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The Effect of Gender and Socioeconomic Status on Concussion Reporting Behavior Among NCAA Student-Athletes

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THE EFFECT OF GENDER AND SOCIOECONOMIC STATUS ON CONCUSSION REPORTING BEHAVIOR AMONG NCAA STUDENT-ATHLETES

by

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Abstract

Concussions are traumatic brain injuries that result from "brain shaking" that can occur during any situation that transmits force to the head. Concussions are defined as a clinical syndrome characterized by immediate and transient post-traumatic impairment of neural functions which lead to a complex grouping of both psychological and physiological symptoms (McCrory, et al., 2013). As knowledge of the long-term implications of these injuries grows, concussions are becoming more of a major health concern worldwide. One subset of concussion classifications, sports-related concussions, is receiving an increasing amount of attention from both scientists and health-care practitioners. It is estimated that more than 3.8 million sport-related concussions occur annually in the United States alone, and some studies suggest that up to 43% of these go unreported and untreated (Harmon et al., 2013; Torres et al., 2013).

To gain insight into why sports-related concussions may go unreported, we created a survey to determine the influence of race, ethnicity, gender, and socioeconomic factors on the underreporting of concussions among NCAA athletes. The survey consisted of questions designed to gauge an individual's experience with and general knowledge of concussions, and to determine any discrepancies between ideal and actual behavior when faced with a hypothetical situation involving concussion-like symptoms. The objectives of this survey were to 1) determine if there was a correlation between gender/socioeconomic status and the likelihood of an athlete reporting a concussion to receive treatment and 2) identify groups that were potentially "at-risk" of intentionally failing to report a concussive injury. We hypothesized that a significant amount of reporting behavior differences would exist between subsets of athletes, due, in part, to race, ethnicity, sport type, gender and socioeconomic status. These objectives were met by comparing the responses between different groups, and interpreting open-ended responses using two *a priori* theories; the theory of planned behavior and the theory of normalization.

Gender had a significant effect on concussion reporting behavior, while race, ethnicity, and socioeconomic status had no significant effect. There were no differences found in behavior between sport types, with the exception that athletes who participated in football had significantly lower concussion reporting ratios than non-football athletes. No significant difference was found between genders and socioeconomic groups regarding the additional measures of "Bell-ringer" event reporting behavior or concussion symptom reporting behavior.

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Narrative

Sport-related concussions are traumatic brain injuries that result from "brain shaking" that occurs during a direct blow to the head, face, neck, or anywhere else that may transmit force to the head (McCrory et al., 2013). Concussions are often defined as a clinical syndrome characterized by immediate and transient post-traumatic impairment of neural functions, such as alteration of consciousness or disturbance of vision and or equilibrium (Guskiewicz, Weaver, Padua, & Garrett 2000). The effects of concussion are a complex grouping of psychological and physiological symptoms that last from days to weeks, depending on the individual and the severity of the trauma. These symptoms range from metabolic instability, mitochondrial dysfunction, diminished cerebral glucose metabolism, altered neurotransmission, chronic headache, fatigue, sleep difficulties, irritability, sensitivity to light, dizziness, and deficits in short term memory (Chrisman, Quitiquit, & Rivara 2013; McCrea et al., 2003; Torres et al., 2013). This results in neurological dysfunction, cognitive deficit, and increased risk for long-term effects. Not surprisingly, concussions are now recognized as a major public health concern both in the United States and worldwide. Researchers estimate that approximately 3.8 million sport-related concussions occur annually in the United States, and females experience a disproportionately larger amount of those concussions then men (Harmon et al., 2013; Covassin & Elbin, 2011).

As more research is conducted on concussions, it is beginning to be recognized as an increasingly dangerous and difficult-to-manage condition among both amateur and professional athletes. Unidentified concussions and mild traumatic brain injuries (mTBIs) can develop into more complicated issues, and carry the risk of second impact syndrome, a deadly condition that has taken approximately 30 to 40 lives over the past decade (Bey & Ostick, 2009; Register-Mihalik, et al., 2013; Torres, et al., 2013). However, due to underreporting, coaches, trainers, and health care professionals face a major obstacle in protecting athletes from mTBIs and concussive events.

Empirical research suggests that nearly half of high school and collegiate athletes with concussive symptoms do not report them (Chrisman et al., 2013). According to an anonymous survey of collegiate student-athletes, 43% of a sample of 262 individuals reported knowingly hiding concussion symptoms to stay in a game, and 22% of those individuals indicated that they were unlikely to report concussion symptoms to a coach or trainer in the future (Torres et al., 2013). Even more alarming, only 13% of student-athletes reported injuries known as "bell ringers" or "dings" (potential mild concussive events) to coaches or medical providers, indicating a potentially large number of undiagnosed concussive injuries may be left untreated due to misunderstanding of what a concussion really is (Register-Mihalik et al., 2013). Similar statistics were reported in both professional and high school athletes (Delaney et al., 2017; Chrisman et al., 2013). These concussions go undocumented and untreated for several reasons; a lack of athlete education on recognizing concussions, a discounted view on the severity of concussions, a desire to remain "in the game," coach approachability, a reluctance to let down teammates, coaches, and fans, or other motivators such as scholarships and personal identity (Chrisman et al., 2013; Register-Mihalik et al., 2013).

A breadth of research has been designed to discover why concussions go undocumented and untreated. There are a variety of theories and ideas that have been proposed; yet, concussions continue to be undetected or intentionally unreported. To better protect athletes, it is necessary to understand the true short- and long-term dangers of concussions and what the proper protocol for treatment is, as well as developing accurate measures of detecting them and appropriate return-to-play procedures. The objectives of this research are two-fold: First, we aim to determine the demographic sub-groups of NCAA student-athletes that are particularly "at-risk" to misrepresent or not report concussive symptoms to a coach or trainer. Second, we aim to understand why student-athletes may misrepresent or not report concussive symptomology. In pursuing the first aim, we will rely on quantitative methodologies. In pursuing the second aim, we will deductively interpret our qualitative data using two a priori theories. First, the theory of planned behavior, which states that an individual's behavior is a result of the overall attitude, perceived control, and perceived subjective

norms. Second, the theory of normalization, which refers to the process of prevalent ideas and actions becoming "normal" within a specific culture or sub-culture. By framing open-ended data using these complementary lenses, the prevalence of concealing concussions and the reasoning behind so doing will become clearer and more readily understood.

