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Addressing the Multiple Needs of Students with Mild Traumatic Brain Injury

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Addressing the Multiple Needs of Students with Mild Traumatic Brain Injury

by

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Abstract

This paper investigates research literature on mild traumatic brain injury and supports for students, guardians, and the implications for educators. Students who experience mild traumatic brain injury will encounter a variety of symptoms (i.e., dizziness, amnesia, headache, sensitivity to sound) throughout their recovery. Students may also experience difficulties in their academic performance: occlusion errors, academic dysfunction, and deficits in long-term cognitive control. Medical staff, guardians, students, and educators must support students, on an individual basis, to serve the multiple needs of students recovering from mild traumatic brain injury.

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Chapter 1: Introduction

In 2006, 13-year-old Zachary Lystedt experienced a disabling concussion during a football game. Zachary's concussion was not properly managed or treated. He was rushed to the hospital after showing signs and symptoms of a severe concussion. Doctors performed surgery on Zachary's head to reduce the swelling in his brain. Doctors diagnosed Zachary as having a traumatic brain injury caused by a direct blow to the head. Ultimately, this traumatic brain injury has forever changed his life (USA Today, n.d.).

Zachary is now a college student in his early twenties. Since he was diagnosed with a traumatic brain injury, Zachary has endured years of rehabilitation to regain his speech and motor movement. Currently, he speaks with a slow and strained voice and he has difficulty with short-term-memory. Doctors predicted that he might never regain the same cognitive function he once had, due to the irreversible damage caused by the concussion (USA Today, n.d.).

The inception of the term mild traumatic brain injury (mTBI) first came to be when soldiers from World War I experienced trauma to the head from blasts and other powerful compressive forces to the head. This trauma to the head caused soldiers to suffer from amnesia, headaches, hypersensitivity to noise, dizziness, and poor concentration. Physicians initially diagnosed this injury as "shell shock," since soldiers presented with no visible organic lesion to the head. These soldiers experienced identical symptoms to those who had experienced lesions to the head from explosion. This caused a need to discover the etiology of this new condition (Jones, Fear, & Wessely, 2007).

In 1917, medical personnel from the United States military and British military came together to find the etiology of shell shock. Medical military would eventually restrict the word

shell shock, since it was too broad of a term to diagnose soldiers who experienced trauma to the head. Soldiers, who came from the front lines with no visible head lesions, were initially diagnosed as "not yet diagnosed, nervous." Soldiers that did not make a full recovery were classified as "neurasthenic" (Jones et al., 2007).

In 1939, Dr. Schaller conceived the term "post-trauma concussion state." This was an effort to properly diagnose soldiers in World War II. Dr. Schaller used this term to describe prolonged disturbance of consciousness with no significant or obvious pathologic change in the brain. Dr. Schaller used symptoms such as dizziness and amnesia to differentiate between head injuries with lesions and without.

The term traumatic brain injury is used to describe individuals that experienced structural injury or physiological interruption of brain function caused by an external force (Blyth & Bazarian, 2010). This external force to the head causes rapid acceleration and deceleration of the head and neck. The dispersed force leads to differential movement of the brain relative to the skull resulting in damage to axons and cellular membranes. Forceful movement of the head and neck may cause a brief alteration of mental status, such as disorientation, loss of memory for events prior to or subsequently after the injury, or abrupt loss of consciousness (Blyth & Bazarian, 2010). Ensuing metabolic damage involves diffuse release of neurotransmitters, abnormal regulation of calcium homeostasis, energy breakdown due to Adenosine triphosphate (ATP) depletion, and cell death (Blyth & Bazarian, 2010).

Historical Background

Child psychiatrist Michael Rutter and his colleagues initiated contemporary research on mTBI in children and adolescents. Rutter conducted a series of longitudinal design studies on

children, comparing the results of children with severe traumatic and mild brain injury. IQ

scores were used to collect data throughout the study. The results indicate that children with

severe traumatic brain injury had an increased recovery curve over time, whereas children with

mild brain injury displayed little change over time. Ultimately, Rutter and his colleagues

suggested that children with severe brain injury had reached an exceeded threshold, but not in the

group of children with mild brain injury (McKinlay, Grace, Horwood, Fergusson, & MacFarlane,

2010).

Mild traumatic brain injury research, historically, has not received a tremendous amount

of attention in children and adolescents. Previously, doctors believed that mTBI are clinically

benign. Recent events in sports and military cases of mTBI have caused great concern for long-

term effects from trauma to the head. Highly publicized reports on adult athletes and military

personnel provoked more research in the consequences of mTBI in all ages. Articles related to

mTBI in children and adolescents increased from 50 to 500 publications over the past 20 years

(Corbin-Berrigan & Gagnon, 2017).

Importance

Children and adolescents suffering from a mTBI will most likely need a variety of areas

to be addressed. Firstly, this starred paper focused on educational and personal needs that a

student enduring mTBI will need. Second, information regarding the proper management from

school personnel are explored. Thirdly, an account of a student's experience with a sustained

mTBI are reviewed.

The student may have needs from the school district and medical personnel to properly

manage the mTBI. However, managing an mTBI for a student may be challenging due to

limited mTBI training from school personnel and lack of correspondence between medical professionals and school personnel (Dreer, Crowley, Cash, O'Neill, & Cox, 2017). Similarly, the student needs a return-to-learn protocol. While some students make a recovery from an mTBI, others experience prolonged symptoms. Although, a student may appear physically unhurt days or weeks after the initial injury, they may exhibit prolonged cognitive effects from the mTBI.

The sustained effects from the mTBI may cause a change in behavior and cognitive function as a sequela from the initial injury. The student may need additional services for symptoms lasting more than a few weeks. Depending on the severity, the student may be eligible for a 504 plan or individualized education plan (IEP). A 504 plan is a formal process where the student receives appropriate accommodations in the student's general education classes. Section 504, of the Rehabilitation Act of 1973, protects individuals with disabilities from discrimination. This includes accommodations in class that aim to help the student compensate for their physical difficulties and learning ability compared to their peers. Documentation from the student's physician is necessary to put the 504 plan into action.

A student experiencing mTBI, for greater that 3 months, are categorized within neurocognitive disorder of the Diagnostic and Statistical Manual of Mental Disorders, 5th (DSM-5). The DSM-5 features a category, Major or Mild Neurocognitive Disorder due to Traumatic Brain Injury, for students who display neurocognitive deficits such as impaired social functioning and or impaired objective measures of cognitive function (Wortzel & Arciniegas, 2014).

In other situations, the student may need special education or rehabilitation services from the effects of an mTBI. An IEP team composed of the child's parent(s), school personnel, and others who spend a significant amount of time with the student. The IEP is a legal document that includes some or all of the following: accommodations, modifications, assistive technology, and, therapy. The student has access to these services through the Individuals with Disabilities Act (IDEA) (Wilmshurst, 2013). This law mandates that all students have the right to a free and appropriate education, including traumatic brain injury. The student would have to be evaluated by the IEP team to determine eligibility for special education services.

Furthermore, students that exhibit prolonged mTBI may have behavioral and cognitive outcomes that may affect their ability to learn. Consistent data observing mTBI in preschool children show behavioral symptoms my last post-injury. A longitudinal outcome of mTBI, from a birth cohort in 1977, compared children with mTBI and a control group. Characteristics from 1,265 students were gathered to compare children with mTBI and the control group prior to the age of 10. The study found children who stayed overnight in the hospital to receive treatment displayed significantly worse parent and teacher assessments of conduct ratings and attention from ages 10 -13. Also, students who sustained the injury prior to age 5 were more likely to have symptoms of attention deficit hyperactive disorder (ADHD), substance abuse, and conduct disorder. These findings have been consistent since this study was performed in 1977 (McKinlay et al., 2010).

