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Concussion and Mental Health: Case Series

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CONCUSSION AND MENTAL HEALTH: CASE SERIES

By

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Concussion and Mental Health: Case Series

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ABSTRACT

Concussion and Mental Health: Case Series

By

Haley M Clark

Concussion is the most common traumatic brain injury in the United States, and is thought to lead to adverse effects on mental health. No studies to date have examined mental health throughout concussion recovery. This project examined the effect of concussion on three aspects of mental health: anxiety (Hamilton Anxiety Rating Scale), depression (Beck's Depression Inventory), and aggression, (Buss-Perry Aggression Questionnaire) at three time points (baseline, mid-season, and postseason). When the athlete had a concussion, they completed the questionnaire once upon diagnosis, bi-weekly until return-to-play, and bi-weekly for two weeks after being cleared for participation. Each concussion showed an initial increase and then decrease in mental health symptoms throughout recovery. This research shows a need for the tracking of mental health symptoms for both concussed and non-concussed athletes throughout the competition season. Administration of these mental health questionnaires is a practice that could be integrated into multiple sports, and allow for athletic trainers and other sports medicine professionals to ensure the best possible mental and physical health care for athletes.

Key words: Concussion, anxiety, depression, aggression

DEDICATION

This work is dedicated to my parents, Bob and Kath Clark, my grandma, Elaine Krause, and my grandpa, George Krause. Thank you for all that you have done to help me in furthering my education, and your unwavering support throughout the last 24 years, and especially the last seven. I know that Poppa would be so excited and proud of what I have accomplished, and I very much wish that he could see it. I love you all to the moon and back.

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CHAPTER 1: JOURNAL ARTICLE

Introduction

Student-athlete mental health is a major concern, not only for student-athletes, but for their families and the health care professionals who treat them. The Centers for Disease Control (CDC)[1] reports that mental health issues are one of the most common health issues in the United States[1]. Athletes at the collegiate level are full-time students in addition to being full-time athletes. Thirty-three percent of athletes report symptoms of depression and struggling to perform tasks outside of their sport due to the physical toll of athletics[2]. Thirty percent of college athletes report feeling overwhelmed with their responsibilities within the past month[2]. Because of their participation in sport, student-athletes are more likely to be injured than college students who do not participate in athletics.

Concussions are caused by the rapid deceleration of the brain inside the skull resulting in shearing or torsional forces to the brain tissues[3]. This in turn causes metabolic and mechanical changes within the brain tissues and manifests in the patient as the symptoms of concussions[4]. These changes occur over several hours, often causing symptoms of concussion to have a delayed onset[3]. Student-athletes are more prone to concussions than the average college student, especially those who participate in contact sports like hockey or football[5]. Studies have been performed to examine mental health after concussion in athletes following retirement, however no studies have been performed that examine mental health throughout concussion recovery. By tracking mental health symptoms and gaining quantitative measurements of mental health symptoms, it may be possible for sports medicine providers to offer appropriate referrals for athletes who struggle with their mental health throughout concussion recovery.

Symptoms of a concussion are similar to symptoms of mental health disorders. This has been determined through previous research compiled into the Sport Concussion Assessment Tool (SCAT5), a common tool utilized by athletic trainers and other sports medicine professionals to assess concussions[6]. Neurobehavioral symptoms of concussion, which are indicative of nerve and brain function, include drowsiness, fatigue, sadness, nervousness and irritability, sleeping more than usual, and trouble falling asleep[6]. Mental health symptoms are those which may be experienced with a mental health disorder, which can include depression, fatigue, aggression, and anxiety[1]. In the SCAT5[6] examination, patients are asked if they have been diagnosed with a mental disorder, as it can affect symptom scores on the exam[6]. Injuries, including concussions, are common in collegiate student-athletes, and the psychological responses to injuries can change the way that the body heals and the timeline of the return-to-play process[7].

In student-athletes, stress can increase the risk of injury and poor recovery[7]. Athletes can have various emotional responses to injury, including feelings of isolation, irritation, lack of motivation, anger, frustration, sleep disturbance, and disengagement[7]. These symptoms also occur with concussions and other traumatic brain injuries[5]. These emotional responses are not currently formally evaluated throughout the concussion recovery process. Problematic emotional responses, including sleep disturbance, aggression, worsening symptoms, sadness that may lead to depression, lack of motivation, disengagement, pain behaviors, excessive anger or rage, and substance abuse can also occur during the process of injury and return-to-play, and may worsen because of an athlete's stress of wanting to return to play faster than is advised or safe[6].

Multiple studies have been performed that examine the relationship between mental disorders following concussion in athletes, and results are still inconclusive. 38.8% of former NCAA DI athletes that participated between 1982 and 2012 reported having at least one

concussion, and former collegiate athletes who reported three or more concussions had depression scores 2.4 times higher than their counterparts who had fewer concussions[5]. Former high school football players who participated in the sport in the 1950s had no significant cognitive or depression outcome differences compared to their counterparts who did not play football[8]. The differences in these results may be because this study only focused on older males who played high school football, while the 2014 study[5] focused on male and female athletes across multiple sports and multiple years of competition. Additionally, the difference in results may be because the 2014 study[5] was a survey-based study, while the 2017 study[8] was performed alongside physicians during a medical exam. In pediatric concussions, the utilization of mental health services increased significantly following a concussion diagnosis in patients regardless of a previous mental health diagnosis[9].

The purpose of this study was to follow student athletes' mental health throughout the season and post-concussion. This project examines the effect of concussion on three aspects of mental health: anxiety (Hamilton Anxiety Rating Scale), depression (Beck's Depression Inventory), and aggression, (Buss-Perry Aggression Questionnaire) at three time points (baseline, mid-season, and postseason) and immediately upon diagnosis of a concussion, bi-weekly until return-to-play, the day of return-to-play, and bi-weekly for two weeks following being cleared for participation.

Methods

We examined three areas of mental health that may increase during a concussion-anxiety, depression, and aggression. Participants two NCAA Division I men's hockey athletes

who were diagnosed with concussions during the competition season. IRB approval was granted by the university, and written consent was given by the participants prior to their participation. There were three hypotheses:

1. Compared to baseline examination, athletes' levels of anxiety will increase following a concussion, and remain increased throughout the concussion recovery process.
2. Compared to baseline examination, athletes' levels of depression will increase following a concussion, and will remain increased throughout the concussion recovery process.
3. Compared to baseline examination, athletes' levels of aggression will increase following a concussion, and decrease throughout the concussion recovery process.

These hypotheses are supported by research which show an increase in anxiety, depression, and aggression following injury, including concussion, in athletes[5, 6, 7, 9].

Instruments used in this study were the Hamilton Anxiety Rating Scale (HAM-A)[10], Beck Depression Inventory (BDI)[11], and the Buss-Perry Aggression Questionnaire (BPAQ)[12]. The HAM-A is a 14-item questionnaire which rates symptoms including cardiovascular, gastrointestinal, and respiratory on a scale from 0-4, with a possible total score of 56[10]. Higher scores indicate more severe anxiety. The BDI is a 21 question, multiple choice questionnaire, where participants rate the intensity of depressive symptoms from zero to three[13]. The score of each question is summed to get a total score between 0 and 63[13]. This questionnaire is used in research where the focus is measuring depression[13]. The BPAQ is one of the most popular measures of aggression[12]. This is a 29-item self-report questionnaire which measures physical aggression, verbal aggression, anger, and hostility on a five-point scale, with a score of 1

meaning “extremely unusual for me” and a score of 5 meaning “extremely typical for me” [12]. The BPAQ has a minimum score of 29, and a maximum score of 145[12].

We combined the three questionnaires into one questionnaire, which participants completed following pre-participation physical exams in August, mid-season in December, and post-season March. These surveys were collected by the researcher following pre-participation exams in August, mid-season in December, and upon the completion of competition in March.

The questionnaire series was administered upon diagnosis of a concussion from the sports medicine staff. Concussed participants completed questionnaires bi-weekly until returning to full participation, and biweekly for two weeks after being cleared for full participation.

Results

Two athletes were diagnosed with sport-related concussions throughout the competition season. One athlete had two sport-related concussions 105 days apart (labeled 2a and 2b) .

