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Concussion Severity and Generalized Anxiety in Professional Ice Hockey Players

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This is to certify that the doctoral dissertation by

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Abstract

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MS, Walden University, 2012

BS, Park University, 2006

Dissertation Submitted in Partial Fulfillment

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Abstract

An estimated 1.6 to 3.8 million concussions occur annually in the United States, and 42 million concussions occur annually worldwide, making concussions one of the most frequent injuries among all athletes at all levels. Research in detecting the relationship between generalized anxiety and concussions in ice hockey players from all professional ranks was lacking. The purpose of this quantitative study was to determine whether professional ice hockey players experienced a form of generalized anxiety when they returned to play following a severe concussion. The intolerance of uncertainty model detailed anxiety regarding fear and anticipation of the unknown or future uncertainty in everyday situations after a concussion. Survey data were collected from 48 professional ice hockey players from leagues worldwide. The 12-question survey included the Generalized Anxiety Disorder (GAD-7) survey to address the research questions. Statistical results produced by the two-way analysis of variance indicated a significant relationship between the number of concussions and GAD-7 results in Research Question 1. The results also confirmed the null hypothesis in Research Question 2, indicating no significant relationship between concussion severity and GAD-7 results. Hockey coaches may use these findings in how they work with players after concussions, how they recognize possible complications and warning signs, and when to intervene.

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Dedication

This endeavor is dedicated to my loving wife, CJ, and my two daughters, Samantha and Marlowe, without whom this study would have been impossible. Thank you for enduring the long days and nights of writing, reading, and stressing over various topics throughout this process.

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A special thank you to my dissertation chair, Dr. Jay Greiner, and dissertation committee member, Dr. Lee Stadtlander, who believed in me, guided me, and remained patient with me throughout this arduous journey. Thanks to Mr. Douglas Smith, Mr. Tony Hand, Mr. Andrew Miller, Ms. Dana Brown, Mr. Dody Wood, Mrs. Mary Stoughton, and Mr. Mike Yff for all your help in distributing my survey and answering my questions. A special thanks to Mr. Ed Courtenay, who gave me my first coaching job and opened my eyes to a different facet of ice hockey beyond playing. A final thanks to all participants who took the time to complete my survey and friends and family members who encouraged, validated, and helped me reflect on this study.

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Chapter 1: Introduction to the Study

Athletes who participate in collision sports such as ice hockey, American football, boxing, mixed martial arts, and rugby are more susceptible to head injuries due to the potential of high-speed collisions, punches to the face, impact with the ball or puck, and impact with stationary boundaries, boards, and plexiglass (Musumeci et al., 2019). Athletes who participate in collision sports such as ice hockey are also more prone to miss playing time because of concussion protocol than noncontact sports (Ochs et al., 2019). Concussions are the most written-about neurologic sports injury of the last decade, and the rate of concussions in the National Hockey League (NHL) has been rising (Wennberg et al., 2008). Ice hockey is a fast-paced, full-contact sport where players skate more than 30 miles per hour and shoot the puck upwards of 100 miles per hour on a surface of ice enclosed by rigid boards and plexiglass. Even though fighting has been minimized because of rule changes, it remains an element of ice hockey in professional ranks (Wennberg et al., 2008).

An estimated 1.6 to 3.8 million concussions occur annually in the United States, and 42 million concussions occur annually worldwide, making concussions one of the most frequent injuries among all athletes at all levels (Iverson et al., 2022; Kumar et al., 2014; Mucha & Trbovich, 2019; Ochs et al., 2019; Sandel et al., 2017). Concussions occur in 36.5% of games involving Canadian late-teen ice hockey players, of which 10%–20% of concussion patients experience complications such as anxiety, depression, and in some cases post-traumatic stress disorder (Todd et al., 2018). The NHL accounts for 50% of players who have missed time from injuries. Concussions account for 20% to

26% of all injuries, despite the hesitancy of many players willing to report symptoms, with rates of 1.55 to 6.1 and 6.6 concussions per 1,000 game hours (Andrews et al., 2022; Gouttebarge et al., 2017; Ochs et al., 2019; Smith et al., 2019; Wennberg et al., 2008). Of those reported concussions, 45%–60% result from player–player collisions, 26%–34% result from collisions of players with the boards or glass, and the remainder result because of collisions with the ice surface, goal posts, sticks, or pucks (Andrews et al., 2022; Gouttebarge et al., 2017; Ochs et al., 2019; Wennberg et al., 2008).

In the National Collegiate Athletic Association (NCAA), concussions account for 6.2% of all injuries from all sports (D'Alonzo et al., 2022). A study conducted in 2017 involving Major League Soccer players from 1996 through 2014 who sustained a concussion (n = 288) compared to those who had not (control group) showed a performance decline in the goals, assists, shots, and shots on goal (Hardy et al., 2017). Further examination of the Hardy et al. (2017) study would help explain the reasons for the decline and whether a heightened sense of anxiety had anything to do with the decrease in statistical categories. The anxiety and mood profile is one of the clinical profiles clinicians use to tailor treatment (Kontos et al., 2019). The concussed individual experiences anxiety, obsessiveness over symptoms, sadness, depression, and panic attacks (Kontos et al., 2019; Sandel et al., 2017; Stephenson et al., 2022). What is not known is whether there is a trend or evidence of this profile within professional ice hockey players after sustaining a concussion.

The present study was significant in that it added to existing literature dedicated to the safety of hockey players and all athletes at all levels of play by providing a better

understanding of generalized anxiety related to concussions (see Jonsdottir et al., 2021; Li et al., 2021). As the knowledge of how concussions affect emotions, actions, and anxiety levels increases, the scholarly community may help illuminate a dark subject by offering preventive therapy, early detection, and postconcussion therapy by using the present study results (see Todd et al., 2018). On a micro level, coaches may tailor their game-time strategy, knowing what their rostered players have endured physically and how that physical damage may have affected their psyche. On a macro level, team general managers may use the data from this study to influence their decisions when drafting a prospect, signing a free agent, or trading a player (see Clarke et al., 2021). The current study's results may affect every level of every sport regarding how coaches see their players and knowing what to look for when faced with a situation in which they put a player in a game or tell them to rest (see Clarke et al., 2021).

Chapter 1 introduces the study and its importance through a concise introduction and background. Chapter 1 also provides the problem statement, purpose of the study, research questions, and the hypotheses associated with each question. The chapter also introduces the theoretical construct on which this study was based, the nature of the study, definitions of key terms, scope and delimitations, limitations, and the significance of the study.

Background

This study was conducted to answer the research questions. Results may expand the literature on concussions concerning anxiety in the sport of ice hockey at the professional level. The study also helped demystify the stigmas associated with personal

psychological aid. The study findings may encourage athletes to seek assistance if they are suffering from psychological dysfunction.

Several researchers addressed limitations and gaps in their research and highlighted different facets of the present study. When examining the literature, I observed a research gap. Research on elements of concussions and anxiety after concussions among ice hockey players at the professional level was lacking. Aron et al. (2019) concluded that there might be higher rates of post-traumatic stress disorder and other trauma-related disorders in elite athletes compared to the general population because of sport-specific traumatic injuries and that further investigation is needed. The results of Datcu et al.'s (2021) study showed that the current study research questions were valid and addressed a significant gap. However, Datcu et al. did not mention specific sports or injuries that may be the root of sports-induced anxiety, leading the reader to believe more research is required. Echemendia et al. (2020) acknowledged limitations in their study that pointed toward potential research gaps. Player access was the chief limitation, followed by test practicality and the ability of the neuropsychologist to "speak the lingo" (Echemendia et al., 2020, p. 20) with the players. Echemendia et al. suggested that a neuropsychologist from the respective player's native country who plays ice hockey would be the ideal setting.

Gouttebarge et al.'s (2017) study was similar to the present study; however, the participant group was not focused on ice hockey players from the NHL, American Hockey League (AHL), East Coast Hockey League (ECHL), or others; the survey used was different; and the time frame was different. Hazar (2021) suggested further research

using different surveying techniques and variations, recruiting participants from different countries, and expanding from field hockey to other sports. Jonsdottir et al. (2022) acknowledged that fewer studies existed on the relationship between anxiety and sport-related concussion (SRC). Nearly every article examined in the current literature review addressed an element of the present study, but none addressed the entire study. Therefore, this research may help empower the players and the organizations they play for to seek treatment for this invisible injury. Current findings may also provide a basis for future research regarding anxiety attributed to injuries other than concussions.

Problem Statement

As a former player, coach, and lifelong student of the ice hockey game, I experienced a knowledge gap in the psychology literature concerning injuries from competition. As a young player, I endured several neurological injuries that later affected me. When I sustained these injuries, I was pressured by coaches and teammates to continue playing; “shake it off” and “stop acting like a baby” were some of the responses I received. It was not until my vision was completely blurry and my fine motor skills ceased to work correctly that I elected to sit on the bench and refused to play. Even then, I experienced criticism for doing so.

There is now a strict protocol for such symptoms resulting from an injury, which acknowledges the severity of neurological trauma. Even with the precautionary measures in place, as an ice hockey coach I see a certain degree of apprehension in my players when they are faced with situations in which they could experience an impact in the form of body contact, including receiving a long pass that could result in a mid-ice collision or

being struck with a puck while blocking a shot. Understanding whether a player experiences anxiety after returning to play from a concussion is valuable information for a coach, general manager, or franchise owner.

Although anxiety in sports is commonplace (Collins & Winter, 2020), research suggested that stress due to concussions has been found in NCAA athletes in several sports including ice hockey (D'Alonzo et al., 2022). A study conducted in 2018 highlighted that concussions occur in 36.5% of games involving Canadian late-teen ice hockey players and how 10%–20% of concussion patients experience complications such as anxiety and post-traumatic stress disorder (Todd et al., 2018). Identifying whether a concussion sustained while playing professional ice hockey manifests as an anxiety disorder has not garnered much attention.

Purpose of the Study

The purpose of this quantitative study was to determine whether professional ice hockey players experienced a form of generalized anxiety when they returned to play following a severe concussion. For Research Question 1, the independent variable was number of concussions, and the dependent variable was generalized anxiety as measured by the Generalized Anxiety Disorder 7 (GAD-7). For Research Question 2, the independent variable was concussion severity, and the dependent variable was generalized anxiety as measured by the GAD-7.

Research Questions and Hypotheses

RQ1: Do professional ice hockey players experience generalized anxiety symptoms related to the number of concussions?

H_o1: There is no statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

H_a1: There is a statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

RQ2: Do professional ice hockey players experience generalized anxiety symptoms related to concussion severity?

H_o2: There is no statistically significant relationship between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

H_a2: A statistically significant relationship exists between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

Theoretical Framework for the Study

Several theories were used to explore general anxiety and its genesis concerning injuries, in this case concussions. According to the *Oxford Handbook of Anxiety and Related Disorders*, the intolerance of uncertainty model (IU), the emotion dysregulation model, the metacognitive model, and the cognitive avoidance theory were the four main psychological models used to explain generalized anxiety (Behar et al., 2009; Fisher & Wells, 2009). For the current study, the IU detailed anxiety regarding fear and anticipation of the unknown or future uncertainty (see Chen et al., 2018; Reuman et al.,

2015). IU was used to explain the genesis of the player's general anxiety levels after a concussion.

Nature of the Study

The research design included a questionnaire to measure generalized anxiety and answer the research questions in this quantitative study. Participants were given a self-rated 7-point Likert-scale ranking of the severity of their concussion in which 1 was *very mild* and 7 was *extreme*. The categories were 1 (*very mild*), 2 (*mild*), 3 (*somewhat moderate*), 4 (*moderate*), 5 (*severe*), 6 (*very severe*), and 7 (*extreme*). Concussion severity was analyzed on two levels: those who experienced a 1 (*very mild*) through 3 (*somewhat moderate*) concussion and those who experienced a 4 (*moderate trauma*) through 7 (*extreme*) concussion. Participants were asked how many concussions they had experienced in their lifetimes. The number of concussions was analyzed on two levels: those who experienced one to three concussions and those who experienced more than three concussions.

Furthermore, participants were asked to take a short survey to recall their anxiety levels after experiencing their most severe self-reported concussion. The 7-question GAD-7 was used to measure general anxiety traits for the period encompassing the athlete's most severe self-reported concussion (see Spitzer et al., 2006). The GAD-7 survey was administered to a sample population of 42 players who played at least 10 games in a professional ice hockey league (NHL, AHL, ECHL, or other) and experienced concussion symptoms.