Much controversy stems from issue of persistent behavioral problems following mTBI. Opposing views debate behavioral changes are difficult to determine in children experiencing mTBI. It can be argued that behavior issues can be preexisting in children who have no

objective pre-injury data (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2009). The opposing view are reviewed in the second chapter.

For a student experiencing mTBI, cognitive outcomes present as less consistent than behavioral outcomes. Some research indicates little evidence to support impairment in intellectual functioning following early mTBI. Conversely, other researchers have found a deficit in visual closure 6 months post injury. Likewise, this study found that children who sustain mTBI were more likely to need assistance with reading (Kirkwood & Yeates, 2012).

Words Defined

Mild Traumatic Brain Injury: trauma induced alteration in mental status that may or may not involve loss of consciousness.

Etiology: the cause or origin of a condition or disease.

Neurasthenic: a condition characterized especially by physical and mental exhaustion usually with accompanying symptoms (irritability, insomnia, and headaches), is believed to result from psychological factors.

Axon: a nerve cell that carries outgoing (efferent) messages to the rest of the body.

Cell membrane: divides a space or organ and is covered by a thin layer of tissue that cover the surface and or lines a cavity.

Calcium homeostasis: the mechanism by which the body uses to maintain adequate calcium levels.

Adenosine triphosphate (ATP): the high-energy molecule that are used for many metabolic processes, known as the universal energy currency for metabolism.

Sequela: a secondary condition of a previous disease or injury.

Guiding Questions

1. How do mild traumatic brain injury affect students and their ability to learn?

2. What supports can educators provide to students with mild traumatic brain injury?

Focus of Paper

I used 10 studies for the literature review in Chapter 2 of this starred paper. My research includes studies of children and adolescents who experienced mTBI and their cognitive and behavioral outcomes. Since there is not enough research on children and adolescents, I had to broaden my search on a few articles to adults with mTBI. Likewise, their educational needs will be explored. Along with studies from children, I have included studies from medical professionals and education personnel and their importance for the success of the student. Research articles in this review are from 2009 to 2017.

Research articles were found via Academic Search Premier, PsycINFO, and CINAHL Plus with Full Test (Nursing). Keywords that were used to discover appropriate literature include the following: *mild traumatic brain injury, concussion, students, education, learning, long-term outcomes, special education, children, and adolescents*.

Chapter 2: Review of Literature

The objective of this literature review is to investigate the guiding questions from Chapter 1. Each guiding question is examined in this chapter. Studies that examine the effects of mild traumatic brain injury are examined first, followed by studies that examine supports that educators can provide to these students. Some of the studies may use the term concussion interchangeably with mTBI.

Effects of mTBI on Students

Pontifex, O'Connor, Broglio, and Hillman (2009) investigated the relationship between a history mTBI and evaluative and regulative cognitive control. Sixty-six male and female college-age student athletes were utilized for this study. The student athletes were divided into two groups: 36 were assigned to the control group and 30 were assigned to the mTBI group. Student athletes in the mTBI group have a history of mTBI diagnosed by a physician, while the control group does not have a history of mTBI.

All participants completed the Kaufman Brief Intelligence Test and the Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) computer based neurocognitive assessment prior to neuroelectric testing. Researchers then used a 64-channel quick-cap on the participants and were instructed to perform cognitive control tasks. The participants were instructed to respond to the direction of arrows (e.g. <<< or >>>) as fast and accurate as possible. Participants were given 20 practice trials before the task began.

The ImPACT is a computer-based assessment used to determine the standard measure of cognition for each participant. This neurocognitive test provides information in the following models: verbal memory, visual memory, reaction time, visual motor speed, and impulse control.

Medical professionals commonly use this test as one method of diagnosing mTBI; researchers use this test to collect data on mTBI as well.

Participants' performance on the ImPACT was assessed using an ANCOVA with verbal memory, visual memory, reaction time, visual motor speed, and impulse control jointly used to signify cognitive function. Each group had no statistically significant difference, $F_{(5,60)} = 0.8$, $p = 0.54$, in cognitive performance according to the ANOVA.

Task performance (reaction time and response accuracy) was measured separately with an ANOVA and *t*-test. Findings from the ANOVA reveal a statistically significant difference in reaction time latency, $F_{(1,64)} = 466.0$, $p < 0.001$, between both groups. A main effect was found in response accuracy, $F_{(1, 64)} = 7.3$, $p = 0.009$, with reduced response accuracy in the mTBI group according to the omnibus report.

In sum, the researchers found reduced response accuracy in the mTBI group when compared to the control group. Researchers also found the ImPACT to be less effective at identifying long-term cognitive impairment subsequent to an mTBI. Findings also suggest an association between repeated mTBI and long-term cognitive control ($r = -0.325$, $p = 0.004$). This association illustrates an increased number of mTBI decreases cognitive control via the 64-channel quick-cap.

Limitations of the study include the participant-reported concussion diagnosis hinders the strength of the research. This pertains to the observed cognitive differences in the controlled and mTBI groups. The researchers noted the need for a longitudinal study to fully explain the findings.

Ransom, Burns, Youngstrom, Vaughan, Sady, and Gioia (2016) explored the adequacy of an evidence-based model to determine a set of tools for identifying students at risk for perceived academic problems during recovery from a concussion. First, the researchers wanted to identify which measures are most advantageous to identifying who is at risk for perceived post-concussion academic problems. Second, the researchers obtained criteria from a specialty concussion clinical patient setting that divided students into high or low perceived academic problems. Third, the researchers wanted to find index tests that produce meaningful data in perceived academic problems following concussion in the areas of executive dysfunction, cognitive exertion, and neuropsychological test performance. Fourth, the researchers wanted to identify the difference between specificity and sensitivity of the index tests.

Participants consisted of 142 adolescents and children, both male and female, with a mean age of 14.95. Participants were utilized from an outpatient concussion clinic within 4 weeks post-concussion. Only participants who were diagnosed with a concussion, 10 years or older, and the child returned to school by the time of the evaluation were applied to this study. Furthermore, children who were diagnosed with learning disabilities, behavior disorders, or ADHD were also included in the study.

First, the participants were measured using the Concussion Learning Assessment and School Survey (CLASS); this questionnaire is used to assess the perception of academic dysfunction ensuing a concussion. The assessment measures two groups: (1) problems related to interfering symptoms (i.e., fatigue, headaches, and concentration difficulties), and (2) problems related with diminished academic skills (i.e., challenges in studying, taking notes, studying, and difficulty understanding class material).

Second, the participants took an index test called the Post-Concussion Symptom Inventory (PCSI). The PCSI is used to measure self- and parent-reported symptom severity. This index test is comprised of 17 items that will be compared to other index tests and outcome measures.

Third, the participants took the Behavior Rating Inventory of Executive Functions (BRIEF). This index test is administered to the parents and participants to measure three different categories: Behavioral Regulation (i.e., self-consciousness), Emotional Control, and Cognitive Regulation (i.e., planning, organizing, working memory, and task).

Fourth, the researchers gather data from the index tests PCSI and BRIEF to determine the effectiveness of specificity and sensitivity of the index tests. Researchers conducted this to identify students reporting high and low academic problems. Also, significance tests were utilized to identify if the index test could discriminate between students reporting high and low academic problems.