Case 1

A 24-year-old male goaltender presented with a sport-related concussion after a collision with a teammate during practice. At the time of presentation, the athlete complained of a headache and dizziness. To diagnose this concussion, a SCAT-5 was performed, along with vestibular ocular motor screening (VOMS) examination, which found difficulty and an increase in symptoms with eye tracking. The concussion diagnosis was confirmed by the team physician, and the athlete was referred to a concussion specialist for further evaluation, which found the

athlete had saccadic intrusions with horizontal saccades. This was the athlete's first diagnosed concussion.

Baseline questionnaire findings for this athlete were a HAM-A score of 6/56, BDI score of 1/63, BPAQ-physical aggression score of 14/45, BPAQ-verbal aggression score of 7/25, BPAQ-anger score of 13/35, BPAQ-hostility score of 13/40, and a total BPAQ score of 47/145. Questionnaires were administered to the athlete on the day of concussion, days 4, 6, 8, and 14 of concussion recovery, the day of return to play, day 16, and days 21, 27, 29, and 34 for post-concussion follow-up questionnaires. The athlete reported no symptoms on day 6 of concussion recovery, when he completed the Buffalo Concussion Treadmill Test to determine aerobic exercise prescription to assist in the concussion recovery process. He participated in non-contact practice on day 8 of concussion recovery, but began to have symptoms including headaches and sensitivity to light. He returned to full-contact practice at day 13, with no exacerbation of symptoms. He completed the Blackhawk Concussion Test and the ImPACT test on recovery day 14. He passed both tests, and was cleared to return to game play by the team physician on day 16 of recovery. (See FIGURE 1)

There was a decrease in HAM-A scoring immediately following concussion, which continued to decrease throughout the concussion recovery process. There were no clinically significant HAM-A scores for baseline questionnaires or during concussion recovery[15]. BDI scores did not change immediately following injury, and decreased to 2/63 points at the first follow-up questionnaire, and continued to decrease to 0/63 throughout concussion recovery. There were no clinically significant BDI scores, defined as a score of 11/63 or higher[12], either during baseline questionnaires or concussion recovery[11].

BPAQ-physical aggression scores remained about the same throughout concussion recovery and during baseline questionnaires. BPAQ-verbal aggression scores were not clinically significant during either baseline or concussion recovery questionnaires, and scores remained relatively consistent during the entire competition season[14]. BPAQ-hostility increased immediately following injury to a score of 15/40, but decreased throughout concussion recovery. Total scores of the BPAQ changed only slightly during the concussion recovery process, consistent with the BPAQ subcategory changes. There were no BPAQ scores that are clinically significant during baseline or concussion questionnaires for this athlete[14]. (See FIGURE 2, TABLE 1)

Case 2(a)

A 21-year-old male goaltender presented with a sport-related concussion following a collision during the second period of a game. The athlete was reported to be unconscious on the ice for approximately 15 seconds by his teammates, but the athlete did not remember losing consciousness. The athlete was immediately removed from competition and brought into the athletic training room and reported an intense headache, photophobia, hyperacusis, and nausea. The athlete spent the remainder of the game lying down with the lights off and a cold compress over his eyes. The athlete was evaluated for a concussion using a SCAT-5 and VOMS, and the diagnosis was confirmed by the team physician. The athlete had a previous history of concussion three years prior to this injury. During that time, he was removed from play, but admitted to returning to play while still symptomatic so that he could participate in the state high school tournament.

Baseline questionnaire findings for the athlete were an anxiety score of 4/56, depression score of 2/63, BPAQ scores included-physical aggression score of 17/45, verbal aggression score

of 16/25, anger score of 13/35, hostility score of 9/40, and total aggression score of 55/145. Questionnaires were administered to the athlete on the day of the concussion, days 2, 7, 11, 17, and 19 of concussion recovery. The athlete performed the Buffalo Concussion Treadmill Test on day three to determine aerobic exercise prescription to assist in the concussion recovery process. The athlete participated in non-contact practice on recovery day 4, and participated in full-contact practice on day 5. The athlete reported no symptoms, and completed the Blackhawk Concussion Test and ImPACT test on day 6 of concussion recovery, and was cleared by the team physician to play on day 7. (See FIGURE 3)

Immediately following concussion, there was an increase in HAM-A scores to 6/56, followed by a decrease in HAM-A scores to 0/56 throughout concussion recovery. There were no clinically significant HAM-A scores either during baseline questionnaires or during concussion recovery[15]. BDI scores increased immediately following injury to a score of 6/63, and decreased to a score of 0/63 throughout concussion recovery. There were no clinically significant baseline or concussion recovery BDI scores in case 2a[11]. There was no change in BPAQ-physical aggression scores immediately following injury, but scores decreased throughout concussion recovery. There was an immediate decrease in BPAQ-verbal aggression to 14/25 points immediately following concussion, and scores continued to decrease throughout concussion recovery. There was no difference in BPAQ-anger scores immediately following injury, however there was a decrease in BPAQ-anger scores throughout concussion recovery. Reported BPAQ-hostility scores increased by 1 point to 10/40 immediately following injury, and decreased throughout concussion recovery. BPAQ-anger scores did not change from baseline on the day of injury, but decreased to a score of 7/35 on day two of concussion recovery, where they remained at the mid-season questionnaire. There was a decrease in total BPAQ scores throughout

concussion recovery due to the decrease in the aggression subcategory scores. Aggression scores were not significant throughout the concussion recovery process[14]. (See FIGURE 4, TABLE 2)

Case 2b

This case followed a concussion sustained 105 days after concussion 2a. The athlete presented with a sport-related concussion following a collision during a game, and was removed from competition after reporting a headache and photophobia. The athlete was extremely aggressive following the injury. The athlete was evaluated for a concussion using the SCAT-5 immediately following injury, and with VOMS testing the following day. The diagnosis was confirmed by the team physician. This was the athlete's third diagnosed concussion.

Questionnaires for this concussion were administered the day of concussion, days 2, 5, and 8 of concussion recovery, which was his return-to-play, and days 13, 16, 20, and 23 of concussion recovery. The athlete performed the Buffalo Concussion Treadmill Test on day 3 of concussion recovery, returned to non-contact practice at day 4 of concussion recovery, participated in a full-contact practice at day 5 of concussion recovery, and passed the Blackhawk Concussion Test and ImPACT test on day 6 of concussion recovery. He was cleared to return to game play by the team physician on day 7 of concussion recovery.

This case showed an increase in HAM-A score to 12/56 points, which decreased to a score of 0/56 throughout concussion recovery. There were no clinically significant HAM-A scores for this concussion recovery period[15]. BDI scores increased to 15/63 points immediately following injury. This is a clinically significant score, indicating a mild mood disturbance[11]. BDI scores decreased throughout injury to a score of 0/63 throughout concussion recovery. BPAQ-physical aggression scores increased to 20/45 points immediately following concussion, where scores

decreased throughout the concussion recovery process. BPAQ-verbal aggression score increased to 8/25 points immediately following concussion, and scores remained at 8/25 at the post-season baseline questionnaire. The BPAQ-anger score increased to 12/35 points immediately following concussion, and scores decreased to 7/35 points throughout concussion recovery. BPAQ-Hostility scores increased to 10/40 points immediately following concussion, but scores did not change throughout the concussion recovery process. The total Buss-Perry Aggression Questionnaire score increased to 50/145 points immediately following concussion and decreased to 41/145 points at the post-season questionnaire. There were no clinically significant BPAQ scores during this concussion recovery period[14].

Discussion

Because of an increased risk for mental health issues in student-athletes[1], precautions should be taken to ensure that athletes' mental wellbeing is considered as much as their physical wellbeing. The psychological responses that may accompany injuries can increase the risk of injury and re-injury[7], which may have been the case in the athlete in cases 2a and 2b. Case 1 showed a longer return-to-play time than cases 2a and 2b. The athlete in case 1 was especially nervous about the impact that the diagnosis would have on his life both as an athlete and following sport, which may have been a contributing factor for the longer recovery process[4].

Though the length in concussion recovery was different between subjects, there were similarities between the cases. Mental health symptoms decreased among all three cases throughout concussion recovery. There was no difference in these results due to the subjects' number of previous concussions or the type of concussion symptoms.

