Evaluating the Need for Return-to-Learn Concussion Protocols in High School Student-Athletes: An Integrative Review

A Scholarly Project

Submitted to the

Faculty of Liberty University

In partial fulfillment of

The requirements for the degree

Of Doctor of Nursing Practice

By

William D. Midgette

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Abstract

Over a million high school students are estimated to sustain at least one sports-related concussion annually. Unfortunately, over a third of these student-athletes suffer from post-concussion syndrome, which leads to the question of whether student-athletes are allowed proper time to heal after a concussion or if more can be done to optimize concussion recovery. Proper and optimal recovery post-concussion encompasses both physical and cognitive rest. While concussion management has traditionally focused on the physical aspects of recovery, emphasis has shifted to the cognitive impacts of concussions. There is literature to support that cognitive rest is vitally important, if not equally important, as physical rest after a concussion. Cognitive rest is essential for healing the brain and speeding up recovery post-concussion, while increased cognitive activity post-concussion is associated with longer recovery. Return-to-learn protocols and methodical reintroductions of students into the academic setting are equally vital to allow the brain to recover from sports-related concussions as physical rest and return-to-play protocols. This review's key focus and purpose is to assess the literature to support suggestions for practice change that involves a mandatory, structured return-to-learn concussion protocol.

Keywords: concussions, sports-related concussions, concussion protocols, cognitive rest, return-to-learn protocols, high school student-athletes

Dedication & Acknowledgements

The author would like to dedicate this project to the many close friends, family members, and loved ones who have dealt with concussions and continue to deal with the lasting detrimental effects of post-concussion syndrome. These individuals inspired the author to pursue researching the given topic in hopes of a better tomorrow. The author acknowledges the impact concussions have had on their lives and seeks a day when there will be a decreased incidence of individuals suffering from post-concussion syndrome and young student-athletes will have improved concussion recovery.

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List of Abbreviations

Mild traumatic brain injury (mTBI)

National Federation of State High School Associations (NFHS)

Post-concussion syndrome (PCS)

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

Return-to-learn (RTL)

Return-to-play (RTP)

Sports Medicine Advisory Committee (SMAC)

Sports-related concussion (SRC)

Evaluating the Need for Return-to-Learn Concussion Protocols in High School Student-Athletes: An Integrative Review

Section One: Formulating the Review Question

Introduction

Sports-related concussions (SRC), also considered mild traumatic brain injuries (mTBI), are a significant and increasingly common concern among parents and student-athletes nationwide. The detrimental effects and long-term sequelae from SRCs on the developing adolescent brain can lead to long-term cognitive, physical, behavioral, and psychological adverse outcomes. Physical and cognitive rest is imperative for optimal healing after a concussion. SRC return-to-play (RTP) protocols are widely used and discussed and adequately address the physical aspect of recovery. Yet very little is often discussed regarding protocols for cognitive rest and return-to-learn (RTL) protocols, which are equally important to concussion recovery (Arbogast et al., 2013; Fetta et al., 2021; Olympia et al., 2016)

Many student-athletes who sustain a concussion are placed into their school or statewide concussion protocol and must meet established requirements to return to the playing field. Nevertheless, the day after a concussion, these students are immediately thrust back into the academic arena with little to no cognitive rest. In fact, the National Federation of State High School Associations (NFHS) and Sports Medicine Advisory Committee (SMAC) make strong suggestions for a stepwise, progressive RTP protocol yet offer very little guidance and no stepwise approach for RTL suggestions (NFHS & SMAC, 2017; Olympia et al., 2016). The issue evolves around the prevalent rates of student-athletes with post-concussion syndrome (PCS). With the rates of high school student-athletes suffering from PCS, one must wonder if enough is being done to nurture healing and optimize concussion recovery. This leads to the purpose of this

review: to evaluate the need for mandatory, structured RTL concussion protocols for high school athletes that would better serve student-athletes in their concussion recovery.

Defining Concepts and Variables

The central concept of this integrative review is the impact of cognitive rest and RTL protocols on concussion recovery. Just as the body needs to heal after a physical injury, the brain must rest after sustaining a concussion. Cognitive rest prevents the brain from working too hard to nurture healing.

Cognitive rest does not mean sleeping all the time. Concussion experts define cognitive rest as the avoidance of activities that require concentration or attention and the limitation of any cognitive activities that may be metabolically demanding or aggravate concussion symptoms (McCrory, Meeuwisse, et al., 2017). These cognitive activities can range from focused cognitive work, like homework/schoolwork, to attendance at large social gatherings with many people, visual stimuli, or background noise. Finding a balance between rest, light activity, and sleep is vital. Examples of activities that are often recommended during cognitive rest include light reading or writing, light aerobic activity, listening to quiet, soothing music, and resting in a quiet, dimly lit room.

Cognitive rest should be part of the immediate post-concussion recovery process, generally considered the first 24 to 48 hours after injury (McCrory, Meeuwisse, et al., 2017). After this time, patients are advised to add cognitive activities gradually and progressively into their routines while staying below their cognitive symptom-exacerbation thresholds. Thus, if symptoms are exacerbated by activity, it is a sign that the mental exertion is too much, and cognitive activity should be decreased (McCrory, Meeuwisse, et al., 2017).

Rationale for Conducting the Review

Data suggest that 15.1% of student-athletes reported having at least one concussion related to sports or physical activity, and 6.0% reported having two or more (DePadilla et al., 2018). It is estimated that 2.5 million high school students sustain at least one SRC each year, and an estimated 1 million students suffer two or more concussions per year (DePadilla et al., 2018; Haarbauer-Krupa et al., 2018). However, various factors, variables, and surveillance methods likely lead to missed concussions among student-athletes, so it is probable that the prevalence of concussions is vastly underestimated in this population; as many as 50% of concussions may go unreported (Haarbauer-Krupa et al., 2018)

The human brain is a powerful, marvelous, and complex organ. For adolescents, the brain is rapidly growing, developing and building a strong foundation for future learning, health, and life success. Any injury or trauma to the brain can impact the physiology of the brain, its development, and its function. This being the case, any form of head trauma has repercussions and places one at risk for future physical, cognitive, behavioral, and psychological conditions (Cunningham et al., 2020; Ledreux et al., 2020; Rice et al., 2017).

SRCs are defined as mTBIs that lead to a cascade of complex pathophysiological processes that affect the brain (McCrory, Feddermann-Demont et al., 2017). Concussions are often caused by a bump, blow, or jolt to the head and body that causes the head and brain to move quickly back and forth. This sudden movement causes the brain, a soft, gelatinous structure, to rattle against the hard, bony skull, injuring the brain. This creates a diffuse axonal injury, a shearing of the neurons in the brain. During an injury and following a concussion, there is metabolic dysfunction and a massive release of neurotransmitters within the neurons. This creates extreme vulnerability within the neurons, in which further injury or stress may cause cell

death or severe cell damage (McCrory, Feddermann-Demont et al., 2017). Sixty-five percent of all concussions occur in children between the ages of 5 and 18 years old. Children and adolescents are at greater risk for TBIs as the young brain is still developing and tissue is not able to recover as quickly as an adult. Children and adolescents are more susceptible to neurochemical and metabolic changes, as their axons are not yet well myelinated, and due to their smaller size and stature, they are unable to absorb mechanical energy throughout their bodies.

Brain cells are stretched and damaged when the brain bounces around or twists in the skull, often creating chemical changes and lasting brain damage. This trauma to the brain can lead to symptoms that impact how a person thinks, learns, acts, and sleeps. Common concussion symptoms include headaches, difficulty concentrating, nausea and vomiting, dizziness or blurry vision, phono or photophobia, confusion or memory problems, sleep disturbances, and fatigue (NFHS & SMAC, 2017). Unfortunately, not only do concussions affect individuals acutely, but the consequences of concussions can impact an individual for a lifetime. The detrimental effects of concussions on the brain and their long-term sequelae include lasting physical, psychological, cognitive, and behavioral changes. These changes place one at risk for PCS symptoms, chronic physical symptoms, cognitive disturbances, and various psychiatric and mental health conditions, as well as dementia and chronic traumatic encephalopathy (Cunningham et al., 2020; Ledreux et al., 2020; Rice et al., 2017). The risk increases when the brain is not allowed time to adequately recover or is exposed to repeated trauma or concussions.

