of awareness can create a disconnect between the athletic training student's classroom education and their clinical education. Roberts and colleagues [127] examined mentorship of athletic training preceptors and the involvement of evidence-based practice in clinical settings. ATs generally hold favorable views regarding evidence-based practice.[127] However, varying levels of comfort and knowledge with evidence-based practice implementation can affect an ATs view along with the willingness to learn. Keely and colleagues examined ATs' beliefs about and utilization of evidence-based practice. Their study revealed that ATs who served as preceptors scored higher on evidence-based practice implementation compared to those who did not serve as preceptors.[128] However, there is limited practical application of this knowledge in their clinical work, which has led to a gap between athletic training students and their clinical experiences.

2.10.2 SRC CAATE Competencies

In addition to the revisions to standards, CAATE also updated standards related to concussion management to ensure that programs incorporate the latest best practices in this critical aspect of athletic training education. The changes to the standards are broader which can lead to differences in interpretation between ATs, educators, and students. There are three specific CAATE standards that relate to concussion assessment and management.

2.10.2.1 CAATE Standard 71

Standard 71 is a generalized standard incorporating the entire systems in the body. The standard states to perform an examination to formulate a diagnosis and plan of care for patients

with health conditions commonly seen in athletic training practice. Standard 71 has eight bullet points adding in system and what the exam should incorporate including:

- Obtaining a medical history from the patient or other individual
- Identifying comorbidities and patients with complex medical conditions
- Assessing function (including gait)
- Selecting and using tests and measures that assess the following to relevant clinical presentation:
    - Cardiovascular system (including auscultation)
    - Endocrine system
    - Eyes, ears, nose, throat, mouth, and teeth
    - Gastrointestinal system
    - Genitourinary system
    - Integumentary system mental status
    - Musculoskeletal system
    - Neurological system
    - Pain level
    - Reproductive system
    - Respiratory system (including auscultation)
    - Specific functional tasks
- Evaluating all results to determine a plan of care, including referral to appropriate provider when indicated.

2.10.2.1 CAATE Standard 76

Standard 76 is more specified to concussions or other brain injury compared to standard 71. The standard states that athletic training students are to be able to evaluate and treat a patient who has sustained a concussion or other brain injury with consideration of established guidelines. Standard 76 has six bullet points accompanied by detailed established guidelines including:

- Performance of comprehensive examination designed to recognize concussion or other brain injury including but not limited to:
    - Neurocognitive evaluation
    - Assessment of the vestibular and vision systems

- Cervical spine involvement
- Mental health status
- Sleep assessment
- Exertional testing
- Nutritional status
- Clinical interview

2.10.2.2 CAATE Standard 93

Develop and implement specific policies and procedures for individuals who have sustained concussions or other brain injuries, including the following:

- Education of all stakeholders
- Recognition, appraisal, and mitigation of risk factors
- Selection and interpretation of baseline testing
- Agreement on protocols to be followed, including immediate management, referral, and progressive return to activities of daily living, including school, sport, occupation, and recreation.

Minimal evidence exists regarding ATs awareness of updated CAATE standards, particularly in the context of concussion assessment and management. However, a recent study reviewed perceptions of athletic training preceptors regarding characteristics for contemporary expertise.[129] According to CAATE, contemporary expertise in athletic training entails comprehending and mastering the latest best practices across various domains such as prevention, urgent care, orthopedics, and beyond. This proficiency is essential for delivering effective athletic training services.[34] This expertise is gained through advanced education, hands-on practice, research, and ongoing learning. It may involve specializing in specific areas of athletic training.[34] Each person's role in the athletic training program should align with their expertise in these contemporary practices. The study's findings revealed that preceptors within accredited programs displayed limited knowledge of the concept of contemporary expertise. The author of the study recommends the implementation of a focused and strategic initiative to ensure that preceptors become well-versed in accreditation requirements and can effectively guide students in their areas of expertise as part of their mentoring role.[129] The CAATE standards are open to broad interpretation. However, when it comes to standard 76, there are specific guidelines that dictate how ATs should conduct a comprehensive examination (e.g., clinical

interview, mental health status, neurocognitive evaluation).[7] Importantly, these CAATE standards align with current consensus group guidelines and recommendations.[12,18,33] Despite ongoing research into multidimensional assessments and management techniques, there is a scarcity of evidence regarding how ATs apply these methods. Therefore, it is crucial to understand if ATs are translating education of CAATE standards into their clinical practice when it comes to the assessment and management of SRC.

2.11 Concussion Knowledge

ATs play a crucial role in the recognition, assessment, and management of concussions in athletes. Typically, ATs are the first licensed medical professional responsible for the initial identification and management of SRCs. AT knowledge of concussions is vital for athlete safety, the prevention of second-impact syndrome, effective communication, and the overall well-being of athletes. Their expertise not only ensures that concussions are managed appropriately but also promotes a culture of safety in sports, which is of paramount importance in today's athletic landscape. Possessing this knowledge and continually updating it is crucial for ATs to effectively protect the health and safety of athletes under their care. Additionally, they should follow established guidelines and protocols specific to their organization or governing bodies.

Lempke et. al,[14] assessed ATs' overall concussion knowledge and found that ATs scored an average of 78% in recognizing signs and symptoms of a concussion.[14] When comparing to ATs only identifying 78% of signs and symptoms of SRC, ATs displayed only a slightly higher rate of accurate recognition, with an average of just 3% more correct identifications than high school athletes (75%) and collegiate athletes (74%).[119].[14,118,119] As the first healthcare professional to possibly assess and manage an athletes concussion it is concerning that the average score of an AT compared to both high school and collegiate athletes is only 3% higher. While ATs are often the first licensed healthcare professional that evaluates an athlete for a concussion, a multidisciplinary healthcare team is crucial in providing comprehensive care to athletes.

The line of care for SRC is not only just the AT but can also include a variety of other healthcare providers (e.g., physician, physical therapist). Previous studies have demonstrated the lack of SRC knowledge among pediatrians,[130]pediatric neurologist,[131] chiropractic interns and residents,[132] along with medical residency specialties. [132,133] Failure to recognize or comprehend the signs of a SRC can result in delayed or incorrect diagnoses for athletes. Although healthcare

professionals are monumental in the diagnosis of SRC there may not always be one on-site for sporting events. Non-medical professionals can use tools such as the concussion recognition tool 5th edition to provide guidance on removal.[131,134] However, it is often that they utilize HEADS UP training from the CDC.[135] Literature has shown that there is lack of immediate management of SRC proving that more SRC education among coaches, sports clubs, and other important stakeholders needs to be completed.[130,136] Therefore, it is of paramount importance that all stakeholders are well-informed and adequately prepared for the evaluation and proper management of SRC.

2.12 Years of Experience

ATs years of experience can play a pivotal role in the field of athletic training, where practical expertise and real-world exposure are essential for ensuring the health, safety, and performance of athletes. While years of experience can provide numerous advantages in the field of athletic training, there are potential downsides as well. The key to experienced ATs is to strike a balance by staying current with best practices, continuously improving their skills, remaining open to new ideas and approaches to ensure they provide the best possible care for athletes.

Over the past two decades, there has been significant evolution and heightened recognition of SRC assessment and management within athletic training practice (ATP). The evolution of these clinical practices may lead to variations in SRC knowledge and practice based on an AT's years of clinical experience. A study examining physical therapists indicated that individuals with <5 years of clinical experience were more than 24 times more likely to have learned about evidence-based practice than those with more 5 or more years of experience.[137] Thus, ATs should maintain a commitment to regularly reviewing best practices and incorporating comprehensive evaluation tools (e.g., symptom check lists, balance assessments, neurocognitive testing) in order to guarantee the highest level of diagnostic precision in their assessments.