The independent variable in Research Question 1 was number of concussions. The dependent variable was generalized anxiety as measured by the GAD-7. The independent variable in Research Question 2 was concussion severity, and the dependent variable was generalized anxiety as measured by the GAD-7. The results of the surveys were analyzed using a two-way analysis of variance (ANOVA) to determine whether there was a relationship between the independent variables and dependent variables.

Definitions

Concussion severity: For Research Question 2, the independent variable of concussion severity was defined as the self-reported severity of the participant's most severe concussion. Participants received a self-rated 7-point Likert-scale ranking of the severity of their concussions, where 1 was *very mild* and 7 was *extreme*. The categories were 1 (*very mild*), 2 (*mild*), 3 (*somewhat moderate*), 4 (*moderate*), 5 (*severe*), 6 (*very severe*), and 7 (*extreme*). A 1 (*very mild*) represented almost nonexistent symptoms, but the player was determined to have a concussion. A 2 (*mild*) represented having slightly higher symptoms such as mild headache, nausea, balance problems, dizziness, fatigue, and sensitivity to noise and light (see Iverson et al., 2022). A 3 (*somewhat moderate*) represented symptoms in which the player needed to sit on the bench and gather their faculties. The player might experience headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog (Iverson et al., 2022). A 4 (*moderate*) represented a player who had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light,

difficulty concentrating and remembering, and mental fog that lasted for a few days (Iverson et al., 2022).

A 5 (*severe*) represented a Grade 2 concussion in which there was a temporary loss of consciousness or amnesia. The player had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that lasts for a few days (Horne, 2018; Iverson et al., 2022). A 6 (*very severe*) was a Grade 3 concussion in which there was a temporary loss of consciousness accompanied by a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, trouble concentrating and remembering, and mental fog that lasts for a few days (Horne, 2018; Iverson et al., 2022). A 7 (*extreme*) represented all symptoms of a Grade 3 concussion. The player would have a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that lasts for over 1 week. The player also may experience heightened emotions and trouble falling asleep (Horne, 2018; Iverson et al., 2022).

Generalized anxiety: For Research Question 1, the dependent variable of generalized anxiety, as measured by the GAD-7, was defined as the direct results of the GAD-7 survey the participant took. The seven-question GAD-7 was used to measure general anxiety traits for the period encompassing the athlete's most severe self-reported concussion (see Spitzer et al., 2006).

Number of concussions: For Research Question 1, the independent variable of number of concussions was defined as the total number of concussions the participant experienced throughout their lifetime.

Assumptions

I assumed that those who experienced concussions during the play of sport had elevated levels of general anxiety throughout their everyday lives. Delving deeper into the research, I also assumed that those who suffered more severe concussions would display higher levels of anxiety than their counterparts who suffered less severe concussions. These assumptions were necessary because they provide future researchers with clues on what to look for and measure. Future researchers may adjust the variables depending on what they are trying to measure. The assumptions also served as a means to keep the study aligned.

The research problem addressed in this study was that the scholarly community did not know whether a player who sustained a concussion while playing professional ice hockey experienced anxiety disorder after returning to play. This problem was addressed by asking two research questions: Do professional ice hockey players experience generalized anxiety symptoms related to the number of concussions? Do professional ice hockey players experience generalized anxiety symptoms related to the concussion severity?

Scope and Delimitations

The GAD-7 survey and a demographic questionnaire were administered to a sample population of 115 players who had played in at least 10 games in a professional ice hockey league (NHL, AHL, ECHL) or other professional ice hockey league worldwide and who had experienced concussion symptoms. All positions played, ethnicities, genders, and ages were considered valid for participation in the study. Players

who had never experienced concussion symptoms or played fewer than 10 games in the NHL, AHL, ECHL, or other were not included in the final data set.

Limitations

Trustworthiness was enhanced by ensuring all surveys were standardized, and the dissertation committee and I agreed on all questions. The surveys were anonymous. The demographic data were limited to the participant's primary position and age at the time of injury. Initially, obtaining the minimum number of completed surveys was challenging because the participant pool was exclusive. The ease of online survey platforms such as SurveyMonkey helped alleviate the logistical problems in distribution to the population group. Also, the participant's ability to recall their feelings after the injury might have been difficult and might have produced inaccurate data. Asking the participant to identify their most traumatic concussion helped them remember the details of how they felt, given the significance and trauma of the event.

Significance

This study was significant because it added to existing literature on the safety of hockey players and all athletes at all levels of play. The study may promote a better understanding of generalized anxiety related to concussions (see Jonsdottir et al., 2021; Li et al., 2021). As knowledge of how concussions affect people's emotions and actions increases, the scholarly community may highlight a dark subject by offering preventive therapy, early detection, and postconcussion therapy by using the study results (see Todd et al., 2018). On a micro level, coaches may tailor their game-time strategy knowing what their rostered players have endured physically and how that physical damage may have

affected their psyche. On a macro level, team general managers may use the findings from this study to influence their decisions when drafting a prospect, signing a free agent, or trading a player (see Clarke et al., 2021). The study's results may affect every level of every sport regarding how coaches see their players and knowing what to look for when faced with a situation in which they put a player in a game or tell them to rest (see Clarke et al., 2021).

Summary

Chapter 1 introduced the study and its importance through a concise introduction and background. I provided the problem statement, purpose statement, research questions, and hypotheses associated with each question. The chapter also introduced the theoretical construct on which this study was based, the nature of the study, definitions of key terms, scope and delimitations, limitations, and significance.

Chapter 2 provides the literature search strategy, theoretical foundation, and a detailed literature review segmented into subcategories. The subcategories not only include an introduction and background but also feature concussion explanation, postconcussion syndrome (PCS), and anxiety. The chapter also highlights concussion symptoms and effects, SRC clinical profiles, diagnosis management, lack of self-reporting, and player performance.

Chapter 2: Literature Review

Ice hockey is a well-known physical sport worldwide, one in which fatalities have occurred on several occasions. On January 13, 1968, the Minnesota North Stars of the NHL hosted the Oakland Seals in a typical NHL regular season matchup. Bill Masterson, star centerman for the North Stars, skated with the puck across the blue line, where two Seals' defenders met him to gain possession of the puck (Rosengren, 2016). One of the defensemen's sticks got accidentally tangled with Masterson's skates, causing him to lose his balance and lurch forward; then, another defender caught him with a clean check that knocked him backward, causing him to impact the ice on the back of his helmetless head (NHL, 2022; Rosengren, 2016). Almost 30 hours later, Masterson died from his traumatic head injury. The NHL honors its top performers every summer at its annual awards ceremony. One of the awards, the Bill Masterson Trophy, is given to the player who best displays the qualities of perseverance, sportsmanship, and dedication to hockey (NHL, 2022). The award is a stark reminder to the world of that fateful January night in 1968, the hazards ice hockey exudes, and how head injuries sometimes have fatal outcomes.

Literature Search Strategy

The strategy used for the literature search encompassed elements of both research questions and theoretical concepts regarding concussions, sports concussions, concussions in ice hockey, concussion severity, PCS, concussions and anxiety, and anxiety from sports concussions. The online databases of the APA's PsycArticles, EBSCO, Google Scholar, Google, PsycINFO, the Walden Library, and the official archives of the Hockey Hall of Fame in Toronto, Ontario, were used. The following

keywords were considered: *concussions*, *neurological injuries*, *ice hockey players*, *professional ice hockey players*, *performance anxiety*, *concussions* and *anxiety*, *anxiety disorder*, *GAD-7* and *sports*, *post-concussion syndrome in athletes*, *sports injuries*, *anxiety theories*, and *GAD theories*. The search was narrowed to peer-reviewed scholarly articles published from 2019 through 2023. Occasionally, older pieces were deemed valuable because of the relevance of the content found in the newer articles' bibliographies. Other sources gathered through internet search engines, eyewitness sources, and professional experts who had not published peer-reviewed articles were included for information validation. Finally, interviews and testimonies courtesy of the NHL were considered to capture the essence of the literature and problem sets. Ninety articles were found relevant to the study and were used in the research.

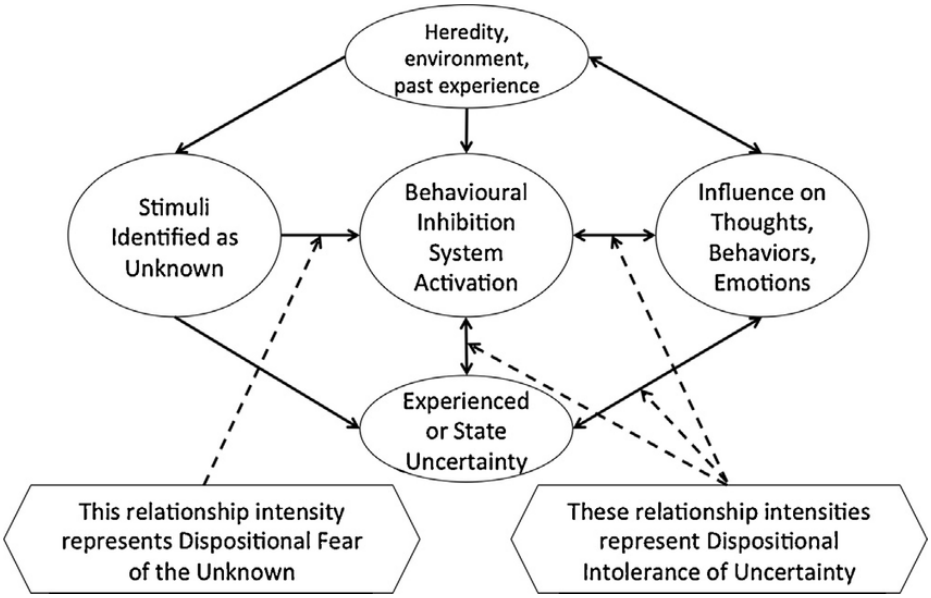
Theoretical Foundation

Several theories were used to explore general anxiety and its genesis concerning injuries, in this case concussions. According to the *Oxford Handbook of Anxiety and Related Disorders*, the IU, the emotion dysregulation model, the metacognitive model, and the cognitive avoidance theory are the four main psychological models used to explain generalized anxiety (Behar et al., 2009; Fisher & Wells, 2009). For the current study, the IU was used to detail anxiety regarding fear and anticipation of the unknown or future uncertainty (see Figure 1; Chen et al., 2018; Reuman et al., 2015). When addressing concussions with an aftermath symptom of anxiety, I used the IU to describe one possible reason why the concussed individual would experience a heightened sense of generalized anxiety. Freeston et al. (1994) introduced the IU and defined the model as

"a relatively broad construct representing cognitive, emotional, and behavioral reactions to uncertainty in everyday situations" (p. 20).

Figure 1

Relational Map of Fearing Unknowns and Intolerance of Uncertainty



Note. Adapted from "Into the Unknown: A Review and Synthesis of Contemporary Models Involving Uncertainty," R. N. Carleton, 2016, *Journal of Anxiety Disorders, 39*, pp. 30–43. https://doi.org/10.1016/j.janxdis.2016.02.007. Copyright 2016 by Elsevier. Reprinted with permission.

Researchers have suggested that the definition of IU has evolved since its inception. Carleton (2016) provided a more refined definition of IU. Carleton defined IU as "an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (p. 20). Anything can trigger IU (Nader, 2020).

Herbert and Dugas (2019) described the components of IU as first the trigger, which begins the state of uncertainty; next are the calamitous beliefs about the uncertainty, followed by feelings of worry, anxiety, and safety strategies, and last are the interactions between all components.

In comparing everyday life occurrences with relation to IU, a person must consider IU as a perspective or lens of the willingness or unwillingness to accept the unknown (Nader, 2020). For example, if a person travels to Europe, the individual with a high tolerance for the unknown may purchase a one-way ticket with a dollar in their pocket. They may rationalize that they will figure it out as needed. The individual with a low tolerance for uncertainty will not only purchase a return ticket but will also have a detailed itinerary for their time in Europe, a backup plan in case something in their itinerary falls through, and plenty of money to sustain their time in Europe (Nader, 2020). Most people fall somewhere between the two extremes, but some let the former affect them more often than not (Nader, 2020).

In the current study, the trigger might have been a concussion sustained during a hockey game. The player might have experienced a lower tolerance of uncertainty regarding bodily injury, affecting performance on the ice or facets of their everyday lives they might otherwise not have considered. O'Connor et al. (2023) studied the Irish collegiate athlete and their perception of concussions to display a contrary way of thinking toward IU. O'Conner et al. hypothesized that those who experienced traumas would have a lower anxiety level when asked about concussions compared to those who had not experienced a concussion. Their hypothesis was confirmed after surveying male

and female athletes from several different sports using the Perceptions of Concussion Inventory for Athletes. O'Connor et al. also found that women displayed more negative perceptions than their male counterparts. O'Connor et al. mentioned that 1 in 4 Irish collegiate athletes reported that they had previously not reported a concussion. Additionally, after falling victim to a concussion, female athletes displayed more significant anxiety symptoms and a higher occurrence of anxiety disorders than their male counterparts (O'Conner et al., 2023).

