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Does Knowledge of Concussion Symptoms Influence an Athlete's Self-Report of History of Concussion Across Age Groups?

John Pfirman
University of Texas at El Paso, jgpfirman@gmail.com

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JOHN PFIRMAN

Program in Speech-Language Pathology

APPROVED:

Anthony P. Salvatore, Ph.D., Chair

Bess Sirmon-Taylor, Ph.D.

Jennifer Sanchez, Ph.D.

Charles Ambler, Ph.D.
Dean of the Graduate School

DOES KNOWLEDGE OF CONCUSSION SYMPTOMS INFLUENCE AN ATHLETE'S SLEF-REPORT OF HISTORY OF CONCUSSION ACROSS AGE GROUPS?

by

JOHN PFIRMAN, B.A.

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Abstract

Purpose: The purpose of this study was to determine if an athlete's self-report of a history of concussion would increase if they are provided with information about concussions.

Study Design: This study used a group design pre-test information group and a post-test information group matched for age.

Methods: Prior to cognitive testing, the athletes were divided into an experimental and control group. The experimental group received information about concussions before taking the cognitive test. The control group did not receive concussion information before cognitive testing. Both groups completed a questionnaire following testing that asked: "Based on your experience here today, do you think you have ever had a concussion?"

Results: A Chi square analysis found that the proportion of those who self-reported a history of concussion was not significantly different between those who received information and those who did not receive information prior to testing (p=0.183). An additional chi square analysis found that age of the athletes was not a factor (p=0.199).

Conclusions: This study concluded that information provided to an athlete about a concussion is not a significant factor in whether or not that individual self-reported a concussion. The study also found no statistically significant changes between age groups. Therefore, this study suggests there may be other factors that play a greater role in predicting self-reporting of concussions.

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Chapter 1: Literature Review

1.1 Introduction

Concussions are becoming an international health crisis. Affecting more than 1.7 million people in the United States annually, concussions are an ongoing risk both for athletes and non-athletes (CDC, 2011). The diagnosis and prognosis of a concussion can be difficult to address. The short-term effects and long-term consequences of a concussion are still not fully understood by health care professionals. Assessment protocols still widely vary among caregivers. The prevalence and implications of a concussion are also under scrutiny by a larger mainstream population, affecting not only athletes and other individuals who are at risk, but also those who are responsible for reporting concussions such as coaches and athletic trainers. Therefore, it is important to understand the politics of honest and accurate reporting and self-reporting concussions.

Many variables could potentially influence accurate self-reporting of concussion. This study specifically focuses on whether descriptive information about concussions or the lack thereof, is a factor that influences self-reporting a history of previous concussion. A lack of knowledge about concussion symptoms may prevent individuals from identifying a concussion. The possibility that the prevalence of concussions may be much higher than is actually reported by high school and college athletes is a major factor in this crisis. This study addresses the idea that knowledge of concussion symptoms will increase the frequency of reporting history of concussion, as athletes are likely to experience more concussions than are reported. This study also examines any potential differences where age could be a factor.

1.2 Incidence of Concussion

The incidence of sports-related concussion is debatable. While Centers for Disease Control and Prevention (CDC, 2011) reports an extrapolated incidence of 1.6 to 3.2 million recreational/sports-related traumatic brain injuries (TBIs) a year, the suspicion is that the incidence is much higher. The exclusion of athletes who sustain an injury to the brain but do not visit the ER underestimates the incidence rate of concussions. Puga (2011) reported that the incidence of sports-related concussion admitted to the emergency departments in El Paso hospitals was statistically smaller than the incidence reported by athletic trainers in the El Paso high schools. A cursory inspection of the incidence of concussion reported by El Paso high school athletes during preseason baseline testing suggests an incidence of approximately 25% (Puga, 2011). Carroll, Cassidy, Holm, Kraus, and Coronado (2004) reporting for the World Health Organization (WHO) Collaborating Centre Task Force on Mild Traumatic Brain Injury stated that 25% of mild TBIs are seen in children 5-14 years of age. While Guskiewicz, Marshall, Bailes, McCrea, and Harding (2000) reported approximately 5% of high school and collegiate athletes, experience a concussion each season. In general, the data above suggests that the actual incidence rate of concussion is higher than what is reported by athletes.

The problem of undiagnosed concussions clearly relates to how a concussion is reported. An important consideration in determining the incidence involves whether concussions are self-reported by the athlete, determined through sideline diagnosis, or documented via admission to an emergency department. A recent study examining self-report concussions of NFL athletes showed that when asked during face-to-face interviews the athletes reported a history of concussion at a rate of approximately 15%,

but when asked to report the incidence anonymously, 75% reported a history of concussion (Guskiewicz et al., 2007). A second consideration is, whether an athlete's knowledge of what constitutes a concussion influences self-report of a history of concussion. According to Puga (2011), the most common reason for not reporting a concussion is lack of knowledge; athletes admitted to having experienced a concussion only after researchers provided a definition of concussion to athletes.

Another reason for underreporting may be related to severity perception. For example, McCrea, Hammeke, Olsen, Leo, and Guskiewicz (2004) reported that high school football players failed to report a probable concussion because they did not think it was sufficiently serious. It has long been thought that football players were hesitant to report a concussion based exclusively on competitive factors—their motivation not to be withheld from competition. However, the survey results suggest that lack of knowledge related to the risks and potential consequences of concussion play an equal or greater role in high school football players not reporting a probable concussion. When provided a definition of concussion and a description of injury signs and symptoms, the players more readily recognized and admitted to sustaining a concussion over the course of the football season (McCrea et al., 2004).

1.3 The Coach Factor

Although knowledge of concussion symptoms may increase the self-report of concussion, the influence of coaches and athletic trainers may also affect whether or not athletes will report symptoms. The motivation to win a football game cannot be underestimated. This is true for both the athlete and the coach. During a game, a coach simultaneously faces the pressure to win from cheering fans, hopeful parents, and the

coach's employer at the high school or college. Historically, this pressure to win the game has caused coaches to tell the athlete to "shake it off" or "get back in the game" when the athlete presents with concussion symptoms. This becomes a major health concern when the athlete has indeed sustained a concussion and returns to play. The athlete could be seriously injured due to cognitive or balance impairments from the concussion. The athlete could also be fatally injured due to second-impact syndrome, which results from rapid swelling of the brain due to a second concussion that can result in death (Cantu, 1998). To protect athletes from coaches allowing them to return to play, every state in the United States now has concussion legislation to protect youth or high school athletes. These are often called "Return to Play Laws."

In general, these pieces of legislation have three action steps. They are: (1) to inform and educate coaches, athletes, and parents; (2) to remove from play athletes presenting with concussion symptoms; and (3) to return an athlete to play only after being cleared by a physician (CDC, 2014). The legislation in Texas that follows this protocol, Natasha's Law, passed in 2011. The problem with this legislation is that it is not appropriately enforced. Part of this is due to the overlap of concussion symptoms with symptoms that may be experienced from the fatigue of a football game. Symptoms such as nausea, headaches, dizziness, and impaired balance may not be the result of a concussion, and a coach's judgment to allow an athlete to return to play is subjective. Another problem may be due to a coach's lack of education or knowledge of concussion symptoms, inhibiting an appropriate on-field decision.

A study by Covassin, Elbin, and Sarmiento (2012) assessed the perception of youth sports coaches in preventing, recognizing, and responding to concussions. In their

study, the authors identified coaches who had exposure to the "HEADS UP: Concussion in Youth Sports" material for at least 6 months. The coaches in the study had an average coaching experience of 7.8 years. The authors chose this educational medium of concussions after surveying other sources, concluding that CDC's HEADS UP: Concussion in Youth Sports material was the most effective educational resource for coaches. The authors claimed that the HEADS UP: Concussion in Youth Sports medium is geared toward youth sports coaches, providing clear signs and symptoms of concussion.