A more recent study by Lempke and colleagues[14] examined the influence of SRC knowledge and clinical experience on assessment and management in 2020. The results of the study found that the utilization of standardized SRC initial sideline tools was influenced by clinical experience and for each additional year of clinical experience, there was a 3% reduction in the odds of using these tools.[14] Moreover, symptom checklist and standardized sideline tools at RTP both decreased by 2%.[14] On the contrary, a study done in 2011 found that among

Division 1 ATs there were no differences based on years of clinical experience on the utilization of SRC assessment tools at baseline, initial, and recovery times points.[138] Variations in years of clinical experience can influence how athletic trainers practice in clinical settings, potentially affecting their use of current and updated techniques versus relying on older, outdated approaches in SRC assessment and management. Therefore, it is important to examine clinical years of experience of the AT utilizing in the 2020 CAATE standards for SRC assessment and management.

2.13 Summary

In conclusion, it is imperative to underscore the importance of understanding how adherence to CAATE concussion standards influences the assessment and management of concussions among ATs. These standards serve as a critical benchmark for professional practice, yet little is known about how ATs, particularly those exposed to preceptorship, implement them in practice. Adhering to these standards not only enhances their knowledge but also contributes to more effective assessment and management of SRC. This is significant because effective SRC management relies on evidence-based practices outlined in these standards. Therefore, further research is needed to explore the utilization of CAATE standards in SRC assessment and management, as it can lead to improved patient outcomes and athlete safety. As the field of athletic training evolves, attention to these educational and practical aspects is crucial for ensuring the delivery of high-quality care to athletes with SRCs.

CHAPTER 3: METHODOLOGY

3.1 Purpose

The purpose of this study was to determine if certified ATs who are preceptors are using CAATE standards for concussion evaluation and management. Secondarily, to examine if years of experience is associated with utilization of the new CAATE standards for concussion evaluation and management. We hypothesized that certified ATs who are preceptors are more likely to utilize CAATE standards for concussion evaluation and management compared to certified ATs who are not preceptors. Secondarily, certified ATs with 6+ years of experience are less likely to utilize CAATE standards for concussion evaluation and management compared to certified ATs with 5 years or less of experience. The rationale behind categorizing athletic trainers' years of experience into two groups, spanning 0-5 years and 6 or more years, is grounded in several pertinent factors. Firstly, the release of the Berlin Consensus Statement in 2017[18] signified a significant advancement in concussion management guidelines, presenting a comprehensive overhaul of existing protocols.[18,32] Given that the study was conducted six years subsequent to the publication of these consensus guidelines, individuals with six or more years of experience would have had sufficient time to assimilate and incorporate these updated standards into their clinical practice. Conversely, ATs with 0-5 years of experience would have transitioned into the period post-2017, potentially demonstrating greater familiarity with the newer consensus guidelines introduced during their tenure.[12,13] Moreover, years of professional experience among ATs were explored through frequency distributions (e.g., 6+ years, 5 or less years). This chapter discusses the research design, participant selection, survey instrumentation, data collection and management, and data analysis that were used for this study.

3.2 Research Design

A cross-sectional research design was used for this study. The survey acquired data on demographic information, concussion assessment, and management among ATs. The study categorized participants into two groups: preceptors and non-preceptors, alongside stratification based on years of experience, specifically 6+ years and 5 or less years of experience. A preceptor is defined as any certified athletic trainer who has mentored an athletic training student since 2020, coinciding with the implementation of the new CAATE standards. Institutional review board approval was obtained from Michigan State University prior to the start of data collection

(See Appendix B). This study was given exempt status, as it collected de-identified information and presented little to no-risk to its participants.

3.3 Sample Population and Participant Selection

The target population for this study included certified ATs over the age of 18 years. Potential participants were recruited from CAATE accredited athletic training programs and National Athletic Training Association (NATA) membership. Data was gathered through multiple channels, including in-person collection at the 74th NATA Clinical Symposia and AT Expo via QR codes and Qualtrics links, as well as e-mail invitations from Qualtrics to ATs from contact information found through the Korey Stringer Athletic Training Locations and Services website and CAATE accredited programs. Furthermore, a sample of 1000 ATs who are active members of the NATA were randomly generated from the NATA online database. ATs were excluded if they did not complete the assessment, management, RTP, plan of care, or policy items. All recruits provided informed consent, which was implied by actively selecting the link in the e-mail or clicking yes to agreeing to participate in the study.

3.4 CAATE Standards

The CAATE standards play a vital role in ensuring the quality and consistency of athletic training education programs across the United States. These standards serve as a foundational framework that guides the development and maintenance of athletic training programs, fostering excellence in education and preparing future ATs to deliver high-quality healthcare services to individuals in need.[7] CAATE standards encompass various aspects of curriculum, clinical education, faculty qualifications, and resources, all aimed at meeting the evolving demands of the athletic training profession and upholding the highest standards of patient care.[7]

3.4.1 CAATE Standard 71

Standard 71 is a generalized standard incorporating the entire systems in the body. The standard states to perform an examination to formulate a diagnosis and plan of care for patients with health conditions commonly seen in athletic training practice. Standard 71 has eight bullet points adding in systems of the body and what the exam should incorporate including:

- Obtaining a medical history from the patient or other individual
- Identifying comorbidities and patients with complex medical conditions
- Assessing function (including gait)

- Selecting and using tests and measures that assess the following to relevant clinical presentation:
    - Cardiovascular system (including auscultation)
    - Endocrine system
    - Eyes, ears, nose, throat, mouth, and teeth
    - Gastrointestinal system
    - Genitourinary system
    - Integumentary system mental status
    - Musculoskeletal system
    - Neurological system
    - Pain level
    - Reproductive system
    - Respiratory system (including auscultation)
    - Specific functional tasks
- Evaluating all results to determine a plan of care, including referral to appropriate provider when indicated.

3.4.2 CAATE Standard 76

Evaluate and treat a patient who has sustained a concussion or other brain injury, with consideration of established guidelines:

- Performance of a comprehensive examination designed to recognize concussion or other brain injury, including (but not limited to) neurocognitive evaluation, assessment of the vestibular and vision systems, cervical spine involvement, mental health status, sleep assessment, exertional testing, nutritional status, and clinical interview.
- Re-examination of the patient on an ongoing basis
- Recognition of an atypical response to brain injury
- Implementation of a plan of care (addressing vestibular and oculomotor disturbance, cervical spine pain, headache, vision, psychological needs, nutrition, sleep disturbance, exercise, academic and behavioral accommodations, and risk reduction)
- Return of the patient to activity/participation
- Referral to the appropriate provider when indicated.
- Identify the courses and/or clinical education experiences.

3.4.3 CAATE Standard 93

Develop and implement specific policies and procedures for individuals who have sustained concussions or other brain injuries, including the following:

- Education of all stakeholders
- Recognition, appraisal, and mitigation of risk factors
- Selection and interpretation of baseline testing
- Agreement on protocols to be followed, including immediate management, referral, and progressive return to activities of daily living, including school, sport, occupation, and recreation.

3.5 Instrumentation

A one-time survey was adapted and modified from previously published surveys that examined concussion assessment and management tools utilized by ATs.[14,139,140] The aforementioned study underwent content validation by four content experts to ensure item constructs and clarity.[14,139,140] Modifications (e.g., addition of CAATE SRC standards) to the survey were necessary to account for new guidelines and assessments, however, it was important to keep the survey as similar as possible to the most recently published survey by Lempke and colleagues.[14] Specific aspects of CAATE standards 71,76, and 93 (e.g., clinical interview, nutrition, recognition of atypical brain injury, implementation of policies) were added into select all that apply questions for both assessment and management techniques. When designing the survey instrument, the inclusion of items related to SRC assessment and management was guided by established CAATE standards and consensus guidelines (e.g., Concussion In Sport Group) to ensure comprehensive coverage of essential elements (e.g., Standards 71, 76, 93).[7,12,33,34] Specifically, the CAATE standards were broken down between diagnosis (CAATE standard 71/76), plan of care (CAATE standard 76), return to play (CAATE standard 76), and policy (CAATE standard 93). The self-administered one-time survey took approximately 10-15 minutes to complete. An electronic survey was conducted using the university's Qualtrics system.[141]

The survey had two sections that included demographics and assessment and management tools that were utilized in the 2020 CAATE concussion standards. The demographic questions including age, sex, race, level of education, current job setting, years of certification, and if they are a preceptor (e.g., any certified AT who mentored an athletic training student since 2020) to a CAATE athletic training student. The assessment and management of

concussion questions used a select all that apply for baseline assessment measures utilized, and typical methods used for concussion assessment (e.g., SAC, balance testing, neurocognitive testing) and management (e.g., clinical interview, mental health status, nutrition), as well as policy (e.g., educate stakeholders). Examples of this from the survey include "what assessments do you typically utilize to assess and diagnose concussion (check all that apply)?", "what do you typically consider for development of a plan of care for a concussion patient?", and "what methods do you typically utilize to make a decision about return to play after a concussion?". The survey also asks about the total number of concussions managed in the last 12 months in a self-report open text manner.