A study in 2021 focused on professional and collegiate football athletes' (N = 196) short-term and long-term mental health effects with anxiety, depression, and psychological distress following an SRC (Mrazik, 2021). The tools used to gather data at baseline and intervals after a concussion were the Patient Health Questionnaire , the GAD-7, and the Brief Symptom Inventory. Mrazik's results confirmed that athletes with previous SRCs at baseline scored higher with anxiety, depression, and psychological distress at 24–48 hours after a concussion. No difference was detected at later observation points, indicating short-term symptoms. Although Mrazik focused on elite athletes, the data were specific to a relatively small sample population from a particular sport. Additionally, the severity of the concussions and the total number sustained over athletes' lifespans were variables that remained unexamined.

Literature Review Related to Key Variables and Concepts

Concussion, Postconcussion Syndrome, and Anxiety Explained

Often referred to as the *invisible injury*, concussions are frequent injuries in athletics (Covassin et al., 2014). Although practitioners debate the definition of a

concussion, many agree that a concussion is a mild form of traumatic brain injury caused by a kinetic energy impact either indirectly or directly to the head or neck area, resulting in a trauma-induced alteration in mental status that may or may not involve the loss of consciousness (Decq et al., 2021; Kazi & Torres, 2019). Concussions are categorized in three grades:

- Grade 1 is no loss of consciousness; amnesia is absent or present (> 30 minutes; Horne, 2018).
- Grade 2 is loss of consciousness (< 5 minutes) or amnesia (30 minutes to 24 hours; Horne, 2018).
- Grade 3 is loss of consciousness (> 5 minutes) or amnesia (> 24 hours; Horne, 2018).

SRCs were the focus of the current study to narrow concussions with relevance to the study. SRCs are concussions incurred during the play of sports and are more prevalent during a game-time situation as opposed to practice. However, SRCs have been known to occur during practice or recreational play and affect the player both on and off the field of play (Hardy et al., 2017; Jonsdottir et al., 2022). A player does not necessarily have to be struck on the head with an object in sports. The player may be involved in bodily contact, where the head is abruptly jerked in one direction, causing a rapid movement motion of the head. This motion produces interior cranial trauma (Hardy et al., 2017). The player may be struck in the head and receive no exterior signs of injury, but the head and the brain are affected by the traumatic impact. The scenarios are limitless, even with cutting-edge protective equipment. This issue shows the importance of

research and development in player equipment, tailoring rules to protect the player, and continuing to study the causes, effects, and therapy of concussions and their aftermath.

One step beyond a concussion is PCS, which is the aftermath of the initial concussive-event symptoms. PCS can be described as a person experiencing headaches, fatigue, noise or light sensitivity, dizziness, imbalance, sleep disturbance, emotional liability, irritability, depression, lack of concentration, memory, thinking quickly, and anxiety (Smith et al., 2019). At least one symptom in at least three of the categories must be present to meet the criteria of PCS:

- Physical symptoms are headache, nausea, balance problems, dizziness, fatigue, and sensitivity to noise and light (Iverson et al., 2022).
- Cognitive symptoms are difficulty concentrating and remembering, and feeling mentally foggy (Iverson et al., 2022).
- Emotional symptoms are irritability, sadness, and heightened emotions (Iverson et al., 2022).
- Insomnia refers to trouble falling asleep or sleeping less than usual (Iverson et al., 2022).

When an athlete sustains an injury, doctors and training staff quickly focus on the physical aspect of the damage. However, many injured athletes experience psychological side effects regarding their injury, most notably anxiety (Covassin et al., 2014). Anxiety has the potential to amplify concussion symptoms, prolong recovery, and reduce the quality of life after a concussion (Iverson et al., 2022). Rice et al. (2018) examined 27 studies that illustrated evidence of psychological disorders in elite athletes from a myriad

of sports after experiencing a concussion. Rice et al. focused on other studies that honed in on anxiety, depression, anger, fatigue, and tension after the athlete had recovered from their concussion and returned to play. Anxiety was prevalent in many athletes' after a concussion, especially in collegiate American football players, 3 days and 1 week after a concussion. The 27 articles highlighted mixed martial arts, boxing, American football (professional and college), wrestling, softball, field hockey, basketball, rugby, soccer, lacrosse, and ice hockey (collegiate).

Like the Rice et al. (2018) study, Yang et al. (2015) analyzed NCAA Division I collegiate athletes and how postconcussion symptoms were correlated with depression and anxiety. Yang et al. hypothesized that concussed athletes who experienced symptoms of anxiety and depression before the injury (at baseline) were likelier to report similar symptoms after an injury than those who had no symptoms of anxiety or depression at baseline. The instrument used to measure anxiety was the 40-item State-Trait Anxiety Inventory (20 questions measuring state anxiety and 20 items measuring trait anxiety). According to Yang et al.,

> the results stated that concussed athletes who had symptoms of depression at baseline were 4.59 times more likely to experience depression symptoms and 3.40 times more likely to experience state anxiety following the concussion than those who did not experience any symptoms at baseline. (p. 20)

The *Diagnostic and Statistical Manual-Version 5* details general anxiety when not related to a specified anxiety disorder as the following:

> anxiety with symptoms similar to an anxiety disorder that causes significant distress or impairment to social, occupational, or other important areas of functioning predominates but does not meet the full criteria for any of the disorders in the anxiety disorders diagnostic class. (American Psychiatric Association [APA], 2013, p. 20)

A more drastic and enduring form of anxiety is termed generalized anxiety disorder (GAD). GAD is the uncontrollable, persistent, unreasonable, and excessive worry about a variety of topics or events that occurs more days than not for at least 6 months and is accompanied by physical symptoms such as muscular tension, fatigue, and restlessness (Aikins & Craske, 2001; APA, 2013; Behar et al., 2009). Other symptoms of GAD include irritability, edginess, restlessness, and difficulty concentrating. Those who experience GAD may fully understand their predicament with excessive worry but think it is out of their control. GAD and the question "what if" are synonymous with one another due to the constant stress and anxiety over everyday occurrences on top of other scenarios playing out in a person's psyche (Herbert & Dugas, 2019).

The *Diagnostic and Statistical Manual-Version 5* outlines specific criteria to be diagnosed with GAD:

- Excessive anxiety should be present for more days than not over 6 months or more than 90 days in 180 days. This criterion is considered a general guideline rather than an exact science (APA, 2013).
- Difficulty in self-soothing is present (APA, 2013).

- Adults must possess three or more symptoms, and children must have one or more symptoms (APA, 2013).
- Daily life impairment, such as difficulty keeping a job, is present (APA, 2013).
- The symptoms are in no way connected to medication, drug abuse, or an underlying physical condition such as hyperthyroidism (APA, 2013).
- Another mental disorder does not better explain symptoms (APA, 2013).

Although anxiety in sports is commonplace (Collins & Winter, 2020), research suggested that anxiety due to concussions has been found in NCAA athletes in several sports including ice hockey (D'Alonzo et al., 2022). *State anxiety* is a rapid, emotionally distressed state brought on by fear, tension, and apprehension with an increase in psychological arousal (Ren et al., 2022). A person may experience state anxiety when they are running late for an appointment but calm down once they arrive on time. *Trait anxiety* is characterized as a predisposition level to perceive specific environments as threatening, bringing on a response of increased state anxiety (Ren et al., 2022). An example of trait anxiety is worrying about getting into a car accident every time people step foot in a vehicle. Anxiety also has cognitive and somatic components, which helps explain how an athlete may subconsciously avoid or experience a heightened sensation of anxiety in a situation they perceive as threatening (Ren et al., 2022).

Although researchers have highly researched concussions, the gave considerably less attention to the relationship between concussions and anxiety (Covassin et al., 2014). Ingram and Karr (2023) endeavored to find a link between college students and student-

athletes who have experienced concussions and those who tested positive for anxiety and depression disorders. Upon evaluation of the results, Ingram and Karr concluded that the concussion participants who screened positive for anxiety/depression reported more severe symptoms than those who had not experienced a concussion. The GAD-7 is said to have shown evidence to be valid and reliable and is relatively short in length (7 items). Similar to Ingram and Karr's article, Lumba-Brown et al. (2023) examined whether student-athletes with a history of mental health problems from the collegiate ranks experienced anxiety and mood disruption following a mild traumatic brain injury, including concussions (Lumba-Brown et al., 2023). The results showed that those students who reported symptoms of anxiety, mood disruption, and mental health problems at baseline showed symptoms of anxiety and mood disorder post-concussion (94.7%; Lumba-Brown et al., 2023).

Concussion Symptoms and Effects

Concussion symptoms reported by the inflicted include the feelings of being dazed, stunned, woozy, foggy, posttraumatic headaches, vomiting, nausea, balance problems, dizziness, visual disturbances, confusion, and memory loss (Echemendia et al., 2020; Makdissi et al., 2009; Musumeci et al., 2019). Short-term and long-term complications of concussions include impaired performance, distress, depression, sleep disturbances, adverse alcohol use depression, cumulative cognitive deterioration, chronic traumatic encephalopathy, and anxiety (Gouttebarge et al., 2017; Makdissi et al., 2009; Musumeci et al., 2019). Many of the described complications can be diagnosed with the use of practitioner observations and psychological testing through surveys like the Sports

Anxiety Survey, the GAD-7, the Hamilton Anxiety Rating Scale, and the Concussion Clinical Profiles Screening (Ingram & Karr, 2023; Mifta et al., 2021; Stephenson et al., 2022). Chronic traumatic encephalopathy can only be diagnosed postmortem (Musumeci et al., 2019). Recent research suggests concussions, particularly SRCs, and anxiety are correlated (D'Alonzo et al., 2022).

Anxiety can be considered a short-term or long-term effect of a concussion, depending on the individual affected, especially in the following months post-convalescence. An estimate of symptom resolution is within 21 days post-concussion; however, 14% of school-aged children, one-third of adult patients, and 10% to 20% of athletes continue to experience these symptoms beyond the 21-day timeframe (Engstrom et al., 2020; Mucha & Trbovich, 2019; Sandel et al., 2017). Engstrom et al. (2020) conducted qualitative research to describe the ramifications of multiple concussions in professional ice hockey players; nine former Swedish hockey players were used as participants. The researchers used hermeneutic phenomenology (unique interpretation for each participant) to interpret and explain the results of the participants' in-person interviews (Engstrom et al., 2020). The development of the study provided a theme of losing one's identity as a hockey player postretirement because of multiple concussions (Engstrom et al., 2020).

Another reoccurring theme was that the participants struggled with their off-ice identities and figuring out other sources of meaning for their lives (Engstrom et al., 2020). Gouttebarge and Kerkhoffs (2017) conducted a similar study. They focused on symptoms of common mental disorders (CMD) in both retired and current professional

ice hockey players from the National Ice Hockey Players' Union from Denmark, Finland, Norway, and Switzerland (Gouttebarge & Kerkhoffs, 2017). The authors acknowledged that the knowledge of such common mental disorders in professional ice hockey is lacking; therefore, Gouttebarge and Kerkhoffs (2017) aimed to bring awareness to highlight the need for proactive measures toward therapy.

Two-hundred fifty-eight participants (135 current and 123 retired) met the inclusion criteria; from those, 258,158 (81 existing and 77 retired) completed the follow-up questionnaire (Gouttebarge & Kerkhoffs, 2017). Distress, anxiety/depression, sleep disturbance, adverse alcohol use, and eating disorders were among the CMDs measured (Gouttebarge & Kerkhoffs, 2017). Distress was measured using the Distress Screener (3 items scored on a 3-point scale) derived from the four-dimensional symptom questionnaire (Gouttebarge & Kerkhoffs, 2017). The 12-item General Health Questionnaire was used to assess symptoms related to anxiety/depression (Gouttebarge & Kerkhoffs, 2017). Their findings confirmed a significant number of self-reported various CMD symptoms, including 24% for anxiety/depression and 12% for distress (Gouttebarge & Kerkhoffs, 2017).