Proper and optimal recovery post-concussion encompasses both physical and cognitive rest. Individuals should be educated to refrain from strenuous physical and cognitive activities the first few days post-concussion. Specifically, mental activities that require concentration and

attention are known to worsen symptoms and delay recovery and include video games, the use of phones, studying, reading, and the use of computers (Brown et al., 2014; Macnow et al., 2021; Sawyer et al., 2016). Individuals can engage in light physical and cognitive activity as long as it does not exacerbate symptoms (Yang et al., 2019). As soon as an athlete no longer has signs or symptoms of a concussion and is cleared to return to activity, the student-athlete can proceed in a stepwise RTP protocol, gradually increasing physical activity (McLeod et al., 2017; NFHS & SMAC, 2017). However, if symptoms of a concussion recur or are exacerbated by activity or signs are observed at any time in the athlete's RTP protocol, the athlete must discontinue activity immediately (McLeod et al., 2017; NFHS & SMAC, 2017). Depending on the situation, athletes may need to be reevaluated and return to the previous step of the RTP protocol. The question is, since an athlete is not allowed to resume play or return to practice following a concussion until symptom-free, why does the same rule not apply to the classroom? Why is it assumed to be okay for students to immediately resume rigorous academic activity the same or next day post-concussion? It is known that rigorous academic work that requires concentration often exacerbates symptoms, does not allow time for healing, and delays recovery (Brown et al., 2014; Sawyer et al., 2016). Thus, there ought to be a stepwise, standardized approach to returning to cognitive activities as there is for physical activities.

Cognitive rest is often overlooked in concussion protocols, so much so that the NFHS and SMAC offer very little guidance and no stepwise RTL protocols within their national concussion protocol suggestions and recommendations (NFHS & SMAC, 2017; Olympia et al., 2016). However, there is literature to support that cognitive rest is critically important, if not equally important, as physical rest after concussion (McLeod et al., 2017; Sawyer et al., 2016). Cognitive rest is essential for the healing of the brain and speeding up recovery post-concussion,

as opposed to increased cognitive activity post-concussion, which is associated with longer recovery (Brown et al., 2014; Sawyer et al., 2016).

The problem at hand centers around the prevalence of PCS among individuals who have sustained a concussion. While many concussions resolve within a few weeks of the injury, some individuals suffer serious, long-term effects. It was noted earlier that a potential consequence of concussions is PCS, defined as the occurrence of clinical symptoms that persist for weeks or months or even become chronic following the incident (Voormolen et al., 2018). PCS physical symptoms often include headache, dizziness, insomnia, fatigue, and photo and photophobia (Ledreux et al., 2020; Voormolen et al., 2018). Psychological symptoms commonly include depression, irritability, and anxiety (Ledreux et al., 2020; Rice et al., 2017). PCS cognitive effects include difficulty concentrating, memory issues, and reduced problem-solving skills that can also persist over time (Cunningham et al., 2020; Ledreux et al., 2020). These long-lasting physical, psychological, and cognitive symptoms can significantly impact one's quality of life, delay one's return to school or work, and add a financial burden to individuals impacted by PCS (Voormolen et al., 2018).

The literature reveals that PCS prevalence rates among student-athletes are as high as 38.7% (Voormolen et al., 2018). This means that over a third of student-athletes who have sustained a concussion suffer from PCS. This is not an insignificant number, and there is undoubtedly room for improvement, leading to the question of whether student-athletes are allowed proper time to heal after a concussion. Some may argue or have the opinion that many student-athletes are not given the proper amount of time to rest and recover with the rigor of academic studies, as they are often thrust back into the academic setting the day after sustaining an SRC. Many high school concussion protocols focus on the physical aspect of returning to

play. But what about the cognitive aspect of concussion protocols? Considering RTL protocols and methodically reintroducing the student back into the academic setting are as vital to allow the brain to recover from an SRC as physical rest and RTP protocols.

Purpose of the Review and Review Question

While concussion management has traditionally focused on the physical effects of concussions, a nuanced position has turned to emphasize the cognitive impact of concussions. Though the physical aspect of recovery post-concussion is vital, the cognitive aspect of recovery regarding cognitive strain and activity level ought not to be neglected and is critical to allow the brain to recover. The key focus and purpose of this review is to assess the literature to suggest a change in practice that advocates for mandatory, structured RTL concussion protocols.

This review seeks to answer the following question: Is there a need to implement methodical, stepwise RTL concussion protocols in high school student-athletes? It appears that the literature supports the implementation of RTL concussion protocols in high school athletes.

Formulate Inclusion and Exclusion Criteria

This review includes studies of adolescent populations; the age range of an adolescent was not strictly defined, but studies were more focused on the high school adolescent population. Studies that investigated SRCs, concussion protocols, and RTL protocols were included. The search focused on the highest level of evidence able to be found that was applicable and pertinent to the given topic. Though study designs were not restricted, higher levels of evidence were prioritized over lower levels. Excluded studies included those that did not consider or mention RTL protocols, did not discuss cognitive rest, solely evaluated RTP protocols, or did not compare the effects of cognitive rest versus no cognitive rest.

Conceptual Framework

According to Whittemore and Knafl's (2005) integrative review methodology, the process of completing an integrative review can be divided into five stages. The first stage is problem identification. In this stage, a clear problem is identified, and the purpose of the review is established. For this project, the fundamental problem is the high rate of PCS. The review aims to evaluate the need for RTL concussion protocols for high school athletes to promote greater concussion healing and recovery. After a problem is identified, Steps 2 through 5 in the integrative review framework involve beginning a literature search, evaluating data, analyzing data, and concluding and presenting the review, respectively.

The integrative review method is one of the few approaches that allows for combining diverse methodologies, such as experimental and nonexperimental research. When used wisely, a proper integrative review method can allow diverse research methods to become a part of evidence-based practice initiatives (Whittemore & Knafl, 2005). With this being said, it is hoped that this integrative review will lead to more discussions and initiatives surrounding high school concussion protocols. When considering the current and future health, safety, and well-being of high-school student-athletes, this topic is significant and can greatly impact countless lives in the future.

Section Two: Comprehensive and Systematic Search

Search Organization and Reporting Strategies

In the literature review, the writer conducted a systematic search of the literature utilizing a variety of databases, mainly the Jerry Falwell Library's databases and PubMed, including CINAHL, EBSCO, ProQuest, and Cochrane. This review included articles published between 2016 and 2022. If a database returned a sizeable number of results that the writer could not

realistically screen, the results were narrowed to more recent publication dates, and papers were selected by how relevant their titles were to the research topic. The search was narrowed to include only articles that were peer reviewed, had the full text online, and were published in the last 6 years. Newspaper articles were excluded from the search results. The search was further narrowed based on discipline such as physical therapy, nursing, sports medicine, general medical sciences, and public health.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was the framework utilized by the author for the integrative review. It should also be noted that Toronto and Remington's (2020) textbook entitled *A Step-By-Step Guide to Conducting an Integrative Review* served as an additional guide and framework for various elements of the integrative review. The literature search was conducted using the PRISMA checklist and PRISMA flow diagram. With all the refinements made to the database search, 417 records were identified from the combined searches. Prior to the screening, 24 duplicates were removed from the database. Due to the sizable number of articles in the search results, the author could not feasibly and accurately screen them all, so papers were selected by how relevant their titles were to the research topic. A total of 57 articles were screened and assessed for exclusion or eligibility. Articles were mainly screened by their titles and abstracts, and the full text was briefly examined when it was unclear if the paper would apply to the integrative review. After the focus of the review was narrowed, 23 publications were selected for inclusion (Appendix A).

Terminology

The primary databases used for the article search were PubMed and the Liberty University Jerry Falwell Library databases, including CINAHL, EBSCO, ProQuest, and Cochrane. The parameters set for the search were articles that were peer reviewed, had full text

online, were journal articles, were not newspaper articles, were published in the English language, and were published in the last 6 years. The search was further narrowed based on discipline such as physical therapy, nursing, sports medicine, general medical sciences, and public health. The following terms and keywords were used in the literature search: *return-to-learn concussion protocols, high-school concussion rates, sports-related concussion protocols, post-concussion syndrome, long term consequences of concussions,* and *concussions* AND *the developing brain.* The following Boolean phrases were used during the search of literature: *cognitive rest* and *concussion recovery, return-to-learn protocols* and *sports related concussion, cognitive rest* and *post-concussion syndrome, post-concussion syndrome* and *high-school athletes,* and *return-to-learn concussion protocols* and *high school student-athletes*.