In their study, Covassin et al. (2012) administered to the coaches a 22-item survey that included demographic information, how serious they thought concussions were, usefulness of concussion resources, and whether or not they thought it was their role to educate the athlete about concussion. The results of the study concluded that 20% of the coaches reported observing a concussion during the season, 72.3% alerted the athlete's parents of a suspected concussion, 65% removed the athlete from play, and 62.6% now view a concussion as a more serious injury. Seventy-seven percent of the coaches reported being able to identify athletes presenting with concussion symptoms. The authors concluded that the study allowed coaches to respond and recognize concussions following exposure to this educational module. Although the study showed that coaches reported that they were better able to recognize and respond to concussions after education, it did not show that they would respond to concussion symptoms during a game. Reporting in a survey that you would respond, and responding to the pressures of a game are two different things. This study also neglected to address the effects of directly educating the athletes about concussion, and how this would increase reporting of

concussion symptoms by athletes and their coaches. Even if provided with the appropriate education, it is still questionable whether coaches will encourage athletes to report symptoms of a concussion appropriately, given all the pressures of a football game.

A recent study by Baugh, Kroshus, Daneshvar, and Stern (2014) examined the perception of support for athletes reporting concussions to their coaches and if there was a difference between an athlete's grade level in school. The investigators used a convenience sample of 734 football players from 10 colleges, including 230 freshman, 164 sophomores, 189 juniors, and 134 seniors. All of the athletes were administered a survey in person asking questions about demographics, perceived concussion reporting, and frequency of concussions. As part of the survey, the athletes were asked to respond to the following: "If I report what I suspect might be a concussion, my coach would think I made the right decision." Responses were recorded using a 7-point Likert-type rating scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Results from the study indicated that perceived coach support between freshman and juniors and freshman and seniors were both significantly different; in both cases, the freshman had a greater perception that their coaches supported reporting of concussions. The authors concluded that upper classmen perceived less support from their coaches than younger athletes. The authors also concluded that lower levels of perceived coach support for concussion symptom reporting was correlated with significantly higher undiagnosed concussions. Results of this study suggest that if athletes perceive they are not getting support from their coaches, they are not going to report as many concussions. It also suggests that, although the coaches may have some understanding and education about concussions,

they are not encouraging their athletes to report symptoms of a concussion. Nonetheless, both the Covassin et al. (2012) study and the Baugh et al. (2014) study fail to recognize that accurate reporting of concussions starts with self-reporting from the athletes and not the coaches. These studies rely heavily on placing the responsibility of reporting concussions on coaches, instead of educating the athlete on what symptoms they should report and how an athlete can identify a concussion and the associated symptoms.

1.3 Concussion Terminology

For an athlete to accurately report the symptoms of a concussion, the athlete must know how to describe those symptoms. To appropriately educate an athlete about concussion symptoms, there must be a consensus among athletes, parents, coaches, and medical professionals about how to define the nature of the injury. However, research suggests that the terminology used to describe concussions varies greatly and is frequently contradictory.

A study by McKinlay, Bishop, and McLellan (2011) investigated the public's knowledge about concussion to see if different terminology changed whether or not they thought they had experienced a concussion in the past. The investigators conducted this study due to a lack of consistency in terms used to describe concussions. They explained that this confusion leads to uncertainty about what steps should be taken following an injury. This uncertainty may result in individuals not accessing the appropriate healthcare. In the study, 103 members of the general public were administered a survey where they were asked to identify whether they associated attributes with either brain injury or head injury, depending on which of the randomized questionnaires they received. Two groups of participants were asked to complete a questionnaire. One

groups' questionnaire used the term brain injury, and the other used the term head injury. In the brain injury group, participants were prompted to identify if they associated 15 attributes with brain injury. These included: kind, patient, greedy, hardworking, lazy, diligent, irritable, aggressive, distractible, eager, trustworthy, happy, sad, negative, or positive. The same questions were given to the participants in the head injury group. Following the questionnaire task, participants in both groups were asked: "Have you ever experienced a concussion?" Out of the 103 participants involved in the study, 28.3% reported having a concussion. More than half (58.6%) of the participants reported that they had received a concussion but had not experienced a head/brain injury. Furthermore, participants allocated different attributes depending on whether the term brain injury or head injury was used. The results showed that changes in the terminology affected reports by the participants about whether or not an injury occurred.

It is possible that if the participants from the general public had received a definition of a concussion, they would not have reported so many differences regarding the nature of their injuries. These differences may also exist when different groups of athletes are not provided with the same definition of a concussion. A study by Weber and Edwards (2010) showed that different terminologies or concepts of concussion in athletes lead to different self-reporting tendencies and different expectations of outcomes. Their study included 224 athletes aged 17-34, ranging in sports from hockey, football, and rugby. The participants were given a questionnaire, presented in three different versions, differing only in the terminology used to identify the nature of the brain injury. The terms used for the three groups in the study were a concussion, minor traumatic brain injury (mTBI), and mild head injury (mHI). An open-ended question asked the participant to

"state the single most important indicator of a concussion, mild traumatic brain injury or minor head injury" depending upon which questionnaire the participants received. The results of this study showed that the term mTBI was viewed as more negative and less familiar than the terms concussion and mHI. The authors also found that the athletes associated the term mTBI with a more serious injury from which an athlete may not recover. This study clearly shows that differing terminologies result in athletes having a different understanding of what a concussion is and how to appropriately define concussion symptoms. The study fails to evaluate the possibility of providing the same information about concussion to the athletes, and how this would affect their understanding of concussions. If athletes were provided with information about concussion terminology, including a definition of the nature of the injury and associated symptoms, then perhaps they could more accurately report those symptoms if they were experiencing them.

So how do we accurately define a concussion? A study by Snedden (2013) examined the history of defining the term "concussion" from antiquity to the present. Using historical and current resources, the author conducted a historical and modern analysis of the term. She suggested that the ambiguity of the different terms used to describe a concussion dates back several hundred years. The earliest known use of the notion of concussion, depending on the translation, was suggested to date back to 400 BC in the writings of Hippocrates. However, the term concussion had conceptual origins that began much later. In the 10th century, the Arabic physician Rhazes described the condition as "a transient abnormal physiological state without gross brain lesions". Lanfracus later described the condition as "brain commotion" and as a "separate entity

from that of other head injuries" (as cited in Snedden, 2013). The notion of "brain commotion" was expanded in the 13th century by de Carpi, who suggested, "the commotion resulted from the thrust of the soft structure of the brain against the hard skull." In the 17th century, the definition was broadened in relation to clinical contexts and physiological changes following an injury. The Age of Enlightenment developments added new depth to the conceptual notion of concussion, including ideas about the pathophysiology and brain mechanisms involved in the injury. Some of the pathological changes described during this period are still found in the diversity of concussion definitions today.

Snedden (2013) also conducted a modern analysis of the definition of concussion. Many of the definitions found included the terms "loss of consciousness" and "presence of amnesia." Other definitions included vague terms such as "stunning" and "shattering effects of a hard blow." Snedden (2013) points out that each definition varied significantly. They described variations of signs and symptoms, varied pathophysiologic processes, and different etiologies. Synonyms and antonyms were also examined to clarify the concept of concussion. Among the synonyms found were an impact, shock, collision, clash, jarring, jolt, and shaking. The antonyms include "perforating head injury," "open head injury," and "penetrating head injury." Finally, slang terms and uses were identified, taken from media sources and lay literature. Some of these terms included an injury that is "part of the game," being "dinged," and "getting your bell rung" (CDC, 2011).

Finally, Snedden (2013) discussed the importance of defining attributes of concussion that have a high frequency of use among different sources. The definition gleaned from these attributes is as follows:

> a complex, pathophysiological process that results from a traumatic bump, blow, or jolt to the head, or to the body with a force transmitted to the head causing simultaneous rotational acceleration of the brain. It results in the quick onset of short-term alterations in one or multiple domains (cognitive, physical, behavioral, and sleep) that may result in rare but severe and/or long-term effects. Generally, the symptoms are short-lived and resolve spontaneously. The presence of concussion does not require the loss of consciousness or amnesia, and it is without evidence of structural abnormality as evidenced by brain imaging. Presenting signs and symptoms of concussion vary between individuals and require individualized attention for evaluation, management, and follow-up. (pg. 216)

The CDC has clearly considered the historical, linguistic, and medical components that factor into a current definition of a concussion. The HEADS UP website defines a concussion as a "a type of traumatic brain injury-or TBI-caused by a bump, blow, or jolt to the body that causes the head and brain to move rapidly back and forth. This sudden movement can cause the brain to bounce around or twist in the skull, stretching and damaging the brain cells and creating chemical changes in the brain (CDC, 2015).