Face validity was established by four content experts including certified and licensed practicing ATs and concussion researchers. The experts were instructed to evaluate the survey and determine if the questions were clear and important. The instrument was revised based on the content expert's feedback. A pilot study was then conducted with a sample of 24 ATs from various sports medicine job settings. There were no additional comments from the pilot study or suggestions from the panel that modified the content and associated components. Reliability was established using Cronbach α grouping by question type for SRC assessment and management. Assessment and management of SRC was considered very reliable[142] with coefficient of 0.93.

3.6 Procedures

Institutional review board approval was obtained from Michigan State University prior to the start of data collection. This study was given exempt status, as it collected de-identified information and presented little to no risk to its participants. The survey was available in both paper and pencil and Qualtrics weblink.

All data was stored on a password protected computer. Subjects who agree to participate in the study were directed to the website to complete the questionnaire or provided a paper copy of the survey. Participants were not required to answer all questions, could exit the survey at any time, and had the option to return to the earlier page. All responses were anonymous, and no risks were foreseen from completing the paper copy or the online survey. The Qualtrics survey remained online for a total of 4 weeks with a follow-up email that was sent to all recipients in week 2.

3.7 Data Analysis

Descriptive statistics (means, standards deviations [SD], percentages, and frequencies) were used to describe the total sample (e.g., ages, sex, highest level of education, years of experience, preceptor history, how many athletic training students since 2020, primary work setting, degrees applicable, currently practicing as an AT, years worked clinically). Years of professional experience among ATs were explored through frequency distributions (e.g., 6+ years, 5 or less years). The rationale for categorizing athletic trainers' experience into two groups, 0-5 years and 6 or more years, stems from the impact of the Berlin Consensus Statement in 2017 on concussion management guidelines, with those having 6+ years likely incorporating these guidelines, while those with 0-5 years may have more familiarity with newer guidelines introduced during their education.[7,143] A descriptive analysis was used to determine the distribution of the data for the number of items responded to diagnosis (CAATE standard 71/76), plan of care (CAATE standard 76), return to play (CAATE standard 76), and policy (CAATE standard 93). The items for each category were determined by CAATE standards in coordination with consensus statements from the Concussion in Sport Group. Diagnosis items were as followed: performance of a comprehensive examination including neurocognitive evaluation, computerized neurocognitive evaluation, assessment of vestibular and visions systems, cervical spine involvement, mental health status, sleep assessment, exertional testing, nutritional status, clinical interview, recognition of atypical response to brain injury, re-examination of patient on an ongoing basis, referral when indicated then were separated into the following categories: 0-7, 8-10-11-14 items. The plan of care items included addressing vestibular and oculomotor disturbance, cervical spine pain, headache, vision, psychological needs, nutrition, sleep disturbances, exercise, academic and behavior accommodation, and risk reduction then were separated into 0-10 and 11+ items. Return to play items included neurocognitive evaluation, computerized neurocognitive evaluation, assessment of vestibular and visions systems, cervical spine involvement, mental health status, sleep assessment, exertional testing, nutritional status, clinical interview, recognition of atypical response to brain injury, re-examination of patient on an ongoing basis, referral when indicated then was separated into 0-6 and 7+ items. Lastly policy items included education of all stakeholders, recognition, appraisal, and mitigation of risk factors, select and interpretation of baseline testing, and agreement on protocols (e.g., referral,

progressions of RTP) and then were grouped together. Separate regression analyses were utilized to examine the following hypotheses:

Hypothesis 1: ATs who are preceptors are more likely to utilize CAATE standards for concussion assessment and management compared to ATs who are not preceptors.

Separate univariate logistic regression was used to estimate odds ratios and a univariate multinomial logistic regression was performed to assess relative odds of an AT utilizing CAATE standards based on status as a preceptor. The univariate multinomial logistic regression was performed for diagnostic items due to multiple levels in the outcome variables (e.g., 0-7, 8-10, 11-14 items). The significance was determined if the 95% confidence internal did not overlap zero. Separate univariate logistic regressions were performed for plan of care, return to play, and policy items. The significance was determined if the 95% confidence interval did not overlap 1. This analysis helped determine whether there is a statistically significant association between being a preceptor and the odds of utilizing CAATE standards for concussion assessment and management.

Hypothesis 2: ATs with 6+ years of experience are less likely to utilize CAATE standards for concussion assessment and management compared to ATs with 5 years or less of experience.

Separate univariate logistic regressions estimated odds ratios and a univariate multinomial logistic regression was performed to assess relative odds of an AT utilizing CAATE standards based on status as years of experience. The univariate multinomial logistic regression was performed for diagnostic items due to multiple levels in the outcome variables (e.g., 0-7, 8-10, 11-14 items). The significance was determined if the 95% confidence internal did not overlap zero. Separate univariate logistic regressions were performed for plan of care, return to play, and policy items. The significance was determined if the 95% confidence interval did not overlap 1. This analysis helped determine whether there is a statistically significant association between being a year and the odds of utilizing CAATE standards for concussion assessment and management.

After both models from hypotheses 1 and 2 were completed a multivariable multinomial logistic regression and a multivariable logistic regression was performed. A multivariable multinomial logistic regression was performed for preceptors utilizing diagnostic items adjusting for years of experience. A multivariate logistic regression was performed for preceptors estimating the odds of utilizing plan of care, return to play, and policy items adjusting for years

of experience. Multinomial logistic regression is suitable for testing this hypothesis because it allows for the examination of the relationship between a categorical outcome variable (utilization of CAATE standards) with more than two categories and one or more predictor variables (years of experience, preceptor, or non-preceptor). In this scenario, the outcome variable includes multiple categories representing different levels of utilization of CAATE standards for concussion assessment and management. The predictor variable is years of experience, which can be categorized as 6+ years or 5 years or less. All data was analyzed using STATA.[144]

CHAPTER 4: RESULTS

The purpose of this study was to determine if certified ATs who are preceptors are using 2020 CAATE standards for concussion assessment and management. Secondarily, to examine if years of experience as an AT is associated with utilization of the new CAATE standards for concussion assessment and management. This chapter includes a report of demographic information, descriptive statistics, and all main findings for each hypothesis.

4.1 Pilot Data

The pilot study was completed June 8-9, 2023, at Michigan Athletic Trainers Society conference consisting of 24 (58.3% n=14 females; 41.7% n=10 males) certified ATs. Of the 24 participants, 79.2% (n=19) were preceptors and 20.8% (n=5) were non-preceptors. The mean age of the participants was 47.4± 13 years (range 28-68). Most of the participants reported that they were white (n=21, 87.5%), followed by black or African American (n=2, 8.3%), and mixed race (n=1, 4.2%). The primary places of employment for participants were high school athletics (n=6, 25.0%), DI college athletics (n=6, 25.0%), and DII college athletics (n=5, 20.8%). Complete demographic information for the pilot data is included in Table 4.1. Due to the low number of respondents that were non-preceptors we did not complete logistic regressions but did compare groups on the pilot data. The pilot study was for the purpose of face validity.