Results of the first procedure showed only a significant difference between groups on self- and parent-report history of ADHD/learning disabilities (LD), depression, anxiety, headache, and executive dysfunction PCSI and BRIEF. PCSI self-report t (140 df) = 6.78, p = .001, d =1.18 high school problems (m=1.26) and PCSI parent-report t (140 df) = 5.81, p = .001, d = .98. The effect size is higher in PCSI self-report (d =1.18) compared to parent-report (d = .98). BRIEF self-report t (140 df) = 6.50, p = .001, d = 1.12 and BRIEF parent-report t (140 df) = 3.77, p = .001, d = .63. Essentially, the children self-reported more symptom severity and executive dysfunction compared to the parent-report.

The second set of results based on the CLASS outcome measures and specialty concussion clinic revealed that 56% (79) of students reported a low number of academic problems and 44% (63) of students reported a high number of perceived academic problems. In short, 44% of students had perceived: (1) problems related to interfering symptoms, and (2) problems related with diminished academic skills.

The third set of results from the BRIEF revealed participants in the pre-injury history of ADHD, learning disability, depression, anxiety, and headache reported high academic difficulties χ^2 (1 df) = 5.86, p = .02. A positive correlation between pre-injury and PSCI-parent and participants with pre-injury history .17, p < .05. Participants from this group displayed higher overall post-concussion symptom exertional response, executive problems, and symptom severity t (140 df) = 6.78, $p < .001$.

The fourth set of results examined the sensitivity and specificity on the self-report scales between the PCSI and BRIEF. To measure sensitivity and specificity, the Rice and Harris criteria was utilized to determine the Area Under Curve (AUC). The AUCs of .80, p < .001 and .84, p < .001 reveal that an arbitrarily selected participant reporting high academic problems score higher than a participant reporting low academic problems 84% of the time and 80% of the time.

This information indicates children and adolescents who endure a concussion are at risk for perceived academic difficulties immediately following recovery and during injury, this incudes difficulty completing work on time and understanding new concepts. Along with academic difficulties, the participants experienced symptoms such as headache and fatigue that

interfere with productivity. Moreover, participants with a pre-injury history of anxiety, ADHD, LD, depression, and headache are more likely to report high academic difficulty.

There are a few limitations in the study. Student use of self-reported criterion excluding independent variables course grades, and measures of teacher report performance. The presence of recall bias may have increased anxiety/concern for new or worsening post-injury academic problems. Finally, including students who were evaluated and treated by a specialty concussion clinic. This may indicate a more affected sample of increased representation of students with a history of ADHD/LD, anxiety, and mood concerns.

Karver et al. (2012) conducted a study to examine the effects of age at injury on enduring behavior problems and social skill deficits in young children with complicated mild to severe traumatic brain injury. These researchers investigated a coalition between age at the time of injury and long-term behavioral problems in children who experienced a TBI early in their childhood.

Participants for this study included an experimental group, comprised of children ages 3-7 years with TBI, and a control group of children who experienced an orthopedic injury. Both groups required minimum hospitalization for one night for their respective injury. Further inclusion criteria involved participants who no history of documented neurological issues, developmental delays pre-injury, child abuse, English as a primary language, and the injury occurred between 36 and 83 months. Researchers further divided the participants into three groups: severe TBI, complicated mild to moderate TBI, and orthopedic injury (OI).

Parents of the children completed retrospective ratings of their child's pre-injury behavior problems, social skills, and executive function behaviors. Parents from both groups completed

the Child Behavior Checklist (CBCL) internalizing and externalizing behavior subscales, and Diagnostic and Statistical Manual of Mental Disorders (DSM-5) ADHD/anxiety scales. Likewise, parents completed the Preschool and Kindergarten Behavior Scale-2 (PKBS-2), Home and Community Social and Behavioral Scales (HCSBS), and Behavior Rating Inventory of Executive Function (BRIEF). Researchers collected baseline data shortly after the children experienced their injury and again 24 months post-injury.

Statistical results show 10% of the OI group, 14% of the complicated mild to moderate group, and 42% of the severe TBI group reported psychopharmacological interventions for symptoms related to ADHD at 83 months post-injury. Researchers found a high correlation (r = .71) between the ADHD subscale on the DSM-5 and CBCL Externalizing behavior scale. Simply put, as external behavior goes up, ADHD related symptoms increase. They also found a moderate correlation (-.23) between anxiety scales and externalizing subscale (-.42) with family income and maternal education.

Researchers conducted longitudinal analysis of behavior outcomes. Results display a significant main effect in the BRIEF $t = 2.43$, $p = .01$, externalizing $t = 2.90$, $p = .004$, and internalizing $t = 2.58$, $p = .01$. The effects show the severe TBI group was higher compared to the complicated to moderate TBI and OI groups. Children, who were younger at age of injury, and in the severe TBI GROUP, displayed higher CBCL ADHD and CBCL Anxiety scale scores.

At the extended follow-up, elevated behavior ratings for the severe TBI group (37%) were consistently higher than mild to moderate TBI (18%) an IO (11%) groups. CBCL ADHD subscale; severe TBI 42%, mild to moderate 26%, and IO 15%. Externalizing behavior; severe-TBI 42 %, mild to moderate- 18%, and IO- 16% groups. BRIEF; severe- 37%, mild to moderate-

12% and IO- 12% groups. In sum, children who sustain a severe TBI at a younger age display significantly higher levels of symptoms than children who were older at age of injury.

The researchers note the primary limitation is the reliance on retrospective parent ratings of premorbid behavior functioning. The parents may have had a preconceived notion of their child's current behavior, in relation to the premorbid symptoms. The researchers also noted a need for more studies of the same nature, since this study is the first of its kind. Lastly, future studies should examine the teacher report measures to gain more insight about behavior functioning across classroom settings.

Pontifex et al. (2012) sought to determine the extent to which a decline in sustained attention was correlated with chronic mild traumatic brain injury (mTBI) cognitive function deficit in young adults. The researchers investigated the following: 1) how mTBI- related deficits in cognitive control might reveal sustained attention deficits, and 2) association between longer delays in attention (omission errors) and mTBI history.

College-age participants from the University of Illinois were utilized for this study. A total of 80 participants, both male and female, were separated into either a control group or mTBI group. Individuals from the control group reported having no previous history of mTBI (n = 42) and the mTBI group had a previously diagnosed concussion from a physician (n = 38), but were symptom free at the time of testing. All participants reported having a normal IQ, they are free from neurological disorders, and had normal vision.

The computer-based Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) was utilized to report mTBI symptoms, demographic information, and to provide a measure of cognition via components assessing visual memory, verbal memory, visual motor

speed, reaction time, and impulse control. Symptoms are based on 22 likert-scale questions, with

0 = not experiencing the symptom and 6 = the most severe. The researchers applied a modified

flanker test to assess cognitive control task. The modified flanker assesses the inhibitory aspects

of cognitive control by having participants discriminate centrally presented target stimulus

amongst lateral flanking stimuli in various congruent arrows (e.g., <<< or >>>) and incongruent

arrows (e.g., <<><< or >><>>). In this exercise, participants were instructed to use their left or

right thumb, in correspondence with the arrows, to press a Neuroscan STIM pad. The Neuroscan

STIM pad collected data on reaction time, response time, and error analysis.

The ImPACT test results displayed no significant difference in cognitive performance

between the control group and mTBI group F $(1, 78) < 0.001$, $p = .93$, $\eta^2 < .001$. Likewise, no

differences in number of symptoms were found between the control groups and mTBI group F

$(1, 78) = 1.0$, $p = .33$, $\eta^2 = .12$.