Using data from the present research, individuals responsible for a student-athlete's health will become more aware of their athlete's behavioral tendencies and better equipped to identify and manage concussions. The present study may also contribute to the general understanding of student-athletes' care-seeking behavior, as an understanding of why NCAA student-athletes sometimes do not seek care for concussions may also inform coaches and trainers about why they sometimes do not seek care for other injuries, helping coaches and athletic trainers better protect student-athletes. Therefore, this research has the potential to enhance student-athlete wellbeing and satisfaction throughout the intercollegiate athletic experience, two stated goals of the National Collegiate Athletic Association (NCAA, 2016).

Methods

Participants

Survey data were collected from 214 NCAA student-athletes (n = 87 males; n = 127 females) ranging in age from 18 to 29 (M = 19.73; SD = 1.4). The majority of the sample (n = 196) identified as White, eight as Multiracial, four as Black or African-American, two as Asian, two as American Indian/Alaskan Native, and two as Other. 130 classified themselves as middle income, 23 as low income, 27 as high income, and 34 did not respond. Student-athletes represented the NCAA's Division I (n = 40), II (n = 101), and III (n = 73). Participants competed relatively equally across non-contact (n = 66) contact (n = 67), and collision (n = 81) sports. These classifications were previously defined by the NCAA (NCAA, 2014).

Data collection procedure

This research was conducted through an online *Qualtrics* survey, and responses were incentivized by the opportunity to win a $25 Amazon gift card. The survey included several sections to determine participant demographics (i.e., gender, ethnicity, socioeconomic status), concussion knowledge, prior behavior in a potential concussion situation, and hypothetical behavior in a concussion situation (see Appendix 3 for the survey instrument).

Data analysis

Data screening procedures were conducted based on the recommendations of Tabachnik and Fidell (2013), and descriptive statistics were calculated on participants from the initial sample. Participants were classified based on four factors: (1) gender, (2) sport type, and (3) socioeconomic status (a composite of parents' education, marital status and income), and (4) race and ethnicity. Using these categorical variables as the independent variables, statistical tests were conducted to assess differences across groups on the following outcomes: general concussion knowledge, individual classification of concussions or sub-concussive events, reporting behavior of suspected concussions, bell-ringer events, and concussion symptoms, and common reasons for choosing to conceal or downplay a suspected concussion. Individual behavior in a hypothetical concussion or near-concussion situation was examined and interpreted according to each participant's classification. We also calculated the average level of symptomology that lead a student-athlete to: (a) suspect a concussion, (b) believe that a concussion should be reported, and/or (c) report a concussion to a coach or athletic trainer. All quantitative data were analyzed using the software program *SPSS (IBM Corp., Armonk, NY)*.

Expected results

It was hypothesized that data would reveal a difference in concussion reporting rates between racial/ethnic groups, reporting behavior differences based on the sport and gender group to which a participant belonged, and that socioeconomic status (a composite of parental education and income) would have an impact on underreporting rates.

Observations

Results

Several dependent measures were of interest. First, we measured the general concussion knowledge of the survey participants (see Table 1) shows the overall understanding of acute symptoms of concussions, the complications of multiple concussions, and the chronic symptoms of concussions. We then calculated the ratio of reported concussions over experienced concussions (reported concussions + suspected concussions), the ratio of reported "bell ringers" over experienced "bell-ringers" (bell-ringer was defined as having any of a number of symptoms [duration of loss of consciousness, nausea, dizziness, light sensitivity, feeling dazed, amnesia, balance problems, or headaches] at a symptom level not severe enough to be considered a concussion), and the ratio of reported symptoms over experienced symptoms.

Table 1

Measure of concussion knowledge, administered to all NCAA student-athletes who participated in the survey. A positive response signifies that a student-athlete thinks the symptom is a symptom of a concussion. The correct answer is included in parenthesis.

Acute Symptoms	**Male** ***n=87***	**Male%**	**Female** ***n=127***	**Female%**
Abnormal Sense of Smell (False)	14	0.16	21	0.17
Abnormal Sense of Taste (False)	15	0.17	19	0.15
Amnesia (True)	55	0.63	84	0.66
Joint Stiffness (False)	11	0.13	9	0.07
Blurred Vision (True)	82	0.94	122	0.96
Black Eye (False)	9	0.10	22	0.17
Bleeding from the Ear (False)	21	0.24	29	0.23
Bleeding from the Mouth (False)	9	0.10	12	0.09
Bleeding from the Nose (False)	23	0.26	20	0.16
Confusion (True)	86	0.99	124	0.98
Fever (False)	12	0.14	22	0.17

Dizziness (True)	84	0.97	125	0.98
Headache (True)	83	0.95	127	1.00
Insomnia (True)	37	0.43	71	0.56
Loss of Consciousness (True)	77	0.89	109	0.86
Nausea (True)	67	0.77	110	0.87
Numbness/Tingling of Arms (True)	32	0.37	40	0.31
Skin Rash (False)	2	0.02	2	0.02
Sharp Burning Pain in Neck (False)	26	0.30	39	0.31
Weakness in Neck Movements (False)	39	0.45	62	0.49
Concussion Facts				
A concussion only occurs if you lose consciousness (False)	3	0.03	3	0.02
If you are experiencing any signs or symptoms of concussion after a blow to the head or sudden movement of the body, you should not return to play (True)	81	0.93	120	0.94
A concussion is an injury to the brain (True)	85	0.98	121	0.95
Chronic Symptoms				
Increased Risk of Further Injury (True)	81	0.93	115	0.91
Brain Damage (True)	87	1.00	125	0.98
Joint Problems (False)	13	0.15	17	0.13
Memory Problems (True)	85	0.98	119	0.94
No Complications Exist (False)	0	0.00	0	0.00
	Male	**Male %**	**Female**	**Female %**