1.4 Differences Among Age Groups

The historical context of concussion, the modern analysis of its definition, and an operational definition by the CDC can be consolidated to provide information to athletes

to increase the likelihood that they will accurately report their symptoms. However, even if athletes are provided with the same terminology and information about concussions, there may be a difference in self-reporting between sub-groups of the athletes. For example, if there was a difference between males and females or between age groups, this may have implications for how or what type of concussion information should be given to athletes to increase the likelihood that they will report a concussion. A previous pilot study investigated how sub-groups of athletes compared in their report of a history of concussion when provided no standardized information about concussions. The pilot study, conducted in the Concussion Management Clinic (CMC) at The University of Texas at El Paso (UTEP), found a difference in reports of a history of concussion between age groups (i.e., 18 and over versus 17 and under).

The athletes assessed in the UTEP CMC are administered the ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing) test for baseline and post-concussion evaluation. This computer-administered test is the most-widely used and most scientifically validated computerized concussion evaluation system. Part 1 of the ImPACT test asks the test-taker to enter basic demographic and descriptive information through a sequence of easy-to-follow instructional screens. The athlete's answers are entered into a secure database at the UTEP CMC. One question posed in this section of the test asks about the athlete's concussion history, specifically, whether or not they have experienced a concussion, and if so, when it occurred. More specifically, the question asks if a physician has ever diagnosed the test taker with a concussion. The study analyzed a convenience sample of 101 athletes' answers to this question, taken from the CMC database. The number of concussions sustained by each athlete was not collected

for this study; the study only looked at the athlete's answer of whether or not they had ever been diagnosed with a concussion. Other information collected for the study included gender, age, grade, sport, and whether they were 18 and over or 17 and under. Data collected for the study involved high school and collegiate athletes from the El Paso area, as well as a semi-professional hockey team. The demographic information from the study is included below in Tables 1.1 to 1.6. The tables list the athletes' demographic information divided into the number of athletes that reported yes or no to a history of concussion. The percentages in Tables 1.1 to 1.6 were calculated for each respective group. For example, out of the 50 male athletes in Table 1.1, 11 (22.0%) reported a history of concussion and 39 (78.0%) reported no history of concussion. Similarly, out of the 51 females in the study, 8 (15.7%) reported a history of concussion and 43 (84.3%) reported no history of concussion.

Table 1.1

Demographic of Gender for HOC Report in Pilot Study (N=101, percentage calculated separately for each gender)

Gender	***n***	Reported Yes to HOC	Reported No to HOC
Male	50	11 (22.0%)	39 (78.0%)
Female	51	8 (15.7%)	43 (84.3%)

Chi-Square ($p = 4.17$)

Overall, the mean age for this group of athletes was 17.1 years old ($SD = 9.01$, range = 14 to 22). Out of all the athletes that reported yes to a history of concussion, 0/9 (0.0%) were 14 years old, 2/21 (9.5%) were 15 years old, 2/6 (33.3%) were 16 years old, 1/14 (7.1%) were 17 years old, 8/27 (29.6%) were 18 years old, 3/14 (21.4%) were 19 years old, 1/4 (25.0%) were 20 years old, 1/5 (20.0%) were 21 years old, and 1/1 (100.0%) was 22 years old (Table 1.2). Fourteen (27.5%) of those 18 and over reported a

history of concussion and 5 (10.0%) who were 17 and under reported a history of concussion (Table 1.3).

Table 1.2

Demographic of Age for HOC Report in Pilot Study (N=101, percentage calculated separately for each age)

Age (years)	***n***	Reported Yes to HOC	Reported No to HOC
14	9	0 (0.0%)	9 (100.0%)
15	21	2 (9.5%)	19 (90.5%)
16	6	2 (33.3%)	4 (66.7%)
17	14	1 (7.1%)	13 (92.9%)
18	27	8 (29.6%)	19 (70.4%)
19	14	3 (21.4%)	11 (78.6%)
20	4	1 (25.0%)	3 (75.0%)
21	5	1 (20.0%)	4 (80.0%)
22	1	1 (100.0%)	0 (0.0%)

Age (mean = 17.1, *SD* = 9.01, range = 14 to 22)

Table 1.3

Demographic of 18 and Over/17 and Under Groups for HOC Report in Pilot Study (N=101, percentage calculated separately for each age group)

Over 18/Under 17 Groups	***n***	Reported Yes to HOC	Reported No to HOC
18 and Over	51	14 (27.5%)	37 (72.5%)
17 and Under	50	5 (10.0%)	45 (90.0%)

Chi-Square ($p = .025$)

The mean grade (year) in school for this group of athletes was 11th grade (*SD* = 9.21, range = 9th grade to senior in college). It should be noted that the semi-professional hockey players in this group might have entered the last grade they had completed in school. It is unclear how many of the hockey players were still in school when they answered this question. Out of all the athletes who responded yes to a history of concussion, 0/16 (0.0%) were in 9th grade, 3/16 (18.8%) were in 10th grade, 1/11 (9.1%) was in 11th grade, 2/9 (22.2%) were in 12th grade, 8/32 (25.0%) were college freshman, 2/9 were college sophomores, 1/5 (20.0%) was a college junior, and 2/3 (66.7%) were college seniors (Table 1.4).

Table 1.4

Demographic of Grade for HOC Report in Pilot Study (N = 101, percentage calculated separately for each grade)

Grade	***n***	Reported Yes to HOC	Reported No to HOC
9th Grade	16	0 (0.0%)	16 (100.0%)
10th Grade	16	3 (18.8%)	13 (81.2%)
11th Grade	11	1 (9.1%)	10 (90.9%)
12th Grade	9	2 (22.2%)	7 (77.8%)
College Freshman	32	8 (25.0%)	24 (75.0%)
College Sophomore	9	2 (22.2%)	7 (77.8%)
College Junior	5	1 (20.0%)	4 (80.0%)
College Senior	3	2 (66.7%)	1 (33.3%)

Grade (mean = 11.8, *SD* = 9.21, range = 9th Grade to College Senior)

Among the athletes in the study who reported a history of concussion, 3/21 (14.3%) were football players, 1/11 (9.1%) were basketball players, 2/9 (22.2%) were soccer players, 1/5 (20.0%) wrestlers, 4/5 (80.0%) were hockey players, 0/1 (0.0%) were in track, 4/16 (25.0%) were baseball players, 4/15 (26.7%) were softball players, 0/2 (0.0%) were cheerleaders, 0/13 (0.0%) were volleyball players, 0/1 (0.0%) ran cross-country, 0/1 (0.0%) were rollerderby players, and 0/1 (0.0%) were bicyclists (Table 1.5).

Table 1.5

Demographic of Sport for HOC Report in Pilot Study (N=101, percentage calculated separately for each sport)

Sport	***n***	Reported Yes to HOC	Reported No to HOC
Football	21	3 (14.3%)	18 (85.8%)
Basketball	11	1 (9.1%)	10 (90.9%)
Soccer	9	2 (22.2%)	7 (77.8%)
Wrestling	5	1 (20.0%)	4 (80.0%)
Hockey	5	4 (80.0%)	1 (20.0%)
Track	1	0 (0.0%)	1 (100.0%)
Baseball	16	4 (25.0%)	12 (75.0%)
Softball	15	4 (26.7%)	11 (73.3%)
Cheer	2	0 (0.0%)	2 (100.0%)
Volleyball	13	0 (0.0%)	13 (100.0%)
Crosscountry	1	0 (0.0%)	1 (100.0%)
Rollerderby	1	0 (0.0%)	1 (100.0%)
Bicycling	1	0 (0.0%)	1 (100.0%)

Out of all 101 athletes in the study, 19 (18.8%) reported yes to a history of concussion and 82 (81.2%) reported no to a history of concussion (Table 1.6).