HAM-A scores decreased throughout the concussion recovery process. In case 1, HAM-A scores decreased throughout the concussion recovery period from a score of 10/56 at the day of injury to a score of 0/56 at day 34 of concussion recovery. In case 2a, HAM-A scores decreased from a score of 6/56 at the day of injury to a score of 0/56 at day 19 of concussion recovery. In case 2b, HAM-A scores decreased from a score of 12/56 at the day of injury to a score of 0/56 at day 23 of concussion recovery. In regards to hypothesis 1, anxiety did increase immediately following injury, but decreased throughout concussion recovery.

BDI scores decreased throughout the concussion recovery process. In case 1, BDI scores decreased from a score of 4/63 at the day of injury to a score of 0/63 at day 34 of concussion recovery. In concussion 2a, BDI scores decreased from a score of 5/63 at the day of injury to a score of 0/63 at day 19 of concussion recovery. BDI scores decreased from a clinically significant[15] score of 15/63 at the day of injury to a score of 0/63 at day 23 of concussion recovery in case 2b. In regards to hypothesis 2, depression did increase immediately following injury, but decreased throughout concussion recovery.

BPAQ-physical aggression scores decreased from a score of 14/45 at the day of injury to a score of 13/45 on day 34 of concussion recovery in case 1. In case 2a, BPAQ-physical aggression scores decreased from a score of 17/45 at the day of injury to a score of 14/45 at day 19 of concussion recovery. In case 2b, BPAQ-physical aggression scores decreased from a score of 20/45 at the day of injury to a score of 13/45 at day 23 of concussion recovery.

BPAQ-verbal aggression scores decreased from a score of 6/25 at the day of injury to a score of 5/25 at day 34 of concussion recovery in case 1. In case 2a, BPAQ-verbal aggression scores decreased from a score of 14/25 at the day of injury to a score of 7/45 at day 19 of

concussion recovery. In case 2b, BPAQ-verbal aggression scores decreased from a score of 8/25 at the day of injury to a score of 5/25 at day 23 of concussion recovery.

BPAQ-anger scores increased from a score of 9/35 at the day of injury to a score of 10/35 at day 34 of concussion recovery in case 1. This was the only aggression symptom that increased during concussion recovery between the three cases. Because this was such a small change, there may not be any true significance, as the other BPAQ subcategory total scores in this case decrease throughout concussion recovery. In case 2a, BPAQ-anger scores decreased from a score of 13/35 at the day of injury to a score of 7/35 at day 19 of concussion recovery. In case 2b, BPAQ-anger scores decreased from a score of 12/35 at the day of injury to a score of 7/35 at day 23 of concussion recovery.

BPAQ-hostility scores showed a similar decrease in scores throughout concussion recovery in all cases. In case 1, BPAQ-hostility scores decreased from 15/40 at the day of injury to a score of 12/40 at day 34 of concussion recovery. BPAQ-hostility scores in case 2a decreased from 10/40 at the day of injury to a score of 9/40 at day 19 of concussion recovery. In case 2b, BPAQ-hostility scores did not change from the day of injury and day 23 of concussion recovery, and remained at 10/40 during the entire recovery period.

BPAQ total scores decreased in case 1 from a score of 44/145 at the day of injury to a score of 40/145 at day 34 of concussion recovery. In case 2a, the BPAQ total score decreased from 54/145 at the day of injury to a score of 37/145 at day 19 of concussion recovery. Case 2b showed a decrease in BPAQ total score, from a score of 50/145 at the day of injury, to a score of 35/145 at day 23 of concussion recovery. In regards to hypothesis 3, aggression scores did increase immediately following injury, but decreased throughout concussion recovery.

Because of this questionnaire, both concussed athletes sought treatment from a mental health professional. The tracking of mental health symptoms for athletes throughout the competition allowed athletes to self-reflect on their own mental health, and evaluate if their mental health symptoms were elevated based on the score of each questionnaire. Tracking athletes' mental health symptoms, including anxiety, depression, and aggression, throughout concussion has not previously been studied.

Concussion can be a lonely injury for athletes, and is not well understood by their peers if they have not been concussed, which takes a mental and physical toll on athletes. Because of this, athletic trainers and other sports medicine professionals need to pay extra attention to their athletes' mental health during concussion recovery.

Comparative outcomes

Previous research examined mental health symptoms in retired athletes who had not participated for a number of years[8]. Using the Center for Epidemiological Studies' Depression Scale, high school football athletes who graduated in 1957 did not have higher levels of anxiety, depression, or aggression compared to non-athletes throughout their lifetimes[8]. No history of concussion or the total exposure to contact or collision sports prior to high school were included in this study, however the authors of this study reported that these results may be relevant to current athletes who play contact sports with similar amounts of head trauma[8]. This is inconsistent with our findings, as athletes with concussion had increased mental health symptoms immediately following injury. The use of mental health services increases following a concussion diagnosis in pediatric patients[9], which is consistent with findings in our study of collegiate hockey athletes, as both concussed athletes sought mental health treatment following concussion.

Using the Patient Health Questionnaire, the Short Form of the Barratt Impulsiveness scale, and the Short Form of the Buss-Perry Aggression Questionnaire, moderate to severe depression and mean scores of aggression were reported to be higher in former athletes with a history of three or more concussions compared to athletes who had no reported concussions[5]. Our study builds from this research, suggesting that there is an increase in anxiety, depression, and aggression immediately following a concussion, which decreases throughout concussion recovery. These findings were also consistent with others who have evaluated athlete mental health following a concussion[5, 6, 7, 9], although none of these studies have evaluated mental health throughout concussion recovery.

These cases showed that mental health symptoms change throughout concussion recovery and there is an increased need for mental health treatment for athletes who are diagnosed with a concussion during their competition season. By tracking athletes' mental health symptoms throughout the competition season, athletic trainers and other sports medicine professionals may gain insight on how to best take care of the mental and physical wellbeing of their athletes. This questionnaire, which was administered three times during the academic year and takes approximately five minutes to complete, allowed athletes to share concerns about their mental health with their athletic trainers, which assisted athletes in getting the proper referrals to mental health providers. By tracking the mental health symptoms of athletes throughout the competition season, athletic trainers may be able to provide better care to athletes, both mentally and physically.