Section Three: Managing the Collected Data

Data Collection

Some may argue whether all studies on a specific subject matter ought to be included in an integrative review. Including studies from a broad spectrum of viewpoints and even including studies of diverse quality and ratings ensure a varied literature sample is utilized (Toronto & Remington, 2020). A diverse pool of literature with varying levels of evidence and methods of research aids in strengthening an integrative review. The review question guided the literature search (Toronto & Remington, 2020). The writer assessed each study's level of evidence using Melnyk levels of evidence when selecting articles for review, and a variety of studies with varying levels of evidence were included in the review (Appendix B). Studies were examined and analyzed by their methods and level of evidence and examined for bias. The writer took careful consideration when selecting studies to ensure they focused on concussion protocols, in particular, protocols that took cognitive rest into consideration. Studies that discussed the

cognitive impact of SRCs, the negative consequences and sequelae from SRCs, and variables that impact concussion recovery were also chosen to support a broad, general view of the topic.

Information Sources

The author integrated literature from an array of professional resources. Both qualitative and quantitative studies utilizing a variety of methodologies were selected to improve the rigor of the review through the inclusion of both empirical and theoretical resources, as suggested by Whittemore and Knafl (2005). Information sources that aided in the literature review included a variety of databases, mainly PubMed and the Jerry Falwell Library databases, including CINAHL, EBSCO, and ProQuest. The Liberty University librarian was a resource that was available if assistance was needed in obtaining studies and literature or if research questions came up.

Eligibility Criteria

During the screening of the literature for eligibility, studies that did not apply to the effects of concussions or treatment of concussions were eliminated (Toronto & Remington, 2020). Excluded studies included those that did not consider or mention RTL protocols, did not discuss cognitive rest, did not discuss cognitive effects from concussions, did not compare the effects of cognitive rest versus no cognitive rest, or solely evaluated RTP protocols. Studies that were published between 2016 and 2022 and investigated SRCs, concussion protocols, cognitive impacts of concussions, and RTL protocols were included. Literature and resources that were not peer reviewed were excluded, along with grey literature. Duplicate studies were eliminated before the literature was screened to avoid duplicate counting (Toronto & Remington, 2020). Research article titles were assessed for relevance and to determine the article's eligibility for inclusion; clearly irrelevant titles were removed. If the title was not clear, there were any doubts

of the relevance from the title, or it was impossible to judge relevance based off the title alone, the abstract of the study was reviewed. Two articles were eliminated after the critique and leveling of evidence because one was control trial study to evaluate if plasma tau protein levels correlated with time to return to play and the second focused on the use of biomechanical data and technological tools to provide objective data to inform an operational definition of SRCs, both of which were not relevant to the review question (Echemendia et al., 2017; Gill et al., 2017).

Section Four: Quality Appraisal

An essential element of an integrative review is the analysis of the selected literature, as the quality of the studies and literature is a direct indicator of the strength of the integrative review (Toronto & Remington, 2020). The writer used the Melnyk levels of evidence as a quality appraisal tool when evaluating the literature (Melnyk & Fineout-Overholt, 2015).

Sources of Bias

Most studies were not randomized and used small sample sizes lacking controls, making it challenging to generalize the findings. Some studies appeared to only evaluate the outcomes without assessing variables that may have impacted the outcomes. In one study, Sawyer et al. (2016) failed to address the individuals who were slow to recover from concussion symptoms and did not discuss potential variables that impeded concussion recovery. Another study by Sabini et al. (2014) discussed when student-athletes could return to school following a concussion and examined cognitive rest; however, the authors failed to provide a precise definition and recommendation for cognitive rest. This omission results in issues with external validity, making it difficult to generalize findings.

Internal Validity

Toronto and Remington (2020) noted that the internal validity of a study is determined by evaluating the credibility and the risk of bias. Unfortunately, bias can compromise the validity of study results and lead to a biased review, potentially resulting in misrepresentation of the effect of a given phenomenon or variable. It is also noted that the appraisal should focus on internal validity because the external validity or applicability of the results may depend on how the results are to be used; thus, if notable bias is present, the results cannot be trustworthy. Therefore, studies selected in integrative reviews need to be thoughtfully appraised (Toronto & Remington, 2020). One researcher conducted this integrative review, and the researcher intentionally sought out studies that addressed the review question. Therefore, the risk of introducing bias was present in this review. The leveling and critique framework based on Melnyk's table of evidence was used to mitigate this potential risk. This framework was used as an appraisal tool to examine the applicability of results and can be found in Appendix B (Melnyk & Fineout-Overholt, 2015).

Reporting Guidelines

PRISMA was utilized to report the review findings and improve the review's transparency and quality (Toronto & Remington, 2020). Various evidence levels were retrieved during the search and utilized in the review: six Level 1 articles, one Level 2, one Level 3, three Level 4, four Level 5, eight Level 6, and one Level 7 article (Melnyk & Fineout-Overholt, 2015). The PRISMA flow diagram for the integrative review can be found in Appendix A.

Section Five: Data Analysis and Synthesis

Analysis

In the literature, there appears to be a consensus suggestion that a brief period of both cognitive and physical rest during the acute phase, roughly 24 to 48 hours after injury, is recommended (McCrory, Meeuwisse, et al., 2017; McLeod et al., 2017; Sawyer et al., 2016). In this 2-day acute phase, it is essential for the individual to ensure adequate hydration and nutrition, prioritize good sleep, and participate in light non-weight-bearing and non-contact physical exercise (e.g., walking) to optimize recovery (Bevilacqua et al., 2019; Lal et al., 2018). It is important to note that currently, there is insufficient evidence that complete rest optimizes outcomes and there is no benefit to "strict rest" beyond 2 days (McCrory, Meeuwisse, et al., 2017; Sawyer et al., 2016; Yang et al., 2019).

After the acute phase, student-athletes can be encouraged to become gradually and progressively more active while staying below their cognitive and physical symptom-exacerbation thresholds. The research shows that after the acute phase, gradually increasing activity to moderate levels of cognitive and physical exertion over the first month postinjury results in improved outcomes compared with long periods of small or large amounts of activity (Lal et al., 2018; McLeod et al., 2017; Sawyer et al., 2016; Yang et al., 2019). Further, neither engaging in high levels of activity soon after a concussion nor a period of "strict rest" beyond 2 days has been found to be beneficial; rather, negative effects may occur (Yang et al., 2019). This further supports the need for a gradual and progressive return to increased cognitive and physical activity.

Yang et al. (2019) noted that engaging in too much cognitive and physical activity too soon after a concussion can exacerbate symptoms, delay recovery, and lead to deleterious effects.

Specifically, it is noted that increased cognitive activity soon following a concussion is associated with longer recovery times (Brown et al., 2014). Brown et al. (2014) revealed that adolescents who engaged in higher levels of cognitive and mental activities in the early days after a concussion took over twice as long to recover from concussion symptoms. Brown et al. (2014) noted that adolescents who engaged in the highest level of mental activities took about 100 days on average to recover from concussion symptoms, compared to about 20 to 50 days for those with lower mental activity in the early days after a concussion. A few specific variables found to exacerbate symptoms and delay concussion recovery include screen time, computer-oriented tasks, and cognitive tasks requiring concentration, such as math and reading (Bevilacqua et al., 2019; Holmes et al., 2020; Macnow et al., 2021). Avoiding or limiting screen time has been found to be crucial for acute concussion recovery and may shorten the duration of symptoms. It is reported that those who abstain from screen utilization in the first 48 hours post-concussion have a quicker recovery time than those who do not (Macnow et al., 2021).

Descriptive Results

The research discussed when a gradual return to learning and increased cognitive workload is warranted for the student-athlete. Once concussion symptoms have improved and the student-athlete can perform basic cognitive tasks and daily activities without symptoms exacerbating, a gradual return to school is warranted (McCrory, Meeuwisse, et al., 2017; Sabini et al., 2014). Following an initial period of moderate cognitive rest during the acute post-concussive phase, a sensible approach involves a gradual return to school and social activities, before physical activity or contact sports, in a manner that does not result in a significant exacerbation of symptoms (McLeod et al., 2017). Holmes et al. (2020) noted that students frequently report difficulty concentrating and memory issues when resuming school activities,

which often necessitates the student to participate in schoolwork in a modified fashion to avoid worsening symptoms. It is recommended that if a student experiences symptoms while engaged in increased cognitive workloads, the student is to discontinue the activity, take breaks when needed, lessen the cognitive workload, then try again to gradually increase the workload.