Flanker test reaction time analysis revealed longer latency for incongruent arrows

(M = 465.5 ms, SD = 5.7) respective to congruent arrows (M = 395.5 ms, SD = 5.1). Simply put,

reaction times were higher when incongruent arrows (<<><< or >><>>) appeared on the

computer screen. Meanwhile, response accuracy analysis revealed decreased response accuracy

from the mTBI group (M = 85.8%, SD = 1.1), with observed decrease in incongruent response

accuracy (M = 81.9%, SD = 1.0). The control group displayed higher accuracy with incongruent

arrows (M = 90.2%, SD = 1.1). Lastly, the result from the error analysis displayed higher

omission errors occurred from the mTBI group (M = 12.3, SD = 2.5) compared to the control

group (M =4.6, SD = 0.9).

A bivariate Spearman's rank correlation was conducted to determine the dependent variable and number of mTBIs experienced. A positive correlation was found between the number of omission errors and number of mTBIs experiences (Spearman's p = .29, p = .009). No other correlations were significant between mTBI and other measures.

In sum, the researchers found that decreased response accuracy was connected to a history of mTBI during cognitive control task (flanker test), although cognitive assessments from the ImPACT were no different. Similarly, participants with a history of concussions experienced more omission errors and sequential errors than those from the control group. Therefore, participants with mTBI cognitive deficits may have difficulty with maintaining attention.

Researchers divulge limitations with participants' self-report of previous concussion. Participants could have experienced a concussion while participating in athletics and not be aware of symptoms. Hence, it is conceivable that some participants may have experienced a concussion without knowing and been participants in the control group.

Ransom, Vaughan, Pratson, Sady, McGill, and Gioia (2015) performed a study to find the nature and extent of students recovering from concussion and adverse academic effects. Researchers sought to investigate the connection of post-concussion symptom severity to academic outcomes. Similarly, students who endured concussion and specific types of academic problems and classes that are affected will be investigated.

Participants consisted of 349 students aged 5 to 18 who were diagnosed by a physician 28 days post-concussion and the student returned to school. Parent-child groups made up 69% (n = 239) of the total participants, and 31% were parents alone. Researchers then formed two groups based on recovery condition at the time of clinical visit. Group 1, actively symptomatic

not yet recovered (Rc-), defined as showing elevated symptoms and/or impaired performance on neurocognitive testing. Group 2, recovered (Rc+) showing no elevation of symptoms and no impairments on neurocognitive test performance.

Researchers utilized the Post-Concussion Symptom Inventory (PCSI) to identify post-concussion effect on school problems, academics, grade performance, and symptom relation to academics. The participants completed the self-report portion of the PCSI, while the parents completed the parent report from the PCSI. Also, participants competed neurocognitive tests of working memory and response speed ages 5 to 12. Participants who are 13 to 18 completed the Multimodal Assessment of Cognition & Symptoms for Children. Parents and participants completed the Concussion Learning Assessment and School Survey (CLASS) to quantify post-injury academic experience.

According to the results, researchers found significant elevations in post-injury symptoms in the Rc- group. A significant difference in neurocognitive performance measures was found between the Rc- group ($p < .001$) and Rc+ group. Meaning the Rc- group, with participants who were actively symptomatic/not yet recovered, displayed higher frequency of impaired neurocognitive scores. Demographic traits showed significantly more males and older children in the Rc+, with no neurocognitive impairments or elevated symptoms, than the Rc- group.

 Results from post-concussion academic effects and concerns reveal significant differences in the report level of concern were found on level of schooling and recovery status. Parents and students in the Rc- group disclosed higher levels of concern for the question "How concerned are you about this injury affecting your/your child's school learning and performance?" Parents in the Rc- group (64%) reported feeling moderately or very concerned

with their child's school learning and performance, while students in the Rc- group (59%) reported moderate or very concerned. Parents and students in the Rc+ group reported Low levels of concern (students 16% and parents 30%). High school students reported the highest level of concern at 67% (n = 66, $p < .05$) than middle school or elementary school. Similarly, 45% of parents of high school students reported moderately to very concerned than parents of middle school (17%) and elementary school (18%) students. Lastly, no difference was found in self-report concern at any school level in the Rc+ group.

Results from student self-report, in regard to post-concussion school problems, reveal significantly more students in the Rc- group had higher post-concussion school problems compared to the Rc+ group ($p < .001$, Cohen's d = 1.54). Students in the Rc- group reported more school problems among high school (Cohen's d = 0.67) and middle school (Cohen's d = 0.44) than elementary students. Specific types of school problem were also found between groups. Students in the Rc- group (88%) reported symptoms such as headache, difficulty concentrating, and fatigue that interfered with school. Similarly, 77% of students in the Rc-group reported decreased academic skills in homework, problems studying, and taking notes. Compared to student self-report in the Rc+ group 38% and 44% accordingly. High school students in the Rc- group reported a greater number of problems with academic skills ($p < .01$, Cohen's d = .038) compared to other grade levels.

Results from effect on class and grade performance in response to the questions "which classes/subjects are you/is your child having trouble with since the injury?" One significant difference researchers found based on recovery status in the number of classes reported to present greater difficulty during concussion recovery ($p < .001$). Parents and students in the Rc+

group reported significantly less trouble in ≥ 1 class compared to the Rc- group. Parents and students in the Rc- group reported significantly more trouble with total number of classes in relation with the Rc+ group students ($p < .001$, Cohen's d = 1.24) and parents ($p < .001$, Cohen's d = 1.36). Compared to elementary school, high school students and parents in the Rc- group reported difficulty in significantly more classes (Cohen's d = 0.93 and1.02 accordingly). Math class was expressed as the most problematic subject coherent over all grade levels followed by language arts/reading, art, science, and social studies. When asked, "Have your/your child's grades been affected?" Both parents and students from the Rc- group observed effects on school grades compared to the Rc+ group. A majority of parents and students from the Rc- group reported perceived drop in grades in ≥ 1 subject, due to affects from the sustained concussion. Conversely, students and parents from the Rc+ group reported less than half found a change in perceived effect on grades.

Researchers examined the relationship of post-concussion symptoms and academic effects and found symptom severity was considerably related to level of concern for the injury affecting learning to perceived impact on school grades. Parents and students 13- to 18-years old reported significantly greater increased levels of concern and symptoms than parents and students who reported no concern or mildly concerned. A positive correlation found and, between symptom severity and total number of school problems, reported by students and parents ($p < .001$). School problems were positively correlated with cognitive, physical, and sleep symptoms. This was especially true of the students' 13- to 18-years-old (n = 162) cognitive (r = .587, $p < .001$), physical (r = .544, $p < .001$), and sleep (r = .487, $p < .001$)

compared to students' 10- to 12-years-old cognitive (r = .457, *p* < .001), physical (r = .267,

p = .065), and sleep (r = .499, *p* < .01).

Researchers note limitations from this study include school records and increased anxiety

from all participants. No objective school records were utilized, only student and parent reports.

Anxiety from all participants may have magnified symptom and educational concerns on the

self-reports. Lastly, the sample only included participants who were clinically diagnosed and did

not include an uninjured contrast group.

McKinlay et al. (2010) sought to find behavioral effects related to mild traumatic brain

injury (mTBI) in young children in a cohort longitudinal study. McKinlay et al. performed

research to find severity of mTBI and longitudinal follow-up. The researchers examined the

mTBI occurrence in preschool students and developmental progress after injury compared to

non-injured cases in the cohort. Researchers charted developmental trajectories from 7 to13

years of age to rating of oppositional defiance/conduct disorder and yearly ADHD scores.