Table 1. Demographics of Pilot Data Participants

Demographic Characteristics	**No. (%)**			
	Preceptor (N=19)	**Non-Preceptor (N=5)**	x^2	p
Sex			0.007	0.932
Female	11 (57.89)	3 (60.00)		
Male	8 (42.11)	2 (40.00)		
Race			0.9023	0.637
White	16 (84.21)	5 (100.00)		
Black	2 (10.53)	NA		
Mixed	1 (5.26)	NA		
Ethnicity			N/A	N/A
Not Hispanic or Latino	2 (100.00)*	1 (100.00)*		
Employment/Position Setting			11.873	0.065
High School	3 (15.79)*	3 (60.00)		
DI	6 (31.58)*	NA		
DII	5 (26.32)*	NA		
College Athletics	NA	1 (20.00)		
Sports Medicine Clinic	1 (5.26)*	NA		
Hospital	1 (5.26)*	1 (20.00)		
Concussions Assessed in last 12 months			3.015	0.555
0	1 (5.56)*	1 (20.00)		
1-5	9 (50.00)*	1 (20.00)		
6-10	4 (22.22)*	2 (40.00)		
11-15	2 (11.11)*	NA		
More than 20	2 (11.11)*	1 (20.00)		
Years of Experience			7.831	0.551
Less than 1	1 (5.26)	NA		
1-5	4 (21.05)	NA		
6-10	2 (10.53)	NA		
11-15	3 (15.79)	1 (20.00)		
16-20	2 (10.53)	1 (20.00)		
21-25	3 (15.79)	1 (20.00)		
26-30	1 (5.26)	1 (20.00)		
31-35	NA	1 (20.00)		
36-40	2 (10.53)	NA		
41-45	1 (5.26)	NA		
Currently Practicing			0.2746	0.600
Yes	18 (94.74)	5 (100.00)		

Table 1 (cont'd)

No	1 (5.26)	NA		
Years of clinical practice			3.8586	0.796
1-5	1 (5.26)	NA		
6-10	4 (21.05)	NA		
11-15	3 (15.79)	1 (25.00)		
16-20	3 (15.79)	2 (50.00)		
21-25	2 (10.53)	NA		
26-30	4 (21.05)	1 (25.00)		
31-35	1 (5.26)	NA		
36-40	1 (5.26)	NA		
46-50	1 (5.26)	NA		
Abbreviation: NA, not available**; ***missing data as participants in the pilot data did not answer all questions equally				

4.2 Demographic Information

A total of 298 (61.7% n=184 females; 38.2% n=114 males) certified ATs were included in the current study. The mean age of the participants was 36.6±11 years (range 22-72 years). Most of the participants reported that they were white (n=268, 90.5%), followed by black (n=11, 3.7%), mixed race (n=7, 2.4%); separately, 93.6% of the participants selected not Hispanic or Latino. The top three places of primary employment were high school athletics (n=87, 29%), DI athletics (n=61, 20%), and academics (n=40, 13%). Complete demographic information as well as chi-squared and p-values for comparison between groups are provided in Table 4.2.

Table 2. Demographics of Certified Athletic Trainers

Demographic Characteristics	**No. (%)**			
	Preceptor (N=187)	**Non-Preceptor (N=111)**	x^2	p
Sex			9.441	0.002
Female	103 (55.08)	81 (72.97)		
Male	84 (44.92)	30 (20.03)		
Race			3.013	0.698
White	166 (89.25)	102 (92.73)		
Asian	3 (1.61)	2 (1.82)		
American Indian/Alaskan Native	1 (0.54)	NA		
Black	8 (4.30)	3 (2.73)		
Other	2 (1.08)	2 (1.82)		
Mixed	6 (3.23)	1 (0.91)		
Ethnicity			1.189	0.552
Hispanic or Latino	8 (4.28)	8 (7.21)		
Not Hispanic or Latino	177 (94.65)	102 (91.89)		
Other	2 (1.07)	1 (0.90)		
Employment/Position Setting			37.976	0.000
High School	44 (23.53)	43 (38.74)		
DI	46 (24.60)	15 (13.51)		
DII	1 (0.53)	3 (2.70)		
DIII	24 (12.83)	5 (4.50)		
College Athletics	3 (1.60)	4 (3.60)		
Sports Medicine Clinic	7 (3.74)	6 (5.41)		
Hospital	1 (0.53)	2 (1.80)		
Professional Athletics	6 (3.21)	3 (2.70)		
Military	1 (0.53)	1 (0.90)		
Industrial	5 (2.67)	13 (11.71)		
Academic Department	33 (17.65)	7 (6.31)		
Fitness Center	NA	1 (0.90)		

Table 2 (cont'd)

Other	16 (8.56)	8 (7.21)		
Concussions Assessed in last 12 months			3.605	0.608
0	32 (17.11)	21 (19.27)		
1-5	69 (36.90)	31 (28.44)		
6-10	40 (21.39)	26 (23.85)		
11-15	16 (8.56)	9 (8.26)		
16-20	7 (3.74)	8 (7.34)		
More than 20	23 (12.30)	14 (12.84)		
Years of Experience			25.148	0.005
Less than 1	4 (2.14)	9 (8.26)		
1-5	34 (18.18)	33 (30.28)		
6-10	48 (25.67)	30 (27.52)		
11-15	24 (12.83)	16 (14.68)		
16-20	30 (16.04)	4 (3.67)		
21-25	14 (7.49)	6 (5.50)		
26-30	12 (6.42)	7 (6.42)		
31-35	13 (6.95)	2 (1.83)		
36-40	4 (2.14)	1 (0.92)		
41-45	1 (0.53)	NA		
46-50	3 (1.60)	1 (0.92)		
Currently Practicing			0.001	0.970
Yes	175 (93.58)	104 (93.69)		
No	12 (6.42)	7 (6.31)		
Years of clinical practice			31.932	0.000
Less than 1	10 (5.35)	14 (12.61)		
1-5	34 (18.18)	40 (36.04)		
6-10	55 (29.41)	32 (28.83)		
11-15	27 (14.44)	13 (11.71)		
16-20	28 (14.97)	3 (2.70)		
21-25	9 (4.81)	3 (2.70)		
26-30	9 (4.81)	5 (4.50)		
31-35	9 (4.81)	NA		
36-40	4 (2.14)	1 (0.90)		
46-50	2 (1.07)	NA		
Abbreviation: NA, not available				

4.3 Evaluation of Hypothesis

H1: ATs who are preceptors will have greater odds of utilizing the 2020 CAATE standards for concussion assessment and management relative to ATs who are not preceptors.

The investigation into hypothesis 1 aimed to discern whether AT preceptors demonstrate higher odds of utilizing CAATE 76[7] and 93[7] for concussion assessment and management relative to non-preceptors. A univariate multinomial logistic regression was performed for diagnostic items due to multiple levels in the outcome variables. The univariate multinomial regression was completed with the primary outcome being the three categories of diagnosis items (e.g., 0-7, 8-10, 11-14 items) and based on being a preceptor. The univariate multinomial logistic regression analysis revealed notable findings for utilization of diagnostic items in standard 76. Preceptors exhibited a higher relative log odds (OR: 0.64, 95% CI: 0.09-1.18) of reporting 8-10 items, and higher relative log odds (OR: 1.28, 95% CI: 0.89-1.97) of 11-14 items relative to 0-7 items than non-preceptors (see Table 4.4).

CAATE standard 76[7] also incorporates concussion management and treatment protocols. As such, logistic regression analysis demonstrated the odd of being a preceptor on specific aspects of concussion management protocols. Notably, when examining plan of care items for a concussed individual, the odds of having 11 or more items were 2.6 (95% CI: 1.58-4.20) times greater among preceptors compared to non-preceptors. Results revealed preceptors exhibited a 2.3 (95% CI: 1.41-3.71) higher odds of having seven or more RTP items compared to non-preceptors.

CAATE standard 93[7] states athletic training students need to develop and implement specific policies and procedures for individuals who have sustained concussion. When examining all four policies (e.g., education, recognition of risk factors, baseline testing, agreement of protocol) logistic regression revealed preceptors had a 2.3 (95 CI%: 1.32-4.05) higher odds of utilizing all four policy items compared to non-preceptors (see Table 4.3). These findings underscore the influence of being a preceptor on utilization of CAATE standards for concussion assessment and management, as well as policy and procedures for concussed individuals among certified ATs. Thus, this highlights the importance of mentorship in promoting best practices within the athletic training field.