In addition, we calculated the likelihood that a student-athlete would report symptoms following a collision with another student-athlete, and the likelihood that he/she would advise another student-athlete to report his/her symptoms in the same situation. Lastly, we calculated three mean symptom severity scores based on five questions related to how severe each symptom (duration of loss of consciousness, nausea, dizziness, light

sensitivity, feeling dazed, amnesia, balance problems, or headaches) needed to be to be considered a concussion, how severe each symptom needed to be to indicate a student-athlete SHOULD report them, and how severe one's own symptoms needed to be for a student-athlete to report them (see Table 2).

Table 2

Mean benchmarks in symptomology that student-athletes reported.

Likert Scale (1-7) (1=no symptoms, 7=intensely symptomatic)	**Mean Symptomology that Indicates Concussion**		**Mean Symptomology an Athlete SHOULD Report**		**Mean Symptomology YOU would Report**	
Symptom	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Duration of Loss of Consciousness	4.54	5.05	4.33	4.39	4.17	4.28
Nausea	4.42	4.69	4.28	4.32	4.46	4.47
Dizziness	4.61	4.96	4.40	4.38	4.47	4.38
Light Sensitivity	4.49	4.80	4.33	4.43	4.43	4.57
Feeling Dazed	4.60	4.88	4.40	4.43	4.59	4.44
Amnesia/Deficit in Short Term Memory	4.75	5.09	4.47	4.50	4.55	4.20
Balance Problems	4.59	4.91	4.38	4.49	4.51	4.4
Headaches	4.97	5.11	4.75	4.64	4.78	4.58

The relationship between these dependent measures and gender (male vs. female), socioeconomic status (low, medium, high), collegiate division (I, II, or III), race (white vs. non-white), sport category (non-contact, contact and collision), and football category (football vs. non-football) were tested using either an independent-samples *t*-test or an ANOVA.

To test for the effect of socioeconomic status, the total parental income and the parent's highest level of education were use as factors in a two-way ANOVA, with concussion reporting ratio, bell ringer reporting ratio, and suspected concussion symptom level as dependent variables. A total parental income of $0-$49,999 was classified as low,

$50,000-$150,000 as medium, and >$150,000 as high. Parental education levels were classified as "no college degree," "undergraduate degree," or "post-graduate degree." No significant main effects of interactions were found regarding parental income or parent's highest level of education.

The ratio of reported to experienced "bell-ringers" was not significantly higher for females (M = .92, SD = .28) than males (M = .88, SD = .51), t (212) = -.86, p = .39. The ratio of reported over experienced concussions was significantly higher for females (M = .41, SD = .39) than for males (M = .32, SD = .43), t (75) = -1.97, p = .05 (See Figure 1).

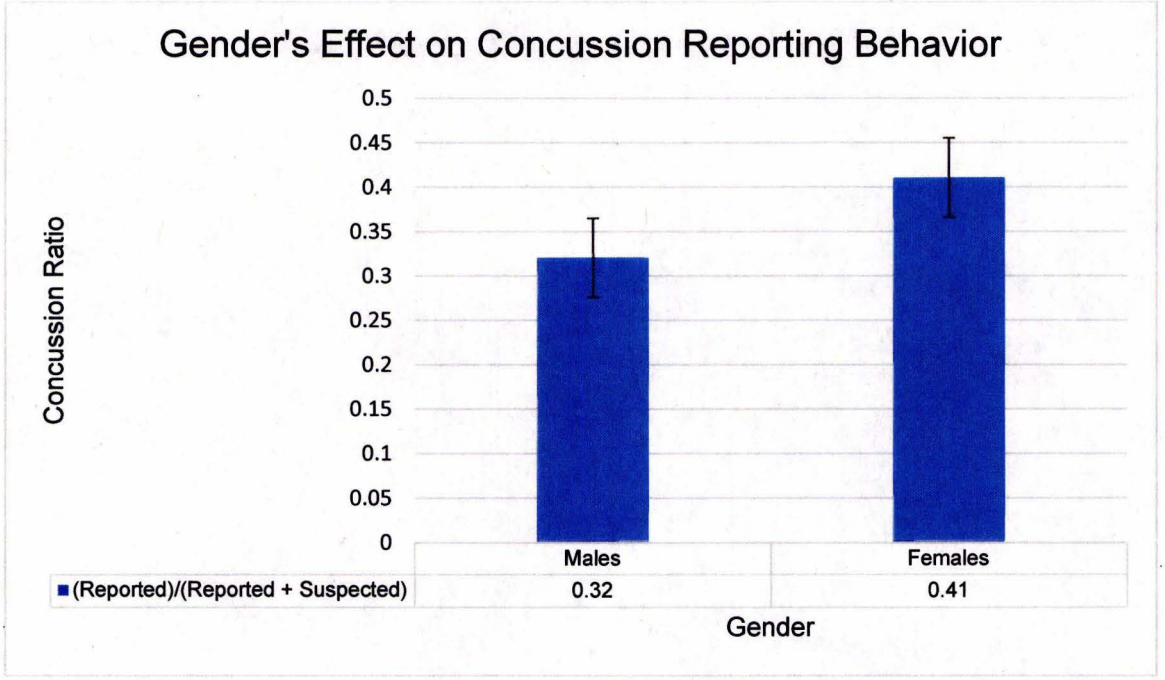

Figure 1

Graphical representation of the ratio of reported concussions to the total number of concussions the average student-athlete sustained, separated by gender.