The subjects utilized were from an epidemiological study of an original birth cohort of

1,265 children born in 1977. Researchers assigned children to one of three groups: two mTBI

groups and one control group. Both mTBI groups comprised of children who sustained a

medically diagnosed concussion, between the ages of 0 and 5. The mTBI groups had no further

traumatic brain injury after the initial reported concussion. Subjects who sustained a mTBI were

defined by: (1) no evidence of skull fracture, (2) loss of consciousness for no more than 20

minutes, (3) hospitalization ≤ 2 days, and (4) Glasgow Coma Scale (GCS) greater than 13.

Researchers assigned mTBI subjects into two groups, outpatient or inpatient, based on severity

of their concussion. The outpatient groups (n = 60) consisted of children with any occurrence of

mTBI before age 5 who had been seen at hospital and sent home. The inpatient mTBI group

(n = 21) included all children who had been admitted to a hospital for less than 2 days before the

age of 5. Parents were asked to keep a yearly documentation of any other injuries the subject

may have sustained. According to the parent yearly documentation, there were only a few

situations of multiple injuries, but they did not affect the main findings. Lastly, the general

reference group (control) included 826 subjects that had no history or medical diagnosis of

mTBI.

Procedures for this study included documentation of behavioral and injury information,

medical records, teacher report, parental interview, and standardized testing. Hyperactivity/

inattention and oppositional defiance/conduct disorder were measured from the Rutter and

Conners questionnaires. The questionnaire corresponds to the Diagnostic and Statistical Manual

III (DSM-III) criteria for ODD/CD and ADHD. Parents and teachers collected yearly data of

problem behavior over the subject's years of age 7-13.

Results from the study show a significant group main effect was apparent ($F_{2,929} = 9.70$,

$p < .001$). According to the *Post hoc* test, the inpatient group had higher ADHD scores were

higher compared to outpatient and reference groups, which did not significantly differ.

Similarly, a main group effect was found for ODD/CD ratings ($F_{2,929} = 9.74$, $p < .001$), with the

inpatient group displaying higher conduct ratings compared to the outpatient and reverence

groups, which did not significantly differ. Researchers also found an increase in conduct

problems over years 12 and 13 from the inpatient subjects compared to outpatient and reference

groups.

McKinlay et al. (2010) concluded that more severe sustained mTBI in pre-school childhood are prone to generate long-term, adverse behavioral development outcomes. The researchers emphasize the combination of mTBI severity and age poses the greatest risk in identifying outcomes after pre-school. This is especially true since the outpatient mTBI and reference groups were no more likely to display behavioral problems from one another.

The researchers identified factors that could have affected the cohort study results: lack of brain imaging and measures used may be outdated (DSM-III). There was no magnetic resonance imaging (MRI) taken to compare with a normal brain and/or their own imaging years later. The DSM-III criterion was utilized at the time of injury, since superseded by the DSM-IV.

Table 1

Effects of mTBI on Students' Studies

Authors	Study Design	Participants	Procedure	Findings
Pontifex, O'Connor, Broglio, & Hillman (2009)	Quantitative	66 total students (Control n = 36 and mTBI = 30)	-Kaufman Brief Intelligence Test -ImPACT -Quick cap (neuroscan) with cognitive control (flanker task)	-Association between repeated mTBI and long-term cognitive control. -Reduced response accuracy in the mTBI group when compared to the control group. - Reduced response accuracy in the mTBI group.

Table 1 (continued)

Authors	Study Design	Participants	Procedure	Findings
Ransom, Burns, Youngstown, Vaughan, Sady, & Gioia (2016)	Quantitative	142 students diagnosed with a concussion ages 11-18.	Participants completed a clinical assessment battery to measure perceived academic problems, symptoms, executive functions, exertional symptoms response, and cognitive performance.	-Executive dysfunction -Post-concussion symptoms severity and executive dysfunction significantly predict perceived post-injury academic problems.
Karver, Wade, Cassedy, Taylor, Stancin, Yeates, & Walz, (2012)	Quantitative	82 children with TBI and 114 with orthopedic injury	Parents completed the Child Behavior Checklist, Behavior Rating Inventory of Executive functions, and the Preschool and Kindergarten Behavioral Scale	-Severe TBI was associated with significantly greater anxiety problems compared to the orthopedic injury group. -Children with early TBI had significantly higher parent-report symptoms of ADHD and anxiety than the other group.
Pontifex, Broglio, Drollette, Scudder, Johnson, Phillip, & Hillman (2012)	Quantitative	80 college-age athletes from U of I	Participants took the ImPACT to provide demographics and mTBI symptoms. Visual motor speed, reaction time, impulsive control, and visual and verbal memory.	-History of mTBI was related to decreased response to accuracy during cognitive control task. -Greater number of omission errors in the mTBI group.

Table 1 (continued)

Authors	Study Design	Participants	Procedure	Findings
Ransom, Vaughan, Pratson, Sady, McGill, & Gioia (2015)	Questionnaire Quantitative	349 students ages 5 to 18 that sustained a concussion and their parents report academic concerns and problems within 4 weeks of injury.	Parents completed a questionnaire reporting symptoms interfering and diminished academic skills. Parents were asked if their child is recovered or actively symptomatic.	-Actively symptomatic students and their parents report higher levels of concern for the impact of concussion on school performance. -More school related problems (actively symptomatic group) -H.S. students report more difficulty and adverse effects than younger students.
McKinlay, Grace, Horwood, Fergusson, & MacFarlane (2010)	Longitudinal	Birth cohort of 1,265 children who experienced an mTBI	-Compared non-injured group to injured group from birth to age 16, and again at ages 18, 21, and 25 years. -Data was gathered from parent survey.	-Children with mTBI had increased inattention/hyperactivity and conduct as rated by mothers. -Increased rates of ADHD at age 14-16. -Increased substance abuse from the mTBI group. -Increased violent offenses and property offenses compared to non-injured individuals.

Educational Support for Students

Arbogast, Mcginley, Master, Grady, Robinson, and Zonfrillo (2013) performed a study to assess pediatric primary care providers' comprehension of cognitive rest for concussion and to describe their concussion management practices. Researchers wanted to gauge pediatric care provides current level of understanding of the approach of cognitive rest and a description of concussion management practices from abstraction of electronic medical records (EMRs).

Participants from the cross-sectional study completed a confidential survey. All participants were from a large children's hospital in Philadelphia, which included physicians, nurse practitioners, and physician assistants. Participants were given a survey that included multiple choice and specific field questions for qualitative comments. Qualitative field questions consisted of two themes: (1) whether or not a cognitive rest plan was describes in detail (i.e., recommended rest from computer use, homework, video games, texting, and/or television), and (2) whether or not participants cognitive rest was mentioned.

Electronic medical records (EMRs) from a random sample of children 5 to 18 years old were reviewed. Children included in the study were diagnosed with a concussion or mild traumatic brain injury (mTBI). Only children with EMR with signs and symptoms of concussion were included.

Results from the survey of providers included 89 survey responses and 84 of the 89 respondents included comments from the qualitative questions regarding their management of pediatric concussion. Of the 84 clinicians, 54 verbalized an awareness of cognitive rest in the management of concussion and only two actually described cognitive rest in detail (i.e., recommending rest from at least one of the following: video games, computer use, homework, and/or texting).

Results from EMRs included 174 children that met criteria for inclusion. Of the EMRs 19% of children reported a decline in school performance or effect on attendance from first-valuation patients and 30% of EMRs reported decline in school performance or effect on attendance from follow-up patients. Children with a first (85%) and follow-up (63%)

evaluations report headache as their primary symptom followed by "in a fog" (first evaluation 18%) and vision problems (follow-up 15%).

Arbogast et al. (2013) found only 11% of first evaluation received fewer instructions about cognitive rest and only 14% of follow-up patients. Researchers revealed only 50% of primary care provided documented instructions for return to play and 67% of providers were aware of cognitive rest as part of concussion management.