Table 3. Univariate Multinomial Logistic regression results for Preceptors and Non-Preceptors

	8-10 Diagnosis items		**11-14 Diagnosis items**	
	Relative Log Odds	**95% CI**	**Relative Log Odds**	**95% CI**
Preceptor	0.64	0.09-1.18	1.28	0.89-1.97

Table 4. Univariate Logistic regression results for Preceptors and Non-Preceptors

	11-14 Plan of Care Items		**6+ RTP Items**		**4 Policy Items**	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Preceptor	2.58	1.58-4.20	2.30	1.41-3.71	2.31	1.32-4.05

H2: Certified ATs with 6+ years of experience are less likely to utilize CAATE standards for concussion assessment and management compared to certified ATs with 5 years or less of experience.

The univariate logistic regression analysis was conducted to investigate the hypothesis that ATs with 6+ years of experience are less likely to utilize CAATE standards 76[7] and 93[7] for concussion assessment and management compared to those with 5 years or less of experience. Similarly, to hypothesis 1 analysis a univariate multinomial logistic regression was performed for diagnostic items due to the multiple levels. Results for univariate multinomial logistic regression revealed that there was no significant relationship between 8-10 diagnosis items relative to 0-7 with having 6+ years of experience (OR: 0.14; 95% CI-0.41-0.69). However, there was a significant relationship for 11-14 diagnosis items relative to 0-7 items for having 6+ years of experience (Relative Log Odds: 0.98; 95% CI: 0.26-1.70) while holding the relationship between 8-10 items constant.

CAATE standard 76[7] also incorporates concussion management and treatment protocols. As such, univariate logistic regression analysis further elucidated the influence of years of experience on specific aspects of concussion management protocols. Notably, when examining plan of care items for a concussed individual, the odds of having 11 or more items were 2.3 (95% CI: 1.41-3.84) times greater among ATs with 6+ years of experience compared to ATs with 5 years or less experience. The was not a significant relationship between 6+ years of experience

with utilizing 6+ RTP items in the univariate logistic regression. CAATE standard 93[7] states athletic training students need to develop and implement specific policies and procedures for individuals who have sustained concussion. When examining all four policies (e.g., education, recognition of risk factors, baseline testing, agreement of protocol) univariate logistic regression revealed ATs with 6+years of experience had 2.4 (95% CI: 1.40-4.30) higher odds of utilizing all four policy items compared to ATs with 5 or less years of experience. (see Table 4.3).

After both models were completed for hypothesis 1 and 2 a separate multinomial logistic regression and multivariable logistic regression were performed for each outcome to adjust for years of experience. The multinomial multivariable logistic regression found 0.65 (95% CI: 0.83-1.21) higher relative log odds of preceptors utilizing 8-10 diagnosis items, and 1.13 (95% CI: 0.42-1.83) higher relative log odds of preceptors utilizing 11-14 diagnosis items relative to 0-7 items while adjusting for years of experience. As for the multivariable logistic regression preceptors had 2.24 (95% CI: 1.35-3.70) higher odds of utilizing 11-14 plan of care items while adjusting for years of experience. Preceptors also had 2.17 (95% CI: 1.32-3.58) higher odds of utilizing 6+ RTP items while adjusting for years of experience. Lastly, there was 1.94 (95% CI: 1.08-3.47) higher odds of preceptors utilizing all four policy items while adjusting for clinical years of experience. These findings suggest a nuanced relationship between years of experience, adherence to CAATE standards, and the utilization of specific assessment and management protocols among certified ATs.

Table 5. Univariate Multinomial Logistic regression results for Years of Experience

	8-10 Diagnosis items		**11-14 Diagnosis items**	
	Relative Log Odds	**95% CI**	**Relative Log Odds**	**95% CI**
Years of experience	0.14	-0.41-0.69	0.98	0.26-1.70

Table 6. Univariate Logistic regression results for Years of Experience

	11-14 Plan of Care Items		**6+ RTP Items**		**4 Policy Items**	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Years of experience	2.33	1.41-3.84	1.50	0.92-2.45	2.44	1.40-4.30

Table 7. Multivariable Multinomial Logistic regression

	Relative Log Odds	**95% CI**
Diagnosis Items (outcome 8-10 items)		
Preceptor	0.65	0.82-1.21
6+years of clinical experience	-0.19	-0.59-0.55
Diagnosis Items (outcome 11-14 items)		
Preceptor	1.13	0.42-1.84
6+years of clinical experience	0.71	-0.02-1.45

Table 8. Multivariable Logistic Regression with adjusted odds ratio (aOR)

	aOR	**95 % CI**
Plan of Care Items (outcome 11-14 items)		
Preceptor	2.24	1.35-3.70
6+ years of clinical experience	1.94	1.15-3.26
Return to Play Items (outcome 7-13 items)		
Preceptor	2.17	1.32-3.58
6+ years of clinical experience	1.22	0.73-2.04
Policy Items (outcome 4 items)		
Preceptor	1.94	1.08-3.47
6+ years of clinical experience	2.07	1.15-3.73

CHAPTER 5: DISCUSSION

5.1 Overview

The purpose of this study was to determine if certified ATs who are preceptors are using updated CAATE standards (e.g., 71,76,93) for concussion assessment and management. Specifically, the CAATE standards were broken down between diagnosis (CAATE standard 71/76), plan of care (CAATE standard 76), return to play (CAATE standard 76), and policy (CAATE standard 93). Secondarily, to examine if years of experience of ATs is associated with utilization of the new CAATE standards for concussion assessment and management.

The results of the study indicated that certified ATs who are preceptors have higher odds of utilizing a greater number of 2020 CAATE standards for concussion assessment and management compared to non-preceptors. Specifically, preceptors had higher odds of using eight or more items for concussion diagnosis (e.g., symptoms, vestibular impairments), 2.6 times higher odds of using 11 or more items when managing a concussed athlete (e.g., vestibular therapy, psychological needs), 2.3 times higher odds of using seven or more items for return to play (e.g., exertional testing), and higher odds of using all four policy items (e.g., education, baseline testing). However, certified ATs who have 6+ years of clinical experience have higher odds of utilizing updated CAATE standards compared to those with 5 years or less clinical experience. This study lends support to the notion that serving as a CAATE preceptor offers certified ATs advantages in staying abreast of updates in concussion assessment and management techniques.

5.2 H1: Preceptors and CAATE Standards

The current study is the first to examine preceptors versus non-preceptors with the 2020 CAATE standards specific to SRC. The results of the study supported hypothesis one with higher odds of preceptors utilizing more SRC items from diagnosis, plan of care, return to play, and policy items compared to non-preceptors. The observed differences between preceptors and non-preceptors underscore the critical role of mentorship programs (e.g., reciprocal learning) in promoting adherence to best practices and standards within the athletic training profession. For instance, the guidance provided by experienced mentors and being a preceptor to athletic training students plays a pivotal role in refining the clinical skills and expanding knowledge base of ATs Through direct mentorship, ATs gain practical insights and learned approaches to SRC assessment and management. This hands-on experience not only enhances their proficiency but

also instills a strong sense of professionalism, fostering a culture of excellence and accountability within the field. Furthermore, mentorship serves as a valuable mechanism for addressing disparities in decision-making among ATs. By observing and learning from seasoned practitioners and being a preceptor, ATs develop standardized approaches to assessing and managing SRC, promoting consistency in care delivery across various athletic settings. This uniformity in practices ultimately contributes to improved patient outcomes and ensures that athletes receive the highest quality of care, regardless of the setting or circumstances.

In a study by Keeley and colleagues,[128] ATs who served as preceptors within a year of when the study was being collected found that they had higher implementation scores for evidence-based practice compared to those who were not preceptors. Although this is not specific to CAATE concussion standards, this supports the results of the current study, by showing that those ATs who serve as a preceptor for CAATE programs are knowledgeable and comfortable in their clinical skills along with passing that knowledge on to athletic training students. Another possible reason for preceptors employing a greater number of diagnostic and management measures with concussed athletes could stem from the requirement by CAATE for preceptors to possess contemporary expertise. Five out of the eight contemporary expertise categories specified by CAATE relate to concussion and include encompassing prevention and wellness, urgent and emergent care, primary care, orthopedics, and rehabilitation. It's plausible that certain preceptors in the present study possessed contemporary expertise in concussion, leading them to adhere more closely to the CAATE concussion standards compared to non-preceptors.