The ratio of reported over experienced symptoms was not different between males (M = .44, SD = .38) and females (M = .32, SD = .43), t (96) = -1.47, p = .14. These findings indicate that females were more likely than males to report suspected concussions, but not symptoms or suspected "bell-ringers". Females were also more

likely than males to advise another to report symptoms in a hypothetical situation (M = .6.04, SD = 1.1 vs. M = 5.45, SD = 1.6), t (212) = -3.20, p = .002, but not more likely than males to report their own symptoms, (M = .4.87, SD = 1.7 vs. M = 4.48, SD = 1.8), t (212) = -1.6, p = .11.

No differences were seen in any of the dependent variables between white (n = 196) versus non-white (n = 18) student-athletes.

There was no influence of parental income level on bell-ringer ratio, concussion ratio, symptom ratio, or likelihood to report one's own symptoms. There was an effect of income level on likelihood to advise another to report symptoms, F (2, 177), 3.7, p = .03. Tukey post-hoc examination revealed a significant difference only between the low and middle-income groups, p = .02, with low income groups being significantly more likely to advise another to report symptoms (6.52 out of 7) than middle income groups (5.74 out of 7).

There was no influence of sport category on bell-ringer ratio, concussion ratio, or symptom ratio. There was an effect of sport category on likelihood to report one's own symptoms, F (2, 211) = 4.19, p = .02, and likelihood to advise another to report symptoms, F (2, 211), 3.7, p = .03. For likelihood to report one's own symptoms, and likelihood to advise another to report symptoms, Tukey post-hoc examination revealed a significantly greater likelihood to report for non-contact (5.03 and 6.03 out of 7 respectively) than collision groups (4.28 and 5.48 out of 7 respectively), (p = .02 and p = .04 respectively).

Significant differences between football and non-football student-athletes were seen for all variables. Football athletes (M = .62, SD = .76) were less likely to report bell-ringers than non-football athletes (M = .94, SD = .29), t (212) = 4.0, p <.0001. Football athletes (M = .14, SD = .26) were less likely to report suspected concussions than non-football athletes (M = .41, SD = .39), t (75) = 2.69, p = .009. Football athletes (M = .09, SD = .22) were less likely to report symptoms than non-football athletes (M = .47, SD = .41),

t (96) = 4.3, p < .0001. Football athletes' (M = 3.15, SD = 1.57) self-reported likelihood to report was less than for non-football athletes (M = 4.93, SD = 1.63), t (212) = 5.21, p < .0001. Finally, football athletes' (M = 4.65, SD = 1.90) self-reported likelihood to advise others to report was less than for non-football athletes (M = 5.96, SD = 1.19), t (212) = 4.82, p < .0001 (see Figure 2).

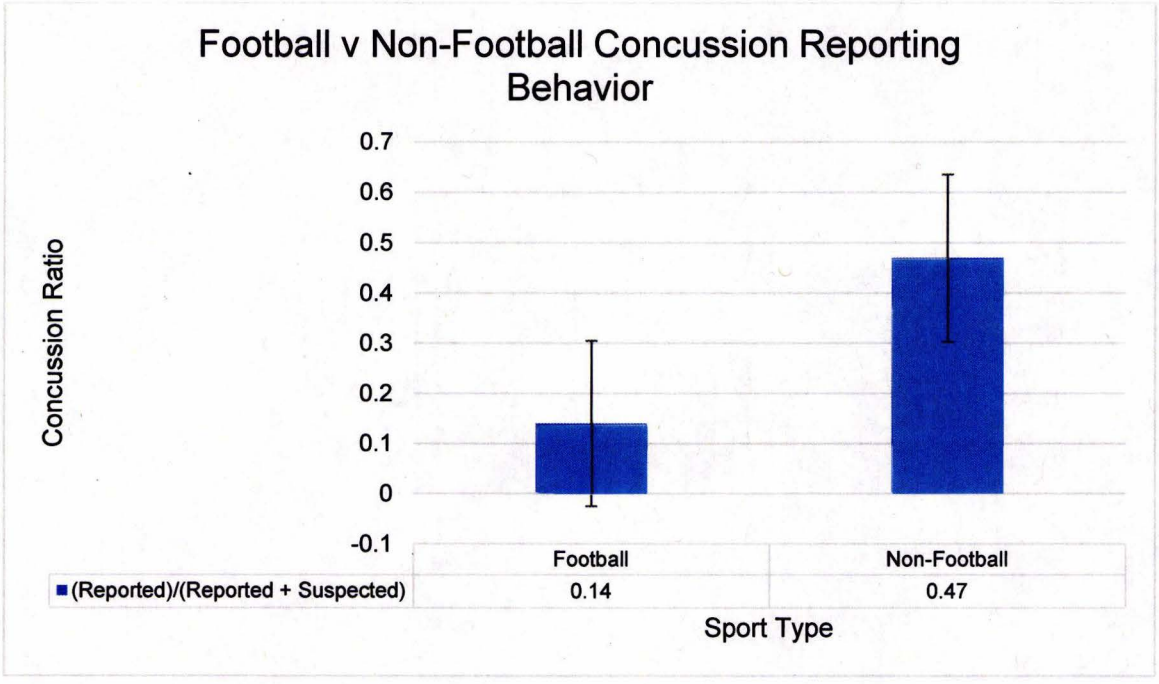

Figure 2

Graphical representation of the ratio of reported concussions to the total number of concussions the average athlete sustains, separated into football and non-football athletes.

Athletes were also asked to choose from several different reasons why they chose to report or not report concussive symptoms or "bell-ringer" events to a coach or athletic trainer (see Table 3). They were also give an "other" box to write in any reasons not included in the options. All responses recorded as "other" fit into the given categories. The primary motivator for reporting concussive symptoms for both genders was a concern for one's own safety, while the primary reason for not reporting concussive symptoms for both genders was a certainty that their symptoms were not resultant of a concussion. The same trend followed in reporting behavior regarding bell-ringer events.