Synthesis

Data suggest that 15.1% of student-athletes report having had at least one concussion related to sports or physical activity, and 6.0% reported having had two or more (DePadilla et al., 2018). It is estimated that 2.5 million high school students sustain at least one SRC per year, and an estimated 1.0 million students suffer two or more concussions per year (DePadilla et al., 2018; Haarbauer-Krupa et al., 2018). Concussions can detrimentally injure brain structure and brain chemistry. These changes place one at risk for PCS symptoms, chronic physical symptoms, cognitive disturbances, and various psychiatric and mental health conditions that can significantly impede one's quality of life and alter one's ability to carry out activities of daily living (Cunningham et al., 2020; Ledreux et al., 2020; Rice et al., 2017).

A systematic review by Cunningham et al. (2020) suggested that a history of SRCs may significantly affect the cognitive domains of memory, executive function, and psychomotor function. Compared with control participants, former athletes with a history of SRCs displayed worse performance in 17 of 31 studies (55%) of memory, 6 of 11 studies (55%) of executive function, and 4 of 6 studies (67%) of psychomotor function, as well as increased subjective concerns about cognitive function in 11 of 14 studies (79%). The review also reported a frequency-response relationship with poorer cognitive outcomes and poor academic performance in athletes with previous concussions (Cunningham et al., 2020). Furthermore, a systematic

review by Rice et al. (2017) found an association between concussion exposure and depression symptoms.

The risks of PCS and the deleterious residual effects of concussions increase when the brain is not allowed time to recover adequately or is exposed to repeated trauma or concussions. Post-concussion, the brain needs time to heal and rest, and the literature stresses the importance of rest in the first 1 to 2 days after a concussion (McCrory, Meeuwisse, et al., 2017; McLeod et al., 2017; Sawyer et al., 2016). After the acute phase, once symptoms have improved and the student can perform basic cognitive tasks and daily activities without symptom exacerbation, the student-athlete can gradually and progressively return to cognitive and physical activities while staying below their symptom-exacerbation thresholds (McCrory, Meeuwisse, et al., 2017; Sabini et al., 2014).

Physical rest is widely discussed in concussion protocols; however, cognitive rest is often overlooked. In fact, the NFHS and SMAC offer very little guidance and no stepwise approach to RTL within their national concussion protocol suggestions and recommendations (NFHS & SMAC, 2017; Olympia et al., 2016). The NFHS and SMAC (2017) guidelines advise that no athlete should return to play/practice on the same day after sustaining a concussion and not return to activity until symptom-free. Furthermore, they advise that when an athlete no longer has concussion symptoms and is cleared to return to activity, the student-athlete must proceed in a stepwise fashion, gradually increasing physical activity to allow the brain to re-adjust to exercise. The process of recovery and the return to sport participation after an SRC follows a graduated stepwise rehabilitation strategy. The RTP example provided by the NFHS and SMAC is outlined in Table 1. Each athlete progresses through no more than one step of the RTP protocol each day. If symptoms of concussion recur or are exacerbated, activity within the

protocol must be discontinued immediately, and the student-athlete must go back to the previous step in the protocol (NFHS & SMAC, 2017).

Table 1

Progressive Return-to-Play Physical Activity Program

Step	Activity	Goal
1. Light aerobic exercise	5-10 minutes on exercise bike or light jog; no weightlifting, resistance training or any other exercises	Increase the heart rate
2. Moderate aerobic exercise	15-20 minutes of running at moderate intensity in the gym or on field without equipment	Add movement
3. Non-contact training drills in full uniform	Add sport specific exercise May begin weightlifting, resistance training and other sport specific exercises and drills	Exercise, coordination, and increased thinking
4. Full contact practice or training	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
5. Full game play	Normal game play	Normal game play

Note. Protocol is from NFHS & SMAC, 2017.

These suggestions are wonderful for physical recovery and returning to the playing field, but what about the cognitive aspect of recovery and returning to the classroom? If a student-athlete is prohibited from returning to play the day a concussion is sustained, should the same apply to cognitive activities? If student-athletes are supposed to adhere to a stepwise RTP concussion protocol returning to the playing field, it can be argued that a similar stepwise approach should be utilized for returning to the classroom, especially considering that it is well documented in the literature that high levels of cognitive activity too soon after a concussion exacerbate symptoms and delays recovery (Brown et al., 2014; Yang et al., 2019). Student-athletes cannot be thrust back into the academic setting with heavy cognitive demands the same day or day after sustaining a concussion and be expected to succeed or recover well. Students may require temporary absence from school after injury, and it is recommended they do not return to school if symptoms are present (McCrory, Meeuwisse, et al., 2017)

From the 5th International Conference on Concussion in Sport, McCrory, Meeuwisse, et al. (2017) released a consensus statement on SRCs. In this report, they provided an example of a four-stage, stepwise graduated return-to-school strategy. An outline of the return-to-school progression is in Table 2. After 24 to 48 hours of initial cognitive and physical rest, symptom-limited activity can be begun, and the student can initiate step one of the return-to-school strategy. The first step of the protocol is to gradually return to typical daily activities at home that do not cause symptoms. Here, the student engages in light reading or light cognitive work for brief periods of time, gradually building up activity as tolerated. In Step 2, the student should engage in school activities outside of the classroom, such as homework or reading, to increase tolerance to cognitive workload. If the student can perform these activities without the recurrence or exacerbation of symptoms, the student can advance to Step 3. In Step 3, the student can return to school part-time so schoolwork and academic activities may be introduced gradually. During this period of concussion recovery, students may fatigue quickly, so it is suggested that the student start with a partial school day or take breaks throughout the day. If all is well, the student should be able to advance to the fourth and last stage, which entails returning to school full-time and gradually progressing with school activities until an entire day can be tolerated.

Table 2

Graduated Return-to-Learn

Aim	Activity	Goal
1. Daily activities at home do not give the child symptoms	Typical activities of the child during the day as long as they do not increase symptoms, (e.g., reading, texting, screen time). Start with 5 – 15 mins at a time and gradually build up	Gradual return to typical activities
2. School activities	Homework, reading or other cognitive activities outside of the classroom	Increased tolerance to cognitive work
3. Return to school part time	Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during day	Increase academic activities
4. Return to school full time	Gradually progress school activities until a full day can be tolerated	Return to full academic activities and catch up on missed work

Note. Protocol is from McCrory, Meeuwisse, et al., 2017.

It is important to note that prior to beginning the RTL protocol, it is recommended that the individual be evaluated by a health care provider and for the practitioner to provide individualized recommendations for support and accommodations for the student. There needs to be communication between the health care team and teachers so the teachers can be made aware of the recommended accommodations and educated on specific signs and symptoms to watch for. If the student is having difficulty advancing through the protocol steps or if symptoms persist beyond a few weeks, extra support and accommodations may need to be established, and the health care team should reevaluate the individual.

Even with the knowledge of the importance of cognitive rest post-concussion and widely available resources such as the RTL strategy by McCrory, Meeuwisse, et al. (2017), RTL protocols are rarely discussed and widely underutilized. Many school professionals and leaders lack an understanding of concussion recovery and RTL policies; however, most school leaders want to learn more about concussion recovery to assist their students in recovering well

(Sarmiento et al., 2019). A study by Williamson et al. (2018) found that 41.2% of athletic trainers reported an absence of evidence-based guidelines for RTL protocols after concussion in their workplace. Furthermore, 73% of respondents noted having an established RTL policy in place, but only 38.1% used such guidelines in their clinical practice (Williamson et al., 2018). In a survey evaluating health care provider knowledge regarding concussion protocols, 83% were unfamiliar with stepwise RTL protocols (Thibaut et al., 2022). Moreover, in a study that aimed to determine the compliance of schools and school nurses in the US with recommendations for cognitive rest for students who sustain a concussion, it was found that only roughly 50% of schools have guidelines to assist students with returning to school after a concussion (Olympia et al., 2016).

The pressing issue and concern with all of this is the prevalence of PCS in young student-athletes. PCS prevalence rates among student-athletes are as high as 38.7% (Voormolen et al., 2018). This means that over a third of student-athletes suffer from PCS, which leads to question whether there is a missing piece in concussion recovery and if student-athletes are allowed proper time to heal after a concussion. Many high school concussion protocols focus on the physical aspect of returning to play. But what about the cognitive aspect of concussion protocols? Some may argue or have the opinion that many student-athletes are not given the proper amount of time to rest and recover, as they are thrust back into a rigorous academic setting almost immediately after sustaining an SRC. The missing piece in concussion recovery may be the implementation of RTL protocols in addition to RTP protocols, given their lack of acknowledgment and utilization amongst schools and health care providers across the nation (Olympia et al., 2016; Thibaut et al., 2022; Williamson et al., 2018).