Preceptors in athletic training play a vital role not only in instructing and guiding students but also in facilitating mutual learning. Preceptors bring a wealth of knowledge, skills, and practical insights that they share with athletic training students. However, the dynamic between preceptors and students is not solely one-directional; rather, it involves a mutual or reciprocal exchange of knowledge and experiences. As a result, preceptors may have employed a greater number of SRC measures for assessment, management and return to play due to this reciprocal learning. Previous literature has noted the importance of mutual or reciprocal learning as part of a role as a preceptor.[125,145-147] For example, Bowman and colleagues[147] found that preceptors appreciated the challenging dynamic and fostering of mutual learning between themselves and the athletic training students leading to a further sense of responsibility to the student.[147] This

highlights how reciprocal learning from a preceptor and athletic training student can enhance the utilization of CAATE standards in the field. However, further research may be warranted to explore the specific mechanisms through which mentorship influences diagnostic decision-making practices and to identify strategies for enhancing mentorship programs within the athletic training profession. Additionally, investigating potential factors (e.g., exposure to SRC cases, institutional policies) contributing to differences in diagnostic practices between preceptors and non-preceptors could provide valuable insights for improving training and professional development initiatives in SRC assessment.

Finally, preceptors in the current study had higher odds of utilizing CAATE standards regarding SRC assessment, treatment, and policy compared to non-preceptors, possibly due to their teaching responsibilities. Preceptors are responsible for supervising and educating athletic training students during clinical rotations. In this role, they must possess a comprehensive understanding of concussion assessment and management to effectively teach and mentor athletic training students. Preceptors may engage in active discussions, case studies, and hands-on training with students, further deepening their knowledge and expertise in this area compared to non-preceptors. Their dedication and commitment to teaching play a crucial role in shaping the future of the profession and ensuring high-quality patient care.

5.3 H2: Years of Experiences and CAATE Standards

The secondary purpose of this study was to examine if years of experience is associated with utilization of the new CAATE standards for SRC assessment and management. The findings of the study did not align with the hypothesis, which suggested that certified ATs with over 6+ years of experience would be less inclined to adhere to CAATE standards for SRC assessment and management compared to those with 5 years or less of experience. The current study found that for certified ATs with 6+

years of experience were more likely to adhere to CAATE standards 76[7] and 93[7] (e.g., diagnosis, plan of care, RTP, policy) than those with less experience. Moreover, those certified ATs who are preceptors and adjusted for years of experience were still more likely to utilize items from the CAATE standards 76[7] and 93.[7]

The discrepancy between the findings of the current study and previous research by Lempke and colleagues[14,27]regarding the utilization of concussion assessment and management tools among ATs with varying levels of clinical experience is noteworthy. Despite Lempke et

al.'s suggestion that ATs with more clinical experience tended to employ these tools less frequently, such a trend was not evident in the current study. There are several possibilities for ATs with more clinical experience utilizing more SRC assessment and management tools. First, experienced ATs have accumulated years of practical experience working with athletes and managing SRCs. This experience often translates into a deeper understanding of SRC which may result in them feeling more competent in utilizing a wider array of assessment and management strategies. Second, ATs are required to engage in continuing education to maintain their certification. Over time, experienced ATs may have participated in more workshops, seminars, and training sessions focused on SRC evaluation and management compared to ATs only certified for 5 years or less. Moreover, this ongoing education enhances their knowledge base and may introduce them to new assessment tools, targeted treatments, and best practices that are part of the CAATE standards. Finally, seasoned ATs often have established relationships with other healthcare providers, including sport medicine physicians, neurologists, and neuropsychologists, who specialize in SRC diagnosis and management. These collaborative partnerships enable them to consult with experts, seek second opinions, and access additional resources when needed, thereby enhancing the quality of care provided to concussed athletes.

Another possible explanation for this inconsistency between Lempke et al's[14] study and the current study might stem from the inclusion of being a preceptor versus non-preceptor within the statistical analysis. Research has shown that serving as a preceptor can challenge ATs but also fosters reciprocal learning and encourages the implementation of evidence-based practices. [31,121,147] As such, being a preceptor may have influenced the clinical practices of ATs in the current study, leading to higher utilization of SRC assessment and management tools regardless of their level of clinical experience.

The current study findings revealed that being a preceptor does not lead to statistically significant differences in the utilization of return-to-play decision-making items for ATs with 6+ years of experience. However, in hypothesis 1 the results found that being a preceptor had higher odds of utilizing 7 or more items return to play items. Despite the potential for preceptors to play a crucial role in shaping clinical practice and decision-making, particularly ATs with 6+ years of experience, the results suggest that this influence may not extend to the realm of return-to-play protocols. This finding may indicate that other factors, such as institutional policies, professional guidelines, or individual clinical judgment, have a stronger impact on the decision-

making process regarding return-to-play assessments. Further exploration into the specific factors driving return-to-play decision-making among ATs, as well as the potential role of mentorship in this context, could provide valuable insights for enhancing concussion management practices and educational strategies within the athletic training profession. Additionally, investigating potential barriers or challenges faced by AT in adhering to return-to-play protocols may inform the development of targeted interventions to support more consistent and evidence-based decision-making in concussion management.

5.4 Limitations

This study is the first study to examine assessment and management techniques of SRC amongst preceptors and non-preceptors, with a particular focus on adherence to CAATE standards. However, this study was not without limitations. First, while self-report measures are valuable tools for gathering data on subjective experiences and behaviors, they come with inherent limitations that should be considered when interpreting study findings. One significant limitation of relying on self-report data is the potential for response bias. Participants may provide responses that they believe are socially desirable or align with perceived expectations, leading to inaccuracies or overestimations of certain behaviors or experiences. This bias can impact studies involving sensitive topics such as SRC assessment and management techniques, where participants may feel pressure to present themselves in a favorable light. Second, practicing at or near an R1 institution, near a leader in concussion researcher could lead to response bias. This could lead to participants responding to the survey and be influential in their responses. Third, this study did not calculate a response rate due to the nature of data collection. Data was gathered through multiple channels, including in-person collection at the 74th NATA Clinical Symposia and AT Expo via QR codes and Qualtrics links, as well as e-mail invitations from Qualtrics to ATs from contact information found through the Korey Stringer Athletic Training Locations and Services website and CAATE accredited programs. However, the exact number of individuals who were exposed to the survey invitations or accessed the provided links cannot be accurately determined, making it challenging to ascertain the proportion of responders relative to the total eligible population. Another limitation that is important to note is that content validity of the study was not captured due to the low number of non-preceptors in the pilot-study. Lastly, although a variety of settings are represented in the sample, the current study does not exhaust all possibilities for AT work settings. Additionally, ensuring the robustness of the

findings through replication in independent samples or settings would strengthen the validity and generalizability of the conclusions drawn from this analysis.

5.5 Conclusion

In conclusion, this dissertation provides valuable insights into the utilization of updated CAATE standards for SRC assessment and management among ATs, focusing on the influence of being a preceptor and years of experience. The findings reveal that certified ATs serving as preceptors demonstrate a higher odd of utilizing CAATE standards compared to non-preceptors, while those with six or more years of clinical experience are also more likely to utilize updated standards. These results underscore the critical role of mentorship in promoting adherence to best practices within the athletic training profession, fostering a culture of excellence and accountability in concussion management practices. However, the need for further research to explore the mechanisms of mentorship influence and address potential barriers to adherence. Furthermore, future research should explore the specific dynamics of mentorship within preceptorship, investigate barriers to adherence among experienced ATs, track the long-term impact of mentorship on adherence and patient outcomes, and explore innovative educational interventions to improve SRC management practices among ATs. Overall, this dissertation lays the groundwork for advancing SRC management practices and improving patient outcomes in the field of athletic training.

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APPENDIX A: SURVEY

Examining Sport-Related Concussion (SRC) assessment and management techniques among ATC

Consent

Consent Form You are being asked to participate in a research study. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Study Title:

Examining Sport-Related Concussion (SRC) assessment and management techniques among athletic training preceptors versus non-preceptors.