LEGENDS TO FIGURES

FIGURE 1: Timeline of Case 1

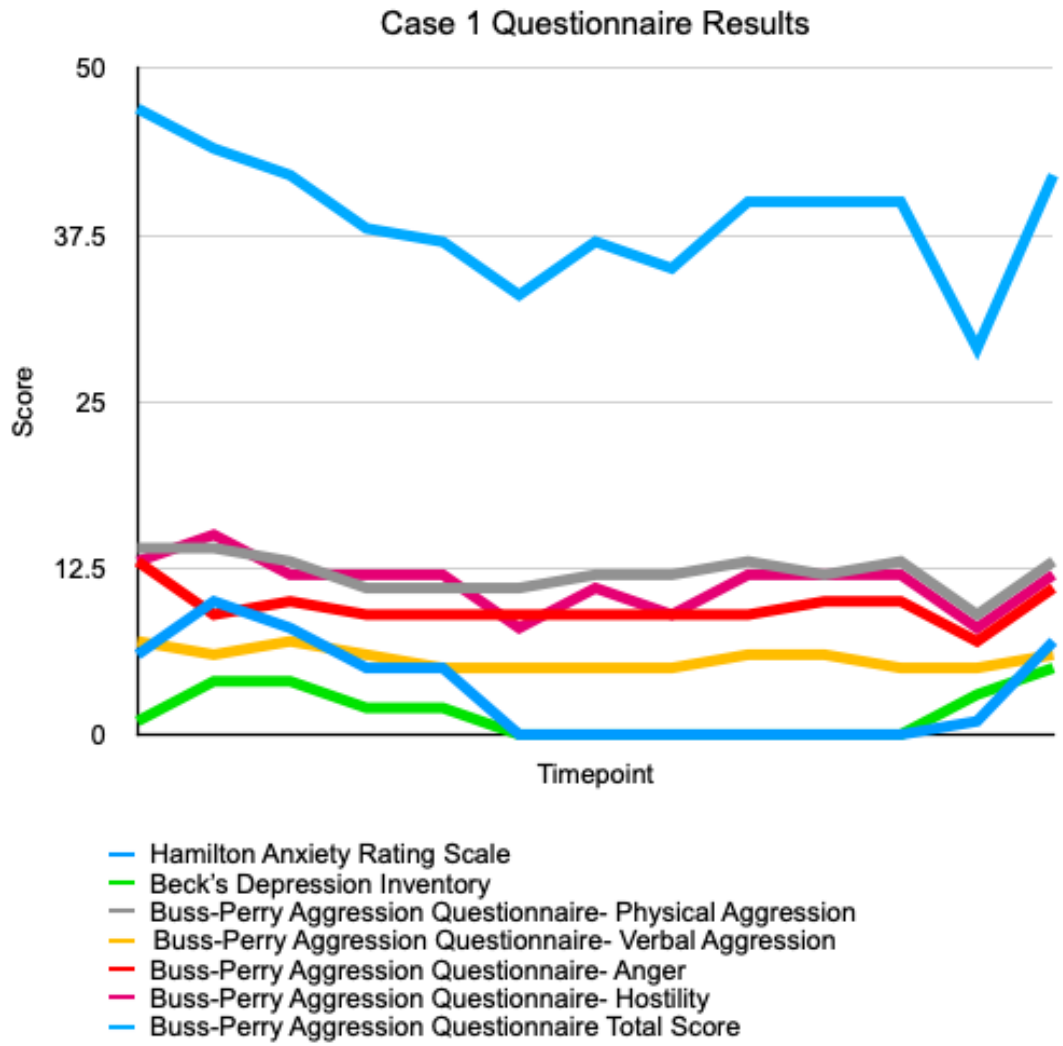

FIGURE 2: Case 1 Questionnaire Results

Case 1 Questionnaire Results

Instrumentation	Pre-Season Baseline	Day of Concussion	Questionnaire 1, Day 4	Questionnaire 2, Day 6	Questionnaire 3, Day 8	Questionnaire 4, Day 14	Return to Play, Day 16	Post-Concussion Questionnaire, Day 21	Post-Concussion Questionnaire, Day 27	Post-Concussion Questionnaire, Day 29	Post-Concussion Questionnaire, Day 34	Mid-Season Baseline	End-Of-Season Baseline
HAM-A	6	10	8	5	5	0	0	0	0	0	0	1	7
BDI	1	4	4	2	2	0	0	0	0	0	0	3	5
BPAQ-Physical Aggression	14	14	13	11	11	11	12	12	13	12	13	9	13
BPAQ-Verbal Aggression	7	6	7	6	5	5	5	5	6	6	5	5	6
BPAQ-Anger	13	9	10	9	9	9	9	9	9	10	10	7	11
BPAQ-Hostility	13	15	12	12	12	8	11	9	12	12	12	8	12
BPAQ Total Score	47	44	42	38	37	33	37	35	40	40	40	29	42

TABLE 1: Case 1 Questionnaire Results

FIGURE 3: Case 2a Timeline

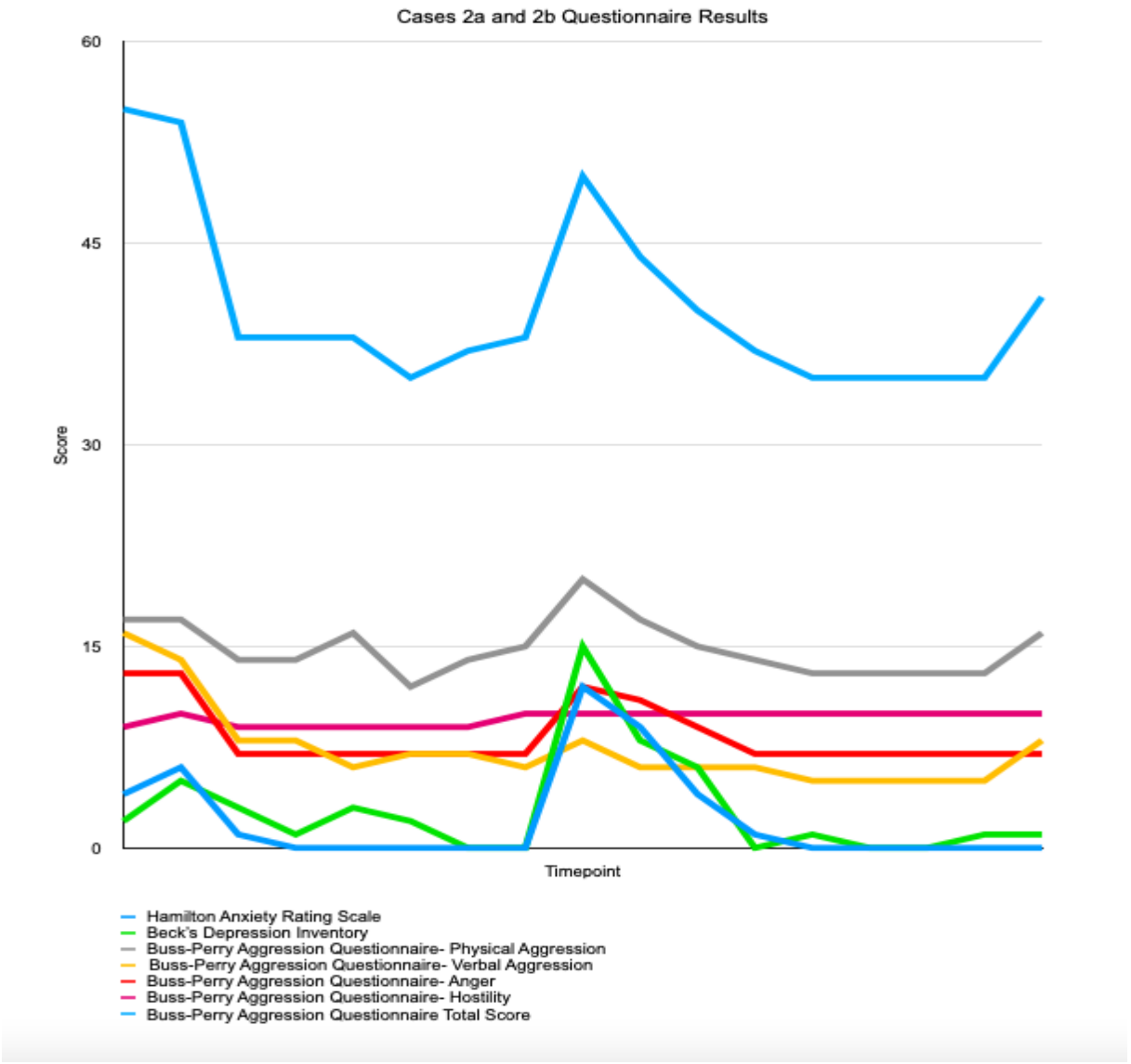

FIGURE 4: Cases 2a and 2b Questionnaire Results

Cases 2 and 3 Questionnaire Results

Instrumentation	Pre-Season Baseline	Day of Concussion	Questionnaire 1, Day 2	Return to Play, Day 7	Post-Concussion Questionnaire, Day 11	Post-Concussion Questionnaire, Day 17	Post-Concussion Questionnaire, Day 19	Mid-Season Baseline	Day of Concussion 2	Questionnaire 1, Day 2	Questionnaire 2, Day 5	Return to Play, Day 8	Post-Concussion Questionnaire, Day 13	Post-Concussion Questionnaire, Day 16	Post-Concussion Questionnaire, Day 20	Post-Concussion Questionnaire, Day 23	End-of-Season Baseline
HAM-A	4	6	1	0	0	0	0	0	12	9	4	1	0	0	0	0	0
BDI	2	5	3	1	3	2	0	0	15	8	6	0	1	0	0	1	1
BPAQ - Physical Aggression	17	17	14	14	16	12	14	15	20	17	15	14	13	13	13	13	16
BPAQ - Verbal Aggression	16	14	8	8	6	7	7	6	8	6	6	6	5	5	5	5	8
BPAQ - Anger	13	13	7	7	7	7	7	7	12	11	9	7	7	7	7	7	7
BPAQ - Hostility	9	10	9	9	9	9	9	10	10	10	10	10	10	10	10	10	10
BPAQ Total Score	55	54	38	38	38	35	37	38	50	44	40	37	35	35	35	35	41

