

PERCEPTIONS REGARDING CONCUSSIONS IN COLLEGIATE FOOTBALL
AT THE UNIVERSITY OF MISSISSIPPI

By
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A thesis submitted to the faculty of the University of Mississippi in partial fulfillment of
the requirements of the Sally McDonnell Barksdale Honors College.

Oxford
May 2018

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Acknowledgements

This study, “Perceptions Regarding Concussions in Collegiate Football at the University of Mississippi” (Protocol #18x-115), was approved by the Institutional Review Board (IRB) as Exempt under 45 CFR 46.101(b)(#2).

This Qualtrics survey was distributed in accordance with the University of Mississippi’s Office of Institutional Research, Effectiveness, and Planning.

ABSTRACT

MADISON FRERKER: Perceptions Regarding Collegiate Football at the University of Mississippi

(Under the direction of Dr. Nicole Ashpole)

Concussions are a form of mild traumatic brain injury (mTBI) that can occur from any force to the head or body that causes the brain to move within the skull.

Concussions are common in the sport of football due to the highly physical nature of the sport, and injured athletes can experience a wide array of symptoms. Like other players participating with powerhouse football programs, those at the University of Mississippi are at risk of concussion throughout their collegiate career. Whether players and fans perceive the risks of concussion equally has not been previously studied.

Considering the passionate history of football at the University, the purpose of this project was to survey full-time students, faculty, and staff at the University of Mississippi regarding their views of the effects and associated risks of concussion on Ole Miss players. We set out to determine which position was perceived to be at greatest risk of concussion. We were also interested in how the public viewed, and was influenced by, the media's presentation of concussions. We sought to analyze responses based on Ole Miss classification, self-reported devotion to Ole Miss football, identification as current, former, or non-athletes in football or other sports. The results of this study serve to open a dialogue regarding the safety of Ole Miss football players in years to come.

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I. Background

The brain is a vastly complex organ, and a basic understanding of the composition and function of the brain is crucial when exploring brain related injuries in football. The adult human brain, weighing just three pounds on average, is capable of extraordinary tasks. It can be divided into three main sections: the hindbrain, midbrain, and forebrain. Each of these divisions is comprised of components that direct specific processes. The hindbrain is composed of the medulla and cerebellum. Located above the spinal cord and part of the brain stem, the medulla oblongata is responsible for autonomic functions such as digestion, breathing, and heart rate. Injuries to the medulla oblongata can have serious, life threatening consequences including paralysis and even death. The cerebellum regulates depth perception and the force of movements made by the body. It also aids in development of motor skills and is thus an important region for establishing athletic ability. An injury to the cerebellum can result in loss of coordination, decrease in motor processing speed, and increased risk of tremors. In football, for example, these regions regulate glucose and oxygen consumption and heart rate as players move to pass and/or catch the ball, locate their opponents, and quickly develop plans of action.

The second section of the brain, the midbrain, is partially composed of the tectum, a region which houses the superior and inferior colliculi. These structures play a role in reflex responses. The superior colliculus has a role in visual reflexes and allows the eyes to track moving objects. The inferior colliculus processes auditory information, including sensory signals from the superior colliculus. In combination, these regions

play a crucial role in allowing football players to respond reflexively to visual and auditory events on the field. The midbrain works in conjunction with the hindbrain to further tune muscle function and coordination. It has been found that the majority of concussions in both National Football League (NFL) and National Collegiate Athletic Association (NCAA) football are due to impacts made on the crown of the head which place damaging strain on structures of the midbrain (Viano, Casson, & Pellman, 2007); (Weinstein, Turner, Kuzma, & Feuer, 2013).

The third section, the forebrain, is composed of the diencephalon and cerebral hemispheres. The diencephalon lies rostral to the midbrain. It can be divided into the thalamus and the hypothalamus which each manage specific regulatory functions. The thalamus regulates and processes information sent from the rest of the central nervous system to the cerebral cortex. The hypothalamus serves to regulate functions of the autonomic, endocrine, and visceral systems. While the components of the diencephalon do not directly regulate motor functions, damage to this zone may inherently disrupt systemic function.