EXPLANATION OF THE RESEARCH and WHAT YOU WILL DO

The purpose of this research study is to determine the confidence of SRC assessment and management techniques among certified athletic trainers who are preceptors compared to non-preceptors. You have been selected as a potential participant in this study because you are at least 18 years old and are a certified athletic trainer. Your participation in this research will last approximately 10 minutes. If you say yes to participating in the study, you will be asked to complete one short survey about your assessment methods, management and treatment of SRCs, as well as questions about your demographic information. This process will take roughly 10 minutes. You will complete this survey online using Qualtrics link.

POTENTIAL RISKS

There are minimal risks to participation in this study. In the event new information becomes available that may affect the risks or benefits associated with this study or your willingness to participate in it, you will be notified so that you can decide whether or not to continue participating.

POTENTIAL BENEFITS

You will not benefit personally from being in this study. However, we hope that, in the future, other people might benefit from this study by determining barriers of implementation of SRC assessment and management techniques.

PRIVACY AND CONFIDENTIALITY

Confidentiality is assured for all participants with regard to any responses and information you provide. All data collected will be numerically coded and grouped with data from other participants. Therefore, no individual data will be identifiable once the study is complete. All records will be kept for a minimum of 3 years after the project closes in a locked secure location and your confidentiality will be protected to the maximum extent of the law. However, government representatives, when required by law, and the Michigan State University Human Research Protection Program may deem it necessary to look at and/or copy your information. In addition, researchers will have access to the data for analysis. However, names and other personal information will not be used if the results of this study are published or presented at scientific meetings. All data obtained from this study will be used for research purposes only, not for the diagnosis of any disorder.

YOUR RIGHTS TO PARTICIPATE, SAY NO, OR WITHDRAW

You have the right to say no to participate in the research. You can stop at any time after it has already started. There will be no consequences if you stop and you will not be criticized. You will not lose any benefits that you normally receive. Under some circumstances, it may be necessary to discontinue your participation in the study.

COSTS AND COMPENSATION FOR BEING IN THE STUDY

There will be no cost and or compensation for participation in this research study.

FUTURE RESEARCH

Information that identifies you might be removed from the database. After such removal, the data could be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you.

CONTACT INFORMATION

If you or you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher (Tracey Covassin; 308 W. Circle Drive; Phone: (517) 353-2010; Email: covassin@msu.edu). If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910. **DOCUMENTATION OF INFORMED CONSENT**

You indicate your voluntary agreement to participate by completing and returning this survey.

Q2 Age

_____

Q3 Sex

- ○ Male (1)
- ○ Female (2)

Q4 Race:

- ○ American Indian or Alaska Native (1)
- ○ Asian (2)
- ○ Black or African American (3)
- ○ Native Hawaiian or Other Pacific Islander (4)
- ○ White (5)
- ○ Mixed Race (6)
- ○ Other (Please Specify): (8)

_____

Q5 Ethnicity

- ○ Hispanic or Latino (1)
- ○ Not Hispanic or Latino (2)
- ○ Other (Please Specify): (3)

_____

Q6 Check **all degrees** that apply to you:

- ☐ BS/BA (1)
- ☐ MS/MA/MEd (2)
- ☐ DAT (3)
- ☐ PhD/EdD (4)
- ☐ MD (5)
- ☐ Other (6) _____

Q7 How many years have you been a certified athletic trainer?

▼ less than 1 (1) ... 50+ (51)

Q8 Are you currently practicing as a certified as an athletic trainer?

- ○ Yes (1)
- ○ No (2)

Q9 How many years have you worked clinically?

▼ less than 1 (1) ... Greater than 50 (51)

Display This Question:

If Are you currently practicing as a certified as an athletic trainer? = No

Q10 How many years has it been since practicing clinically?

▼ less than 1 (1) ... Greater than 50 (52)

Q11 Have you been a preceptor for an athletic training student at a CAATE accredited program?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Have you been a preceptor for an athletic training student at a CAATE accredited program? = Yes

Q12 How many athletic training students have you had since 2020?

▼ 0 (1) ... Greater than 50 (51)

Q13 Please indicate your current primary employment/position setting (where you spend the most of your time in a given week)**:**

- ○ High School Athletics (1)
- ○ DI College Athletics (2)
- ○ DII College Athletics (3)
- ○ DIII College Athletics (4)
- ○ College Athletics (outside of what is listed above) (5)
- ○ Sports Medicine Clinic (6)
- ○ General Hospital Setting (7)
- ○ Professional Athletics (9)
- ○ Corporate Health (8)
- ○ Military Setting (10)
- ○ Industrial Setting (11)
- ○ Academic Department (education/faculty) (12)
- ○ Fitness Center (13)
- ○ Personal Trainer (14)
- ○ Other (please specify): (15)

_____

Q14 In the past 12 months, how many athletes have you managed following a suspected or diagnosed concussion?

Q15 Do you currently administer baseline concussion testing for your athletes?

- ○ Yes (1)
- ○ No (2)

Display This Question:
If Do you currently administer baseline concussion testing for your athletes? = Yes
Q16 If you do perform baseline testing, which **category best describes the athletes** that are included in your testing protocols?
Please select all that apply:

- ☐ Collision/contact athletes (1)
- ☐ Limited contact (2)
- ☐ Non-contact (3)
- ☐ I do not administer baseline concussion testing (4)
- ☐ Other (Please Specify) (5)

_____

Display This Question:

If Do you currently administer baseline concussion testing for your athletes? = Yes

Q17 What assessments do you typically utilize for **baseline** concussion testing (check all that apply)?

- ☐ Clinical examination (575)
- ☐ Symptom assessment scale (600)
- ☐ Concussion assessment tool (SAC, SCAT, King-Devick, etc.) (610)
- ☐ Concussion severity grading scale (576)
- ☐ Neuropsychological testing (non-computerized) (568)
- ☐ Neuropsychological testing (computerized) (569)
- ☐ Balance assessment (608)
- ☐ Ocular motor assessment (VOMS, King-Devick, etc.) (577)
- ☐ Reaction time assessment (601)
- ☐ Head impact sensors (609)
- ☐ Mobile application concussion assessment (594)
- ☐ Other (please specify) (579)

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Q18 What assessments do you typically **utilize to assess and diagnose concussion** (check all that apply)?

- [ ] Neurocognitive evaluation (non-computerized) (1)
- [ ] Neurocognitive evaluation (computerized) (14)
- [ ] Assessment of vestibular systems (2)
- [ ] Assessment of vision systems (3)
- [ ] Cervical spine involvement (4)
- [ ] Mental health status (5)
- [ ] Sleep assessment (6)
- [ ] Exertional testing (7)
- [ ] Nutritional status (8)
- [ ] Clinical interview/examination (9)
- [ ] Re-examination of the patient on an ongoing basis (10)
- [ ] Symptom assessment scale (11)
- [ ] Balance assessment (12)
- [ ] Head impact sensors (13)
- [ ] Concussion severity grading scale (15)
- [ ] Reaction time (16)

- [ ] Concussion assessment tool (SAC, SCAT, etc) (17)
- [ ] Ocular motor assessment (VOMS) (18)
- [ ] Recognition of atypical response to brain injury (19)
- [ ] Other (please specify): (20)

_____

Q19 What do you typically consider for **development of a plan of care** for a concussion patient (check all that apply):

- ☐ Vestibular disturbance (1)
- ☐ Ocular disturbance (2)
- ☐ Cervical spine pain (3)
- ☐ Headache (4)
- ☐ Vision (5)
- ☐ Psychological needs (6)
- ☐ Nutrition (7)
- ☐ Sleep disturbances (8)
- ☐ Exercise (9)
- ☐ Academic accommodations (10)
- ☐ Behavioral accommodations (11)
- ☐ Risk reduction (12)
- ☐ Return of patient to activity/participation (13)
- ☐ Referral to the appropriate provider when indicated (14)
- ☐ Recognition of atypical response to brain injury (15)
- ☐ Other (please specify): (16)

_____

Q20 What method(s) do you typically **utilize to make a decision** about **return to play after concussio**n (check all that apply)?