TABLE 2: Cases 2a and 2b Questionnaire Results

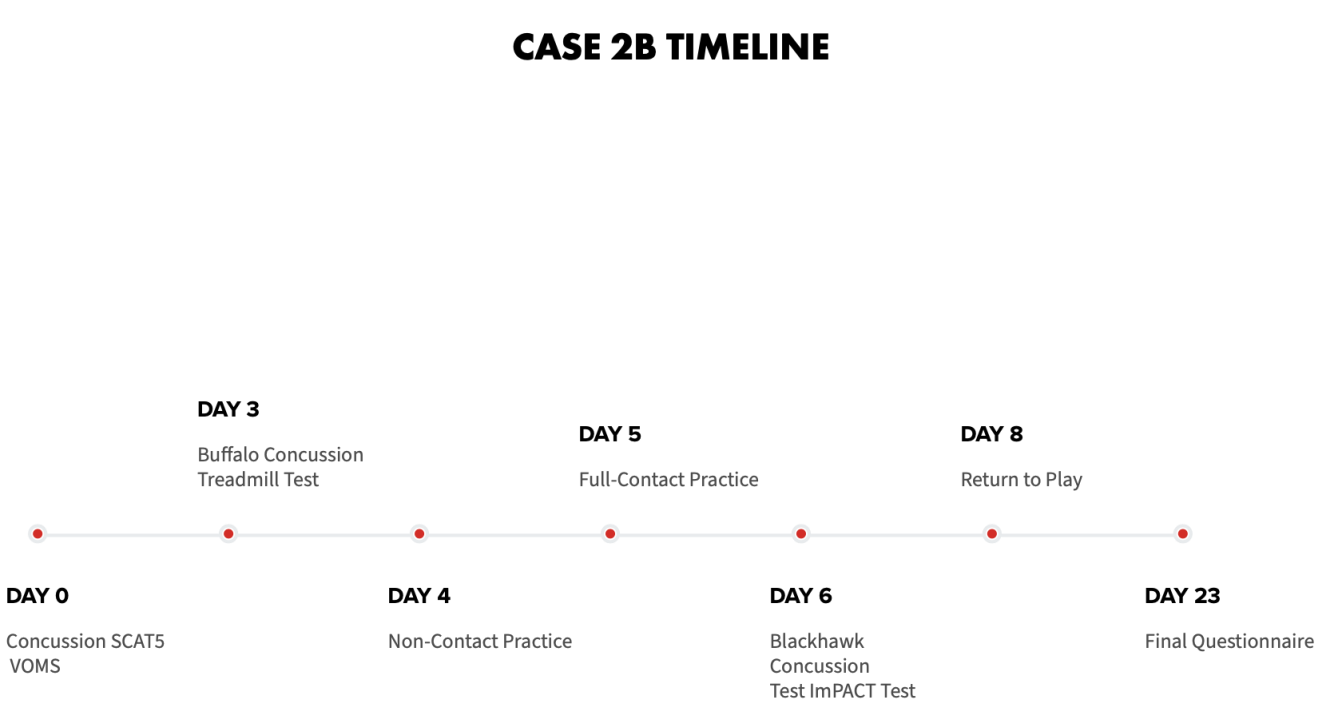

FIGURE 5: Case 2b Timeline

CHAPTER 2: REVIEW OF THE LITERATURE

Student-Athlete Mental Health

Up to 33% of all student-athletes experience symptoms of depression, which is approximately 148,500 student-athletes throughout the United States[16]. Among collegiate Athletic Trainers (AT), 85% report anxiety disorders among student-athletes[16]. According to the 2015 NCAA GOALS Report[17], 30% of student-athletes stated that they were severely overwhelmed by their responsibilities in the previous month, with an additional 33% of student-athletes reporting that they struggle to perform tasks outside of their sport due to the physical demands of their sport. Between the years of 2004 and 2008, suicide was the third leading cause of death of student-athletes[18]. Approximately 10% of college students in the United States have suicidal ideations at some point in their college careers, and approximately 1% of these students attempt suicide[18]. Approximately 10-15% of student-athletes have rates of psychological issues that are severe enough to need counseling, which is 2% more than their non-student-athlete counterparts[19]. This means that of the 40,600 student-athletes who participate in NCAA athletics, up to 6,090 student-athletes have mental health issues severe enough to need counseling services throughout their college career[19].

Student athletes report a lack of life balance due to the time commitment of being both a full-time athlete and a full-time student[16]. Athletes perceive a greater amount of stress due to the lack of control over their lives and schedule compared to their non-student-athlete counterparts[20]. Time constraints and a busy schedule are one of the main barriers to student-athletes seeking

mental health services[16]. These barriers also include attitudes of numerous athletic stakeholders, like coaches, administrators, and teammates, gender bias, lack of mental health knowledge, student-athlete perceptions of media outlets, lack of mental health resources, and the lack of proper institutional protocols[16,21,22].

The ability to identify student-athlete mental health disorders is key to supporting student-athletes who may struggle with their mental health. Often, athletic trainers are the healthcare professionals most in contact with student athletes, making them well-positioned to assist in the early identification and referral of student-athletes with mental health disorders[23]. Only 39% of team physicians and athletic trainers in the collegiate setting report that their institution has a written plan related to identifying student-athletes with mental health concerns. Of this 39%, only 32.3% screen for depression, and only 30.7% screen for anxiety[23]. This indicates that fewer than half of all collegiate sports medicine departments in the United States have plans for the identification and treatment of student-athletes with mental health disorders, or screening of student-athletes for mental health disorders. The strongest indicators of mental health screening are the existence of a written plan that identifies student-athlete mental health concerns, in addition to the employment of a clinical psychologist[23].

The National Athletic Trainers' Association (NATA) began urging colleges and universities to treat the mental health of collegiate athletes as seriously as their physical well-being following the suicides of two high profile student-athletes in 2014, one of whom stated the decline in their mental health was due to multiple concussions[18]. Following these suicides, the NCAA instituted concussion protocols that worked to reduce dangerous hits during games, as well as provide better diagnosis and treatment for traumatic head injuries[18]. Following these changes, the NATA urged the NCAA to discuss student-athlete mental health in the same way

that the organization discussed concussions. In response, the Associate Director for the NCAA Sport Science Institute stated that "intervention cannot come out of the national office," because the NCAA is "not a medical organization," later saying that "concussions get more attention [than mental health issues] because of the media, the NFL, lawsuits, and Congress" [18].

The goal of recommended changes to NCAA institutions regarding the mental health of their student athletes is to create minimal changes that will have a large impact at the lowest possible cost to institutions[18]. Education and training on mental health identification and treatment is encouraged by the NATA, and this training should increase at all levels of intercollegiate athletics[18], including athletic trainers, team physicians, coaches, and administrators. Additionally, mental health professionals should be made more accessible and available to student-athletes[18]. Finally, preseason screenings should be conducted prior to the start of the academic year, and incorporate mental health screenings into the existing physical screenings of the pre-participation examination[18]. The NATA recommends that pre-participation examinations be standardized and validated for use throughout all levels of athletics, and by all institutions[23]. The differences in pre-participation examinations between institutions can result in inadequate protection of the health and safety of all student-athletes. A major cause of the lack of or differences in screening during pre-participation examinations between institutions is differences in budget[23]. NCAA Division I institutions tend to have larger budgets than Division II or Division III institutions, as sports medicine departments are often funded by the institution's athletic department[23]. Division I institutions and institutions with a greater ratio of AT's to student-athletes tend to engage in more mental health screening compared to institutions that do not have access to these resources[23]. Additionally, administrators may believe that there is no point in screening for mental health disorders if the institution does not have the budget or

personnel to manage the results of these screenings[23]. These barriers limit the amount of high-quality mental health care that is available to student-athletes, and is detrimental to their overall health and wellness.