Table 1.6

Demographic of Report of History of Concussion (N=101)

HOC	Number of Athletes
Yes	19 (18.8%)
No	82 (81.2%)

The data collected from the study were used to run two separate Pearson chi-square analyses. The first analysis looked for any significant differences between males who reported a history of concussion on the ImPACT and females who reported a history of concussion on the ImPACT. The results showed no significant differences between males who reported a history of concussion on the ImPACT (22.0%), and females who reported a history of concussion on the ImPACT (15.7%; $p = .417$; Tables 1.1 and 1.7).

Table 1.7

Pearson Chi Square Analysis of HOC Report between Males and Females in Pilot Study (N = 101)

Analysis	*p*
HOC Report between Males/Females	.417

The second analysis looked for significant differences between those who were 18 and over that reported a history of concussion on the ImPACT and those who were 17 and under that reported a history of concussion on the ImPACT. The results showed a significant difference between those who were 18 and over that reported a history of concussion on the ImPACT (27.5%), and those who were17 and under that reported a history of concussion on the ImPACT (10.0%; $p = .025$; Tables 1.3 and 1.8).

Table 1.8

Pearson Chi Square Analysis of HOC Report between 18 and Over Group and 17 and Under Group in Pilot Study (N=101)

Analysis	*p*
HOC Report between 18 and Older/ 17 and Younger	.025

The results showed that, from the sample taken, there were a significantly greater number of concussions reported on the ImPACT test by those who were 18 and older. This difference in age suggested that a difference in concussion reporting between older and younger athletes could possibly be found if a larger study was conducted. A review of the literature did not find a study looking at differences in self-reporting of concussions between athletes who are 18 and older and athletes who are 17 and younger. A study by Gessel et al. (2007), however, did find a difference in concussion rates between younger and older athletes as reported by athletic trainers. The study looked at differences in concussion rates between high school athletes and college athletes. The study involved an internet-based surveillance system, including 100 U.S. high schools and 180 U.S. College settings. Over the course of one school year, the athletic trainers from the high schools and colleges would log into the Reporting Information Online (RIO) website and record specific information about their athletes. This information included demographic information, the athlete's sport, the definition of injury, what medical attention was administered, concussion symptoms, and length of time until return to play. The results of the study found that concussions were highest among football players. The study also found that high school athletes had a lower rate of concussion compared to college athletes among the participants in their study. This result is similar to the ImPACT pilot study that found a lower rate of concussion among athletes 17 and

younger (Table 1.3). The Gessel (2007) study, however, did not consider how the concussions were reported to the athletic trainers.

Many concussions cannot be diagnosed without the athlete appropriately identifying concussion symptoms. Younger athletes can be assumed to have less experience with symptoms of concussions due to their age. In general, younger athletes may have less exposure to information about concussion. This may lead to lower self-reports of concussions by younger athletes because they do not realize they are experiencing concussion symptoms. This was demonstrated in a study by Miyashita et al., (2014), that specifically looked at high school athletes' current perception of concussion. The investigators also examined reports of history of concussion before and after providing information to the same group of athletes. An anonymous survey was first conducted at 6 high schools involving 454 high school athletes. The athletes answered demographic inquires followed by questions aimed at establishing their perception of concussion. Then an educational lecture, lasting 25 minutes, was delivered to athletes via PowerPoint presentation. The presentation included information about signs and symptoms of concussions, long-term side effects, impact on education/learning, and return to practice (RTP) protocols. Thirty-eight percent of the athletes reported a history of concussion before the lecture, and 64.3% reported a history of concussion after the lecture. The results clearly showed that the information provided to the athletes led to a higher frequency of reports of a history of concussion. The study found that high school athletes still do not have an understanding of how one identifies a concussion, whether or not they have sustained one, or the seriousness of the injury if symptoms are present. The

authors concluded that providing information to athletes about concussion might lead to appropriate identification and action if a concussion occurs.

Perhaps the difference found between older and younger athletes in the pilot study may be a result of different perceptions of concussion between the older and younger athletes. Older athletes may have more exposure to information about concussion symptoms and terms used to define the injury than younger athletes. This exposure to information may be a factor in why older athletes seem to be reporting more concussions. The studies by McKinlay et al. (2011) and by Weber and Edwards (2010) showed that the nature and content of the concussion information presented, as well as how it is presented, both effect whether a concussion is appropriately self-reported. Both studies outlined different perceptions of concussion based on what terms, synonyms, and symptoms were presented. The Miyashita (2014) study concluded that providing information to athletes about concussion might lead to appropriate identification of concussions. The current study sought to find out whether providing the same information about concussion terminology, synonyms, and symptoms presented in the same way (verbally) to both the older and younger groups of athletes would increase their self-report of history of previous concussions compared to those who did not receive this information.

1.5 Purpose of Study

The purpose of this study is to investigate whether providing information about concussion will increase the self-report of a history of concussion. This study also investigates whether there is a difference in self-reporting between those are 18 and over and 17 and under. The results of this study will help to determine factors involved in

whether or not athletes are reporting symptoms associated with concussion. These factors may include what type of information is presented to athletes, and how the information is presented. Addressing these factors will help parents, coaches, athletic trainers, and clinicians make better on and off field decisions about how athletes are identifying concussion symptoms. This study also has implications about the importance of informing athletes about concussions. The study may potentially result in more accurate documentation of incidence rates of history of concussion.

Chapter 2: Methods

2.1 IRB Approval

The institutional review board (IRB) for human subjects at UTEP approved this study.

2.2 Study Design

This study used a group design comparing a Pre-Test Information Group and a Post-Test Information Group matched for age.

2.3 Participants

The participants involved in this study consisted of 202 middle and high school athletes from the El Paso region, college athletes, and a semi-professional hockey team. Three of the participants did not complete the questionnaire and were excluded from the analysis. The analysis included the 199 participants that completed the entire questionnaire. It should be noted that the semi-professional hockey players in this group might have entered the last grade they had completed in school. It is unclear how many of the hockey players were still in school when they answered what grade they were in on the questionnaire. The demographic information of the participants is included in Tables 3.2 to 3.11. Out of the 199 participants, 59 (30%) reported a history of concussion, whereas 140 (70%) did not (Table 3.11). Tables 3.3, 3.5, 3.6, 3.8, and 3.10 show the demographic information with the participants divided into two groups, those who reported a HOC and those who did not.

2.4 Instruments

The following script was read to the Pre-Test Information Group. The script was used to provide the athletes in the experimental group (i.e., the pre-test information group) with information about concussions during preseason baseline testing.

> *A concussion is a type of traumatic brain injury (TBI) caused by a bump, hit, or jolt to the head. Concussions can also occur from a fall or a hit to the body that causes the head to shake back and forth. Common phrases used to describe a concussion are "having your bell rung," "getting a ringer," and "seeing stars." They cannot be seen on x-rays or CT scans because concussions change the way the brain functions, not the way it looks. These changes can show up symptomatically throughout the entire body, and they may affect how you feel physically and emotionally, your vision, balance, concentration, and sleep. Since brain injuries are not visible to the eye, someone with a concussion may "look normal." However, a concussion can be a very serious injury, identified mainly by concussion symptoms that you cannot just "walk off." It is important to be aware of the many indicators of concussions and understand the recovery process. If you ever suspect that you may have a concussion, tell your coach, parent, or trainer right away.*

During preseason baseline testing, an anonymous questionnaire was given to all athletes in both the Pre-Test Information Group (after the script was read) and the Post-Test Information Group, posing the following questions:

- B*ased on the information we have given you, as well as on your experience today, do you think you have ever had a concussion?*
- *What is your age?*

- *What school do you attend?*
- *What grade are you in school?*
- *Are you male or female?*

2.5 Procedures

The UTEP CMC conducts baseline neurocognitive testing for athletes in the El Paso area before they begin training in their respective sport. All of the athletes involved in the present study underwent a computerized neurocognitive assessment using the ImPACT test. The ImPACT test was administered to athletes in computer labs at UTEP and at area middle and high schools. Before taking the ImpACT test the athletes were randomly separated into two groups, the Pre-Test Information Group and the Post-Test Information group. The Pre-Test Information Group was read a script (see above) describing symptoms associated with a concussion prior to taking the ImPACT test. An anonymous questionnaire was administered to both groups upon completion of the ImPACT test. On the demographic section of the ImPACT, the athlete was asked if a physician had ever diagnosed them with a concussion. The questionnaire was developed to obtain a history of prior concussion solely based on the athlete's report. The questionnaire posed specific questions (see above).