Sport-Related Concussion Clinical Profiles

Upon experiencing a concussive event, the victim is categorized into one of five identified clinical profiles (or subtypes) and two modifiers for SRCs that aid clinicians in treating the patient properly using the proper strategy (Kontos et al., 2019; Mucha & Trbovich, 2019; Sandel et al., 2017). The five profiles include the vestibular profile, ocular profile, post-traumatic migraine profile, cognitive fatigue profile, and anxiety and

mood profile (Figure 2; Kontos et al., 2019; Mucha & Trbovich, 2019; Sandel et al., 2017). The two modifiers are cervical (neck) irregularities and sleep disruption (Kontos et al., 2019; Mucha & Trbovich, 2019; Sandel et al., 2017; Stephenson et al., 2022). The vestibular profile would exhibit symptoms such as dizziness, fogginess, lightheadedness, balance problems, and balance difficulty (Kontos et al., 2019; Stephenson et al., 2022). The ocular profile contains symptoms of blurry vision, difficulty reading, headaches, and fatigue due to eye strain (Kontos et al., 2019; Stephenson et al., 2022). The post-traumatic migraine profile exhibits characteristics such as severe headaches, nausea associated with headaches, and a visual aura consisting of flashing zig-zagging lines or specks, otherwise known as “stars,” in the field of view of the affected (Kontos et al., 2019; Stephenson et al., 2022).

Figure 2

Common Symptoms, Clinical Examination/Evaluation Findings, Risk Factors, and Targeted Treatment Strategies for Clinical Profiles

Common symptoms, clinical examination/evaluation findings, risk factors, and targeted treatment strategies for clinical profiles.

	Clinical Profiles				
	Vestibular	Ocular	Cognitive-Fatigue	Posttraumatic Migraine	Anxiety/Mood
Common symptoms	• Slow, wavy dizziness with movement or change of positions • Dizziness, nausea, mental fogginess, and anxiety in busy environments • Balance problems • Motion sensitivity • Vertigo when lying down, looking up, or rolling over	• Blurry vision, diplopia, eye strain, difficulty focusing • Difficulty reading (*e.g.,* skipping lines, reading comprehension problems) • Headache and fatigue triggered specifically by visual activity	• Feeling ''in a fog'' • Difficulty concentrating • Memory problems • Feeling slowed down • Fatigue or low energy • Symptoms worsen throughout the day, especially headache	• Intermittent, moderate to intense headache • Headache often present upon wakening • Headache with nausea and/or phono/photosensitivity • Visual aura including flashing or shimmering lights, zigzagging lines, or stars • Pulsating quality • Motion sickness and sleep problems common	• Anxiety/depression, worry, difficulty turning off thoughts, rumination, excessive preoccupation or focus on symptoms • Sadness, limited social interaction or loss of interest • Panic attacks
Clinical examination/ evaluation findings	• Abnormal vestibular screening (*e.g.,* symptom provocation with vestibular ocular reflex testing)	• Abnormal near point convergence measurements • Tracking, saccadic deficits • Neurocognitive deficits typical, especially reaction time	• Neurocognitive deficits across domains	• Neurocognitive deficits across domains are common	• Elevated scores above cut-off on mood/anxiety questionnaires
Risk factors	• Personal history of motion sickness/sensitivity • Personal history of vestibular disorder • Comorbid migraine • Comorbid anxiety disorder	• Not established • Personal/family history of eye muscle surgery, strabismus, amblyopia, or other ocular diagnosis	• Not established • Personal history of ADHD, learning disability	• Personal/family history of migraine • Personal history of motion sickness • Comorbid anxiety disorder or sleep problems • Female gender	• Personal and/or family history of psychiatric issues • Psychiatric/mood medications taken in past • Comorbid migraine and sleep problems • Presence of significant life stressor
Targeted treatment strategies	• Vestibular rehabilitation • Dynamic Exertion Therapy • Exposure/recovery approach in day to day activity	• Vision therapy • Exposure/recovery approach when engaging in visually demanding tasks	• Brief academic/work accommodations • Behavioral regulation • Medication with stimulant properties	• Referral to headache specialist • Behavioral regulation	• Psychotherapy approaches, including cognitive behavioral therapy, behavioral activation, and exposure therapy • Psychotropic medication

Note. Adapted from "Sport-Related Concussion Clinical Profiles: Clinical Characteristics, Targeted Treatments, and Preliminary Evidence," by A. P. Kontos, A. Sufrinko, N. Sandel, K. Emami, and M. W. Collins, 2019, *Current Sports Medicine Reports, 18*(3), pp. 82–92 https://doi.org/10.1249/JSR.0000000000000573. Copyright 2019 by Wolters Kluwer Health, Inc. Reprinted with permission.

Although migraines are a common symptom, scholars and practitioners still debate the exact genesis of such phenomena (Kontos et al., 2019; Stephenson et al., 2022). The cognitive fatigue profile consists of symptoms such as memory loss, a feeling of one's head being "in a fog," and difficulty concentrating (Kontos et al., 2019; Stephenson et al., 2022). Finally, the anxiety and mood profiles are one where the concussed individual experiences anxiety, obsessiveness over symptoms, sadness, depression, and panic attacks (Kontos et al., 2019; Sandel et al., 2017; Stephenson et al., 2022). The anxiety and mood profiles are highly dependent upon self-reporting, which leaves room for error, misreports, and even a lack of reports.

The frequency of primary concussion clinical profiles highlighted in Kontos et al. (2019) showed that out of a sample population of (N = 236), vestibular (46.19%), ocular (38.16%), and migraine (61.26%), cognitive/fatigue was responsible for 26.11%, anxiety/mood for 56.24%, and no clear profile for 9.4%. These statistics represented the distribution of profile type (Kontos et al., 2019). Greenberg et al. (2023) conducted a qualitative study to analyze the impact of a recent concussion (less than or equal to 10 weeks) on college-aged individuals with co-occurring anxiety (greater than or equal to 5 on the GAD-7). The authors acknowledged that a concussion is the most common form of traumatic brain injury and that anxiety is one of the most significant risk factors associated with post-concussion symptoms (Greenberg et al., 2023). Although the article detailed different themes associated with the inclusion criteria, it was difficult to pinpoint the genesis of the participant's anxiety with their most recent concussion, given that the interview was at a single point in time (Greenberg et al., 2023).

Diagnosis Management

The evaluation process is complex and multifaceted because some concussion symptoms are closely related to one another and can mimic possible pre-existing conditions, such as migraines, psychiatric disorders, and oculomotor and vestibular dysfunction (Mucha & Trbovich, 2019). Notably, there are no concussion-specific psychiatric assessments despite a high presence of post-traumatic findings in this area, hence showing the importance of using instruments already established within the psychiatric field (Mucha & Trbovich, 2019). Tools used in acute concussion assessment (3 or fewer days) in sports are the Standardized Assessment of Concussion, the multidimensional Sports Concussion Assessment Tool, and the Military Acute Concussion Evaluation. These tests are limited to the first few days post-injury (Mucha & Trbovich, 2019).

The NCAA adopted a six-step protocol requiring each step to be symptom-free for at least 24 hours between each step (Kumar et al., 2014). In 2013, the NFL adopted its concussion protocol that requires an evaluation by an unbiased neurologist and a prohibition from returning to play if any symptoms are present (Kumar et al., 2014). After the player is deemed physically able to play, they face neuropsychological testing, including the Immediate Post-Concussion Assessment and Cognitive Testing and the Sports Concussion Assessment Tool, third edition (Kumar et al., 2014).

Ultimately, the burden of proof relies upon the player's honesty in reporting and the physician's opinion (Kumar et al., 2014; Musumeci et al., 2019). The odds of returning to play within 7 days increase by 18% for every 1-year increase in career years

of experience at the time of injury, leading one to believe that the older players do not report symptoms as often as the younger players (Kumar et al., 2014). A study conducted in 2020 showed that the current assessment strategies regarding sport-related concussions lack reliability. The authors contested that small sensorimotor functions could be unidentified or overlooked, exacerbating the injury and increasing the risk of re-injury (Johnston et al., 2020). The introduction of the Y Balance test (YBT), a test that includes placing a sensor on the lower lumbar region (fourth lumbar) of the back that measures lateral reach distance, could identify concussion-induced alterations in abrupt movement control (Johnston et al., 2020). One of the study's main objectives was to determine whether or not the YBT can discriminate pre- and post-concussion performance 24- and 48-hours post-injury and at the return to full contact play (Johnston et al., 2020).

Two hundred twenty-six Elite Rugby Union players, Collegiate Division I athletes in American football, and ice hockey athletes were used to test the YBT. Seventeen athletes who sustained a concussion agreed to participate in 24-hour and 48-hour follow-up evaluations, and 20 uninjured athletes also participated in the whole gamut of test batteries. They were the control group (Johnston et al., 2020). The study's result suggested that the concussed athletes could not reach as far outside their support base 24 to 48 hours post-injury, indicating a possible physical examination to determine the length of convalescence time (Johnston et al., 2020). Physicians can use the YBT and other concussion diagnostic tools to determine cognitive and sensorimotor improvements.

Lack of Self-Reporting

On March 10, 2014, Dallas Stars Player Richard Peverly suffered a cardiac arrest during a game (Miller, 2016). His heart rate flatlined for approximately 2 minutes until he was resuscitated by chest compressions and a defibrillator. When he regained consciousness, his first words to the medical staff were how much time was left in the game and if he could return to play (Miller, 2016). Ice hockey athletes pride themselves on toughness and resilience to injuries and pain. Hockey players, especially within the professional ranks, tend to play through an injury with the hopes of helping their team to victory. Stories similar to the Richard Peverly incident are familiar, albeit not necessarily as extreme. The understanding of the player returning to the game and playing through the injury is a culturally accepted mentality (Kristensen et al., 2023; Schuster, 2017).

Several reasons have concerned the lack of self-reporting psychological symptoms related to concussions. Researchers have recognized the negative stigma of mental health and how employees (athletes) may neglect the care they need for fear of repercussions (Muhammad et al., 2020). Between 35% and 62% of collegiate athletes fail to divulge prior concussion data to their coaches and trainers before their collegiate lives (Kerr et al., 2014).

In high school football players, the underreporting is from a desire to continue playing, and the players know that if they self-report symptoms, their return to play can be prolonged, or they can be removed from their sport altogether (Hardy et al., 2017; Meier et al., 2015). Youth ice hockey athletes and collegiate athletes from many sports are found to underreport from a lack of concussion awareness (Meier et al., 2015). Meier

et al. (2015) stated, “Unlike the cognitive symptom domain, the psychiatric and portions of the somatic domains remain uniquely vulnerable to underreporting” (p. 20). Education was mentioned to help remedy this underreporting trend in athletes, hoping to encourage them to self-report their psychological symptoms (Meier et al., 2015). Meier et al. (2015) found that over 50% of cleared athletes still had at least mild psychiatric symptoms 9 days post-concussion. One of the reasons males reported lower psychological effect scores and less affective symptoms (sadness, feeling more emotional) than females from sports ethics (beliefs about what it means to be a great athlete) and sports socialization (learning process including social norms; Stephenson et al., 2022). To help rectify this trend, a concise reporting tool such as the GAD-7 could help encourage the athlete to answer the survey questions honestly at different time intervals in the aftermath of a concussion. Regarding on-ice anxiety, there is a need to develop a survey measuring anxiety during on-ice situations so that researchers can pinpoint exactly when the player is apprehensive and their play is affected.

The survey may contain game elements by asking the player situational questions. Those who report a history of concussion show more symptoms of distress and feel worse compared to athletes who register no account of concussions (Jonsdottir et al., 2022). Some researchers examined the correlation between self-reported concussion history and stress, depression, anxiety, and quality of life among female athletes from Iceland (Jonsdottir et al., 2022). The researchers used the following measuring tools: Stress = (PSS), Depression = (PHQ-9), Anxiety = (GAD-7), and Quality of Life (Jonsdottir et al., 2022). Their findings include that those who reported 2–3 or 4 or greater concussions

were 3.52 and 3.40 times more likely to score above the clinical cut-off of the GAD-7 (Jonsdottir et al., 2022).

Player Performance

Buckley et al. (2019) endeavored to evaluate post-concussion NHL player performance using advanced metrics from the 2008–2009 through the 2014–2015 (seven seasons) NHL regular seasons. The authors used a participant group of 93 players who met all criteria to be examined (sustained a sports-related concussion and returned during the same season) and a control group of 51 players who have missed games due to non-injury-related reasons (Buckley et al., 2019). The metrics used were points per 60 minutes, Corsi percentages, personal Fenwick shooting percentages, score chances per 60 minutes, penalty differences, and save percentage/shooting percentages (Buckley et al., 2019). The periods related to the injury that were evaluated were five games pre- and post-concussion, 10 games pre- and post-concussion, and the entire pre- and post-concussion regular season (Buckley et al., 2019). Although the researchers hypothesized that the advanced metrics would show a negative trend with the concussed NHL players as opposed to the non-injury-related players, the results proved the null hypothesis to be true in that there was no significant difference between the two population groups in the statistics as mentioned earlier through the prescribed evaluation period (Buckley et al., 2019).