Concussion

Concussions are the most common type of traumatic brain injury in the United States[5]. Sport-related concussion is defined as a subset of mild traumatic brain injury caused by a force applied directly to the head, or to another area of the body with impulsive forces that transmit to the brain, causing transient functional impairments[5]. This force, which is a rapid acceleration or deceleration of the brain within the skull causes shearing or torsional force to the neural tissues, and metabolic and mechanical changes to the brain, known as diffuse axonal injury[5]. The long axons which are involved in high-level associated functions, such as memory and concentration, and injury to these neurons causes difficulties in these high-level associated functions. Along with shearing and torsional forces, axonal stretching is also observed, meaning that the axons stretch, like a frozen rubber band. Overall, these physiological changes are known as the metabolic cascade.

The Metabolic Cascade

The metabolic cascade begins with an initial depolarization of neuronal membranes, followed by the release of glutamine and other excitatory amino acids which produce fluxes of potassium and calcium ions across both neural and vascular tissue[22]. These ion fluxes cause a hyper metabolic glycolytic state as the neurons are attempting to restore equilibrium to the body. Calcium ions cause vasoconstriction, a constriction of the blood vessels in the brain, which

restricts blood flow to the brain, cerebral blood flow. This reduces how much blood can get to the neuronal tissue, and negatively impacts glucose delivery[22]. The loss of glucose delivery is detrimental to the tissue, as glucose is the preferred fuel source of the brain[5]. Because there is a shortage of both blood supply and nutrients, the brain is unable to function properly, causing metabolic depression[22]. Metabolic depression can last for weeks to months, meaning that concussed individuals can experience decreased blood flow to the brain for extended periods of time during concussion recovery. This state of metabolic depression makes the neural tissue more susceptible to injury because of the reduced amount of nutrients and blood flow to the brain, explaining why individuals with a history of concussion are more susceptible to sustaining another concussion, in addition to being more likely to develop post-concussion syndrome[22]. Disruptions in the blood-brain barrier that occur during the metabolic cascade can last for months to years following a concussion[22].

The metabolic cascade causes most concussion symptoms, and this physiological process can occur over several hours, or several days. It is common to observe new or worsening concussion symptoms for approximately 48 hours following a concussion[2]. In addition, the number of symptoms, or the severity of symptoms, can increase during this initial 48-hour period. Concussion can have a major adverse effect on cognitive functioning and balance during the first 24 hours following injury, and concussed individuals usually report symptoms within a week of their injury[22].

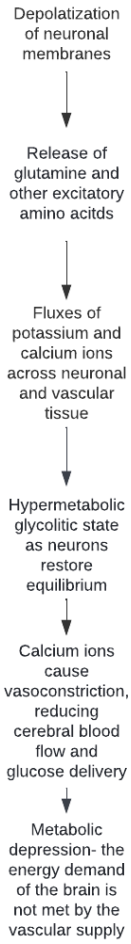

Figure 6: Neurometabolic Cascade

The Role of the Autonomic Nervous System in Concussion

The autonomic nervous system, or the ANS, is the portion of the nervous system that is directed mostly from the brainstem[23]. The ANS maintains cardiac and pulmonary function, in addition to a vast amount of other physiological processes. It is generally unknown whether autonomic nervous system dysfunction following a concussion is reflective of injury to specific areas of the brain involved in autonomic control, or if this dysfunction is a result of diffuse brain injury.

Mediators to autonomic nervous system dysfunction during concussion are currently unknown, however there is some evidence that there is altered central chemosensitivity following concussion[23]. The cells which sense arterial carbon dioxide tension, or the partial pressure of carbon dioxide, ($PaCO_2$) are in the brainstem near the autonomic control centers for cardiopulmonary function[23]. It is shown that collegiate female athletes with post-concussion syndrome had an abnormally low sensitivity to $PaCO_2$, meaning that these athletes did not breath as much as they needed to for a given level of arterial CO_2, causing a relative hypoventilation during exercise which raised their $PaCO_2$ levels out of proportion to exercise intensity.

Elevated $PaCO_2$ levels raise cerebral blood flow disproportionately to exercise intensity, causing symptoms like headaches, dizziness, and low exercise tolerance[23]. Aerobic exercise is known to be a non-pharmacological approach for enhancing sympatho-vagal ANS balance, meaning that aerobic exercise as a treatment for concussion could possibly improve autonomic function in concussed patients[23]. Studies have shown that aerobic exercise as a treatment for concussion can restore abnormal local cerebral blood flow regulation, and one study shows that regulation of cerebral blood flow to normal when observing functional MRI activation patterns[23].

ANS dysfunction and altered control of cerebral blood flow has a role in concussion pathophysiology, both early after injury and in those with prolonged symptoms, such as with post-concussion syndrome[23]. Heart rate variability is the measure of the normal variation in heart rate that shows the balance between the sympathetic and parasympathetic divisions of the autonomic nervous system[23]. High frequency heart rate variability is a marker for parasympathetic activity, while low frequency heart rate variability is a marker of both parasympathetic and sympathetic activity[23]. Low frequency heart rate variability is an indicator

of sympathetic nervous system predominance, which is associated with clinical severity in conditions such as cardiovascular disease and depression[23].

Heart Rate Variability and Nervous System Activity	
High Frequency	Marker for parasympathetic activity
Low Frequency	Marker for sympathetic and parasympathetic activity Indicator of sympathetic nervous system predominance Clinical severity and mortality in conditions like cardiovascular disease and depression

Table 3: Heart Rate Variability and Nervous System Activity

Facial cooling stimulates the trigeminal nerve to create increases in cardiac parasympathetic activity after approximately 1 to 2 minutes of cooling but should be followed by a sustained increase in sympathetic activity[25]. Concussed athletes have significantly decreased cardiac parasympathetic activity, or high frequency heart rate variability, and sympathetic activation, which increases the athletes' heart rate and blood pressure when compared to age and sex matched controls[25]. Concussed athletes are unable to switch to the proper branch of the autonomic nervous system when they are subjected to a stressful physiological situation or condition when concussed. Therefore concussed athletes are consistently in "fight or flight mode"[25].

Concussed athletes, in general, have significantly higher resting systolic blood pressure than age and sex matched controls, greater systolic blood pressure responses to standing, and prolonged systolic blood pressure normalization times after performing the Valsalva maneuver within 48 hours of sustaining a sport-related concussion[26]. These differences resolve within 24 hours of concussion. Psychological and physiological measures are significantly worse than controls in the acute symptomatic phase of concussion, or the period immediately following injury when the metabolic cascade has not fully occurred[23].

Female athletes tend to have a more sensitive cardiac response to concussion and have reduced frequency heart rate variability compared to males[23]. Male athletes have a greater suppression of the low frequency heart rate variability, associated with mood disturbances[23]. Male athletes are more likely to have mood disturbances following a concussion, but these disturbances normalize by the athlete's return to sport.

Concussion Symptoms

Concussion symptoms and severity vary between individuals. The Sport Concussion Assessment Tool 5, or the SCAT5, is a tool used by clinicians to diagnose a concussion[27]. The SCAT5 reports 4 categories of concussion symptoms- cognitive, physical, emotional, and sleep symptoms[22]. Additional concussion symptoms can include amnesia, nystagmus, and other visual problems[22].

Most concussion symptoms resolve within a 2-week period[27]. However, if concussion symptoms do not resolve within 2 weeks for adults and within 4 weeks for adolescents, the concussion becomes post-concussion syndrome[27]. Post-concussion syndrome can last for months to years following a concussion.

Concussion Symptoms			
Cognitive	Physical	Emotional	Sleep
Feeling "slowed down" Feeling like "in a fog" "Don't feel right" Difficulty concentrating Difficulty remembering Fatigue or low energy Confusion	Headache "Pressure in head" Neck pain Nausea or vomiting Blurred vision Balance problems Sensitivity to light Sensitivity to noise	More emotional Irritability Sadness Nervous or anxious	Drowsiness Trouble falling asleep

Table 4: Concussion Symptoms

The Effect of Concussion on Mental Health

Concussion is thought to affect mental health and mood changes following injury and into the concussion recovery period and behavioral changes sometimes occur as a result of repeated concussion[28]. Concussion has been found to have a negative effect on levels of anxiety, depression, and stress in collegiate athletes[29]. Anxiety can be predicted by concussion and

attentional bias to threat; however, concussion was not found to be associated with attentional bias to threat[29]. Concussions had altered the mood and emotions of athletes, but there was little evidence to determine if differences in emotional response are present in regards to a non-concussion injury[30].