Both groups received a pamphlet containing information about concussions before leaving the computer lab. Each participant's questionnaire was reviewed, and the data were recorded and entered into an Excel file. The data was separated into: report of history of concussion (yes or no), gender, age, school, grade, control group (Post-Test Information Group), and experimental group (Pre-Test Information Group). Age criteria were separated into two groups, distinguished by participants who were 18 and over, and

those who were 17 and under. Two independent scorers checked the data from the questionnaires with 100% agreement.

2.6 Statistical Analysis

SPSS version 20.0 software was used to analyze the data in this study. Pearson chi-square tests were used to compare the report of the history of concussion in the Pre-Test Information Group and the Post-Test Information Group as well as the 18 and over and 17 and under age groups. The data collected for the current study did not follow a normal distribution. For this reason, Pearson chi-square tests were used because it is a non-parametric test that can be applied to the uneven distribution of participants in the current study.

Chapter 3: Results

The first question of the study investigated whether there would be a difference in report of history of concussion between the Pre-Test Information Group (who received information about concussions before reporting a history of concussion) and the Post-Test Information Group (who received information about concussions after reporting a history of concussion). The second question investigated whether being in either the pre-test and post-test group would result in a difference in report of history of concussion between those who were 18 and over and those 17 and under. Pearson chi-square tests were used to compare the report of the history of concussion in the Pre-Test Information Group and the Post-Test Information Group as well as the 18 and over and 17 and under age groups. The chi-square analysis in Table 3.1 showed that there was not a significant difference in self-reported history of concussion between the experimental group (i.e., those who received concussion information) and the control group (i.e., those who did not receive concussion information; $p = .183$).

An additional Pearson chi-square analysis found that there was also no significant difference in self-reported history of concussion between the two age groups (i.e., those who are 18 and over and those who are 17 and under; $p = .199$; Table 3.1). It was recognized that further statistical analysis of the two age groups (i.e., over 18/under 17) was not justified because no differences were found between groups (i.e., pre-test information group and post-test information group); however, the analysis was conducted anyway to identify any trends in the data (Djkman, Kooistra, & Bhandari, 2009).

Table 3.1

Pearson Chi Square Analyses

Analysis	*p*
HOC * Pre/Post Test Analysis	.183
18 and Over/ 17 and Under Analysis	.199

The majority of the participants in the study were male (*n* = 136, 68%), and less than half were female (*n* = 63, 32%; Table 3.2). Out of the male participants, 38 (27.9%) reported yes to a history of concussion (Table 3.3). Out of the female participants, 21 (33.3%) reported yes to a history of concussion (Table 3.3).

Table 3.2

Demographic of Gender (N=199)

Gender	Number of Athletes
Male	136 (68%)
Female	63 (32%)

Table 3.3

Demographic of Gender for HOC Report (N=199, percentage calculated separately for each gender)

Gender	***n***	Reported Yes to HOC	Reported No to HOC
Male	136	38 (27.9%)	98 (72.1%)
Female	63	21 (33.3%)	42 (66.7%)

Overall, the mean age for this group of athletes was 16.81 years old (*SD* = 19.54, range = 14 to 24; Table 3.4). Out of all of the athletes that reported yes to a history of concussion, 5 (33.3%) were 14 years old, 8 (21.1%) were 15 years old, 4 (15.4%) were 16 years old, 17 (36.9%) were 17 years old, 16 (31.4%) were 18 years old, 3 (30%) were 19 years old, 3 (30%) were 20 years old, 1 (100%) was 21 years old, 1 (100%) was 22 years old, and 1 (100%) was 24 years old (Table 3.5). Percentages were calculated separately for each age.

Table 3.4

Demographic of Age (N=199)

Age (years)	Number of Athletes
14	15 (7.5%)
15	38 (19.1%)
16	26 (13.1%)
17	46 (23.1%)
18	51 (25.7%)
19	10 (5.0%)
20	10 (5.0%)
21	1 (0.5%)
22	1 (0.5%)
24	1 (0.5%)

(mean = 16.81, *SD* = 19.54, range = 14 to 24)

Table 3.5

Demographic of Age for HOC Report (N=199, percentage calculated separately for each age)

Age	***n***	Reported Yes to HOC	Reported No to HOC
14	15	5 (33.3%)	10 (66.7%)
15	38	8 (21.1%)	30 (78.9%)
16	26	4 (15.4%)	22 (84.6%)
17	46	17 (36.9%)	29 (63.1%)
18	51	16 (31.4%)	35 (68.6%)
19	10	3 (30.0%)	7 (70.0%)
20	10	3 (30.0%)	7 (70.0%)
21	1	1 (100.0%)	0 (0.0%)
22	1	1 (100.0%)	0 (0.0%)
24	1	1 (100.0%)	0 (0.0%)

Age (mean = 16.81, *SD* = 19.54, range = 14 to 24)

Twenty-seven (36.5%) of those 18 and over reported yes to a history of concussion and 32 (25.6%) of those who were 17 and under reported yes to a history of concussion (Table 3.6).

Table 3.6

Demographic of 18 and Over/17 and Under Groups for HOC Report (N=199, percentage calculated separately for each age group)

Over 18/Under 17 Groups	***n***	Reported Yes to HOC	Reported No to HOC
18 and Over	74	27 (36.5%)	47 (63.5%)
17 and Under	125	32 (25.6%)	93 (74.4%)

The mean grade for this group was 11th grade (*SD* = 19.20, range = 8th grade to Senior in college; Table 3.7).

Table 3.7

Demographic of Grade (N=199)

Grade	Number of Athletes
8th Grade	1 (0.5%)
9th Grade	32 (16.1%)
10th Grade	39 (19.5%)
11th Grade	43 (21.6%)
12th Grade	31 (15.6%)
College Freshman	46 (23.1%)
College Sophomore	4 (2.0%)
College Junior	1 (0.5%)
College Senior	2 (1.0%)

(mean = 11.25, *SD* = 19.20, range = 8th grade to Senior in college)

Out of all athletes who responded yes to a history of concussion, 1 (100.0%) was in 8th grade, 8 (25.0%) were in 9th grade, 7 (17.9%) were in 10th grade, 11 (25.6%) were in 12th grade, 16 (37.2%) were college freshman, 2 (50.0%) were college sophomores, 1 (100.0%) was a college junior, and 2 (100.0%) were college seniors (Table 3.8). Percentages were calculated separately for each grade.

Table 3.8

Demographic of Grade for HOC Report (N=199, percentage calculated separately for each grade)

Grade	***n***	Reported Yes to HOC	Reported No to HOC
8th Grade	1	1 (100.0%)	0 (0.0%)
9th Grade	32	8 (25.0%)	24 (75.0%)
10th Grade	39	7 (17.9%)	32 (82.1%)
11th Grade	43	11 (25.6%)	32 (74.4%)
12th Grade	31	11 (35.5%)	20 (64.5%)
College Freshman	46	16 (37.2%)	30 (65.2%)
College Sophomore	4	2 (50.0%)	2 (50.0%)
College Junior	1	1 (100.0%)	0 (0.0%)
College Senior	2	2 (100.0%)	0 (0.0%)

Grade (mean = 11.25, *SD* = 19.20, range = 8th grade to Senior in college)

The athletes in the study included 30 football players (15.1%), 39 basketball players (19.6%), 50 soccer players (25.1%), 16 Wrestlers (8.0%), 53 hockey players (26.6%), 9 softball players (4.5%), and 2 volleyball players (1.0%; Table 3.9). Out of all athletes that responded yes to a history of concussion, 13 (43.3%) were football players, 11 (28.2%) were basketball players, 15 (30.0%) were soccer players, 8 (50.0%) were wrestlers, 11 (20.8%) were hockey players, and 1 (10.1%) were softball players (Table 3.10). Percentages were calculated separately for each sport.