When picturing the brain, the cerebrum is the principal portion. Its patterns of gyri and sulci, the “peaks and valleys” of folded tissue forming the cerebral cortex, increase surface area throughout this brain region. The cerebrum can be divided into two hemispheres that each include four bilateral structures: the cerebral cortex, basal ganglia, hippocampus, and amygdaloid nuclei. The basal ganglia aid in regulation of motor skill performance. Several neurological diseases associated with impaired motor coordination result from damage to the basal ganglia. Similarly, sports related injury in

this region can severely disrupt body movements. Regarded as the center of emotion and memory storage, the hippocampus functions to both store and retrieve long term memories as well as process memories of the location of objects and people. Many studies have shown this region is particularly sensitive to brain damage, including that caused by mTBIs resulting from participation in football. Studies on players, both with and without formal concussion diagnosis, have shown hippocampal atrophy (Coughlin et al., 2015; Singh et al., 2014). Derived from the Greek word for almond due to its shape, the amygdaloid nucleus dictates sense of smell, motivation, and emotional behavior. Research regarding chronic traumatic encephalopathy (CTE), a pathology induced by repeated brain injuries like concussion, has shown extensive damage in this region. Neurofibrillary tangles and abnormal accumulation of tau protein within the amygdala, and also throughout the brain, can contribute to erratic emotions and behavior of former football players (McKee et al., 2009; Omalu et al., 2005). Since its initial discovery in a retired NFL player in the early 2000s, hundreds of additional posthumous diagnoses have been made. Strikingly, diagnoses have also been made in former high school and collegiate football players. Of the 202 brains examined in a study released in 2017 by Ann McKee and colleagues, 87% revealed neuropathological features of CTE. Though the study analyzed the brains of players at the high school, collegiate, semiprofessional, Canadian Football League, and NFL level, particular to this study is the data revealed by those in the collegiate group. 48 of 53 cases studied, or 91%, revealed CTE. (Mez et al., 2017).

While each cerebral hemisphere performs the aforementioned functions, the left and right sides have further specializations which distinguish them. Muscular contraction within the body is under contralateral control; the left hemisphere controls the right side of the body while the right hemisphere controls the left. Speech and language skills are largely developed by the left hemisphere. The right hemisphere manages most nonverbal, spatial skills. Coordination between both hemispheres is critical for many aspects of body function; damage to one hemisphere affects corresponding functions within the other. Damage to communication pathways, like the corpus callosum, can prove devastating to a person's ability to seamlessly perceive subjective experiences (Max-Planck-Gesellschaft, 2011).

Hemispheres can be further divided into the frontal, parietal, occipital, and temporal lobes. The frontal lobe is located near the forehead and is largely concerned with planning future actions and controlling movement. Damage to the frontal lobe leads to impaired inductive reasoning skills and reduced processing speed of memory recall and association. The parietal lobe directs reading and writing abilities; damage to the parietal lobe may heavily impact an injured student athlete's performance in the classroom. Vision is processed by the occipital lobe at the rearmost portion of the brain. Lastly, the temporal lobe is heavily responsible for processing auditory information and maintaining memory skills. Additionally, the temporal lobe also plays a role in emotion, learning, and memory. Alterations in the structure of the temporal lobe have been observed in retired professional athletes with known concussions. It is thought that damage in this area can cause dysregulation of emotions and behavior leading to

paranoia and rage. Prior research suggests variable degrees of atrophy within all lobes following head injury (McKee et al., 2009).

While each region of the brain may differ in its unique set of tasks, the building blocks of all regions are two classes of cells: neurons and glial cells. In whole, neurons are responsible for conducting electrochemical signals throughout the nervous system. Neurons are comprised of three regions: dendrites, the cell body, and the axon. Each of these structures plays a critical role in cellular communication. Dendrites are branched extensions from the cell body which serve to receive incoming signals from other neurons. Connections between a terminal button of one neuron (a presynaptic neuron) with a dendritic spine of another neuron (a postsynaptic neuron) form a synapse. It is known that brain injuries, including mTBI, can induce damage to synapses, disrupting cellular functions and instigating neurotoxicity. As signals are received by dendritic spines located on the dendrites, they are conducted toward the cell body. The cell body houses the nucleus and serves as the primary site of protein synthesis. From the cell body, the signal moves to the axon. Axons carry the signal, now called action potential, unidirectionally to subsequent neurons. To accelerate the process of signal transduction between neurons, axons are insulated by myelin sheath. Oligodendrocytes and Schwann cells are two important types of glial cells that produce myelin for axonal insulation. Several pathological disease states in the brain are known to disrupt myelination. Current research aims to examine a loss of myelination in concussed athletes following multiple mTBIs (Donovan et al., 2014).

While glial cells play an important role in cellular signaling, their roles extend far beyond myelination. Glial cells surround neurons to provide support as well as contribute their own functions. Glial cells are partly important for maintaining structure. Glial cells can be broken into subclasses depending on their function.