Following concussion, athletes report higher intensity of depressive symptoms than their pre-concussion levels as determined by the BDI, suggesting that mild alterations to mood may exist following concussion[31]. Some research has shown that higher cardiorespiratory fitness is associated with lower levels of anxiety[32]. Athletes who were diagnosed with ADHD were more likely to experience increased levels of depression and anxiety following a concussion[33].Collegiate student-athletes tend to show higher levels of disinhibition, aggressiveness, and irritability than their non-athlete counterparts[36]. When examining the differences in aggressive tendencies between contact and non-contact athletes, Ziaee et al[37] found that contact athletes tend to be more aggressive; however these findings are inconsistent with other studies evaluating the same concept[38]. Athletes who are more aggressive in their lives tend to be more aggressive during their participation in sport[38]. College athletes with a history of concussion have significantly higher levels of physical aggression, as rated by the Buss-Perry Aggression Questionnaire[36].

Ice hockey is played by over 820,000 individuals in North America[39]. Hockey is a high impact sport, and 43% of injuries in ice hockey occur to the head and neck[39]. Aggressive youth ice hockey athletes are more likely to sustain severe head impacts in practices than their less aggressive counterparts; there is a significant difference in the frequency of severe head impacts in games between more and less aggressive athletes[40]. Ice hockey athletes tend to believe that aggression in game play is acceptable if an opposing player was aggressive toward them or their

teammates first; this aggression is seen as acceptable and is often reinforced by coaches and teammates[40].

Instruments Used to Evaluate Mental Health Symptoms

The Hamilton Anxiety Rating Scale (HAM-A) has been utilized in both anxiety diagnosis and research since its creation in 1959[15]. The HAM-A is a 14-item questionnaire, where each item is scored from zero to four. Higher scores are indicative of more severe anxiety[41]. It is considered to be the gold standard in diagnosing anxiety in adults. The HAM-A examines cardiovascular, gastrointestinal, and respiratory symptoms of anxiety[41].

The HAM-A has been used in research involving concussions and athletics. Higher scores on the HAM-A were associated with reduced cerebral blood flow following concussion, indicating that a reduced cerebral blood flow is a potential cause of anxiety following concussion[42]. To the author's knowledge, there is a paucity of research on anxiety and concussion utilizing the HAM-A. Other anxiety rating scales, including the Sport Anxiety Scale (SAS) can be utilized to measure anxiety in athletics[43]. Though the SAS has been useful in sports previously, the HAM-A was chosen for this project because of the multiple categories of anxiety symptoms which are examined with this questionnaire.

Beck's Depression Inventory (BDI) was created by Beck, Ward, Mendelson, Mock, and Erbaugh in 1961[10]. This is a 21-item, multiple choice questionnaire where individuals rate the intensity of their depressive symptoms[12]. BDI is commonly used in research where the focus is to identify or detect depression in adults[12]. Each symptom of the BDI is rated by an individual from 0 to 3, with 3 being the highest rating[44]. The total score is calculated by adding the score of all 21 items, with a score ranging from zero to 63[44]. The BDI has been utilized in the general

population to assess depressive symptoms[12]. However, the use of the BDI has been expanding to be utilized in other populations, specifically athletics. The Hamilton Depression Rating Scale (HDRS)[45], is another popular assessment tool for depression, but is a clinician-administered examination, and therefore was not utilized in this research.

The BDI has been utilized to examine depressive symptoms in injured athletes in prior research. Concussed athletes with a prolonged recovery period had significantly higher levels of depressive symptoms than their non-concussed counterparts[46]. Male athletes who suffered an injury had higher levels of depression than their non-injured counterparts[44]. Because of previous research performed with injured athletes, the BDI was determined to be the best instrument to utilize in our research.

The Buss-Perry Aggression Questionnaire (BPAQ)[14] is one of the most popular means of identifying aggression in individuals[11]. This is a 29-item self-report questionnaire that measures components of aggression, including physical aggression, verbal aggression, anger, and hostility on a five-point scale, with a score of 1 meaning "extremely unusual for me" and a score of 5 meaning "extremely typical for me"[11]. The BPAQ has a minimum score of 29, and a maximum score of 145[11,40]. A high score in physical aggression is associated with an individual's inability to control physical aggression[40]. A high verbal aggression score is indicative of an individual being more argumentative than the average individual[40]. A high anger score is associated with irritability, emotional liability, and frustration[40]. A high hostility score indicates an attitude of paranoia, bitterness, and social isolation[40]. The BPAQ has been evaluated for its generalization, and found to be applicable to adults in the general population[35].

The BPAQ has been utilized in research involving athletics in multiple studies. Contact athletes have lower aggression scores than non-contact athletes as well was non-athletes[47].

Retired college athletes who had reported having three or more concussions had higher aggression scores than those who had fewer or no concussions, meaning that more concussions may make an individual more aggressive over time[2]. Individuals who had a history of concussion, regardless of their status as an athlete, had higher aggression scores than their counterparts who had no history of concussion, again adding to the idea that concussion may cause an individual to become more aggressive[35].

Gaps in the Literature

Though there has been much research on concussions and mental health following a concussion or retirement from athletics, there have not been any studies that track mental health symptoms before a concussion occurs, and throughout the course of the healing process. By tracking mental health symptoms throughout a concussion and return to play process, as well as during the season, the athletic trainers may better understand the concussion symptoms the athlete is experiencing, and better recognize the needs of athletes for support through mental health services, and to better predict emotional response to concussions in the future. In addition, no research regarding mental health and concussion has been performed with male NCAA DI hockey athletes. By tracking the mental health of this population, student-athletes, their families, and the healthcare professionals who treat them can better help these athletes throughout their healing process. Tracking mental health symptoms following a concussion or other brain injury may assist in the early diagnosis of chronic traumatic encephalopathy, which is currently impossible to diagnose pre-mortem[4].

Concussions are prevalent in NCAA DI male hockey athletes, but there is little information about how concussions affect these athletes' mental health. There were multiple hypotheses for this research study. First, mental health symptoms regarding depression, anxiety,

and aggression will increase immediately following concussion. Second, mental health symptoms regarding depression and anxiety will continue to increase throughout the return-to-play protocol. Third, symptoms regarding anxiety and aggression will increase close to the athletes' return-to-play, while symptoms of depression decrease. Finally, these symptoms will return to baseline following the athletes' return to play. These specific symptoms are important to examine, especially in student-athletes, who have higher incidences of anxiety and depression than the average college student[2].

There has been no research performed that examined the mental health, including anxiety, depression, and aggression, of any athletes throughout concussion recovery. There is little known regarding mental health and the needs of athletes throughout concussion recovery. Because college student-athletes are at risk of having increased mental health symptoms, and because these symptoms are thought to increase following retirement from athletics, it is important to evaluate these symptoms throughout concussion recovery. Anxiety, depression, and aggression are mental health symptoms most attributed with concussion and with problematic injury response in athletes. Therefore, these specific symptoms would be the most beneficial to evaluate throughout concussion recovery. Due to their use in research in both the general population and in athletics, the best suited questionnaires to use to examine anxiety, depression, and aggression throughout concussion recovery in elite hockey athletes would be the Hamilton Anxiety Rating Scale, Beck's Depression Inventory, and the Buss-Perry Aggression Questionnaire.

CHAPTER 3: CONCLUSIONS AND SUMMARY

This research shows that evaluating mental health symptoms, including anxiety, depression, and aggression, throughout concussion recovery may help athletic trainers and other sports medicine professionals care for concussed athletes by allowing them to offer appropriate referrals to mental health providers when necessary. Additionally, this research suggests that when self-evaluating their own mental health symptoms, athletes may be more inclined than usual to ask for referrals to mental health providers.

In the future, I plan to expand this research to involve athletes from more sports, including contact and non-contact sports, as well as expanding this research to include mens' and womens' sports. I believe it is beneficial to evaluate mental health symptoms of all athletes throughout the competition season, as an evaluation of this nature may prompt student-athletes to seek referrals for mental health concerns. In addition to the two concussed athletes, four athletes who were not concussed throughout the competition season sought referral to a mental health provider because of this project. I also hope to include all injuries in future research, not just concussion.