Table 3.9

Demographic of Sport (N=199)

Sport	Number of Athletes
Football	30 (15.1%)
Basketball	39 (19.6%)
Soccer	50 (25.1%)
Wrestling	16 (8.0%)
Hockey	53 (26.6%)
Softball	9 (4.5%)
Volleyball	2 (1.0%)

Table 3.10

Demographic of Sport for HOC Report (N=199, percentage calculated separately for each sport)

Sport	***n***	Reported Yes to HOC	Reported No to HOC
Football	30	13 (43.3%)	17 (56.7%)
Basketball	39	11 (28.2%)	28 (71.8%)
Soccer	50	15 (30.0%)	35 (70.0%)
Wrestling	16	8 (50.0%)	8 (50.0%)
Hockey	53	11 (20.8%)	42 (79.2%)
Softball	9	1 (10.1%)	8 (88.9%)
Volleyball	2	0 (0.0%)	2 (100.0%)

Out of all of the athletes, 59 reported a prior history of concussion (29.6%), and 140 reported no prior history of concussion (70.4%; Table 3.11). Out of the athletes who reported yes to a history of concussion, 36 (61.0%) were in the experimental group (i.e., the pre-test information group), and 23 (39.0%) were in the control group (i.e., the post-test information group; Table 3.12).

Table 3.11

Demographic of Report of History of Concussion (N=199)

HOC	Number of Athletes
Yes	59 (29.6%)
No	140 (70.4%)

Table 3.12

Report of History of Concussion from the Pre-Test Information Group and Post-Group Information Group (N=199, percentages out of 199)

Test Group	Reported Yes to HOC	Reported No to HOC
Pre-Test Group	36 (61.0%)	71 (50.7%)
Post-Test Group	23 (39.0%)	69 (49.3%)

Although athletes who received information about concussions were slightly more likely to report yes to history of concussion (61.0%), compared to athletes who did not

receive this information (39.0%), the percentage of athletes who reported no to history of concussion was almost identical regardless of whether or not the athlete received information regarding concussion (50.7% and 49.3%, respectively; Table 3.12). With respect to the 18 and over athletes who reported yes to history of concussion, 18 (66.6%) were in the pre-test information group and 9 (33.3%) were in the post-test information group (Table 3.13). With respect to the 17 and under group who reported yes to history of concussion, 17 (53.1%) were in the pre-test information group and 15 (46.9%) were in the post-test information group (Table 3.13).

Table 3.13

Report of History of Concussion for 18 and Over/17 and Under (N=199, percentages calculated from age and HOC report groups)

Age Groups	Reported Yes to HOC	Reported No to HOC
18 and over (Pre-Test Group)	18 (66.7%)	26 (55.3%)
18 and over (Post-Test Group)	9 (33.3%)	21 (44.7%)
17 and under (Pre-Test Group)	17 (53.1%)	46 (49.5%)
17 and under (Post-Test Group)	15 (45.5%)	47 (50.5%)

Despite no significant difference, two trends in the data were identified when percentages were calculated from each group (18 and over in the pre-test group, etc.). The first trend showed that athletes who were 18 and over were more likely to report a prior history of concussion (Table 3.14). The second trend showed that in both age groups, those who were provided with information were slightly more likely to report yes to a prior history of concussion when compared to those who were not. Even though there was not a significant difference, there is a slight numerical difference between the two age groups. The presentation of information about concussion seemed to have a greater effect on the athletes in the 18 and over group because a higher percentage reported yes to a history of concussion when compared to the 17 and under group.

Table 3.14

Report of History of Concussion for 18 and Over/17 and Under (N=199, percentages from each group respectively)

Age Groups	Reported Yes to HOC	Reported No to HOC
18 and over (Pre-Test Group)	18 (41%)	26 (59%)
18 and over (Post-Test Group)	9 (30%)	21 (70%)
17 and under (Pre-Test Group)	17 (27%)	46 (73%)
17 and under (Post-Test Group)	15 (24%)	47 (76%)

Chapter 4: Discussion

This study investigated two questions: (1) Would the proportion of those who self-reported a history of concussion would be different between those who received information and those who did not receive information? and (2) Would there be a difference in reporting a history of concussion between age groups (i.e., those who are 18 and over/those who are 17 and under). The purpose of this study was to determine if providing information about concussion would increase frequency of self-reporting concussions. The information about concussions provided to an athlete did not significantly affect whether or not they self-reported a concussion. Despite the absence of statistical significance, Table 3.12 showed that providing information about concussion to athletes did lead to a slightly higher frequency of reporting of a history of concussion. Out of the athletes that reported a prior history of concussion, 61% received information about concussion before reporting and 39% did not receive this information until after reporting a history of concussion. Although there was no statistical significance, this trend of a higher frequency of reports of a history of concussion by those who received information about concussion has implications about the importance of informing athletes about concussions. Providing information to athletes about concussion might result in more accurate documentation of incidence rates of history of concussion.

The second question of this study asked if there was a difference in reporting a history of concussion between age groups (i.e., those who are 18 and over/those who are 17 and younger). Table 3.13 showed that athletes who were 18 and older and who were provided information about concussion also reported a higher percentage of history of concussion than those who were 18 and over and did not receive prior information about

concussion. Out of those who were 18 and over and reported a prior history of concussion, 66.7% received information before reporting and 33.3% did not receive the information about concussion until after reporting (Table 3.13). Table 3.13 showed that in regards to those who were 17 and under who reported a history of concussion, there was a smaller difference between those who did and did not receive information about concussion before reporting a history of concussion. Out of the athletes who were 17 and younger and reported a history of concussion, 53.1% received information about concussion before reporting and 46.9% did not receive the information until after reporting a history of concussion (Table 3.13). Both the 18 and older group and the 17 and younger group reported a higher frequency of concussion. However, the information about concussion seemed to have a greater impact on the older group.

4.1 Age Differences

There are several possibilities for why the older group was slightly more likely to report a history of concussion when provided prior information about concussion. One reason may be that the older group had more exposure to the terminology used in the script. Another reason may be that the older group is more mature than the younger group, and was more attentive when the information was being read to the athletes. A third reason may be that the two groups have a different relationship with their coaches. In the study by Baugh et al. (2014), the authors discussed the different variables that comprised the relationship between coaches and their athletes, and how this relationship is different in high school and college. Competitive pressures are greater in college than they are in high school. Baugh et al. hypothesized in their study, that this increased pressure in college sports, relative to high school, might lead to a disincentive for

collegiate coaches to promote concussion reporting. Interestingly, Baugh et al. suggested that older college athletes in their study perceived less support for reporting concussions and reported fewer concussions than their younger teammates.

The difference in reporting between younger and older athletes when comparing the results of the Baugh et al. (2014) study to the trends in the current study can perhaps be reconciled by comparing the age groups from both studies. The Baugh et al. study compared differences between younger and older athletes who were all in college. Their study only included college freshman, sophomores, juniors, and first year seniors. The current study compared two groups that were 18 and older and 17 and younger. A key difference between the two groups in the current study is that the 17 and under group were presumably still in high school and the 18 and older group were in college (excluding the previously mentioned exception of the hockey players). Another major difference between the current study and the Baugh et al. study is that the current study provided information about concussion to athletes before they reported on a prior history of concussion. Baugh et al. discussed the issues associated with non-reporting of concussions between high school ad college athletes. The authors discussed a different set of social, emotional, and environmental challenges when comparing high school athletes to college athletes. Practice time, competition for playing time, and experience with coaches vary widely between high school and college athletes. Perhaps the differences between high school and college athletes underline the difference in findings between the Baugh et al. study and the trends of the current study. It may be that college athletes are more prepared to use information about concussion to appropriately report a history of concussion.