Table 3

Reasoning reported by athlete's for why he/she chose to report or not report a bell-ringer event or symptoms of a concussion to a coach or athletic trainer

Symptoms - Reported	**Male**	**Male %**	**Female**	**Female %**
I'm supposed to report concussions	12	0.14	29	0.25
I was worried about my health/safety	20	0.23	34	0.29
My teammates/family told me to	6	0.07	17	0.15
I was unsure if I had a concussion	18	0.21	17	0.15
Someone noticed my symptoms	5	0.06	13	0.11
My coach or athletic trainer noticed my symptoms	5	0.06	23	0.20
Symptoms - Unreported				
I knew I did not have a concussion	26	0.30	32	0.27
I am tough	18	0.21	18	0.15
I wanted to keep playing	30	0.34	27	0.23
I am expected to play injured	3	0.03	5	0.04
My coach would react poorly if I told him/her	5	0.06	5	0.04
I didn't want to disappoint coach/team/fans	10	0.11	14	0.12
My team needed me	15	0.17	13	0.11
I didn't want to go to doctor	8	0.09	9	0.08
Bell Ringer - Reported				
I felt like something was wrong	22	0.25	30	0.26

I considered it a concussion	8	0.09	20	0.17
I could not play well after the incident	6	0.07	8	0.07
I needed time to recover	11	0.13	19	0.16
Bell Ringer - Unreported				
Not worth the trouble	19	0.22	13	0.11
I was sure I did not have a concussion	25	0.29	21	0.18
I felt fine	15	0.17	23	0.20
part of the game	21	0.24	12	0.10
I am tough	18	0.21	15	0.13
	Male	**Male %**	**Female**	**Female %**

Discussion

We hypothesized that differences in concussion reporting behavior would depend on gender, race, ethnicity, sport type, and socio-economic status. Our aim was to determine the demographic sub-groups of NCAA student-athletes that are particularly "at-risk" to misrepresent or not report concussive symptoms to a coach or trainer. Second, we aim to understand why student-athletes may misrepresent or not report concussive symptomology. Through the data this study produced, we confirmed that there were differences in reporting behavior due to gender and participation in football, but not due to any of the other factors.

The results of the present study allow for a variety of conclusions. Specifically, there is a possibility that the differences between the genders' concussion reporting behavior has basis in either social conditioning or innate characteristics, or a combination of both. The findings involving concussion reporting behavior differences between the genders is supported by similar findings in different studies (Kerr et at., 2014). The fact that there were no differences in concussion reporting behavior among separate socioeconomic groups or races could be due to athlete identity manifesting a stronger influence on this specific behavior than any previous identity assumed by individuals (Curry, 1993). It is also very interesting that, although gender identity had an influence on concussion

reporting behavior, it showed no influence on bell-ringer event reporting or concussion symptom reporting, which are arguably related to concussion reporting behavior.

The difference between *ideal* behavior and *actual* behavior among athletes is also notable; the average athlete indicated that they would report a concussion if they experienced symptoms of moderate intensity. Importantly, neither gender achieved a "concussions reported versus total concussions suspected ratio" of 0.50, signifying that neither group reported even half of the concussions they suspected sustaining during their NCAA career. More than 3.8 million concussions occur per year (roughly seven per minute), and most go unreported. Perhaps this is the reason that concussions have been termed the "silent epidemic" by the Center for Disease Control and Prevention (Broglio et al., 2017). This dissonance suggests that athletes recognize the dangers of concussions and the importance of reporting them to a coach or athletic trainer but fail to behave appropriately when they experience a concussion for a variety of different reasons. These reasons are summarized in Figure 3 and might include factors such as a desire to compete, a lack of knowledge, perceived coach support or lack thereof, traditionally ascribed traits of an athlete that an athlete feels pressure to meet, or the pressure to conform with perceived reporting norms among their own cohort (Baugh et al., 2014; Kerr et al., 2014; Kroshus et al., 2015b; Kroshus et al., 2015c). A study including focus groups with high school athletes suggest such factors as a desire to continue playing, to avoid looking weak, and not wanting to disappoint teammates explain underreporting, even when the athletes possess adequate concussion awareness and symptom knowledge (Kroshus et al., 2014). Research involving NCAA Division I men's ice hockey players showed that concussion knowledge is not significantly associated with concussion reporting behavior and that attitude towards the reporting of concussions is a stronger indicator of an athlete's in-season reporting behavior (Kroshus et al., 2015a). Additionally, even when an athlete reports concussive symptoms initially, follow-up treatment requires continued honesty from the athlete. Many athletes that are cleared to continue in competition are still symptomatic over 1-week post-concussion (Meier et al., 2014).

An overarching theme gleaned from the present research is that concussion reporting behavior among all athletes requires improvement. Although females tend to report concussions more often than males, neither males nor females reported even half of the concussions they experienced. This is perhaps due to a standing culture of not reporting injuries that has become the norm among athletes through the process of normalization, which is the social process through which otherwise unacceptable behavior becomes "routine and uneventful" (Curry, 1993). A study on the efficacy of a leading survey measuring concussion knowledge and attitude in athletes, the Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS), revealed that the measure was accurate in