Limitations from the study included: survey biases, primary care instructions, and single care network. Although results displayed lack of understanding by primary care providers, the survey could have been subject to selection biases. Primary care physicians may have provided return-to-learn or cognitive rest recommendations verbally, and not recorded in EMRs. Lastly, only one hospital was utilized, which could limit generalizability of the results.

Glang et al. (2015) conducted a randomized control trial to investigate the efficacy of Brain 101: The Concussion Playbook web-based intervention for student athletes, who sustained a concussion, and their parents. The researchers sought to find the following based on the Brain 101 website: (1) increased knowledge of concussion management compared to controls, (2) increased athlete and parent behavioral intention to implement concussion management strategies compared to controls, and (3) positive affect concussion management practices from (i.e., observed by healthcare professional, classroom accommodations provided, return to full activity).

Researchers chose school that included the following criteria: (a) school access to high speed internet, (b) a registered athletic trainer, and (c) agreement to utilize data from the student athletes. The study is comprised of 25 schools (13 intervention and 12 control) with a total of

4,804 student athletes (2,264 intervention and 2,180 control). Parent participation included a total of 1,004 (445 intervention and 559 control).

Student athletes completes a survey with items from the Brain 101 website and items from two validated instruments. The survey included 18 correct or incorrect signs and symptoms of concussions (i.e., difficulty sleeping) and true/false items (i.e., you have to be hit in the head to have a concussion).

Parent and student athlete knowledge was measured with scenarios involving concussions. A five-point scale (1 = strongly disagree to 5 = strongly agree) was utilized to measure each scenario.

Athletic trainers (ATs) collected information (concussion logs) regarding number of days until return to full activity, concussion symptom experienced, and information about the injury. ATs concussion logs also included whether the student athlete received classroom accommodations and description of accommodations.

Researchers also performed exit interviews with each school's athletic director or principal in each respective group. The following questions were asked: explain the concussion management program at your school, did you create a concussion management team? If yes, is there an appointed coordinator for the concussion management team?

Results from the pretest and posttest, to determine increase in concussion knowledge based on the Brain 101 website, revealed students and parents from the intervention school had increased their knowledge compared to the control group. Students from the intervention group increased their knowledge from a mean of m = .63 to m = .80, while the control group went from a mean of m = .62 to m = .66. Parents from the intervention group increased from m = .69 to

m = .86, while parents from the control group went from m = .68 to m = .76. Likewise, students

in the intervention group increased their knowledge application from m = 3.59 to m = 4.01, and

students from the control group went from m = 3.55 to m = 3.64. Lastly, students from the

intervention group increased behavior intention from m = 3.13 to m = 3.61, while students from

the control group went from m = 3.13 to m = 3.27. Parents from the intervention group increase

their behavioral intention from m = 3.33 to m = 3.98, while parents form the control group went

from m = 3.32 to m = 3.61. Scores from intervention and control groups displayed a medium to

high effect size of Hedges' g = .52 for students and g = .61 for parents.

ATs collected concussion data logs from 354 cases (201 intervention and 153 control) of

diagnosed concussions. According to the 354 concussion log cases, 297 students returned to full

activity within 90-days, 57 students did not return to activity within the fall season. ATs also

collected data based on accommodations. Students receiving accommodations, from the

intervention and control group, displayed a medium effect size t (15) = 1.98, p = .067, g = .56.

The concussion log revealed two significant differences from the control and intervention

groups. More students from the intervention group received extended time to complete task

(78% Intervention and 47% control). More students from the intervention group (46%) received

a reduced workload compared to the control group (5%). While there were no other statistically

significant differences, other accommodations included the following: provided written notes or

instructions, quiet room for testing, no PE or weightlifting, postponed exams, 504 plan, and time

to visit school nurse.

Results from the principal or athletic director exit interview revealed more Brain 101

schools (intervention) implemented best practice guidelines than control schools. Of the

intervention schools, 77% created a concussion management team (CMT), and 54% had an assigned a CMT coordinator, while 20% of the control schools provided a CMT, but no coordinator. These findings display a statistically significant difference $\chi^2(1,23)=7.34$, $p=.007$ and $\chi^2(1,23)=7.74$, $p=.005$, correspondingly.

Researchers note limitations in small sample size of schools. The inclusion of more schools could display more statistical strength. Also, this study did not include an assessment of coaches,' administrators,' and/or teachers' behavioral intentions and concussion knowledge. Researchers did not have a measurement for student's symptoms/injury characteristics and academic outcomes. This lack of connection may have excluded vital information for long-term outcomes. Lastly, researchers did not have a baseline fidelity measure. This leaves an unknown regarding prior knowledge of the Brain 101 website for all participants.

Kasamatsu, Cleary, Bennett, Howard, and McLeod (2016) conducted a study to examine the academic support after concussion for the adolescent student athlete. The researchers utilized athletic trainers (ATs) perspectives on return to learn, communication with school professionals, and cognitive rest after concussion. Similarly, formalized return-to-learn policy and academic adjustments for students who experience a concussion. Lastly, the ATs paid though the school district or outreach and their communication with school professionals.

Participants included 1124 certified ATs that reported full-time employment status at their secondary high school. ATs employed and paid through the district made up a majority of the study followed by ATs paid through the school, ATs paid hospitals, and ATs paid through a physical therapy clinic.

Researchers sent ATs a web-based survey to examine current concussion management practices and academic support for students after concussion. The survey featured sections that focused on AT demographics, concussion-management policy, return-to-learn, and academic adjustments.

Results from return-to-learn policy reveal 84% of ATs (915/1088) recommended a gradual return-to-learn; however, only 43% of ATs (435/995) report having a return-to-learn policy. ATs (173/1088) who did not provide return-to-learn recommendations made up 15%, the explanation for not making recommendations were lack of school professionals' knowledge of concussions (44/146), lack of school support (28/146), lack of time to monitor academics (19/146), lack of time to develop the return-to-learn policy (15/146), not being part of the ATs responsibility (12/146), academic expectations (15/146).

Athletic trainers that communicated frequently with teachers, after an athlete's concussion, was the strongest predictor of the existence of a return-to-learn policy. ATs total years of experience, years of experience at the current school, and primary salary source was not statistically significant. Athletic trainers who always or often communicated with teachers were 1.5 times more likely have a policy for return-to-learn than ATs who never or rarely communicated with teachers. ATs years of experience, experience at school, or employment status did not indicate a significant difference.

Researchers collected data from ATs in regard to cognitive rest and academic accommodations. After an athlete experiences a concussion, ATs commonly recommend situational ([36%] 391/1087) or complete ([45%] 492/1087) cognitive rest to student-athletes and parent(s)/guardian(s). Restrictions of all cognitive activity include text messages, schoolwork,

computer, and television. Typical academic accommodations implemented were partial school attendance (740/954 [77.6%]), allowed rest breaks (765/954 [80.2%]), and postponed school due dates (789/954 [82.7%]). ATs perceive these academic accommodations, after concussion, to be very effective ([59%] 631/0173), somewhat effective ([31%] 337/1073), unsure effectiveness ([9%] 96/ 1073), or not effective ([0.8%] 9/1073). Overall, a majority of athletic trainers found academic accommodations to be effective with managing symptoms and return-to-learn.

Monitoring of recovery and academic progress results indicate that ATs most often identify themselves as the primary "point person" to monitor a student-athlete's health status ([73%] 764/1037) and academic development ([35.5%] 359/1011) following concussion. ATs were the primary "point person" followed by school nurse ([11.9%] 120/1011) and counselors ([17.2%] 174/1011) to monitor the student-athlete's academic progress. Of the 1,011 ATs who responded 21% reveal no "point person" was assigned to monitor academic progress. ATs indicated that a school counselor ([32.4%] 73/225) or AT ([28.9%] 65/225) should monitor academic progress.