There were many limitations in this research. Originally, research was going to include two other NCAA Division I Men's Ice Hockey teams, but this was no longer possible because of the COVID-19 pandemic. Only two athletes were concussed throughout the competition season, which meant that there was very little concussion data to evaluate, making statistical analysis nearly impossible. The length of time for each concussion recovery was different, making it difficult to compare the concussions.

A concern about this research, in general, was that concussed athletes would lie about concussion and mental health symptoms in order to return to game play faster. I do not believe that was the case, because of the utilization of the Blackhawk test, which is extremely physical and difficult to pass if an individual is still experiencing concussion symptoms. However, in cases 2a and 2b, this athlete admitted to lying about symptoms in his first concussion so he was able to return to play faster. This was a concern for this athlete, but because he passed both the Blackhawk test and the ImPACT test, this was no longer a concern.

I learned a great deal from this research, including how to ensure the best mental and physical health care for athletes in the future. I hope to continue this work so that all athletes have access to the care that they both need and deserve.

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APPENDICES

APPENDIX A : HAM-A, BDI, BPAQ Combined survey

The Relationship Between Concussions and Mental Health in Elite Hockey Athletes
Research Questionnaire (HS21-1162)
Subject Number _____

Put a check mark in the box that BEST describes how you have felt in the last 6 months.

Symptoms	Not Present	Mild	Moderate	Severe	Very Severe
Worry, irritability, fearful anticipation					
Restlessness, stress, inability to relax					
Irrational phobia, excessive worry					
Fatigue, inability to sleep, nightmares, night terrors					
Poor concentration, memory impairment					
Decreased interest in activities, mood swings, waking up earlier than normal					
Aches and pains, stiffness, muscle twitching, teeth grinding					

Ringing in the ears, blurred vision, hot/cold flushes, weakness					
Tachycardia, palpitations, chest pain, fainting, throbbing					
Chest pressure/constriction, choking, sighing, difficulty breathing,					
Difficulty swallowing, abdominal pain, nausea, weight loss					
Frequent or urgent urination, impotence					
Dry mouth, flushing, more pale than normal, sweating, dizziness, headache					
Fidgeting, restlessness, tremors, sighing, paleness, straining					

Circle the answer that is most correct.

1. I do not feel sad

I feel sad
I am sad all the time and I can't snap out of it
I am so sad and unhappy that I can't stand it

2. I am not particularly discouraged about the future
I feel discouraged about the future
I feel I have nothing to look forward to
I feel the future is helpless and that things cannot improve

3. I do not feel like a failure
I feel I have failed more than the average person
As I look back on my life, all I can see is a lot of failures
I feel I am a complete failure as a person

4. I get as much satisfaction out of things as I used to
I don't enjoy things the way I used to
I don't get real satisfaction out of anything anymore
I am dissatisfied or bored with everything

5. I don't feel particularly guilty
I feel guilty a good part of the time
I feel quite guilty most of the time
I feel guilty all of the time

6. I don't feel I am being punished
I feel I may be punished
I expect to be punished
I feel I am being punished

7. I don't feel disappointed in myself
I am disappointed in myself
I am disgusted with myself
I hate myself

8. I don't feel I am worse than anybody else
I am critical of myself for my weaknesses or mistakes
I blame myself all the time for my faults
I blame myself for everything bad that happens

9. I don't have any thoughts of killing myself
I have thoughts of killing myself, but I would not carry them out
I would like to kill myself
I would kill myself if I had the chance

10. I don't cry any more than usual
I cry more than I used to
I cry all the time now
I used to be able to cry, but now I can't cry even though I want to

11. I am no more irritated by things than I ever was
I am slightly more irritated now than usual
I am quite annoyed or irritated a good deal of the time
I feel irritated all the time

12. I have not lost interest in other people
I am less interested in other people than I used to be
I have lost most of my interest in other people

I have lost all of my interest in other people

13. I make decisions about as well as I ever could
    I put off making decisions more than I used to
    I have greater difficulty in making decisions more than I used to
    I can't make decisions at all anymore

14. I don't feel that I look any worse than I used to
    I am worried that I am looking old or unattractive
    I feel there are permanent changes in my appearance that make me look unattractive
    I believe that I look ugly

15. I can work about as well as before
    It takes an extra effort to get started at doing something
    I have to push myself very hard to do anything
    I can't do any work at all

16. I can sleep as well as usual
    I don't sleep as well as I used to
    I wake up 1-2 hours earlier than usual and find it hard to get back to sleep
    I wake up several hours earlier than I sued to and cannot get back to sleep

17. I don't get more tired than usual
    I get tired more easily than I used to
    I get tired from doing almost anything
    I am too tired to do anything

18. My appetite is no worse than usual
    My appetite is not as good as it used to be
    My appetite is much worse now
    I have no appetite at all anymore

19. I haven't lost weight, if any, lately
    I have lost more than 5 pounds
    I have lost more than 10 pounds
    I have lost more than 15 pounds

20. I am no more worried about my health than usual
    I am worried about physical problems like aches, pains, upset stomach, or constipation
    I am very worried about physical problems and it's hard to think of much else
    I am so worried about my physical problems that I cannot think of anything else

21. I have not noticed any recent change in my interest in sex
    I am less interested in sex than I used to be
    I have almost no interest in sex
    I have lost interest in sex completely

Rate each of the following items in terms of how characteristic they are of you. Use the following scale:

1	2	3	4	5
Extremely uncharacteristic of me				Extremely characteristic of me

_____ Once in a while, I can't control the urge to strike another person
_____ Given enough provocation, I may hit another person
_____ If someone hits me, I hit back

_____ I get into fights a little more than the average person
_____ If I have to resort to violence to protect my rights, I will
_____ There are people who pushed me so far that we came to blows
_____ I can think of no good reason for ever hitting a person
_____ I have threatened people I know
_____ I have become so mad that I have broken things

_____ I tell my friends openly when I disagree with them
_____ I often find myself disagreeing with people
_____ When people annoy me, I may tell them what I think of them
_____ I can't help getting into arguments when people disagree with me
_____ My friends say that I'm somewhat argumentative

_____ I flare up quickly, but get over it quickly
_____ when frustrated, I let my irritation show
_____ I sometimes feel like a powder keg ready to explode
_____ I am an even tempered person
_____ Some of my friends think I'm a hothead
_____ Sometimes I fly off the handle for no good reason
_____ I have trouble controlling my temper

_____ I am sometimes eaten up with jealousy
_____ At times I feel I have gotten a raw deal out of life
_____ Other people always seem to get the breaks
_____ I wonder why sometimes I feel so bitter about things
_____ I know that "friends" talk about me behind my back
_____ I am suspicious of overly friendly strangers
_____ I sometimes feel that people are laughing at me behind my back
_____ When people are especially nice, I wonder what they want

APPENDIX B: IRB Approval

Graduate Studies and Research
Marquette, MI 49855-5301
906-227-2300
www.nmu.edu/graduatestudies/

Memorandum

TO: Marguerite Moore
Haley Clark
School of Health and Human Performance

FROM: Lisa Schade Eckert
Dean, Graduate Studies and Research

DATE: February 8, 2021

SUBJECT: IRB Proposal HS21-1162
"The Relationship of Concussions and Mental Health in Division I Hockey Players"
IRB Approval Date: 2/8/2021
Proposed Project Dates: 6/1/2021 – 6/1/2022

Your proposal "The Relationship of Concussions and Mental Health in Division I Hockey Players" has been approved by the Northern Michigan University Institutional Review Board. Please include your proposal number (HS21-1162) on all research materials and on any correspondence regarding this project.

If you find that modifications of investigators, methods, or procedures are necessary, you must submit a Project Modification Form for Research Involving Human Subjects before collecting data. Any changes or revisions to your approved research plan must be approved by the IRB prior to implementation.

Until further guidance, per CDC guidelines, the PI is responsible for obtaining signatures on the COVID-19 Researcher Agreement and Release and COVID-19 Research Participant Agreement and Release forms.

All forms can be found at the NMU Grants and Research website: http://www.nmu.edu/grantsandresearch/node/102