Experience may be a factor that increases the frequency of reported concussions by athletic coaches as well. The study by Covassin et al. (2012) examined the effects of providing information to youth coaches to assess prevention, responsiveness, and recognition of concussions. Since receiving the materials, 62.6% of the coaches viewed concussions as more serious than before the information was provided, and 77.0% of youth coaches reported the ability to more easily identify athletes who may have had a concussion than before the study. This improvement in the coach's perceptions may in part be due to their experience. The average experience of the coaches in the study was 7.8 years. As discussed earlier, this experience may lead to more successful use and interpretation of concussion information.

The results from the current study, though not statistically significant, showed that older and more experienced athletes reported a slightly higher history of concussion when provided information about concussion. Again, this experience may be a factor in how athletes and coaches use the information about concussion. Overall, the coach's responses in thier survey suggested that the "HEADS UP: Concussion in Youth Sports" material was to some degree successful at informing coaches about concussion so they may better identify and respond to concussions. This study, however, only involved youth coaches at the high school level and younger. The concerns raised earlier in the Baugh et al. (2014) study discussed increased pressures on college coaches when compared to high school coaches. These pressures become increasingly important when making on the field decisions about returning athletes to play after an injury.

A comparison of the pilot study and the current study also suggests that older athletes may report a higher frequency of history of concussions then younger athletes.

Over a third (36.5%) of those who were 18 and over reported a prior history of concussion in the current study compared to 27.5% who were 18 and over and reported a history of concussion in the pilot study (Tables 3.6 and 1.3, respectively). This difference is even greater between the 17 and younger groups compared in the two studies. Approximately one-fourth (25.6%) of the athletes in the current study who were 17 and younger reported a prior history of concussion compared to just 10.0% in the pilot study who were 17 and younger and reported a history of concussion (Tables 3.6 and 1.3, respectively).

Despite the age differences between studies, some general conclusions can be made. One conclusion is that there may be differences in reporting concussions when comparing two different age groups of athletes (i.e., college freshman to college seniors compared to 17 and under to 18 and over). Another conclusion is that providing information about concussion may have a slight increase on the frequency of reporting a history of concussion. For example, if provided information about concussion, college athletes may be more likely to report a history of concussion when compared to high school athletes that received the same information. Again, this conclusion has implications about the importance of informing athletes about concussions and might result in more accurate documentation of incidence rates of history of concussion.

4.2 Gender Differences

Differences in the gender demographic between the current study and other studies previously reviewed should be noted as a point of comparison. All participants in the Baugh et al. (2014) study were male football players compared to the 68% of males in the current study. Out of the 340 athletes coached in the Covassin et al. (2012) study, 115

of the coached athletes (33.8%) were male and 108 (31.9%) were female. In the current study, 136 (68.0%) were male and 63 (32.0%) were female. The remaining 34.3% represent coaches who coached both males and females. Although the percentage of females in the two studies were similarly represented the overall distribution of males and females between the two studies were very different. Specifically, the distribution of males and females in the Covassin et al. study is almost equal (i.e., 33.8% males, 31.9% females). In the current study, males represented the overall sample by a margin of 66%. In contrast, the 58% of the 224 participants in the Weber et al. (2010) study were female and 42% were male. The Miyashita et al. (2014) study, involving high school athletes' perceptions of concussion, had a more even gender distribution. Almost half (46.7%) were female and 53.3% were male. A comparison of gender demographics between the pilot study and the current study shows the previously mentioned trend of a higher report of history of concussion when information is provided. Males in the current study reported a higher frequency of history of concussion (27.9%) when compared to the report of history of concussion from males in the pilot study (22.0%; Tables 3.3 and 1.1, respectively). This trend was found to be greater in a comparison of female reports of history of concussion between both studies. Approximately one-third (33.0%) of females in the current study reported a frequency of reported history of concussion while 15.7% of females from the pilot study reported a history of concussion (Tables 3.3 and 1.1, respectively). The trend of higher frequency of report of history of concussion among males and females in the current study compared to the pilot study highlights a major difference in the two studies. Namely, that some athletes in the current study received

standardized information about concussion while the athletes in the pilot study received no standardized information.

4.3 Sports Differences

There are also differences in the sports demographic between the current study and the other studies previously reviewed. As previously mentioned, all of the athletes in the Baugh et al. (2014) study were football players. Out of the 199 athletes involved in the current study, only 15.1% were football players and 68.0% of the total participants were male. The sports that were most represented in the current study were soccer (25.1%) and hockey (26.6%; Table 3.9).

In the Covassin et al. (2012) study, 27.4% coached football compared to the 15.1% who played football in the current study, 12.6% played basketball compared to the 19.6% in the current study, 23.5% played soccer compared to the 25.1% in the current study, and 4.1% played volleyball compared to the 1.0% in the current study. The sports demographic in the Weber et al. (2010) study was not broken down by each sport, although the authors claimed that more than half of the athletes (57.6%) in their study played a contact sport. This is very similar to the current study, where 49.7% of the athletes played a contact sport. In the Myashita et al. (2014) study, football players had the highest representation at 34.1%; the second most represented sport in the study was cheerleading (31.9%).

When comparing the current study's sports demographic to the pilot study, the trend of a higher frequency of report of history of concussion was further evident. Again, a major difference between these two studies is that some of the athletes in the current study received information about concussion. For example, 43.3% of football players in

the current study reported a history of concussion when compared to 14.3% of football players who reported a history of concussion in the pilot study (Tables 3.10 and 1.5, respectively). Over one-fourth (28.2%) of basketball players reported a history of concussion in the current study while only 9.1% reported a history of concussion in the pilot study (Tables 3.10 and 1.5, respectively). Among soccer players, 30.0% reported a history of concussion in the current study compared to 22.2% who reported a history of concussion in the pilot study (Tables 3.10 and 1.5, respectively). Contrary to the trend, only 20.8% of hockey players in the current study reported a prior history of concussion compared to (80.0%) who reported a history of concussion in the pilot study (Tables 3.10 and 1.5, respectively).

4.4 Sample Size Differences

For the sake of comparison, the sample sizes of the studies reviewed for the current study were compared to the current study's sample size. The Baugh et al. (2014) study had a far greater number of participants to analyze; specifically, 717 athletes compared to the 199 used in the current study. The Covassin et al. (2012) study had 340 athletic coaches. The Weber et al. (2010) study comprised of 224 athletes, while the Miyashita et al. (2014) study had 454 athletes. The current study had almost twice as many athletes (199) as the pilot study (101), which may be a factor in the difference in reporting in the two studies.

4.5 Concussion Information

The importance of providing concussion information to athletes can be clearly seen when comparing the athlete's report of history of concussion in the ImPACT test pilot study to athlete's report of history of concussion in the current study. The athletes

involved in the pilot study received no standardized information about concussions before reporting a history of concussion on the ImPACT test. During preseason baseline testing at the CMC at UTEP, athletes were told they were going to take a computerized neurocognitive concussion test, and the athletes fill out the appropriate consent forms. They were encouraged to do the best they could, and that the test would monitor the athlete's speed and accuracy. They were told to have a good blend of speed and accuracy while taking the test. This information suggests that a concussion may involve cognitive impairments in speed and accuracy performance on the ImPACT test. It does not, however, provide any standardized information about concussion. In the current study, 107/199 athletes received information about concussion presented verbally in a standardized script (see above). Overall, the athletes in the current study reported a higher percentage of history of concussion (29.6%) than the athletes that reported that a history of concussion on the ImPACT test in the pilot study (18.8%; Tables 3.11 and 1.6 respectively). Out of the 29.6% (59 athletes) that reported a history of concussion in the current study, 61% (36 athletes) received information about concussion via the verbally read script (Tables 3.11 and 3.12). A major difference between the two studies was that some athletes in the current study received standardized information about concussion while the athletes in the pilot study received no standardized information. This trend of a higher frequency of report of history of concussion in the current study when compared to the pilot study was evident when previously contrasting the demographics of age, gender, and sport of the athletes from the two studies.