Limitations

One researcher and writer conducted this integrative review, which has the potential to introduce some bias. Though the writer kept an open mind while reviewing the literature, the project was guided by a specific review question, which alone could inadvertently incite confirmation bias. The PRISMA flowchart and a leveling and critique framework were utilized for the selected studies to mitigate single-researcher bias. Due to the lack of literature on RTL protocols, another limitation was the flaws and limitations of the selected studies. External validity was a limitation due to the limited number of studies with a high level of evidence, the quality and methodology of some of the studies, and the small sample sizes of some selected studies.

Theoretical Framework

This integrative review utilized Viktor Frankl's theory of meaning as a framework. Frankl believed the primary human motivation was to seek meaning and purpose in life (Smith & Liehr, 2014). Life purpose is the central concept of the theory of meaning, and Smith and Liehr (2014) noted that there is a theme to one's life purpose—making a contribution to the world and leaving it a better place. The writer of the integrative review chose this theory for personal reasons. The author feels that part of his purpose in life is to contribute to the world by shedding light on concussion education and management and ways to improve concussion protocols to provide better outcomes for student-athletes. Life is too short and challenging already, and nobody should endure the negative consequences and sequelae of PCS that hinder one's quality of life.

Section Six: Discussion

Implications for Practice

For years, discussions on concussion management have focused on physical rest with RTP protocols. However, the prevalence of PCS in young student-athletes reveals the need for a shift in the discussion to how SRCs are managed and shows the need to suggest a practice change amongst health care providers, athletic trainers, and school leaders. Given that roughly only 11% of health care providers provide education about RTL instructions and discuss cognitive rest as part of concussion management practices, there is a need to shed light on cognitive rest and RTL protocols (Arbogast et al., 2013).

Young student-athletes have their whole lives ahead of them, and their future well-being greatly depends on their physical, cognitive, and mental health. The cognitive aspect of concussion recovery cannot be neglected, as it can significantly impact an individual's recovery and future well-being. Health care providers and school leaders must collectively take a holistic approach and address all aspects of concussion recovery to treat and support the individual. There is a need for standardized concussion policies that incorporate cognitive rest and RTL protocols to be implemented for high school student-athletes. There is hope for a change in practice and potential policy change on how concussion protocols are managed to promote the health and well-being of students and future generations.

Dissemination

Concussion management is an ever-evolving topic that is relevant in the health care field, as it is a topic many nurses will encounter in their careers. At some point in one's career, whether as a nurse or nurse practitioner, one will likely care for someone with a concussion or the sequelae of a concussion. The writer values the dissemination of the findings of the integrative

review to advance the practice of nurse practitioners, educate the public, improve outcomes, and, most importantly, improve the health and safety of young student-athletes. Due to a gap in the literature on RTL concussion protocols, the writer plans to submit the integrative review for publication. The writer is passionate about sports medicine, public health education, and health promotion. With these passions, the writer intends to disseminate these findings among colleagues, patients, school administrators and public education leaders, and local sports leagues and athletic clubs.

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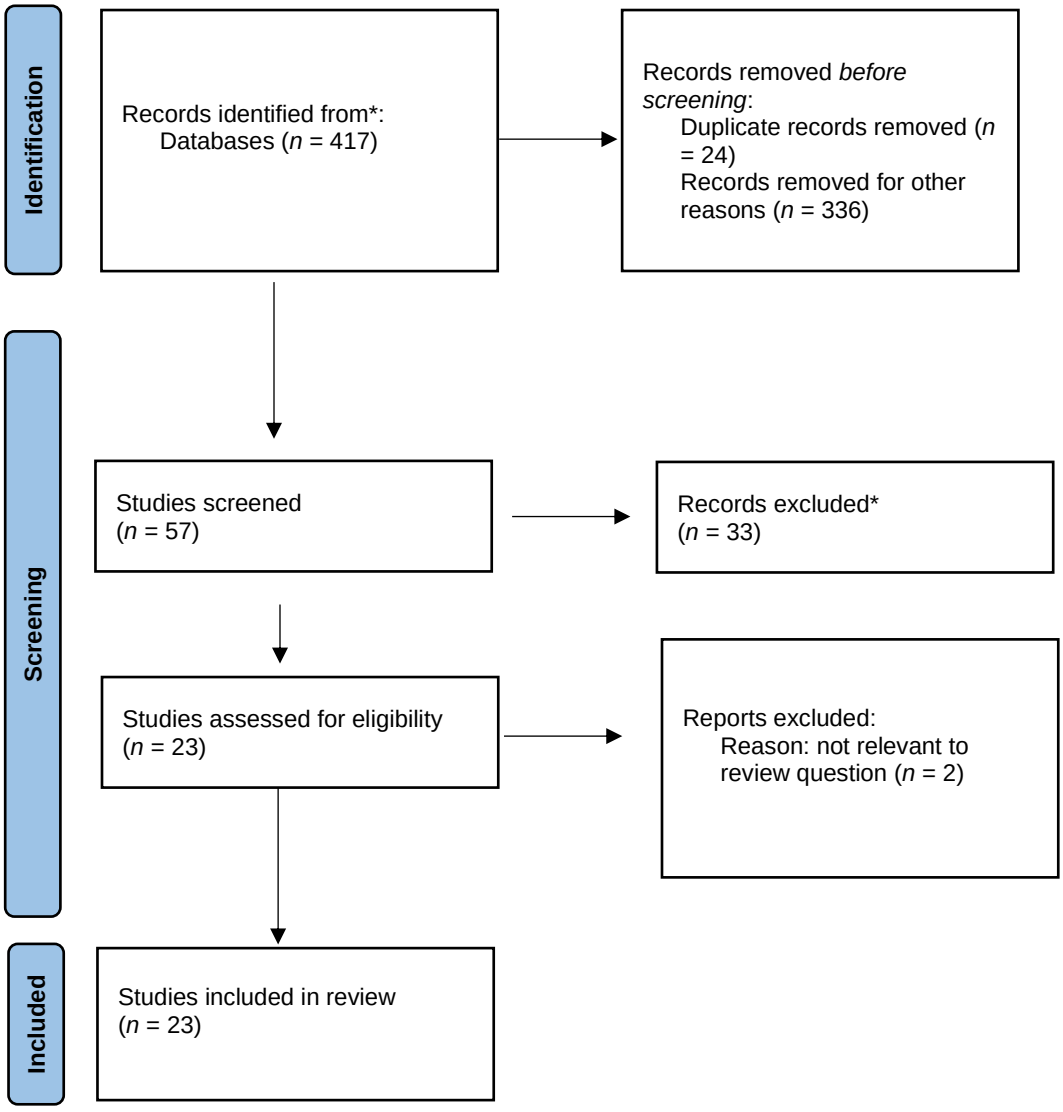
Appendix A

PRISMA Diagram



Appendix B

Evidence Table

Article Title, Author, etc.	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change?
Arbogast, K. B., McGinley, A. D., Master, C. L., Grady, M. F., Robinson, R. L., & Zonfrillo, M. R. (2013). Cognitive rest and school-based recommendations following pediatric concussion: The need for primary care support tools. *Clinical Pediatrics, 52*(5), 397–402. https://doi.org/10.1177/0009922813478160	Assess pediatric primary care providers' understanding of cognitive rest for concussion and describe their concussion management practices.	89 of 201 providers responded to the survey and 91 EMRs were reviewed.	A survey of general pediatric providers and an EMR review of children 5 to 18 years old treated for concussions. The survey asked about treatment recommendations for concussion, and results were coded to identify cognitive rest recommendations. The EMR review	Greater than 50% of documented discharge instructions reviewed instructions regarding return to play, however, "return-to-learn" messaging for this population has not been disseminated as widely. In fact, roughly only 11% of providers provided information about return to learn instructions and discussed cognitive rest.	Level 6: Qualitative study	The survey could have been subject to potential response and selection biases. The abstraction of data from the medical record was limited to that information recorded in the EMR. Providers may have provided return-to-school or cognitive rest recommendations verbally but not recorded it in the chart.	Yes. Emphasizes the need to ensure thorough discharge instructions are communicated not only to the patient but also to the patient's school/institution regarding the need for cognitive rest post-concussion.

			included injury details, medical evaluation, and recommendations for resuming school and sports/recreation.				
Bevilacqua, Z., Kerby, M., Fletcher, D., Chen, Z., Merritt, B., Huibregtse, M., & Kawata, K. (2019). Preliminary evidence-based recommendations for return to learn: A novel pilot study tracking concussion recovery in college students. *Neurology*, *93*(14 Suppl. 1), S33–S34. https://doi.org/10.	Investigate the potential factors influencing resolution of chief concussion symptoms in a longitudinal design and assess subjects' perception of their concussion recovery and what types of activities and	Nine concussed, college aged (18-26 years), full-time students	Descriptive longitudinal study	Students reported five variables that were associate with symptom resolution, this included sleep, light activity, water, soft music, and time. Subjects reported computer-oriented tasks as most difficult and often exacerbated symptoms. Subjects also noted that additional time on assignments and exams, as well as reducing screen time, reducing	Level 6	Small sample size	Yes, but with caution due to the strength of the study. However, the study does provide insight to accommodations that may help student-athletes.