Researchers note this study is not without limitations. Other school professionals were not included in the study. Exploration into collaboration of school professionals and ATs may increase the understanding and inter-professional education between medical staff and school staff. The researchers also reveal predictive variables in the study do not explain causation and complex employment, such as ATs who are graduate assistants. Thus, the employment characteristics and models of ATs may vary greatly since a wide variety of ATs were included (i.e., ATs paid by a district, ATs paid by the school, ATs from an outreach clinic/hospital).

Corwin et al. (2014) performed a study to examine characteristics correlated to prolonged recovery from concussion in a sample of pediatric subjects. Researchers also hypothesized those with a history of learning disabilities and mood disturbances, abnormal oculomotor convergence, and those who are younger and history of prior concussion would display prolonged symptoms.

Participants for this study included 247 patients from a pediatric sports medicine clinic. Patients were 5-18 years old and experienced a concussion from July, 2010, to December, 2011. Eligible participants received a diagnosis of concussion by a sports medicine physician. Electronic medical record query (3740 visits) was utilized to collect data from each patient.

Researchers analyzed patients using five categories correlated to exposure types for delayed recovery: (1) pre-existing conditions (i.e., anxiety, depression, ADHD, and LD); (2) physical examination at initial visit, particularly increased symptoms following oculomotor examination and abnormal near-position eye convergence; (3) patient age at time of injury; (4) prior history of concussion; and (5) recommended cognitive rest by referring provider. Patients also received a return-to-learn protocol, which includes no school, reading, homework, or electronics. The protocol recommendations gradually add moderate reading, homework, and then school with accommodations as symptoms subside. Accommodations include full days with breaks, elimination of examinations, extra time on tests, notes, and elimination of honors classes, and homebound education.

According to the results a median number of days until returning to school homebound education or part-time was 12 days. Students that returned to school full-time without any accommodations was 35 days and 64 days was the median time until the patients were symptom free. Patients took a median of 76 days to be cleared from all sport/school activities.

Data from pre-existing conditions revealed that patients with anxiety took twice as long to be fully cleared compared to patients without anxiety (168 days vs. 76 days, p = .001). Similarly, patients with depression required 2.2 times longer than patients without depression to be symptom free (142 days vs. 64 days; p = .05). School accommodations were imposed more frequently for patients with depression than patients without depression (87% vs. 69%; p = .165). Finally, patients with anxiety experienced prolonged symptoms beyond 4 weeks compared to patients without anxiety.

Patients that present with signs and symptoms immediately following injury include dizziness, abnormal near-point convergence, and loss of consciousness (LOC). Patients who displayed abnormal near-point convergence (62%) experienced more symptoms during the initial clinical examination. Likewise, patients who reported dizziness at the time of examination were more likely to experience symptoms past 4 weeks than those without dizziness (77% with vs. 61% without; p = .028). Patients who experienced LOC took 1.8 times longer before symptoms began to subside (116 with LOC vs. 63 without LOC days; p = .94). The most significant results came from patients with symptoms provoked by physical examination.

Those with symptoms from oculomotor examination were more likely to be prescribed school accommodations (94% vs. 36%; p = .0001*) and they required more time until returning to school full-time (61 vs. 14 days; p = .050). These students displayed greater symptoms past 4 weeks (80% vs. 45%; p = .001) and they were more likely to report a decline in grades (65% vs. 45%, p = .035). Lastly, patients with atypical near-point convergence on initial evaluation were more likely to be prescribed accommodations (82% vs. 60%; p = .038) than patients with normal convergence.

Researchers gathered information regarding age of patient at time of injury. Results indicated that patients at ages 13-14 years old took 1.8 times longer (median = 40 days) than the youngest patients age 12 or younger (median = 22 days), while patients 15-16 years old (median = 35 days) took 1.6 times longer to return to school full-time. Patients 12 years old or younger (78 days) took twice as long to become symptom-free compared to patients aged 17-18 (43 days). However, patients 12 years old or younger we prescribed school accommodations less frequently (57%) than patients all other age groups (70%).

Results, from patients past history of concussion, reveals patients with multiple concussions tool longer to become symptom-free than those with one or less. Patients with a history of two or more concussions took two times longer to become symptom-free, compared to those with two or less (ranging from 122 days for patients with three or more and 45 days for patients with no prior concussion. Researchers also found that patients with 0 or 1 previous concussion took a range of 64 days to be fully cleared, while those with a history of three or more took a range of 243 days to be fully cleared (p = .0006).

Researchers found limitations in the retrospective chart review of patient's history, baseline data, and accommodations. The use of retrospective chart review limited the ability to standardize the outcomes of results. Similarly, researchers did not collect baseline data. They utilized physical examination records from patients that may have had pre-existing psychological or neurological disorders. Lastly, accommodations used by schools opens a bias for influence of recent effect and recall.

Table 2

Educational Support for the Student

Authors	Study Design	Participants	Procedure	Findings
Arbogast, Mcginley, Master, Grady, Robinson, & Zonfrillo (2013)	Quantitative	89 healthcare providers responded to a survey. 174 patients ages 5 to 18 years old who were treated for a concussion.	A survey was sent to the individuals via email. This survey included multiple-choice and a text box for medical professional to describe concussion management (qualitative).	-Recommended cognitive rest. -Implementing a return to learn protocol. A stepwise list of acceptable and discouraged activities.
Glang, Koester, Chesnutt, Gioia, McAvoy, Marshall, & Gau (2015)	Qualitative	2,991 high school student athletes and their parent(s) (intervention = 1,517 and control = 1,472). -The intervention group received concussion education via Brain 101	-Athlete survey: knowledge of sports concussion, application, and intent to report concussion -Parent survey: concussion survey, knowledge, application, behavioral intention. - Concussion logs: Treatment and evaluation by medical staff, return-to-full activity, academic accommodations. -Exit interview with school admin. concussion management.	-Schools offering a concussion education program were more likely to receive varied academic accommodations than students from schools without such programs. -Participants from the Brain 101 intervention group were able to accurately identify concussion symptoms. Likewise, the Brain 101 program positively influenced intentions towards concussion management.

Table 2 (continued)

Authors	Study Design	Participants	Procedure	Findings
Kasamatsu, Cleary, Bennett, Howard, & McLeod (2016)	Qualitative	1,124 Secondary school athletic trainers (ATs)	Assessment of ATs demographics, return-to-learn (RTL), and academic accommodations via web-based survey.	-Frequent contact between ATs and school staff was the strongest predictor of a school system having an RTL. -Delayed due dates (82%), rest breaks (80%), and partial attendance (77%) were the most common adjustment made for concussed students. -Recommended cognitive rest. -ATs (73%) reported that they were the primary person to monitor student health after concussion and 35% considered themselves the designated monitor of academic progress.

Table 2 (continued)

Authors	Study Design	Participants	Procedure	Findings
Corwin, Zonfrillo, Master, Arbogast, Grady, Robinson, & ... Wiebe (2014).	Qualitative	247 concussed youth ages 5-18	-Retrospective cohort study of patients treated for concussion. -Data collected via electronic medical record query.	-Older adolescents were prescribed accommodations more frequently than their younger peers. -Exacerbated symptoms during ocuolomotor exam more likely to report a decline in academic performance and take longer to RTL than those who did not experience exacerbated symptoms. -Adolescents with 3 or more concussions took 3 times longer to RTL than those with no history of concussion. -Older children were more likely to report a decline in grades than younger children. -54% of medical providers recommended cognitive rest. -Median time to RTL part-time was 12 days, and full-time was 35 days.