determining concussion knowledge, but was a poor fit for determining an athlete's attitude toward reporting concussions (Chapman et al., 2017). Several theories in psychology and sociology have been applied to concussion reporting behavior to better understand and prevent underreporting instances. One of the most prominent of these is the Theory of Planned Behavior (TPB). The TPB has been used extensively and proven accurate in past study (Kroshus et al., 2014). According to TBP (which seeks to understand why individuals act as they do), attitude is one of the three determining factors of human behavior, and thus exceptionally significant in concussion reporting behavior (Azjen, 1991; Register-Mihalik et al., 2013). To protect the current and future health of athletes, a better metric of concussion reporting behavior attitudes needs to be developed and utilized to improve concussion education for athletes. A recent study was able to identify three general patterns of intentions and attitudes toward concussion prevention and management, classifying the patterns as proactive, reactive, or indifferent (Jorgensen et al., 2017); perhaps these metrics could be combined with the RoCKAS to create a more effective survey. This would allow head athletic trainers and coaches to identify athletes with limited concussion knowledge and/or risky attitudes toward concussions and preemptively act to reduce the number of unreported concussion, thereby enhancing student-athlete wellbeing and satisfaction throughout the intercollegiate athletic experience thus fulfilling two stated goals of the National Collegiate Athletic Association (NCAA, 2016). By the TBP, improving attitudes toward concussion reporting among athletes will improve concussion reporting rates, and the Theory of Normalization then supports that such improved behavior will eventually become the norm across NCAA athletics; thus, the ability to measure both concussion knowledge and reporting attitude would help to improve concussion reporting behavior among NCAA student-athletes.

Conclusion

The present study advances understanding on concussion reporting behavior and provides evidence to support the hypothesis that reporting behaviors differ across gender. However, we did not show any specific difference in concussion reporting behavior across socio-economic class, race, or ethnicity. This suggests that concussion reporting behavior is more dependent on gender than socioeconomic factors, as males across all races, ethnicities, and socioeconomic groups are more at risk to not report a concussion to a coach or athletic trainer. Interestingly, sport classification (collision, contact, and noncontact) had no significant effect on concussion reporting behavior.

However, an exception exists in that athletes participating in football showed significantly more negative concussion reporting behaviors.

It is important to note that no significant differences existed between the genders in bell-ringer event reporting behavior, or the reporting of concussion-like symptoms to a coach or athletic trainer. The data also suggest that athletes would benefit from additional training on the symptoms of concussion and how to recognize them. It also suggests that athletes would benefit from attitude reconditioning regarding concussion reporting.

Limitations

Our sample was drawn from universities where a head athletic trainer or athletic director was willing to distribute the survey to athletes. Institutions with an involved trainer or a trainer who cares more about concussion research may have been more likely to participate. This could have led to an inherent bias toward reporting in the student-athletes from these universities. For a more comprehensive and representative data collection, athletes from all regions of the United States would need to participate. Additionally, respondents to the survey were disproportionately white. A larger and more diverse sample would allow for more nuanced analyses comparing more subgroups and inferential pathways.

Best Practices

Initially, requests for help distributing surveys to athletes at each institution were sent to three individuals; generally, the athletic director, the head athletic trainer, and an assistant athletic trainer. Requests were made over email, and primarily to the athletic director. This proved to be ineffective and yielded a low success rate (n = 50 responses). Second and third requests were subsequently sent to different institutions' head athletic trainers alone, which proved to be much more effective; response rates increased (n = 214 responses). Using a mail merge program during the second and

third round of contact allowed for efficient personalization of each email and possibly contributed to the increased response rate.

Reflection

My capstone project started with my own personal interests in the relationship between healthcare and athletics; as an aspiring physician and forever an athlete at heart, I could do little to avoid exploring something that might contribute to improving the care we can provide to athletes. As this interest brewed, I sought research experience with Dr. Breanna Studenka, who helped me to get involved in several different research projects, some of which were concerned with concussion detection procedures. After two years spent working of various projects, I had formulated what I wanted my capstone project to be by examining the different things I learned from each project. The experience provided a unique opportunity to put the many years of studying the scientific method into practice; I developed the project from a simple question that crossed my mind and carried it through to the conclusion of the research. However interesting the research, I learned much more from the process of the project than I did from the data themselves.

When I initially began this project, I approached Bree with my idea to create and distribute a survey to NCAA student-athletes throughout the nation. Although Bree didn't have the most experience in survey research, I asked her to be my mentor in this project because I knew she would be supportive when I came across difficulties. This decision proved to be the right one, as the project had it challenges. The first hurdle we cleared with this project regarded creating a survey that would yield accurate and meaningful responses; I tried writing a survey numerous times before I was able to create something workable. After careful revisions and minor adjustments over the number of months, the survey turned into what I had envisioned it to be. However, even with the newly minted survey, the largest difficulty we overcame in this project was finding participants. I initially tried communicating with athletic directors, then with student-athletes directly through social media platforms, and then with head athletic trainers themselves. The athletic directors that we contacted proved to be less than supportive of our research, and we found that we were unable to generate many survey responses from them. When we tried to contact student-athletes through social media, we were able to find a few participants within our own social networks, but this detracted from finding results that were generally applicable. When we finally decided to contact only head athletic trainers, we found that survey responses began coming in larger numbers and from larger geographical regions. With the new influx of survey participants, we were finally able to collect the proper amount of data to accurate draw our conclusions. Perhaps the greatest lesson I pulled from our difficulties in this project

is one in creativity; to create a useable survey required me to approach writing from a new angle, and to acquire the right amount of participation in the survey forced me to change my initial plans and try new means several times.

Another interesting facet of this project is the eclectic mix of disciplines it included; I am a self-declared human biologist, but I enlisted the help of a human movement scientist, a human developmentalist, and a sociologist. There are no two collaborators are part of the same department. This has made for an interesting mix of opinions and ideas, but also made clear the fact that there exist connections between all disciplines of thought. There never was a point in time where a collaborator had nothing of value to contribute. Although there was a unique mixture of individuals who participated in this study, it also allowed for me to delve deeper into my understanding of my own discipline as I studied into the physiological effects and symptomology associated with concussive injuries.