1212/01.wnl.0000581156.65140.2e	accommodations appeared beneficial.			screen brightness were the most beneficial accommodations.			
Brown, N. J., Mannix, R. C., O'Brien, M. J., Gostine, D., Collins, M. W., & Meehan, W. P. (2014). Effect of cognitive activity level on duration of post-concussion symptoms. *Pediatrics*, *133*(2), e299–e304. https://doi.org/10.1542/peds.2013-2125	To determine the effect of cognitive activity level on duration of post-concussion symptoms.	335 patients included in the study, 62% were male. The mean age of participants was 15 years (range, 8-23).	A prospective cohort study	Adolescents who engaged in the highest level of mental activities took about 100 days on average to recover from symptoms of concussion, compared to about 20 to 50 days for those with lower mental activities in the early days after a concussion. Increased cognitive activity is associated with longer recovery from concussion. This study supports the use of cognitive rest and adds to the current consensus opinion.	Level 4: Cohort study	Sample size	Yes, because this provides substantial evidence to support the need for cognitive rest after a concussion.
Cunningham, J., Broglio, S. P., O'Grady, M., & Wilson, F.	To synthesize and appraise the evidence	The search yielded 46 cross-	Systematic review of cross-	The results from the systematic review suggest that a history of SRC	Level 5	The author noted that the results must be interpreted in	Yes, shows the longterm cognitive impact and longterm

(2020). History of sport-related concussion and long-term clinical cognitive health outcomes in retired athletes: A systematic review. *Journal of Athletic Training*, *55*(2), 132–158. https://doi.org/10.4085/1062-6050-297-18	base regarding cognitive health in former athletes with a history of SRC.	sectional observational studies that were included in a qualitative synthesis. The total sample consisted of 13,975 participants: 7,387 collision-sport athletes, 662 contact-sport athletes, 3,346 noncontact-sport athletes, and 2,580 participants classified as controls.	sectional studies	may more greatly affect the cognitive domains of memory, executive function, and psychomotor function. Compared with control participants or normative data, former athletes with history of SRC displayed worse performance in 17 of 31 studies (55%) of memory, 6 of 11 studies (55%) of executive function, and 4 of 6 studies (67%) of psychomotor function and increased subjective concerns about cognitive function in 11 of 14 studies (79%). The authors of 13 of 46 investigations (28%) reported a frequency-		light of the lack of methodologic rigor and moderate quality assessment of the included studies.	sequelae from concussions.

				response relationship, with poorer cognitive outcomes in athletes who had previous concussions.			
DePadilla, L., Miller, G. F., Jones, S. E., Peterson, A. B., & Breiding, M. J. (2018). Self-reported concussions from playing a sport or being physically active among high school students — United States, 2017. *Morbidity and Mortality Weekly Report*, *67*(24), 682–685. https://doi.org/10.15585/mmwr.mm6724a3	To determine how many students sustain a SRC per year	14,765 high school students	Cross-sectional study	15.1% of students reported having at least one concussion, and 6.0% reported having two or more. There are an estimated 2.5 million high school students reporting at least one SRC per year, and an estimated 1.0 million students reported having two or more concussions per year	Level 6: Single descriptive study	Study type and design Sample size does not account for all students in the US. The concussions, self-reported by students, were not validated	Yes, because it reveals the prevalence of high school athletes in the US with concussions per year.
Fetta, J., Starkweather, A., Huggins, R., Van Hoof, T., Casa, D., & Gill, J.	The focus of the study was on the perception of key	28 studies were included in the	Integrative review/systematic review	The integrative review revealed barriers to understanding the unseen impact of	Level 5: Systematic review	Type of study and number of studies reviewed.	Yes, because it reveals how little is emphasized on return to learn protocols for

(2021). Implementation of return to learn protocols for student athletes with sport and recreation related concussion: An integrative review of perceptions, challenges and successes. *The Journal of School Nursing, 39*(1), 18–36. https://doi.org/10.1177/1059840521056646	stakeholders regarding the implementation of return to learn protocols for concussed student athletes.	review, 10 studies used a qualitative design (grounded theory, phenomenology), 17 used a descriptive quantitative design (cross-sectional surveys), and one study used a mixed methods design		someone who suffered a concussion and the need for enhanced communication amongst stakeholders in the return to learn process. There are very few laws for concussions that include compliance with return to learn protocols.			concussed student athletes and implies that there needs to be a practice change to further address this. This in part is due to the knowledge gap surrounding the impact of concussions and the need for proper healing.
Gill, J., Merchant-Borna, K., Jeromin, A., Livingston, W., & Bazarian, J. (2017). Acute plasma tau relates to prolonged return to play	To assess whether tau changes after sport-related concussion relate to when the athlete can	46 athletes who sustained a sports-related concussion, and a control	Controlled trial, no randomization	Elevated plasma tau concentration within 6 hours following a concussion was related to having a prolonged time to return to play. This may suggest that	Level 3: Controlled trial	Small sample size. Missing data on taue following concussion in some athletes as well as blood results not	No, although this may investigate the diagnostic workup and how the results of the tau proteins can have on how soon an athlete can return to play, the

after concussion. *Neurology*, *88*(6), 595–602. https://doi.org/10.1212/wnl.0000000000003587	return to play.	group of 37 athletes (teammates). The second control group consisted of 21 healthy nonathletes.		tau levels may help inform the length of time the athlete to wait to return to sport.		reflecting central changes.	article did not discuss cognitive effects or how the tau proteins effect returning to cognitive activities.
Holmes, A., Chen, Z., Yahng, L., Fletcher, D., & Kawata, K. (2020). Return to learn: Academic effects of concussion in high school and college student-athletes. *Frontiers in Pediatrics*, *8*, Article 57. https://doi.org/10.3389/fped.2020.00057	The purpose of the study was to examine to what extent concussion influences academic performance and to whether there would be a difference in concussion effects on academic performance between high school	This cross-sectional survey study included students between 14 and 24 years old and sustained a sport-related concussion within the previous year.	Cross sectional survey	Students reported difficulty concentrating, with higher rates reported amongst college students (84% college vs 68.6% high school). High school students reported more difficulty with math, as college students experienced difficulty with reading and computer use. Asymptomatic duration of	Level 6	Sample size and study design	Yes, it is clear that there is a need for guidelines and accommodations to support students with concussion in academic settings

	and college students.	There were 130 respondents with a history of concussion in the past year (n = 59 high school, n = 71 college).		cognitive activity was influenced by age, where younger students were less tolerant in performing academic tasks after a concussion than older students.			
Lal, A., Kolakowsky-Hayner, S. A., Ghajar, J., & Balamane, M. (2018). The effect of physical exercise after a concussion: A systematic review and meta-analysis. *The American Journal of Sports Medicine, 46*(3), 743–752. https://doi.org/10.1177/0363546517706137	To assess the role of physical exercise on different outcomes in patients with a concussion.	The search generated 1,096 studies, of these, 14 met the inclusion criteria.	Systematic review & meta-analysis	physical exercise significantly decreased the post-concussion symptom scale (PCSS).	Level 1: Systematic review & meta-analysis	In the review and meta-analysis, there were several cohort studies, and only a few RCTs. Unable to identify the clear effect of exercise in patients with a concussion.	Yes, because after the initial rest period, we can strongly encourage individuals to participate in light, noncontact physical exercise to help decrease post-concussion symptoms.