This trend shows that there is a difference in reporting concussions between athletes in the two studies. One difference already discussed is that some of the athletes in

the current study received information about concussion before reporting a history of concussion. The information provided to the athletes must be considered as a possible factor for this difference. Another reason for the differences in reporting may be in the nature of the question asked in the two studies. The athletes in the pilot study were asked during the ImPACT test to report whether a physician had ever diagnosed them with a concussion. The athletes in the current study were asked if they thought they had ever had a concussion. Despite these differences, it is clear that athletes should somehow be provided with as much information as possible about the nature of a concussion in order to appropriately identify any symptoms and report them.

4.6 Types and Delivery of Concussion Information

The questions remain, however, regarding what type of information should be provided, and how should the information be delivered to athletes and their coaches. The study by Covassin et al. (2012) examined the effects of providing information to youth sport coaches to assess prevention, responsiveness, and recognition of concussions. As previously, mentioned, all of the coaches in that study were provided with the same information. This information was provided in the form of the CDC's "HEADS UP: Concussion in High School Sports." After receiving this information, the coaches were provided with a 22-item survey containing questions about how serious the coaches thought concussions were, how they responded to concussions, what they thought a coach's role was in educating athletes about concussion, and how many concussions they observed during the season. The survey also asked about the usefulness of the "HEADS UP: Concussion in Youth Sports" material (Covassin et al., 2012). In response to this last question, coaches responded that the information provided in the form of the CDC's

"HEADS UP: Concussion in Youth Sports" material was very useful and 92.1% claimed they would use the information on the field on the form of a clipboard. Interestingly, 69.6% of the coaches claimed that they did not have access to other concussion materials before receiving the CDC's: "HEADS UP: Concussion in Youth Sports" material prior to this study. This lack of access to materials is a major concern, since coaches are often making decisions about their athlete's injuries, and whether or not they continue play. Regardless, it was still clear that the "HEADS UP: Concussion in Youth Sports" information provided to the coaches was somewhat successful in informing the coaches about concussions. Overall, the authors concluded that the need to understand what types of materials are successful and accessible to coaches is extremely important.

The current study showed that there is also a need to understand what type of information should be provided to athletes. The type of information and the way it is delivered has implications for athletes. Information about concussions should convey the seriousness of concussions and the importance of reporting them. Information about concussion should include a standardized definition, and symptoms associated with the injury. Also, if athletes are not familiar with the consequences associated with a concussion, they may not understand the importance of reporting concussion symptoms. The study by Weber et al. (2010) showed that providing athletes with inadequate or confusing information about concussions negatively affected expected injury outcome and familiarity about concussions. The information provided to athletes in the Weber et al. study was administered in the form of different terms associated with concussion. The participants were given a questionnaire, presented in three different versions, differing only in the terminology used to identify the nature of the brain injury. The terms used for

the three groups in the study were a concussion, minor traumatic brain injury (mTBI), and mild head injury (mHI). The results of the study showed that the term mTBI was viewed as more negative and less familiar than the terms concussion and mHI. The authors also found that the athletes associated the term mTBI with a more serious injury from which an athlete may not recover. The study clearly showed that differing terminologies resulted in athletes having a different understanding of what a concussion is and how to appropriately define concussion symptoms.

In contrast to the Weber et al. (2010) study, athletes in the current study were provided with standardized information via the verbally read script (see script above). Although the results were not statistically significant, there was a higher frequency of reporting a history of concussion by the athletes that received the information about concussion. The Weber et al. study provided the athletes in their study with a different term for each group (concussion, minor traumatic brain injury, and mild head injury). This led to varying degrees of expectations and familiarities about the nature of a concussion. The athletes in the Pre-Test Information Group in the current study, on the other hand were provided with an operational definition of what a concussion is, as well as colloquial terms associated with the injury, such as "having your bell rung" (See script above). The script also contained symptoms associated with concussions. Again, the information provided to athletes in the current study led to a slightly higher frequency of reported history of concussion in the athletes that received this information. Most athletes in the general public are not provided with the kind of information contained in the script used for the current study. Athletes may only have been exposed to generic terms like the ones used in the Weber et al. study, and this terminology does not provide the athlete

with the appropriate information they need to take concussion symptoms seriously enough to report them. If athletes are not provided with, at the very least, the type of information contained in the script in the current study, perceptions of concussion will not be adequate enough to lead to accurate reporting of concussions by athletes.

The study by Miyashita et al. (2014) also showed that providing appropriate concussion information to athletes increased the frequency of a reported history of concussion. In their study, an educational lecture, lasting 25 minutes, was delivered to athletes via PowerPoint presentation. The presentation included information about signs and symptoms of concussions, long-term side effects, impact on education/learning, and RTP protocols. More than one-third (38.0%) of the athletes reported a history of concussion before the lecture, and 64.3% reported a history of concussion after the lecture. The results clearly indicated that the information provided to the athletes led to a higher frequency of reports of a history of concussion. This is similar to the findings, although statistically insignificant, in the current study. Nonetheless, there were differences between the two studies. One, was that the Miyashita et al. study used the same group of athletes when assessing the effect of concussion information (assessing their knowledge before and after providing concussion information, while the current study used two different groups (Pre-Test Information Group and Post-Test Information Group). Another difference was age-related. The current study involved participants in both college and high school while the by Miyashita et al. study involved only high school athletes. Another difference was the type of information provided to the athletes in the two studies. The Miyashita et al. study included information about long-term side effects and return to play protocols. The current study did not provide this information.

The significance of the Miyashita et al. (2014) study findings in regard to the insignificance of the current study may be in some part due to the difference in the type of information provided to the athletes. It is clear that providing information to athletes increases their frequency of report of a history of concussion. Providing athletes of all ages with information containing a definition, signs/symptoms, as well as long-term effects, and return to play protocols may increase frequency of reporting history of concussion. Formalized education containing appropriate information about concussion should be considered for both college and high school athletes as well. This could potentially result in more accurate documentation of incidence rates of history of concussion.

4.7 Limitations

This study is not without limitations. Factors that may have limited the results of this study include levels of education, as participants were athletes from high school, college, and a semi-professional hockey team. Another factor that may have an effect on the results is gender, where both females and males were involved in the study. The sample size of the study could have been larger as well, however, this was limited to which athletes were involved in preseason baseline testing. Time constraints also limited sample size.

4.8 Future Work

Future work should concentrate on what type of concussion information is presented to athletes and how that information is delivered. A formal education protocol should be explored for all grade levels. This education protocol should be explored as an

ongoing educational program for athletes and others at risk for concussions. Other factors that motivate athletes to report a concussion should also be explored in future work.

4.9 Conclusion

This study concluded that information provided to an athlete about a concussion is a factor, though not statistically significant, in whether or not that individual will self-report a concussion. The study also found that athletes who were 18 and over reported a higher frequency of history of concussion than those who were 17 and under when both groups received the same information about concussion. Due to the statistical insignificance of the findings, however, it can be concluded that there are other factors involved in predicting frequency of reports of history of concussion, such as the type of information presented, and how that information is presented to athletes. Other factors involved in whether or not athletes report a prior history of concussion may be volitional, and these factors warrant further investigation. This study has implications about the importance of informing athletes about concussions. The study may potentially result in more accurate documentation of incidence rates of history of concussion.

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Vita

John Pfirman graduated from The University of Colorado at Boulder with a Bachelor of Arts degree in Linguistics. He is currently pursuing a Master's of Science Degree in Speech-Language Pathology with a Concussion Management Certificate at The University of Texas at El Paso. John may be contacted at: jgpfirman@gmail.com

Permanent address: 1122 Thunderbird El Paso, Texas 79912

This thesis was typed by John Pfirman.