Like Buckley et al. (2019), Neustadtl et al. (2021) conducted a similar study that examined player performance pre-concussion compared to post-concussion. The sample population was taken from 2013 through the 2019 NHL seasons, and the statistical

variables that measured performance for the study were goals, assists, points, plus/minus, time on ice (TOI), and hits (Neustadtl et al., 2021). The timeframe used to compare player performance was five games before the injury and five games upon return from injury, and the statistical methods used to measure the data during the five games pre- and post-injury were a paired t-test and a regression model using STATA (Neustadtl et al., 2021). A total of 269 SRC cases was considered, but 124 met the inclusion criteria. The researchers concluded that concussions did not affect NHL players' performance after they returned to play (Neustadtl et al., 2021).

Like the previous two studies, Andrews et al. (2022) conducted a third study and discussed concussions in the NHL, particularly the performance of position players (excluding goaltenders) during the 2009–2010 and 2015–2016 seasons. In a pool of 364 confirmed concussion events, 48 met the criteria for examination (Andrews et al., 2022). In addition to descriptive metrics (age, body mass index, position, and number of concussions during an NHL's playing career), performance metrics (games played, time on ice during games played, points per 60 minutes, shooting percentage, goals per 60 minutes, and assists per 60 minutes) were collected (Andrews et al., 2022). Pre-concussion and post-concussion data were collected in both the short term and long term, where the short-term data were represented by data 1 year before and after the injury. In contrast, long-term data were represented 3 years before and after the injury (Andrews et al., 2022). A control group of 96 players who never experienced concussions was used to contrast the data with the concussed population. The results indicated no significant difference in performance statistics with players pre-concussion compared to post-

concussion when the player returned to play and no significant difference between both cohort groups (Andrews et al., 2022).

Similarly, Van Pelt et al. (2019) evaluated the on-ice performance of NHL players after a concussion compared to those who sustained lower body injuries. The authors determined whether NHL players who sustained a concussion or concussions performed worse than those who sustained a lower-body injury or were completely uninjured (Van Pelt et al., 2019). The examined timeframe was the 2013–2014 and 2014–2015 (two seasons) NHL regular seasons. The targeted population was NHL players who missed games due to concussions (n = 22), lower body injuries (n = 21), and players who missed games due to nonjury-related causes (n = 13; Van Pelt et al., 2019). Demographical data to categorize the concussed athletes were used to identify like-players with lower body injuries, and those who missed time because of noninjury were time on ice, their team, position, and time loss because of injury or noninjury. The primary tracked statistical measure was a modified plus-minus statistical calculated by the following equation: Adjusted Plus-Minus Score = Team's Simple Rating System X Plus-Minus Score (Van Pelt et al., 2019). The study results concluded that those who missed games because of concussions and lower body injuries displayed a similar performance impairment after return. Initially, both groups showed a drop in performance within the first 2 weeks after returning to play, but after 5 to 6 weeks, both groups improved (Van Pelt et al., 2019).

Ochs et al. (2019) corroborated all four previous articles when examining game time performance post-concussion convalescence in the NFL and NHL. The researchers found little to no difference in performance post-concussion compared to pre-concussion

(Ochs et al., 2019). Clarke et al. (2021) conducted a systematic review and meta-analysis of seven articles (Buckley et al., 2019; Hardy et al., 2017; Kuhn et al., 2016; Kumar et al., 2014; Reams et al., 2017; Wasserman et al., 2015; Yengo-Kahn et al., 2016) focusing on performance metrics in professional athletes' pre- and post-concussion performances. The authors noted that traditional physical measurements of concussion symptoms included time-course changes in saccadic eye movements and eye tracking, balance and vestibular performance, gait and dual-task stability, processing speed, and neurocognitive and neurophysiological assessment (Clarke et al., 2021). Clarke et al. (2021) hypothesized that the athletes' performance would deteriorate post-concussion and that the metrics would decline compared to the control athletes. In the end, the articles proved the null hypothesis to be valid. In Kuhn et al.'s (2016) study, the category of blocked shots showed slight differences, indicating a degree of degradation to the player's willingness to put themselves in a potential kinetic situation that could cause harm. The study, however, did not include the category of "hits." Clarke et al. (2021) noted the importance of post-concussion performance to coaches and managerial staff when determining how to compose a team and game plan execution.

Summary and Conclusions

Chapter 2 went into more depth with the literature search strategy, theoretical foundation, and a detailed literature review segmented into subcategories. The subcategories not only gave an introduction and background, but they also featured concussion explanations, PCS, and anxiety. The chapter also showed concussion symptoms and effects, SRC clinical profiles, diagnosis management, an explanation of

the lack of self-reporting, and player performance, as referenced throughout the comprehensive literature review.

Chapter 3 delves into the research design and rationale. The research methodology section details the population, sampling and sampling procedures, and recruitment procedures. The instrumentation and operationalization of constructs are also explained. Finally, the data analysis plan and possible threats to validity are addressed.

Chapter 3: Research Method

The purpose of this quantitative study was to determine whether professional ice hockey players experienced a form of generalized anxiety when they returned to play following a severe concussion. Chapter 3 provides the research design and rationale. The methodology section details the population, sampling and sampling procedures, and recruitment procedures. The instrumentation and operationalization of constructs are also explained. Finally, the data analysis plan and possible threats to validity are addressed.

Research Design and Rationale

RQ1: Do professional ice hockey players experience generalized anxiety symptoms related to the number of concussions?

H_o1: There is no statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

H_a1: There is a statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

RQ2: Do professional ice hockey players experience generalized anxiety symptoms related to concussion severity?

H_o2: There is no statistically significant relationship between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

H_a2: A statistically significant relationship exists between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

The research design included a questionnaire and measure of generalized anxiety to address the research questions in this quantitative study. Participants received a self-rated 7-point Likert-scale ranking of the severity of their concussion, where 1 was *very mild* and 7 was *extreme*. The categories were 1 (*very mild*), 2 (*mild*), 3 (*somewhat moderate*), 4 (*moderate*), 5 (*severe*), 6 (*very severe*), and 7 (*extreme*). Concussion severity was analyzed on two levels: those who experienced a 1 (*very mild*) through 3 (*somewhat moderate*) and those who experienced a 4 (*moderate)* through 7 (*extreme*). A 1 (*very mild*) was represented as almost nonexistent symptoms, but the player was determined to have a concussion. A 2 (*mild*) was represented as having slightly higher symptoms such as mild headache, nausea, balance problems, dizziness, fatigue, and sensitivity to noise and light (Iverson et al., 2022). A 3 (*somewhat moderate*) represented symptoms in which the player needed to sit on the bench and gather their faculties. The player might have felt like they had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog (Iverson et al., 2022). A 4 (*moderate*) represented a player who had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that would last for a few days (Iverson et al., 2022). A 5 (*severe*) represented a Grade 2 concussion in which there was a temporary loss of consciousness or amnesia. The player also had a headache, nausea,

balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that lasts for a few days (Horne, 2018; Iverson et al., 2022). A 6 (*very severe*) was a Grade 3 concussion in which there was a temporary loss of consciousness accompanied by a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, trouble concentrating and remembering, and mental fog that lasts for a few days (Horne, 2018; Iverson et al., 2022). A 7 (*extreme*) showed all symptoms of a Grade 3 concussion. The player had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that lasts for over 1 week. The player also could have experienced heightened emotions and trouble falling asleep (Horne, 2018; Iverson et al., 2022).

Participants were also be asked how many concussions they had experienced within their lifetime. The number of concussions was analyzed on two levels: those who experienced one to three concussions and those who experienced more than three concussions. Furthermore, participants were asked to take a short survey to recall their anxiety levels after experiencing their most severe self-reported concussion. The 7-question GAD-7 was used to measure general anxiety traits for the period encompassing the athlete's most severe self-reported concussion (see Spitzer et al., 2006). The GAD-7 survey was administered to a sample population of 42 players who had played at least 10 games in a professional ice hockey league (NHL, AHL, ECHL, or other) and experienced concussion symptoms.

Trustworthiness was enhanced by ensuring all surveys were standardized and I and my dissertation committee agreed on all questions. The surveys were anonymous, and the demographic data remained limited to the participant's primary position and age at the time of injury. Initially, obtaining the desired number of completed surveys was a challenge because the participant pool was exclusive. The ease of online survey platforms such as SurveyMonkey helped alleviate the logistical problems in distribution to the population group. Finally, the participant's ability to recall their feelings after the injury might have been difficult and could have produced inaccurate data. Asking the participant to recall their most traumatic concussion might have helped them recall the details of how they felt, given the significance and trauma of the event. Addressing such potential pitfalls as a disclaimer with the final product was vital.

This study was significant because it added to existing literature that suggested the need for further studies dedicated to the safety of hockey players and all athletes at all levels of play. The study findings may encourage a better understanding of generalized anxiety related to concussions (see Jonsdottir et al., 2021; Li et al., 2021). As understanding of how concussions affect people's emotions and actions increases, the scholarly community may highlight a dark subject by offering preventive therapy, early detection, and postconcussion therapy by using the study results (see Todd et al., 2018).

On a micro level, coaches may tailor their game-time strategy knowing what their rostered players have endured physically and how that physical damage may have affected their psyche. On a macro level, team general managers may use the findings from this study to affect their decisions when drafting a prospect, signing a free agent, or

trading a player (see Clarke et al., 2021). The current study's results may affect every level of every sport regarding how coaches see their players and knowing what to look for when facing a situation in which they put a player in a game or tell them to rest (see Clarke et al., 2021).

Methodology

Population

The target population was current and former players of the NHL, AHL, ECHL, or other professional ice hockey league around the world. A power analysis was conducted outlining the research questions and highlighting the independent and dependent variables. The analysis showed the need for a minimum sample of 42.

Sampling and Sampling Procedures

The sampling strategy was primarily snowball sampling, which meant the link and email sent out to the initial contact listing were sent by the contacts themselves. In other words, they were sent to and by friends of friends. The procedure was to formulate an email detailing the study's parameters to be distributed to the potential participant. Inside the email was a hyperlink directing them to the survey via the automated online platform SurveyMonkey (see Appendix A). Once the email was sent, a follow-up text or phone conversation was used to ask them to distribute it to other prospective participants. Two head coaches and two assistant coaches in the NHL; employees of the Hockey Hall of Fame; and various staff members from the NHL, AHL, ECHL, and other professional ice hockey league teams agreed to aid with this enterprise.

The participant must have been at least 18 and played at least 10 games in the NHL, AHL, ECHL, or other. The participant must have sustained at least one reported concussion or, if unreported, experienced concussion symptoms after an injury. Symptoms must have included the following: headache, nausea, balance problems, dizziness, fatigue, and sensitivity to noise and light. If the participant did not satisfy any of these criteria, they were excluded.

A power analysis was conducted using the program G*Power for Mac, last updated in June 2023 (see Appendix D; Faul et al., 2007). The analysis outlined the research questions and highlighted the independent and dependent variables and a recommended sample population of 42. The *F*-test family for an ANOVA fixed effects, special effects, main effects, and interactions was conducted. The type of analysis conducted was a priori, which computed the required sample size given α, power, and effect size. The input parameters were as follows: effect size $f = 0.5$, α err prob = 0.05, Power (1- β err prob) 0.8, numerator $df = 2$, and number of groups = 2 (see Sullivan & Feinn, 2012). The output parameters were as follows: noncentrality parameter $\lambda = 10.5000000$, critical $F = 3.2327270$, denominator $df = 40$, total sample size = 42, and actual power 0.8042360. The parameters were chosen because of the realistic ability to obtain a sizeable participant population with at least an 80% power rating. A higher participant sample was unattainable.

Procedures for Recruitment, Participation, and Data Collection

Although the pool of potential participants was exclusive to many, my social and prior professional encounters enabled me to have access to such a population. As a two-

time prior collegiate hockey coach and high-level player, I had many friends who had played in the leagues in which the study was focused (NHL, AHL, ECHL, or other). The procedure for recruiting participants was elementary because it involved my network and secondary contacts through snowball sampling. I had 52 contacts of current and former players. After contacting them, I asked them to forward the email I sent to their contact list of current and former players. The survey included 12 questions (five separate questions and the seven-question GAD-7) and took the participant 5 minutes or less to complete.