Chapter 2 Summary

This chapter included research analysis of literature from 10 articles. Chapter 2 featured

six articles pertaining to the effect of mTBI on students and 4 articles regarding support for the

students and educators. The rationale for selecting these articles, were to find a breadth of

information that answers the guiding questions. The results are discussed in Chapter 3, along

with conclusions and recommendations for students who sustained mTBI.

Chapter 3: Conclusions and Recommendations

The purpose of this research paper was to identify how mild traumatic brain injury affects students and their ability to learn. Similarly, I wanted to identify supports an educator can provide to students with mild traumatic brain injury. Background information on this matter is provided in Chapter 1, and Chapter 2 features a review of research literature. In Chapter 3, I explain findings, recommendations, and implications from research findings.

Conclusions

I reviewed six studies that examined the effect of mild traumatic brain injury on students' ability to learn (Karver et al., 2012; Pontifex et al., 2009; Pontifex et al., 2012; Ransom et al., 2015; Ransom et al., 2016). Likewise, I reviewed five articles that provide educators support for students with mild traumatic brain injury (Arbogast et al., 2013; Corwin et al., 2014; Glang et al., 2015; Kasamatsu et al., 2016; McKinlay et al., 2010).

The six studies that reviewed mild traumatic brain injury effect on students' learning ability revealed a wealth of information in regards to cognition, executive function, ADHD, anxiety, age at time of concussion, attention issues, and parent/student self-report of concern on school performance. Pontifex et al.'s (2009) findings indicate that students who have a history of mTBI display deficiencies in cognitive control. Likewise, students with a history of multiple mTBI display poor stability for control during conflict. Ransom et al. (2016) revealed that both parents' and students' self-reports indicate higher executive dysfunction, symptoms, and exertional response in post-concussion students. Karver et al. (2012) found higher anxiety problems, at extended follow-up, than a control group. Also, students who sustained a severe traumatic brain injury at a younger age had a greater amount of parent-report symptoms of

ADHD and anxiety when the student was older. Pontifex et al. (2012) found that a history of mTBI was correlated to greater omission errors and frequent subsequent occurring omission errors when compared to a control group. These results indicate deficiencies in ability to maintain attention for students with chronic mTBI. Ransom et al. (2015) concluded that students and parents report greater levels of concern for the effect of concussion on school performance. These students displayed more school related problems associated with prolonged symptoms, regardless of time since injury.

The sixth study from McKinlay et al. (2010) utilized a birth cohort of 1,265 children born in 1977, who sustained an mTBI. This longitudinal epidemiological study examined the effects of mTBI associated with behavioral issues. Outcomes from teacher/mother ratings for behaviors associated with ADHD, conduct disorder, and oppositional defiance indicated a higher incidence from inpatient mTBI compared to outpatient mTBI and control group. The researchers concluded that pre-school students who experience mTBI are vulnerable to negative effects in terms of psychological development.

Of the total studies, four included support for educators and students when recovering from mTBI. Arbogast et al. (2013) found that clinicians were prescribing concussion management that included cognitive rest (i.e., no television, text messages, computer, homework). Clinicians found cognitive rest as the most important aspect of concussion management. Glang et al. (2015) performed a control trial examining the efficacy of the web-based intervention Brain 101. The researchers found that parents and students who utilized Brain 101 were more knowledgeable of sport concussion, application, and they were more likely to implement concussion management methods. Kasamatsu et al. (2016) found that athletic

trainers who have frequent communication with teachers after concussion, are more likely to have a return-to-learn policy. A majority of ATs are recommending complete and/or limited cognitive rest for students who sustain a concussion. The researchers also recommended accommodations for students including rest breaks, postponed due dates, and partial attendance. Corwin et al. (2014) asserted that students who experience a concussion took a median time of 12 days to return to school part-time. Similarly, students' symptoms continued for a range of 64 days and an additional 75 days until being fully cleared to return to sports. Students that received school accommodations made up 73%. Moreover, students that presented with symptoms during the oculomotor examination were more likely to be prescribed accommodations (i.e., no computers, reading, testing, video games).

The results indicate that a majority of students who suffer an mTBI will make a full recovery. However, every school should have return-to-learn policies and guidelines that will support all stakeholders. Moreover, a team comprised of medical staff and school personnel should be identified. This support team must have a designated person who is in daily contact with the student, and they must keep record of academic performance during the recovery process.

Recommendations for Future Research

From the research articles utilized, only one study, Glang et al. (2015), had an intervention group. This study had both the student and parent(s) (intervention group) take a web-based concussion course to address knowledge, application, and intent to report concussion. The researchers also compared data to a control group. Unfortunately, no other interventions were found for concussion.

McKinlay (2014) was the only researcher to perform a longitudinal study of a cohort from 1977. A major limitation to this study was the use of measurements from the late 70s (DSM-III), which may not be as reliable as current measurement to identify oppositional defiance/conduct disorder and ADHD. Likewise, the researcher noted a lack of brain imaging (MRI) to physically see mTBI damage and compare to other individuals from the cohort.

Student and parent questionnaires/surveys were a limitation for Ransom et al. (2015), Arbogast et al. (2013), Glang et al. (2015), and Kasamatsu et al. (2016). This limitation may cause lack of conscientious responses, difference in understanding, and difficulty analyzing the questionnaire/survey. Some survey questions may be difficult to understand and may be interpreted differently. Similarly, selection and response biases were found to be a limitation in these articles.

Further research must be performed on interventions to support the parents, students, and educators. The study performed by Glang et al. (2015) featured one web-based intervention called Brain 101: The Concussion Playbook, a school-wide concussion management program. While the study did reveal a greater wealth of knowledge from parents and students, there was no other intervention to compare this web-based education system to. This would necessitate more concussion management programs to compare with Brain 101.

Implications for Current Practice

As an educator and Certified Athletic Trainer, I am in an ideal position to support students who sustain an mTBI from the time the injury occurs and throughout the recovery process. As an educator I must understand what the student athlete is enduring while they return-to-learn. It is imperative to watch for signs and symptoms of the student athlete to make

accommodations as needed. This might include cognitive rest breaks, quiet room for testing, reduced homework, providing notes, and avoiding noisy hallways.

In some cases, a student may need additional service, such as an IEP or 504 plan, like the student mentioned in Chapter 1. Zachary Lystedt experienced an mTBI, which eventually caused permanent brain damage. Zachary is an example of a student who will need IEP services, which will address his needs physically, intellectually, socially, and behaviorally. As an educator, I must provide academic support for this student that would be outlined in an IEP.

An important aspect that I learned pertains to adolescents 14-18 years old. These students experience the most symptoms of mTBI and for an extended period of time. Their symptoms persist longer than students 13 years old or younger. This part of their life is especially important since these students are preparing to transition to college or vocation. Thus, sound medical and academic advising is necessary to educate students about future outcomes from mTBI.

Summary

Conflicting findings of results stem from the studies performed by Ransom et al. (2015) and McKinlay et al. (2010) regarding mTBI at time of age. Ransom et al. (2015) reported more difficulty and adverse effects than younger students, while McKinlay (2010) found children who sustain an mTBI at a younger age are susceptible to increased inattention/hyperactivity. One study indicates that students 14-18 experience more symptoms, yet younger students are being diagnosed later with ADHD around the ages of 14–16 from mTBI sustained earlier in life. Overall, this leads me to believe that students are at great risk for long-term outcomes of mTBI.

In summary, the research emphasizes the importance of addressing the multiple needs of students with mTBI.

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