This project was also very empowering; as I researched this topic and prepared to conduct my study, I found that little research has been conducted to date on this same subject and I knew that whatever information I could find and whatever conclusions I could draw would make a significant contribution to the current understanding of concussion reporting behaviors. Truthfully, I found myself intimidated by the project at first, but after I received positive feedback from different individuals at varying institutions who expressed interest in my research, I began to be more confident in what I was doing. I found it to be a unique experience for me to create and conduct a nationwide study, and the opportunity has conferred a sense of confidence upon me, knowing that I can conduct both important and large-scale research.

In the end, this has been an opportunity for me to learn about the severity of concussive injuries among NCAA student-athletes throughout the nation and to address one of the main problems that exist; the underreporting of concussions by the student-athletes themselves. What we found can hopefully inspire athletes across all levels of NCAA athletics to be more likely to report concussion like symptoms to a head coach or athletic trainer and help head athletic trainers throughout the nation to be more proactive in diagnosing concussions to protect athletes. If we can improve policy, procedure, and behavior regarding concussion, we will be able to safeguard the health of NCAA student-athletes both now and in the future. I hope that the work that was done for this project can have a significant impact as future researchers seek to continue improving upon our understanding of these pervasive issues.

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Appendix

1) Correspondence with Head Athletic Trainers

Dear Mr. or Mrs.

My name is Josh Hansen, and I am a student research assistant working under the direction of Dr. Breanna Studenka at Utah State University. Under Dr. Studenka's supervision, I am conducting a project titled "The Effect of Ethnicity and Socioeconomic Factors on the Reporting of Concussions among NCAA Student-Athletes." The project is designed to help us identify groups of student-athletes who are less likely to report a concussion, and why. Participating student-athletes will be asked to report anonymously on a number of items via online survey. We believe our findings will advance knowledge of concussion reporting across NCAA divisions, and therefore have the potential to inform policy and practice at NCAA institutions. At the conclusion of our study, we would be happy to share the aggregate data with you and your staff.

The Qualtrics survey should take no more than 15 minutes, and participating student-athletes will be entered into a drawing to win one of twenty $25 Amazon gift cards. We would appreciate your help distributing the survey link to student-athletes at your institution. To do so, we simply ask that you forward the survey link out to the student-athletes at your institution and encourage them to participate. Reminder emails will be sent to you each week for the duration of data collection.

We greatly appreciate your help!

2) Correspondence with student-athletes

Dear Mr. or Mrs.

My name is Josh Hansen, and I am a student research assistant working under the direction of Dr. Breanna Studenka at Utah State University. Under Dr. Studenka's supervision, I am conducting a research project designed to further our understanding of concussions in sports. If you choose to participate, you will be asked to report anonymously on a few items via online survey. Your answers will be recorded and separated from your name, thus protecting your confidentiality. We believe our findings will advance knowledge of concussion reporting across NCAA divisions, and therefore have the potential to inform policy and practice at NCAA institutions. This will directly benefit you by contributing to your safety and long-term health, as well as the safety of the student-athletes who will come after you. Your honest participation could contribute to the benefit of athletes across levels nationwide.

The Qualtrics survey should take no more than 15 minutes, and participating student-athletes will be entered into a drawing to win one of twenty $25 Amazon gift cards. We would appreciate your honest participation in this research.
To participate, you simply need to follow the survey link included in the body of this email. After your participation in the survey, you may follow another link at the end of the survey to have your email address entered into the drawing for an Amazon gift card. Reminder emails will be sent to you each week for the duration of data collection.

Click to following link to participate in the survey:

We greatly appreciate your help!

3) Qualtrics Survey

What is your age? _____

What is your gender?
a. Male
b. Female

Please select your ethnicity:
c. Hispanic or Latino
d. Not Hispanic or Latino

Please select your race:
e. American Indian / Alaskan Native
f. Asian
g. Black or African American
h. White
i. More than one race
j. Unknown
k. Other _____

What is your mother's highest level of education?
l. Elementary
m. Junior high/middle school
n. Some high school
o. High school graduate or GED
p. Some college
q. Associate degree
r. Bachelor's degree
s. Master's degree
t. Professional degree
u. Doctorate degree
v. Other _____

What is your father's highest level of education?
a. Elementary
b. Junior high/middle school
c. Some high school
d. High school graduate or GED
e. Some college

f. Associate degree
g. Bachelor's degree
h. Master's degree
i. Professional degree
j. Doctorate degree
k. Other _____

What is your mother's relationship status?
O Married
O Single, never married
O Living with partner, not married
O Widowed
O Divorced
O Separated
O Other _____

What is your father's relationship status?
O Married
O Single, never married
O Living with partner, not married
O Widowed
O Divorced
O Separated
O Other _____

Please indicate the average annual income of the household in which you were raised.
O < 10,000
O $10,000 - $24,999
O $25,000 - $49,999
O $50,000 - $74,999
O $75,000 - $99,999
O $100,000 - $150,000
O > $150,000

- Are you right or left handed, or ambidextrous?
- Are you a NCAA Division I, II, or III athlete?
- Please indicate (by checking the box beside the question) which of the following you would consider to be a sign or symptom of concussion. Check all that apply. [1]

1. Abnormal sense of smell (false)
2. Abnormal sense of taste (false)
3. Amnesia (true)
4. Joint stiffness (false)
5. Blurred vision (true)
6. Black eye (false)
7. Bleeding from the ear (false)
8. Bleeding from the mouth (false)
9. Bleeding from the nose (false)
10. Confusion (true)
11. Fever (false)
12. Dizziness (true)
13. Headache (true)
14. Insomnia (true)
15. Loss of consciousness (true)
16. Nausea (true)
17. Numbness or tingling of arms (true)
18. Skin rash (false)
19. Sharp burning pain in neck (false)
20. Weakness in neck movements (false)

Which of the following is true regarding concussions? Select all that apply.

- A concussion only occurs if you lose consciousness (false)
- If you are experiencing any signs and symptoms of concussion after a blow to the head or sudden movement of the body, you should not return to play (true)
- A concussion is an injury to the brain (true)

Multiple concussions: Of the following, what are possible complications of having multiple concussions? Check all that apply.