Ledreux, A., Pryhoda, M. K., Gorgens, K., Shelburne, K., Gilmore, A., Linseman, D. A., Fleming, H., Koza, L. A., Campbell, J., Wolff, A., Kelly, J. P., Margittai, M., Davidson, B. S., & Granholm, A.-C. (2020). Assessment of long-term effects of sports-related concussions: Biological mechanisms and exosomal biomarkers. *Frontiers in Neuroscience*, *14*, Article 761. https://doi.org/10.3389/fnins.2020.00761	The aim of this systematic review is to discuss novel, quantitative, and objective measurements that can predict long-term outcomes following repeated sports-related concussions.	Sample of the studies reviewed included high school and college athletes of which many of which sustained a sports related concussion	Systematic review	Discusses the physical, psychological, and cognitive symptoms of PCS. Notes current post-concussion clinical tests are not sufficiently sensitive to injury and do not accurately quantify post-concussion alterations associated with repeated concussions or other brain injuries. This review proposes that current practices should closely monitor symptoms, routinely assess cognitive function (especially assessment of executive function and impulse control), and to closely assess balance, as well as	Level 1: Systematic review	Poor sample size in studies analyzed along with conflicting evidence.	Yes, because it shows areas to focus on, such as focusing on assessing one's balance prior to returning to sport.

				perform vestibulo-ocular assessments prior to returning to sport.			
Macnow, T., Curran, T., Tolliday, C., Martin, K., McCarthy, M., Ayturk, D., Babu, K. M., & Mannix, R. (2021). Effect of screen time on recovery from concussion: A randomized clinical trial. *JAMA Pediatrics*, *175*(11), 1124–1131. https://doi.org/10.1001/jamapediatrics.2021.2782	To determine whether screen time in the first 48 hours after a concussion has an impact on the duration of symptoms.	125 patients with a concussion were involved in the study with the average age of 17, with 64 of the participants being male	RCT. 125 patients with a concussion were enrolled. 66 patients were randomized to the screen time permitted group. 59 patients randomized to the screen time abstinent group.	The findings of this study indicated that avoiding screen time during acute concussion recovery may shorten the duration of symptoms. The screen time permitted group had a significantly longer median recovery time of 8.0 days compared with 3.5 days in the screen time abstinent group.	Level 2 Randomized controlled trial	Unable to fully identify or assess the effect of screen-time exposure.	Yes, it will further guide recommendations when treating student athletes with SRC by recommending they avoid screen-time within the first 48hrs to decrease length of concussion related symptoms.
McCrory, P., Feddermann-Demont, N., Dvorak, J., Cassidy, J. D., McIntosh, A., Vos, P. E., Echemendia, R. J., Meeuwisse, W., & Tarnutzer,	Accurately define a sports-related concussion (SRC) and to assess the role of biomechanical studies	When screening literature criteria, eligibility criteria were studies reporting clinical	This was a systematic literature review.	SRC is a traumatic brain injury that is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces with several common features	Level 1: Systematic review	The literature discusses that limitations include that the current criteria for diagnosing SRC are clinically oriented and that there is no	Yes, this helps define SRC.

A. A. (2017). What is the definition of sports-related concussion: A systematic review. *British Journal of Sports Medicine, 51*(11), 877–887. https://doi.org/10.1136/bjsports-2016-097393	in informing an operational definition of SRC	criteria for diagnosing sports-related concussions (SRC) and studies containing SRC impact data. Out of 1601 articles screened, 36 studies were included (2.2%), 14 reported on criteria for SRC definitions and 22 on biomechanical aspects of		that help define its nature. Currently, the use of helmet-based systems to study the biomechanics of SRC is limited to few collision sports, however, there are other technological tools being researched to find objective date to assess when assessing sports related brain injuries. In the future, newer approaches need to be developed to provide objective markers for SRC.		gold standard to assess their diagnostic properties.	

		concussions.					
McLeod, T. C., Lewis, J. H., Whelihan, K., & Bacon, C. E. (2017). Rest and return to activity after sport-related concussion: A systematic review of the literature. *Journal of Athletic Training*, *52*(3), 262–287. https://doi.org/10.4085/1052-6050-51.6.06	To review the literature regarding rest and return to activity after sport-related concussion.	After filtering out the literature search using specific inclusion and exclusion criteria, there were 40 articles in which data were extracted that were synthesized in the results. These consisted of 9 studies of the use of rest, 10 studies of rest effectiveness, 17	Systematic literature review	Rest is important in the first 1–2 days after concussion. A sensible approach involves a gradual return to school and social activities (before contact sports) in a manner that does not result in a significant exacerbation of symptoms. Main findings suggest that rest is underused by health care providers. An initial period of moderate physical and cognitive rest may improve outcomes during the acute post-concussive phase.	Level 5: Systematic review of descriptive & qualitative studies	Due to the descriptive nature of the study, they were unable to evaluate the risk of bias. Unable to find studies specifically investigating the effectiveness of the graded return-to-activity progression.	This article provides fruitful insight on recommendation to make regarding return to play and return to learn concussion protocols.

		studies evaluating compliance with guidelines, and 4 studies of return-to-activity outcomes.					
National Federation of State High School Associations & Sports Medicine Advisory Committee. (2017). *Suggested guidelines for management of concussion in sports*. https://www.nfhs.org/media/1018446/suggested_guidelines__management_concussion_april_2017.pdf	To provide suggested guidelines for management of sports related concussions in high-school athletes	n/a	Expert opinion and guideline	The guideline advises that no athlete should return to play/practice on the same day and should not return to activity until symptom free. Advises that when an athlete no longer has concussion symptoms and is cleared to return to activity, the student-athlete must proceed in a stepwise fashion to allow the brain to re-adjust to	Level 7: Expert opinion	Lowest level/quality of evidence. Does not provide detailed suggestions for cognitive rest or stepwise return to learn protocols	Yes, because this is a national federation that serves as an advisory board for state high school boards across the country

				exercise. Each step in the return-to-play protocol is often progressed no more than one step each day. If symptoms of concussion recur, all activity within the program must be discontinued immediately.			
Olympia, R. P., Ritter, J. T., Brady, J., & Bramley, H. (2016). Return to learning after a concussion and compliance with recommendations for cognitive rest. *Clinical Journal of Sport Medicine, 26*(2), 115–119. https://doi.org/10.1097/JSM.0000000000000208	To determine the compliance of schools and school nurses in the US with recommendations for cognitive rest for students who sustained a concussion.	1033 questionnaires were completed.	Cross-sectional questionnaire based study. A questionnaire was developed based on recommendation for cognitive rest was electronically distributed to members of the national association of school nurses	Only 53% of schools have guidelines to assist students with returning to school after a concussion.	Level 6: Single descriptive study	Low response rate to the questionnaires may not reflect the true state of compliance of schools in the US. The distribution of the questionnaires was limited to school nurses who were members of the NASN, thus, the study may have excluded schools whose nurses who were not	Yes. Helps ensuring that schools have policies established for a student's return to learning, having specific guidelines to provide an individualized approach to return to learning based on post-concussion signs/symptoms.

			(NASN) working at the high school level.			members of NASN and therefore could not participate in the study.	
Rice, S. M., Parker, A. G., Rosenbaum, S., Bailey, A., Mawren, D., & Purcell, R. (2017). Sport-related concussion and mental health outcomes in elite athletes: A systematic review. *Sports Medicine, 48*(2), 447–465. https://doi.org/10.1007/s40279-017-0810-3	The study's aim was to appraise the evidence base regarding the association between sport-related concussion and mental health outcomes in athletes	Systematic review of 27 studies	Systematic review	The studies found an association between concussion exposure and depression symptoms and mixed evidence was found for an association for anxiety and concussion exposure.	Level 5	Causation cannot be determined at this stage of enquiry because of the lack of well-designed, prospective studies.	Yes, because it shows the extensive ramifications from concussions, especially the possible effects on ones mental health.
Sabini, R. C., Nutini, D. N., & Nutini, M. (2014). Return-to-play guidelines in concussion: Revisiting the literature. *The Physician and*	Guideline recommendations of when student-athletes can return to school or sport	The sample studied included various literature reviews studying concussio	This was a systematic review and a concussion guideline for athletes and to advise when	Once concussion symptoms have improved and the student-athlete is able to perform cognitive tasks without symptoms exacerbating, a gradual return to	Level 1: Clinical guidelines based on systematic reviews	A precise definition of and recommendation for cognitive rest beyond the protocol is lacking neurocognitive	Yes, this guideline helps providers and athletic trainers recommend and clear student athletes to return to sport and