In addition to the GAD-7 survey, participants were asked survey questions to obtain background information on them as players and self-report on concussion data (see Appendix B). The primary method of data conveyance and collection was through email, SurveyMonkey, and informed consent. Debriefing was not necessary for this quantitative study; however, if participants had any other questions or concerns, they received an email address and phone number to respond to if desired (see Appendix B).

Instrumentation

The main instrument for measuring generalized anxiety was the GAD-7 developed by Spitzer et al. (2006; see Appendix E). Spitzer et al. explained that before their study, GAD was one of the most common mental disorders despite the fact that there was no brief clinical tool for assessing it. Spitzer et al. noted that measures of anxiety are rarely used in a clinical setting due to their length, proprietary nature, and irrelevance regarding severity and diagnostic measures, as well as a clinician-directed requirement as opposed to self-reported. Spitzer et al. also explained that the GAD-7

assessed one anxiety disorder despite several per the *Diagnostic and Statistical Manual-Version 5*.

Ingram and Karr (2023) found a link between college students and student athletes who experienced concussions and those who tested positive for anxiety and depression disorders. Ingram and Karr provided an example of why the GAD-7 was a viable candidate for the current study. Ingram and Karr's measuring instruments were the GAD-7, a self-report health questionnaire, and the Patient Health Questionnaire. Five hundred fifty-four participants met the inclusion criteria. If they answered "yes" to a history of concussions, they were asked if it was from sports participation and whether it was within the last 3 months. Results indicated that concussion participants who screened positive for anxiety/depression reported more severe symptoms than those who had not experienced a concussion. This study showed why the GAD-7 was reported to have validity and reliability. The study also showed why the survey was relatively short in length, with seven items.

Operationalization of Constructs

Research Question 1 was the following: Do professional ice hockey players experience generalized anxiety symptoms related to the number of concussions? The independent variable was the number of concussions, and the dependent variable was generalized anxiety measured by the GAD-7. The independent variable was a self-reported figure by the participant. The number of concussions was analyzed on two levels: those who had experienced one to three concussions and those who had experienced more than three concussions. The dependent variable was the result of the

seven-question GAD-7 taken by the participant. According to Spitzer et al. (2006), the GAD-7 results were calculated by assigning scores of 0, 1, 2, and 3 to the response categories, respectively, of *not at all*, *several days*, *more than half the days,* and *nearly every day*. The GAD-7 total score for the seven items ranged from 0 to 21: 0–4 (*minimal anxiety*), 5–9 (*mild anxiety*), 10–14 (*moderate anxiety*), and 15–21 (*severe anxiety*).

Research Question 2 was the following: Do professional ice hockey players experience generalized anxiety symptoms related to the concussion severity? The independent variable was concussion severity, and the dependent variable was generalized anxiety measured by the GAD-7. The independent variable was a self-reported figure by the participant upon answering the following question: On a scale of 1 through 7, where 1 (*very mild*), 2 (*mild*), 3 (*somewhat moderate*), 4 (*moderate*), 5 (*severe*), 6 (*very severe*), and 7 (*extreme*), how would you rate your most severe experienced concussion? The dependent variable was the result of the seven-question GAD-7 taken by the participant. According to Spitzer et al. (2006), the GAD-7 results were calculated by assigning scores of 0, 1, 2, and 3 to the response categories, respectively, of *not at all*, *several days*, *more than half the days*, and *nearly every day*. The GAD-7 total score for the seven items ranges from 0 to 21: 0–4 (*minimal anxiety*), 5–9 (*mild anxiety*), 10–14 (*moderate anxiety*), and 15–21 (*severe anxiety*).

Data Analysis Plan

Once all data were collected and ready for analysis, the computer program Statistical Package for the Social Sciences (SPSS) Version 29.0.0.0 was used to conduct a two-way ANOVA for each of the two research questions. No other statistical test was

conducted outside of the two-way ANOVA. This study addressed the following research questions and hypotheses:

RQ1: Do professional ice hockey players experience generalized anxiety symptoms related to the number of concussions?

H_o1: There is no statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

H_a1: There is a statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

RQ2: Do professional ice hockey players experience generalized anxiety symptoms related to concussion severity?

H_o2: There is no statistically significant relationship between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

H_a2: A statistically significant relationship exists between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

Threats to Validity

The present study contained several opportunities that could threaten validity, and it was essential to address such issues. Because the essence of this study was predicated on self-reported research and survey questions, one prevalent threat to validity was the

accuracy and honesty with which the participants answered the questions. The independent variables from Research Questions 1 and 2 were the results of self-reported number of concussions and concussion severity, respectively. If the participant had difficulty remembering either, validity must be questioned. The dependent variable was generalized anxiety measured by the GAD-7.

Again, if the participant had difficulty remembering or was uncomfortable with answering such questions, then validity must be questioned. The validity in truthfulness should be sound and reinforced because the survey length was short, the questions were simple, and every measure to assure anonymity was explained and outlined to the participant. Because the events in question, concussions, might have been documented or the participant might have known the possible concussion symptoms (if undocumented), they should be able to recall such events. An internal validity threat might have been the misuse of statistical programs (SPSS), which could have skewed the resulting information.

Another internal validity threat might have entailed not addressing all possible statistical points of view for the collected data. This process was used to solidify future study recommendations but riddled the present study with questions. One final threat to validity was obtaining the desired number of participants to meet the parameters of the power analysis. Suppose at least 42 participants were not obtained. In that case, adjustments were made in the power analysis to coincide with the actual number of participants to represent the study's validity accurately.

Ethical Procedures

Agreement to gain access to participants or data was completed through a consent statement in the participation flyer. The statement read,

> If you think you might like to take part in this study, please click HERE to read the consent form and start the survey. If you do not wish to take part, then please ignore this e-mail and have a nice day.

The sampling strategy was through the snowball sampling method. Therefore, the link and email sent out to the initial contact listing were sent further by the contacts themselves. In other words, they were sent to and by "friends of friends."

Because the sole data collection method was through an online survey taken from the participant's device (phone, computer, or tablet), contact with human subjects extended to the distribution of the participation flyer and survey link embedded within the flyer. No other contact was necessary, nor was it entertained. The exact participation flyer used for distribution is presented in Appendix A.

This survey was anonymous, and at no time was the participants' personal information used, nor were the answers given to the survey questions connected to the participants in any way. Aggregate data were not shared or included in the final report to add another level of anonymity. Aggregate data could not have pinpointed the participant's team, former or present, played for, exact age, and position. Participating in this survey did not pose any risks beyond those of typical daily life.

All data were secured under a password-protected Apple MacBook Air laptop, where they were kept under double lock and key when stored and not in use. All data

associated with the surveys will be stored for no longer than 5 years after all statistical calculations have been executed and documented and the dissertation process completed. Back-up devices were also used in case of a catastrophic emergency. Devices included one password-protected and encrypted thumb drive.

Summary

Chapter 3 examined the research design and rationale. The research methodology detailed the population, sampling and sampling procedures, and recruitment procedures. The instrumentation and operationalization of constructs were explained. Finally, the data analysis plan and possible threats to validity were addressed.

Chapter 4: Results

The purpose of this quantitative study was to determine whether professional ice hockey players experienced a form of generalized anxiety when they returned to play following a severe concussion. The following research questions and hypotheses were developed for this study:

RQ1: Do professional ice hockey players experience generalized anxiety symptoms related to the number of concussions?

H_o1: There is no statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

H_a1: There is a statistically significant relationship between the independent variable number of concussions and the dependent variable generalized anxiety as measured by the GAD-7.

RQ2: Do professional ice hockey players experience generalized anxiety symptoms related to concussion severity?

H_o2: There is no statistically significant relationship between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

H_a2: A statistically significant relationship exists between the independent variable concussion severity and the dependent variable generalized anxiety as measured by the GAD-7.

Chapter 4 provides the research findings and highlights the data collection and analysis process. The pilot study results and data collection are also explained. Finally, the results are used to answer the research questions and confirm either the null or alternative hypothesis for both.

Pilot Study

To ensure the survey worked correctly and the questions were understood, a small pilot study was conducted to test the survey process the participants experienced. Five family members were recruited and given the email solicitation flyer that was given to the participants, at which time they executed the survey process. The results showed that the process was understood, and the survey questions were easily followed, rendering the venture successful.

Data Collection

Data collection started the day the Institutional Review Board approved the study. The approval number given for this study was 03-22-24-0236363, with an expiration date of March 21, 2025. The goal was to wait until I obtained a sample of at least 50 participants to allow the inclusion protocol to work should it be needed. The anticipated 2 weeks to gather such a sample size needed to be increased, and 2 additional weeks were required to obtain 50 participants. There was no resistance to the survey, and it was well received by those who decided to contact me. Many players personally thanked me for dedicating my dissertation to such a topic and helped me in any way they could, mostly with survey distribution. I sent 252 flyers via email, Facebook Messenger, and text message.

The collected data were mostly complete with little ambiguity. Six surveys indicated a range of concussions, and I had to either exclude their responses or develop additional protocols to keep the data. New measures were taken, and the data were accepted. The new protocol developed was to interpret the data in an average; in other words, if the participant said they experienced between two and four concussions, the data were interpreted as the participant experienced three concussions. An additional measure was to include NCAA Division 1 athletes (three) who were given the name, image, and likeness compensation. Finally, one professional roller hockey player participated.

Fifty participants completed the survey, and 42 were required per the power analysis. Of the 50 participants, 48 met the inclusion criteria. Of the 48, 17 were ages 25–34, 13 were ages 45–54, 11 were ages 35–44, four were ages 55–64, and three were ages 18–24. In positions in ice hockey, 12 participants were 12 centermen, 12 were left wingers, nine were left defensemen, seven were right wingers, four were right defensemen, and four were goaltenders. The participants represented several professional leagues worldwide. Twelve came from the ECHL, six were from the AHL, five were from the NHL, five were from the Michigan Independent Hockey League, five were from the Federal Prospects Hockey League, three were from NCAA Division 1, three were from the French Professional League, two were from the Swedish professional league, one was from the Kontental Hockey League, one was from the British Elite League, one was from the European Professional Hockey, one was from Major League Roller

Hockey, one was from the National Ice Hockey League, and two indicated “Other” with no specificity.

Results

A two-way ANOVA using SPSS Version 29 was conducted to determine whether there was a statistically significant number of concussions and concussion severity mean GAD-7 differences among former and current professional ice hockey players. The independent variable in Research Question 1 was number of concussions with two groups: Group 1 with one to three concussions and Group 2 with four or more concussions. The independent variable in Research Question 2 was self-reported concussion severity with two groups: Group 1 with Severity Levels 1 through 3, and Group 2 with Severity Levels 4 through 7 (see Table 1). The reported GAD-7 result was the scale-dependent variable with a possibility of a high score of 21, where each question in the GAD-7 had a possibility of 3 points. A total of 50 participants took the survey, but two were excluded because of not meeting the inclusion criteria. The remaining 48 participants met all of the criteria required to take the survey (see Table 2). Statistical results produced by the two-way ANOVA indicated a relationship between the number of concussions and GAD-7 results in Research Question 1, confirming the alternative hypothesis. The results also confirmed the null hypothesis in Research Question 2, indicating no relationship between concussion severity and GAD-7 results (see Table 3).