- No complications exist (false)
- Increased risk of further injury
- Brain damage (true)
- Joint problems (false)
- I don't know (false/not checked)
- Memory problems (true)

At what level of symptom intensity would the following symptoms be considered a concussion (list is not conclusive)? (1 being no symptoms and 7 being intensely symptomatic) [1]

  - Duration of loss of Consciousness
  - Nausea
  - Dizziness
  - Light sensitivity
  - Feeling dazed
  - Amnesia/Deficit in short term memory
  - Balance problems
  - Headaches

- If any of these symptoms occur, but are not severe enough to be considered a concussion, what would you typically call the event?
  - Open ended

- How many times have you EXPERIENCED such an incident during your collegiate career?

- How many times in your collegiate career have you REPORTED such an event to your coach or athletic trainer?

- Why DID you tell your coach or athletic trainer about an event? [1][2]
  - I felt like something was wrong
  - I did not consider that event to be a concussion
  - I couldn't play well after
  - I needed to take some time to recover
  - Other (explain)

- Why did you NOT tell your coach or athletic trainer about an event? [1][2]
  - It wasn't worth the trouble
  - I considered that event to be a concussion
  - I felt fine afterwards
  - It's part of the game
  - I am a tough player
  - Other (explain)

- At what level of symptom intensity for the following symptoms (list is not conclusive) do you think an athlete should report a concussion? (1 being no symptoms and 7 being intensely symptomatic) [1]

- Duration of loss of Consciousness
- Nausea
- Dizziness
- Light sensitivity
- Feeling dazed
- Amnesia/Deficit in short term memory
- Balance problems
- Headaches

- Answer the following questions pertaining to the symptoms listed above:

- How likely would you be to report a concussion to a coach or trainer if you collided with another athlete and began to experience these symptoms? (1 being not likely at all and 7 being completely likely) [2]

- How many times have you felt these symptoms after an impact (with another player, the ground, or anything else) during practice or a game during your collegiate career?

- How many times in your collegiate career have you told a coach or athletic trainer that you were experiencing these symptoms?

- Why did you choose to tell the coach or athletic trainer that you were feeling those symptoms? (Check all that apply) [1][2]
  - I'm supposed to report a concussion
  - I was worried about my health
  - My teammates or family told me to
  - I was not sure if I had a concussion or not
  - Someone else noticed my symptoms
  - The coach or trainer noticed my symptoms
  - Other (explain)

- How many times did you recognize these symptoms in yourself, but NOT report them to a coach or athletic trainer during your collegiate career?

- Why did you choose to NOT report to the coach or athletic trainer that you were feeling these symptoms? (Check all that apply) [1][2]
  - It wasn't a concussion
  - I am tough
  - I wanted to keep playing
  - I am expected to play injured

- My coach would react poorly
- I didn't want to let down my coach, team, or fans
- My team needed me
- I didn't want to go to the doctor
- Other (explain)

- How many total concussions have you experienced that were DIAGNOSED by a medical professional (athletic trainer or doctor) during your college career?

- How many total concussions do you SUSPECT you have experienced that were not diagnosed by a medical professional (athletic trainer or doctor) during your college career?

- At what level of symptom intensity would YOU report your symptoms to a coach or athletic trainer for the following symptoms? [1]
  - Duration of loss of Consciousness
  - Nausea
  - Dizziness
  - Light sensitivity
  - Feeling dazed
  - Amnesia/Deficit in short term memory
  - Balance problems
  - Headaches

- How likely (1-7) would you be to advise another athlete to report his/her symptoms to a coach or athletic trainer if he/she had hit his/her head and was exhibiting any of these symptoms [2]

Thank you for participating in this survey! Upon clicking the ">>" button in the bottom right hand of the page, you will be redirected to a page to enter your email address in the drawing for one of twenty $25 Amazon gift cards. Multiple entries are not allowed and will disqualify your entry.

Questions came directly from, or were influenced by:

[1] Register-Mihalik, J. K., Guskiewicz, K. M., McLeod, T. C. V., Linnan, L. A., Mueller, F. O., & Marshall, S. W. (2013). Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. Journal of athletic training, 48(5), 645-653.

[2] Chrisman, S. P., Quitiquit, C., & Rivara, F. P. (2013). Qualitative study of barriers to concussive symptom reporting in high school athletics. Journal of Adolescent Health, 52(3), 330-335.

Author Biography

Josh was born in Logan, Utah, and raised in Pocatello, Idaho. In 2012, he decided upon Utah State University to continue his education with the goal of becoming a physician. His interests lead him to declare his major in the Biology. He quickly began to create opportunities to enhance his education, seeking out experience as a researcher with Dr. Robert Ward of the NFDS department. There, he researched the relationship between diet and tissue composition in Argentine whales. Following his first year, Josh put his education on hold for two years to serve an LDS mission in Brazil. After gaining a wealth of experience, Josh returned home and resumed his studies at USU. He again became involved as a researcher, this time with Dr. Breanna Studenka, studying sports concussions. His research has helped him to gain insights into his own interests in healthcare.

Since beginning at Utah State University, Josh has been awarded several awards and distinctions. He has received the USU Presidential Scholarship, attained the Dean's List distinction several times, been awarded the John R. Simmons Scholarship, the Thomas L. Bahler Scholarship, and an URCO grant, acknowledged with the Undergraduate Researcher Distinction, and nominated for Researcher of the Year in the 2017-2018 school year. He plans to graduate *magna cum laude* in the Spring of 2018 with University Honors and Departmental Honors.

Josh and his beautiful wife, Aubry, have one wonderful daughter, Everette. They enjoy spending time together as a family, watching movies, camping, and going to sporting events. Josh plans to pursue a medical degree at Uniformed Services University of Health Sciences in Maryland beginning in the Fall of 2018.