Sportsmedicine, *42*(3), 10–19. https://doi.org/10.3810/psm.2014.09.2070		n treatment and management for children, high-school, and collegiate athletes.	to return to play and return to school concussion guideline.	school is warranted.		testing cannot be used as the sole source for concussion management and deciding when to return to learning or play activities due to being unreliable, as some may be able to score well on neurocognitive tests yet still have obvious symptoms. Further research is needed to help determine the utility and limitations of neurocognitive testing in the post-concussive athlete	return to learning activities.
Sarmiento, K., Donnell, Z., Bell, E., & Hoffman, R. (2019). From the CDC: A qualitative study	To better understand school profesionals' perception of	The research design and populatio n	Qualitative data collection method, six focus groups that	The study found that the majority of school professionals are engaged and want to gain knowledge	Level 6: Qualitativ e study	The small sample size. The study did not include a wide variety of school	The findings in this study can help inform the integration of concussion management

of middle and high school professionals' experiences and views on concussion: Identifying opportunities to support the return to school process. *Journal of Safety Research, 68*, 223–229. https://doi.org/10.1016/j.jsr.2018.10.010	concussion and experience with return to learn policies.	included six focus groups with two to four school professionals per group: including, two groups of teachers, two groups of school psychologists and counselors, and two groups of school nurses.	evaluated school professionals' experiences with concussions and the CDC's HEADS UP campaign.	about concussions and the importance of helping their students recover. It was important for school professionals to educate peers and students of the long-term benefits of taking time to recover and to encourage them to follow the necessary steps needed for recovery.		professionals. Lastly, the participants in the study were motivated on the subject matter, this may not represent many schools and other school professionals.	policies in schools.
Sawyer, Q., Vesci, B., & McLeod, T. C. (2016). Physical activity and intermittent post-concussion symptoms after a period of	To assess whether athletes who experience intermittent symptoms return to asymptomatic condition	The search revealed 749 articles evaluating the effects of rest and	Systematic review	Current literature suggests an initial period of rest for the initial 24-72 hours. Those who reported moderate levels of cognitive and physical exertion over the	Level 1: Systematic review	There was little that was known about evaluating the athletes resting period. Pharmacologic interventions and specific PT	Yes, because after the initial resting period, it may be of benefit to encourage post-concussive patients to engage in light activity.

symptom-limited physical and cognitive rest. *Journal of Athletic Training*, *51*(9), 739–742. https://doi.org/10.4085/1062-6050-51.12.01	more quickly with physical activity than with prolonged physical rest	1,175 articles evaluating the effects of treatment. Of these articles, after reviewing the inclusion criteria, the authors narrowed it down to a total of 12 articles.		first month postinjury appeared to demonstrate improved outcomes compared with those who pursued small or large amounts of activity. Patients with cervical spine or vestibular dysfunction often benefit from PT targeted at their individual symptom profile to enhance recover.		interventions were not thoroughly discussed. Gaps with individuals who were slow to recover from concussion symptoms were not discussed.	
Thibaut, A., Kaux, J.-F., Martens, G., Urhausen, A., Tscholl, P., Hannouche, D., Le Garrec, S., Crema, M., Winkler, L., Cabri, J., & Leclerc, S. (2022). Way for improvement:	Evaluate knowledge on concussion management in three countries participating in a concussion forum conference	Target population consisted of 85 participants of an educational conference on concussion's	Cross-sectional survey	50% of the participants were not aware of international guidelines for the management of concussions, 76% and 83% were not familiar with the stepwise "return to sport" and "return to learn" protocols, respectively	Level 6	Quality of the study, number of participants	Yes, the study highlights the lack of common knowledge about concussion diagnosis, management and treatment as well as emphasizes the need for continuing education regarding

Primary survey on concussion knowledge of sports stakeholders in three European countries. *Science & Sports*, *37*(2), 94–100. https://doi.org/10.1016/j.scispo.2021.08.001		management					concussion management
Voormolen, D. C., Cnossen, M. C., Polinder, S., von Steinbuechel, N., Vos, P. E., & Haagsma, J. A. (2018). Divergent classification methods of post-concussion syndrome after mild traumatic brain injury: Prevalence rates, risk factors, and functional outcome. *Journal of Neurotrauma*, *35*(11), 1233–1241. https://doi.org/10.	The purpose of this study was to determine prevalence rates, risk factors, and functional outcome associated with post-concussion syndrome 6 months after mTBI	731 mTBI patients were included in this study, 63% were male.	Prospective observational study	Prevalence of PCS 6 months following mTBI ranged from 11.4% to 38.7% 27.1% of patients were functionally impaired 6 months post-injury	Level 4: Cohort study	PCS concerns a complex interplay of several factors and include prior health, life stressors, and compensation/litigation issues. Thus, an overview of many aspects of a patient's current, but also previous life before the trauma, is required for accurate assessment.	Yes, because it reveals the prevalence of PCS and its risk factors

1089/neu.2017.5257							
Williamson, C. L., Norte, G. E., Broshek, D. K., Hart, J. M., & Resch, J. E. (2018). Return to learn after sport-related concussion: A survey of secondary school and collegiate athletic trainers. *Journal of Athletic Training*, *53*(10), 990–1003. https://doi.org/10.4085/1062-6050-234-17	To investigate current RTL practices and to evaluate if they are being implemented in practice	A total of 1083 individuals (27%) from a random sample of 4000 athletic trainers in the National Athletic Trainers' Association membership database completed an electronic survey.	Cross-sectional study/survey	Overall, the majority of athletic trainers understood the importance of RTL protocols. 41.2% of the athletic trainers reported that there was an absence of evidence-based RTL protocols used in their workplace. Most respondents, 73%, noted having an established RTL policy in place, but only 38.1% used such guidelines in their clinical practice. Despite sound RTL protocol recommendations, roughly two thirds of the total sample were neutral, disagreed, or strongly disagreed with the need for RTL guidelines.	Level 6	Equal representation among providers per state was not achieved, therefore, geographic bias may have been noted. If respondents were unfamiliar with RTL protocols, this could have altered responses.	Yes, emphasizes the need to mandate RTL protocols and policies to be set in place. Even still in situations where institutions have guidelines in place, there is nothing holding one accountable to using such guidelines.

Yang, J., Yeates, K., Sullivan, L., Singichetti, B., Newton, A., Xun, P., Taylor, H. G., MacDonald, J., Pommering, T., Tiso, M., Cohen, D., Huang, Y., Patterson, J., & Lu, Z. L. (2019). Rest Evaluation for Active Concussion Treatment (ReAct) protocol: A prospective cohort study of levels of physical and cognitive rest after youth sports-related concussion. *BMJ Open*, *9*(4), Article e028386. https://doi.org/10.1136/bmjopen-2018-028386	To assess the optimal level of rest needed to promote recovery after a sports-related concussion (SRC).	110 student athletes who suffered from a SRC, ages ranging from 11-17 years of age.	Cohort study Youth participants are prospectively followed to objectively monitor daily physical and cognitive rest, surveys are also used to assess daily symptoms.	Engaging in high levels of activity too soon after concussion could exacerbate symptom duration and lead to deleterious effects. Conversely, a period of 'complete' rest for long periods of time could negatively affect young athletes with concussion because of muscular deconditioning and withdrawal from school and sports activities, and may also be impractical or unnecessary after some concussions.	Level 4: Cohort study	The cognitive activities participants engage in during school hours are not measured due to privacy concerns of wearing the one of the electrical devices to assess data at school. The study noted that quantifying cognitive rest can be challenging, variable, and skewed.	No, though the data is interesting, the level of evidence is not impressive and the data is nothing far from what was previously known.

Appendix C

IRB Approval

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

February 28, 2023

William Midgette
Tonia Kennedy

Re: IRB Application - IRB-FY22-23-1173 EVALUATING THE NEED FOR RETURN-TO-LEARN CONCUSSION PROTOCOLS IN HIGH SCHOOL STUDENT-ATHLETES: AN INTEGRATIVE REVIEW

Dear William Midgette and Tonia Kennedy,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds that your study does not meet the definition of human subjects research. This means you may begin your project with the data safeguarding methods mentioned in your IRB application.

Decision: No Human Subjects Research

Explanation: Your study is not considered human subjects research because it will not involve the collection of identifiable, private information from or about living individuals (45 CFR 46.102).

Please note that this decision only applies to your current application. Any modifications to your protocol must be reported to the Liberty University IRB for verification of continued non-human subjects research status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this determination or need assistance in determining whether possible modifications to your protocol would change your application's status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

Appendix D

CITI Certificate

CITI PROGRAM

Completion Date 14-Dec-2022
Expiration Date 14-Dec-2025
Record ID 53199728

This is to certify that:

William Midgette

Not valid for renewal of certification through CME.

Has completed the following CITI Program course:

Biomedical Research - Basic/Refresher
(Curriculum Group)
Biomedical & Health Science Researchers
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Liberty University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wadd01aaa-36dc-4555-bb65-de0b3e4f5e7c-53199728