- ☐ Neurocognitive evaluation (non-computerized) (1)
- ☐ Neurocognitive evaluation (computerized) (2)
- ☐ Assessment of vestibular systems (3)
- ☐ Assessment of vision systems (4)
- ☐ Cervical spine involvement (5)
- ☐ Mental health status (6)
- ☐ Sleep assessment (7)
- ☐ Exertional testing (8)
- ☐ Nutritional status (9)
- ☐ Clinical interview/examination (10)
- ☐ Re-examination of the patient on an ongoing basis (11)
- ☐ Symptom assessment scale (12)
- ☐ Balance assessment (13)
- ☐ Head impact sensors (14)
- ☐ Concussion severity grading scale (15)
- ☐ Reaction time (16)

☐ Concussion assessment tool (SAC, SCAT, etc) (17)

☐ Ocular motor assessment (VOMS) (18)

☐ Recognition of atypical response brain injury (19)

☐ Other (please specify): (20)

_____

Q21 Who is **primarily responsible** for making the final decision regarding **return to play** following concussion at your institution (please select one)?

○ Athletic trainer (1)

○ Team physician (2)

○ Primary care physician (3)

○ Neurologist (4)

○ Neuropsychologist (5)

○ Neurosurgeon (6)

○ Coach (7)

○ Player (8)

○ Parents (9)

○ Military personnel (10)

○ Other (please specify) (11)

_____

Q22 Who is **involved** in making the final decision regarding **return to play** following concussion at your institution (select all that apply)?

- ☐ Athletic trainer (1)
- ☐ Team physician (2)
- ☐ Primary care physician (3)
- ☐ Neurologist (4)
- ☐ Neuropsychologist (5)
- ☐ Neurosurgeon (6)
- ☐ Coach (7)
- ☐ Player (8)
- ☐ Parents (9)
- ☐ Military personnel (10)
- ☐ Other (please specify) (11)

_____

Q23 In general, I am confident that I can assess an athlete with a suspected concussion.

- ○ Not confident at all (1)
- ○ Slightly confident (2)
- ○ Somewhat confident (3)
- ○ Fairly confident (4)
- ○ Completely confident (5)

Q24 In general, I am confident that I can safely return an athlete to play following a concussion.

- ○ Not confident at all (1)
- ○ Slightly confident (2)
- ○ Somewhat confident (3)
- ○ Fairly confident (4)
- ○ Completely confident (5)

Q25 In general, I am confident in **performing a comprehensive examination** to recognize concussion including the following:

	Not confident at all (1)	Slightly confident (2)	Somewhat confident (3)	Fairly confident (4)	Completely confident (5)
Neurocognitive evaluation (non-computerized) (1)	○	○	○	○	○
Neurogonitive evaluation (computerized) (2)	○	○	○	○	○
Assessment of vestibular systems (3)	○	○	○	○	○
Assessment of vision systems (4)	○	○	○	○	○
Cervical spine involvement (5)	○	○	○	○	○
Mental health status (6)	○	○	○	○	○
Sleep assessment (7)	○	○	○	○	○
Exertional testing (8)	○	○	○	○	○

Nutritional status (9)	○	○	○	○	○
Clinical interview (10)	○	○	○	○	○
Re-examination of the patient on an ongoing basis (11)	○	○	○	○	○
Recognition of an atypical response to brain injury (12)	○	○	○	○	○
Symptom assessment scale (13)	○	○	○	○	○
Balance assessment (14)	○	○	○	○	○
Head impact sensors (15)	○	○	○	○	○
Concussion assessment tool (SAC, SCAT, etc.) (16)	○	○	○	○	○

Ocular motor assessment (VOMS) (17)	○	○	○	○	○

Q26 In general, I am confident in **implementation of a plan of care** for a concussion patient including the following:

	Not confident at all (1)	Slightly confident (2)	Somewhat confident (3)	Fairly confident (4)	Completely confident (5)
Vestibular disturbance (1)	○	○	○	○	○
Ocular disturbance (2)	○	○	○	○	○
Cervical spine pain (3)	○	○	○	○	○
Headache (4)	○	○	○	○	○
Vision (5)	○	○	○	○	○
Psychological needs (6)	○	○	○	○	○
Nutrition (7)	○	○	○	○	○
Sleep disturbances (8)	○	○	○	○	○
Exercise (9)	○	○	○	○	○
Academic accommodations (10)	○	○	○	○	○
Behavioral accommodations (11)	○	○	○	○	○

Risk reduction (12)	○	○	○	○	○
Return of patient to activity/participation (13)	○	○	○	○	○
Referral to the appropriate provider when indicated (14)	○	○	○	○	○

Q27 In general, I am confident in **developing and implementing specific policies and procedures** for individuals who have sustained concussions or other brain injuries including the following:

	Not confident at all (1)	Slightly confident (2)	Somewhat confident (3)	Fairly confident (4)	Completely confident (5)
Education of all stakeholders (1)	○	○	○	○	○
Recognition, appraisal, and mitigation of risk factors (2)	○	○	○	○	○
Selection and interpretation of baseline testing (3)	○	○	○	○	○
Return of the patient to activity/participation (5)	○	○	○	○	○

Q28 In general, I am confident in **development and implementation** **of protocols** for concussions or other brain injuries including:

	Not confident at all (1)	Slightly confident (2)	Somewhat confident (3)	Fairly confident (4)	Completely confident (5)
Immediate management (1)	○	○	○	○	○
Referral (2)	○	○	○	○	○
Progressive return to daily activities (3)	○	○	○	○	○
Progressive return to school (4)	○	○	○	○	○
Progressive return to sport (5)	○	○	○	○	○
Progressive return to occupation (6)	○	○	○	○	○
Progressive return to recreation (7)	○	○	○	○	○

Q29 Please answer the following questions **based on your professional opinion** during the **management** and **return to play decision** of a concussed athlete:

	Strongly Disagree (1)	Disagree (2)	Neither Agree Nor Disagree (3)	Agree (4)	Strongly Agree (5)
I believe concussions are treatable (1)	○	○	○	○	○
I understand what concussion clinical profiles/subtypes are (3)	○	○	○	○	○
Concussion clinical profiles should be used to assess a concussion (4)	○	○	○	○	○
Concussion clinical profiles should be used to manage a concussion (8)	○	○	○	○	○

Q30 Do you **utilize concussion clinical profiles/subtyping** in your clinical practice?

- ○ Yes (1)
- ○ No (2)

Q31 Do you **interpret the data** and **decide** a concussion clinical profile/subtyping?

- ○ Yes (1)
- ○ No (2)

Q32 I am confident that I can utilize clinical profiles/subtypes as a **framework for developing targeted treatment plans**

- ○ Not confident at all (1)
- ○ Slightly confident (2)
- ○ Somewhat confident (3)
- ○ Fairly confident (4)
- ○ Completely confident (5)

Q33 Please select all the **clinical profiles/subtypes**:

(Select all that apply)

- [ ] Anxiety/Mood (1)
- [ ] Cognitive/fatigue (2)
- [ ] Migraine (3)
- [ ] Ocular (4)
- [ ] Vestibular (5)
- [ ] Sleep (6)
- [ ] Neck (7)
- [ ] Physical (8)

Q34 Please select all the clinical profiles/subtype modifiers:
(Select all that apply)

- [ ] Anxiety/Mood (1)
- [ ] Cognitive/fatigue (2)
- [ ] Migraine (3)
- [ ] Ocular (4)
- [ ] Vestibular (5)
- [ ] Sleep (6)
- [ ] Neck (7)
- [ ] Physical (8)

Q35 Are you **aware** of the **literature** on **clinical profiles**?

- ○ Yes (2)
- ○ No (3)

Q36 Have you attended a seminar, workshop, webinar, formal course, or continuing education on concussion assessment and management in the past 12 months?
Please select all that apply:

- ☐ Seminar (1)
- ☐ Workshop (2)
- ☐ Webinar (3)
- ☐ Formal Course (i.e. Graduate Course) (4)
- ☐ Continuing education (5)
- ☐ None of the above (6)
- ☐ Other (Please Specify) (7)

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