Table 1

Between-Subjects Factors

Variable	Number	Value label	N
Number of concussions	1.0	1–3 concussions	34
	2.0	4 or more concussions	14
Concussion severity	1.0	1–3 concussion severity	23
	2.0	4–7 concussion severity	25

Table 2

Descriptive Statistics: Dependent Variable: GAD-7 Results

Number of concussions	Concussion severity	*M*	*SD*	*N*
1–3 concussions	1–3 concussion severity	4.95	4.708	19
	4–7 concussion severity	6.40	4.997	15
	Total	5.59	4.819	34
4 or more concussions	1–3 concussion severity	10.50	7.416	4
	4–7 concussion severity	11.10	4.725	10
	Total	10.93	5.313	14
Total	1–3 concussion severity	5.91	5.501	23
	4–7 concussion severity	8.28	5.335	25
	Total	7.15	5.489	48

Table 3

Tests of Between-Subjects Effects: Dependent Variable: GAD-7 Results

Source	Type III sums of squares	*df*	M^2	*F*	Sig.	Partial ETA^2	Noncent. parameter	Observed power[b]
Corrected model	301.532[a]	3	100.511	3.968	.014	.213	11.905	.799
Intercept	2313.090	1	2313.090	91.324	<.001	.675	91.324	1.000
Concussion numbers	223.986	1	223.986	8.843	.005	.167	8.843	.829
Concussion severity	8.978	1	8.978	.354	.555	.008	.354	.090
Concussion numbers Concussion severity	1.549	1	1.549	.061	.806	.001	.061	.057
Error	1114.447	44	25.328					
Total	3867.000	48						
Corrected total	1415.979	47						

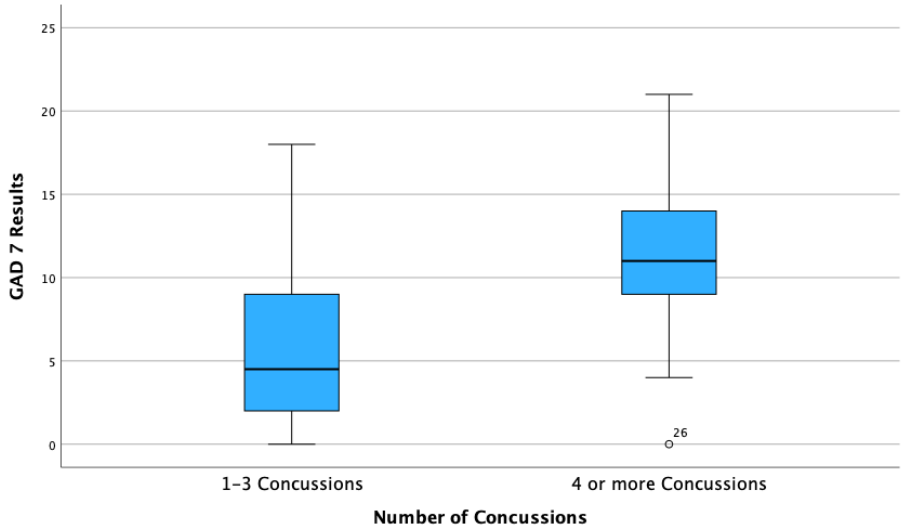
[a]. $R^2 = .213$ (Adjusted $R^2 = .159$)

[b]. Computed using alpha = .05

Preliminary analyses were conducted to examine the assumptions of outliers, normality, and equality of variances. One outlier was identified in the four or more concussions group (see Figure 3), which was retained in the analysis.

Figure 3

Number of Concussions



Results showed that the number of concussions affected the GAD-7 scores, $F(1, 44) = 8.843$, $p = .005$, partial $n^2 = .167$. Four or more concussions ($M = 10.8$) had higher GAD-7 scores than those with one to three concussions (see Tables 3 and 4).

Table 4

Number of Concussions: Dependent Variable: GAD-7 Results

Number of concussions	*M*	*SE*	95% confidence interval	
			Lower bound	Upper bound
1–3 concussions	5.674	.869	3.922	7.425
4 or more concussions	10.800	1.489	7.800	13.800

There was no significant evidence that concussion severity affected the GAD-7 scores: $F(1, 44) = .354$, $p = .555$, partial $n^2 = .008$. Concussion severity rated 4 through 7 ($M = 8.750$) had higher GAD-7 scores than concussion severity rated 1 through 3 ($M = 7.724$; see Tables 3 and 5).

Table 5

Concussion Severity: Dependent Variable: GAD-7 Results

Concussion severity	*M*	*SE*	95% confidence interval	
			Lower bound	Upper bound
1–3 concussions	7.724	1.384	4.934	10.514
4–7 concussions	8.750	1.027	6.680	10.820

There was no significant evidence that the number of concussions by concussion severity affected GAD-7 scores, $F(1, 44) = .061$, $p = .806$, partial $n^2 = .001$ (see Tables 3 and 6).

Table 6

Number of Concussions and Concussion Severity

Number of concussions	Concussion severity	*M*	*SE*	95% confidence interval	
				Lower bound	Upper bound
1–3 concussions	1–3 concussion severity	4.947	1.155	2.620	7.274
	4–7 concussion severity	6.400	1.299	3.781	9.019
4 or more concussions	1–3 concussion severity	10.500	2.516	5.429	15.571
	4–7 concussion severity	11.100	1.591	7.893	14.307

The implications for positive social change include evidence for further education in the field of concussion quantities and to illustrate such risks to not only the player and coaching staff but also to those who spend a prolonged time with the player, such as parents and significant others.

Levene's test of equality of error variances indicated that the assumption of equal variances of the two-way ANOVA was satisfied, given that the *p* value was above .05 (see Table 7).

Table 7

Levene's Test of Equality of Error Variances[a, b]: GAD-7 Results

Test	Levene statistic	*df1*	*df2*	Sig.
Based on *M*	.592	3	44	.624
Based on *Mdn*	.250	3	44	.861
Based on *Mdn* and with adjust *df*	.250	3	38.603	.861
Based on trimmed *M*	.514	3	44	.675

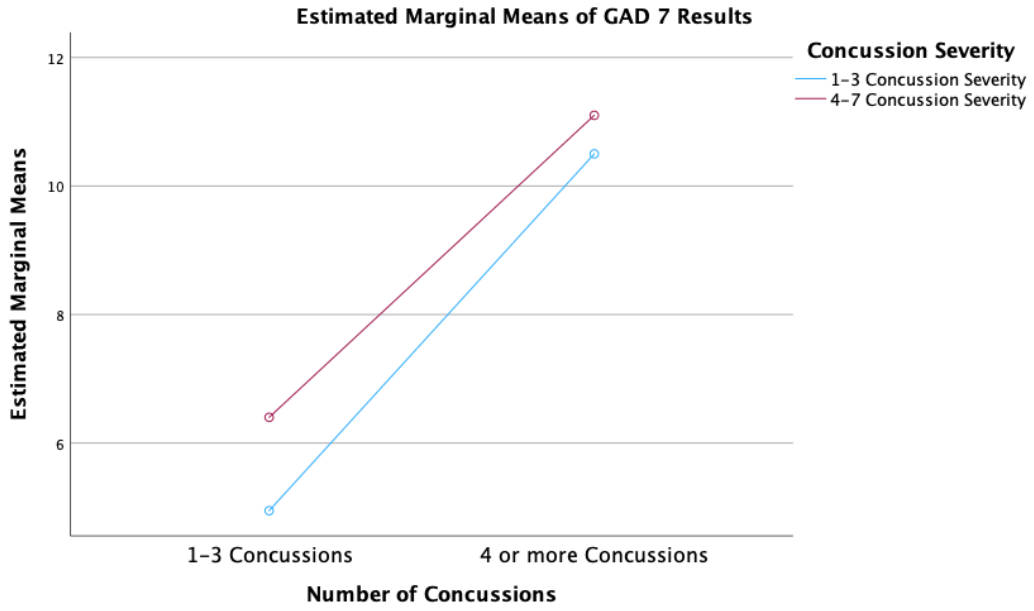
Note. Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

[a]. Dependent variable: GAD-7 results

[b]. Design: Intercept + ConcussionNumbers + ConcussionSeverity + ConcussionNumbers * ConcussionSeverity

Figure 4

Estimated Marginal Means of GAD-7 Results



Summary

Chapter 4 provided the research findings and highlighted the data collection process. The results answered the research questions. Statistical results produced by the two-way ANOVA indicated a relationship between the number of concussions and GAD-7 results in Research Question 1, confirming the alternative hypothesis. The results also confirmed the null hypothesis in Research Question 2, indicating no relationship between concussion severity and GAD-7 results. Chapter 5 provides an interpretation of the findings, limitations, research recommendations, and implications for social change.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this quantitative study was to determine whether professional ice hockey players experienced a form of generalized anxiety when they returned to play following a severe concussion. The research design included a questionnaire and measure of generalized anxiety to answer the research questions. Participants received a self-rated 7-point Likert-scale ranking of the severity of their concussion.

The categories were 1 (*very mild*), 2 (*mild*), 3 (*somewhat moderate*), 4 (*moderate*), 5 (*severe*), 6 (*very severe*), and 7 (*extreme*). A 1 (*very mild*) represented almost nonexistent symptoms, but the player was determined to have a concussion. A 2 (*mild*) represented having slightly higher symptoms such as mild headache, nausea, balance problems, dizziness, fatigue, and sensitivity to noise and light (Iverson et al., 2022). A 3 (*somewhat moderate*) represented symptoms in which the player needed to sit on the bench and gather their faculties. The player might have felt like they had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog (Iverson et al., 2022). A 4 (*moderate*) represented a player who had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that would last for a few days (Iverson et al., 2022).

A 5 (*severe*) represented a Grade 2 concussion in which there was a temporary loss of consciousness or amnesia. The player also had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that lasts for a few days (Horne, 2018; Iverson et al., 2022).

A 6 (*very severe*) was a Grade 3 concussion in which there was a temporary loss of consciousness accompanied by a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, trouble concentrating and remembering, and mental fog that lasts for a few days (Horne, 2018; Iverson et al., 2022). A 7 (*extreme*) represented all symptoms of a Grade 3 concussion. The player had a headache, nausea, balance problems, dizziness, fatigue, sensitivity to noise and light, difficulty concentrating and remembering, and mental fog that lasts for over 1 week. The player also could have experienced heightened emotions and trouble falling asleep (Horne, 2018; Iverson et al., 2022).

Participants were also asked how many concussions they had experienced in their lifetimes. The independent variable in Research Question 1 was number of concussions with two groups: Group 1 with one to three concussions and Group 2 with four or more concussions. The independent variable in Research Question 2 was self-reported concussion severity with two groups: Group 1 with Severity Levels 1 through 3 and Group 2 with Severity Levels 4 through 7. Furthermore, participants were asked to take a short survey to recall their anxiety levels after experiencing their most severe self-reported concussion. The 7-question GAD-7 measured general anxiety traits for the period encompassing the athlete's most severe self-reported concussion (see Spitzer et al., 2006). The GAD-7 survey was administered to a sample population of 48 players who had played at least 10 games in a professional ice hockey league and had experienced concussion symptoms.

Interpretations of the Findings

The IU model details anxiety regarding fear and anticipation of the unknown or future uncertainty after a concussion (Chen et al., 2018; Reuman et al., 2015). IU can help explain the genesis of the player's general anxiety levels after a concussion. Carleton (2016) defined IU as "an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (p. 20). Anything can trigger IU (Nader, 2020). Statistical results produced by the two-way ANOVA indicated a relationship between the number of concussions and GAD-7 results in Research Question 1, confirming the alternative hypothesis and affirming the IU model explaining such behavior.

The results also confirmed the null hypothesis in Research Question 2, indicating no relationship between concussion severity and GAD-7 results, leading one to believe that the IU model would not apply to concussion severity under the parameters of the current study. Further investigation is required to either confirm or disconfirm this result. Although anxiety in sports is commonplace (Collins & Winter, 2020), research suggested that anxiety from concussions has been found in NCAA athletes in several sports, including ice hockey (D'Alonzo et al., 2022). The current study's results corroborate those in a professional athletic capacity.

Youth ice hockey athletes and collegiate athletes from many sports have been found to underreport concussions due to a lack of concussion awareness (Meier et al., 2015). Meier et al. (2015) stated that "unlike the cognitive symptom domain, the

psychiatric and portions of the somatic domains remain uniquely vulnerable to underreporting" (p. 20). Meier's results confirm many of the participant interactions in my study. Several players contacted me to ask more questions about the subject matter. One player contacted me and told me that when he played, there was an understanding that when people got their "bell rung" or experienced concussion symptoms, they sat on the bench until their vision cleared and continued with the game. They did not realize how concussions could affect their general anxiety levels and were eager to help with the study, which would add to the existing literature and attempt to fill that knowledge gap.

Limitations of the Study

The surveys were anonymous, and the demographic data were limited to a participant's primary position, the league in which they played, and their age. Obtaining the desired number of completed surveys proved challenging because the participant pool was exclusive. Many players failed to answer the survey. Reasons were speculated, but one of the potential participants mentioned that if they were contacted during the offseason, they would be more apt to participate. The ease of online survey platforms such as SurveyMonkey and the relatively short time to take the survey helped alleviate the logistical problems in distribution to the population group.

Another suspected limitation was the inaccurate data given by a participant who did not take the survey seriously or had difficulty comprehending a question. One participant had to be excluded from the study because they did not specify a number of concussions. Finally, the participant's ability to recall their feelings after the injury could have been difficult and could have produced inaccurate data. Asking the participant to

recall their most traumatic concussion could have helped them recall the details of how they felt, given the significance and trauma of the event. Finally, many players might have felt uneasy about the subject matter and ignored the participation request. Addressing such potential pitfalls as a disclaimer with the final product was vital.

Recommendations

A recommendation for further study on the subject matter is to use different surveys other than the GAD-7 to measure anxiety. For example, Rios et al. (2021) elected to study the relationships between anxiety and the psychological aspects of sports performance in high-performance athletes using a cross-sectional and correlational study on 63 participants from the sports of softball, soccer, and baseball. The vehicles used to gain the pertinent data were the Questionnaire on Sports Aspects and Injuries, the State-Trait Anxiety Inventory, the State in Competition Anxiety Inventory, and the Psychological Inventory of Sports Execution. Rios et al. found that softball athletes were more anxious during competitions, whereas soccer athletes suffered more serious injuries. Rios et al. also concluded that the psychological variables correlated with the athlete's performance were self-confidence, negative coping control, positive coping control, and attention control.

An additional recommendation is the creation of a specialized survey that focuses on a hockey player's environment concerning anxiety. The GAD-7 was a good measuring tool. However, a survey tailored to the hockey player could help a researcher focus on more specialized forms of anxiety.

The current study could be replicated with the addition of player interviews through a mixed-methods study. Such a study may include interviewing hockey players fitting the inclusion criteria. Such interviews may present a more in-depth profile of the concussed player and reveal the essence of the phenomenon to the readers, possibly creating empathy with those affected.

To help accentuate the increase in participation, a power analysis was conducted using the program G*Power for Mac, last updated in June 2023 (see Appendix D; Faul et al., 2007). The analysis outlined the research questions and highlighted the independent and dependent variables and a recommended sample population of 42. The *F*-test family for an ANOVA fixed effects, special effects, main effects, and interactions was conducted. The type of analysis conducted was a priori, which computed the required sample size—given α, power, and effect size. The input parameters were as follows: effect size *f* = 0.5, α err prob = 0.05, Power (1- β err prob) 0.8, numerator *df* = 2, and number of groups = 2 (see Sullivan & Feinn, 2012). The output parameters were as follows: noncentrality parameter λ = 10.5000000, critical *F* = 3.2327270, denominator *df* = 40, total sample size = 42, and actual power 0.8042360. The parameters were chosen because of the realistic ability to obtain a sizeable participant sample with at least an 80% power rating. A higher participant sample was unattainable.

If all variables were kept constant except for the effect size of *f*, the required number of participants could be increased. It is recommended that the effect size (*f*) be decreased from 0.5 to 0.25, increasing the required number of participants from 42 to 158. The higher the number of participants, the more accurate the results.

Finally, if this study is replicated, it is suggested that any survey question be changed from an open-ended format to a multiple-choice format. Regarding the current study, one may change the number of concussions sustained from an open-ended question to a multiple-choice question of sustained concussions such as one to three concussions, four to six concussions, and seven or more concussions. This format change may help stave off any doubt about the accuracy of the question.

Implications

On a macro level, the results of this study help bring attention to an invisible injury (concussions) and accentuate the many dimensions of such an injury, in this case general anxiety. Highlighting one sport and one demographic of a sport shows that general anxiety is linked (to a certain degree) to concussions. On a micro level, understanding that general anxiety levels can be affected because of a concussion allows those closest to the hockey player to take notice and urge them to seek treatment once symptoms begin to manifest (often, unbeknownst to the player). Perhaps psychopharmacology or psychotherapy are the answers to relieve anxiety symptoms. Either way, the player has options for treatment. If those closest to them (family, friends, coaches, or trainers) notice the heightened sense of general anxiety after a concussion, then they can help persuade the player toward treatment.

Conclusion

Concussions are injuries that no one can see with the naked eye, and if a person is keen to the symptoms, they may be able to mask them. Understanding the destructive nature of this invisible injury and how it affects many aspects of a person's life is the first

step in treating such an injury. General anxiety is one dimension of many that can be caused by a concussion. Understanding that the victim may have psychological damage because of the concussion is vital in diagnosis and treatment. Pushing the limits of the human body beyond the concussion without treatment may not be the wisest decision given the unpredictable aftermath of the injury.

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Appendix A: Invitation Flyer to Participate

Dear Sir,

You are invited to participate in a survey for my doctoral dissertation, which I am completing as the final part of my doctoral program. The purpose of the survey is to gather data from those who have sustained one or more concussions while playing professional ice hockey. The self-reported survey will include the highest professional level in which you played in at least ten games (NHL, AHL, ECHL, other), your primary position, your age range, the number of concussions you sustained, a self-reported rating of your most severe concussion, and a seven-question survey that measures general anxiety after the most severe self-reported concussion.

This online survey is voluntary and should take five minutes to complete. This survey is anonymous, and at no time will your personal information be used, nor will the answers you give be connected to you in any way. Participating in this survey would not pose any risks beyond those of typical daily life, and no monetary compensation will be given.

If you think you might like to take part in this study, please click HERE to read the consent form and start the survey. If you do not wish to take part, then please ignore this email and have a nice day. If the above hyperlink labeled "HERE" does not work, the exact address of the survey is https://www.surveymonkey.com/r/2G53DWM.

It is suggested that you save this consent for your records. If you have any questions or concerns, please feel free to give me a call, text, or email me. If you wish, my University Research Participant Advocate can be reached at (612) 312-1210 or via

email at irb@mail.waldenu.edu should you have any ethical concerns or complaints.

Thank you for your time.

Respectfully,

Edward L. Yerage, MS

Doctoral Candidate, Doctor of Psychology

Walden University

[redacted]

Cell: [redacted]

Appendix B: SurveyMonkey Questions

*****Hyperlinked to Survey Monkey for the following questions:

1. What is the highest level of professional ice hockey in which you played at least ten games? NHL/AHL/ECHL/OTHER
    a. If "other," please specify
2. What was/is your primary position? C/LW/RW/LD/RD/G
3. What is your age range? 18-25 26-30 31-40 41-50 >50
4. How many concussions have you sustained throughout your lifetime?
5. On a scale of 1 through 7 where (1) very mild, (2) mild, (3) somewhat moderate, (4) moderate, (5) severe, (6) very severe, and (7) extreme, how would you rate your most severe experienced concussion? 1 2 3 4 5 6 7

*Questions six through twelve are the GAD 7 survey

Appendix C: GAD-7 Survey Use Permission

PsycTESTS®

Generalized Anxiety Disorder 7

PsycTESTS Citation:
Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). Generalized Anxiety Disorder 7 [Database record]. Retrieved from PsycTESTS. doi: https://dx.doi.org/10.1037/t02591-000

Instrument Type:
Screener

Test Format:
Subjects are asked how often, during the last 2 weeks, they were bothered by each symptom. Response options were “not at all,” “several days,” “more than half the days,” and “nearly every day,” scored as 0, 1, 2, and 3, respectively.

Source:
Supplied by author.

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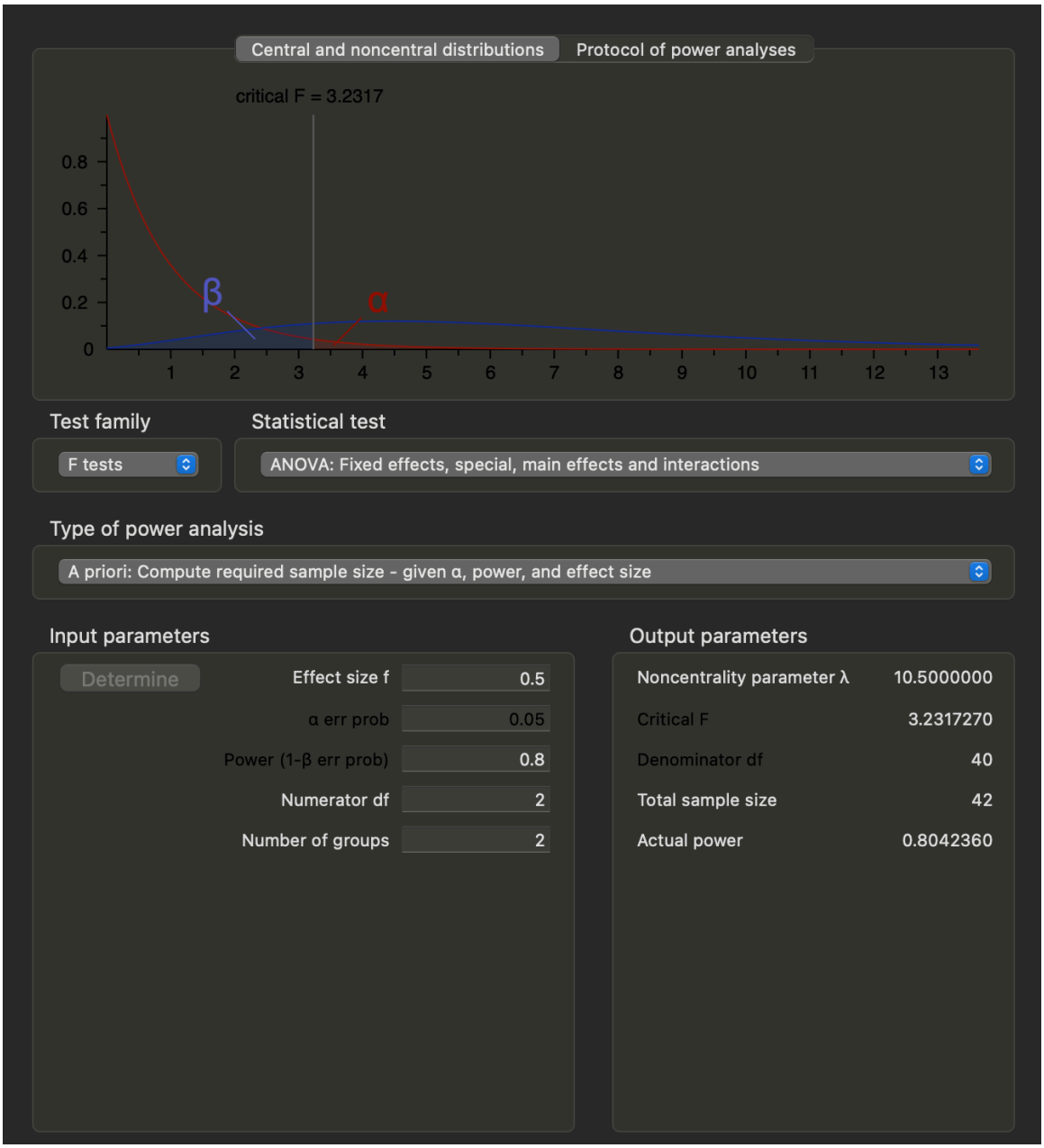
Appendix D: G*Power Analysis



Appendix E: Generalized Anxiety Disorder - 7

Developed by Spitzer et al. (2006)

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). Generalized Anxiety Disorder 7 [Database record]. Retrieved from PsycTESTS.

https://doi.org/10.1037/t02591-000

Instrument Type: Screener

Test Format: Subjects are asked how often, during the last 2 weeks, they were bothered by each symptom. Response options were “not at all,” “several days,” “more than half the days,” and “nearly every day,” scored as 0, 1, 2, and 3, respectively.

Source: Supplied by author.

Appendix F: Consent Form

Dear Sir,

You are invited to complete an anonymous survey by a Walden University student working toward a doctoral degree.

Study title: Concussion Severity and Generalized Anxiety in Professional Ice Hockey Players

Doctoral student name: Edward L. Yerage

Doctoral student contact information: email: [redacted] Cell: [redacted]

Number of volunteers needed: 42

Number of minutes needed for survey: 5

Volunteers must be:

- At least 18 years of age or older
- Have played in at least 10 professional ice hockey league games (NHL/AHL/ECHL/Other)
- Must have sustained a concussion or experienced concussion symptoms

Your role:

- can end any time you wish
- involves no more risk than daily life
- involves no payment

Privacy:

To protect your privacy, the doctoral student will not collect, track, or store your identity or contact info. In place of a consent signature, your completion of the survey would indicate that you consent to your responses being analyzed in the study. Data will be kept secure by using password-protected devices and platforms. Data will be kept for a period of at least 5 years, as required by the university.

Use of your responses:

Your survey responses will be used for academic research purposes only. Once the doctoral student graduates, the study's results will be posted online in Scholarworks (a searchable publication of Walden University research).

Protecting You:

If you want to talk privately about your rights as a participant or any negative parts of the study, you can call Walden University's Research Participant Advocate at 612-312-1210 or email IRB@mail.waldenu.edu. Walden University's approval number for this study is 03-22-24-0236363 and it expires on March 21, 2025. You might wish to retain this consent form for your records. You may ask the doctoral student or Walden University for a copy at any time using the contact info above.