Astrocytes, the most numerous type of glial cell, have unique star shaped cell bodies that distinguish them from other glial cells. One function of astrocytes is to perform uptake of extracellular potassium that accumulates as neurons fire. If not removed, extracellular potassium interferes with cell signaling and can cause cellular distress. Astrocytes take in this excess potassium to protect neighboring cells. A second function of astrocytes includes aiding in reuptake of neurotransmitters following their release into the synapse. Additionally, astrocytes provide nutrients and support to surrounding neurons. Neurons have a high metabolic rate which requires constant input of glucose and oxygen and continual removal of waste products. Each neuronal axon is indirectly connected via tight junctions with endfeet of astrocytes to an individual capillary. These tight junctions serve to restrict movement of materials between endothelial cells, establishing the blood-brain barrier. Nearly all neurological diseases and neuronal injuries are associated with impairments in the neurovascular coupling normally regulated by astrocytes. When the endfeet separate from the blood vessels as a result of injury, the blood-brain barrier is weakened and toxic components carried in the blood are exposed to the brain (Kandel, Schwartz, & Jessell 1991). Several conditions can disrupt the blood-brain barrier including high blood pressure, infection, and most

applicable to this research, trauma that induces loss of blood supply to, inflammation of, and/or pressure on the brain.

While the exact definition is widely debated, concussions can occur from any force, to the body or head that causes the brain to move within the skull. The brain can rotate upon itself and/or collide with the bony walls of the cranium. Functional abnormalities caused by the movements produce a wide array of clinical symptoms, some of which can be observed by those around the injured player while others must be reported by the athlete themselves. Movement may stretch axons throughout the entire brain, often causing damage which interferes with cellular signaling. In areas of intense damage, blood vessels can rupture and leak toxic substances into the brain.

When damaged, astrocytes cannot efficiently regulate potassium and neurotransmitter levels. In extreme circumstances, potassium and excitatory levels of glutamate can be released from multiple sources into already highly concentrated areas. This overstimulation, known as excitotoxicity, causes cell death. Furthermore, an accumulation of excess neurotransmitters in the space surrounding neurons can cause moderate to severe swelling. Swelling increases pressure on the brain which affects blood flow. Loss of consciousness (LOC) occurs when extracellular potassium accumulates and inhibits action potential entirely for some period of time. In addition to LOC, observers of concussed athletes may also witness displays of confusion, failure to follow instruction or recall plays, awkward or troubled movements, and changes in mood and/or behavior. Symptoms reported by the athlete may include headache, nausea, vomiting, vision problems, memory loss, sensitivity to light, and trouble

concentrating, among others. In some cases, signs appear immediately. In others, symptoms may take hours or days to appear. Furthermore, the effects of concussion can be temporary or persist for an extended period of time. One or more of the above signs can indicate the player has sustained a concussion, but proper diagnosis cannot be made without evaluation by a licensed medical professional.

Traumatic brain injuries can range in degrees of severity. In most cases, visible structural damage does not occur. However, to rule out such damage, CT or MRI equipment can be utilized. CT and MRI scans detect skull fractures, contusions, bleeding, swelling, and/or scarring in the brain. The presence of one or more of the aforementioned symptoms indicates more severe injury that may require intense treatment and/or surgery. Damage that is not visible proves more difficult to diagnose; in these cases diagnosis is largely dependent on the injured player's feedback. Determining if a player has suffered a concussion involves an array of neurological testing and evaluation methods.

Once other severe injuries are ruled out, a multifaceted approach to assessing and monitoring the injured athlete is necessary. Symptoms are reported by severity, balance skills are tested, and neurological examinations are widely performed to evaluate the functionality of brain processes following concussion. Such examinations can study changes in vision, hearing, balance, strength, coordination, and/or reflexes. Memory loss, confusion, and lack of concentration are common in concussed athletes, and examinations take these symptoms into consideration (Concussion, 2017). There are numerous tests available for each area of examination including the Glasgow Coma

Scale, Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT), Standardized Assessment of Concussion (SAC), Sport Concussion Assessment Tool, 3rd Edition (SCAT3), Military Acute Concussion Evaluation (MACE), King Devick Test, and Balance Error Scoring System (BESS), among others. Football players at the University of Mississippi are evaluated using the ImPACT and SCAT3 tests.

ImPACT testing, Immediate Post-Concussion Assessment and Cognitive Testing, is an online “neurocognitive test to help evaluate and manage concussions.” This neurocognitive test measures “attention span, working memory, sustained and selective attention time, non-verbal problem solving, and reaction time.” Two forms of the test are available: baseline and post-injury. Baseline testing is performed before the beginning of a season and measures athletes’ brain function under “normal” conditions. It takes approximately twenty-five minutes to complete and can be administered by a “physician, nurse, athletic trainer, athletic director, or coach.” The test cannot be given at home. The company advises baseline tests should be given every two years. Ole Miss athletes are required to complete a baseline ImPACT assessment upon their arrival at the University. In case of injury, the athlete’s post-injury ImPACT scores are compared to his baseline testing scores. The ImPACT post-injury test is administered to evaluate changes in neurological and cognitive function so that an appropriate treatment plan can be constructed. It is important to emphasize that ImPACT is used as a diagnostic tool. Test results are considered in conjunction with examinations of the injured athlete conducted by licensed healthcare providers. In the test, the injured athlete indicates the severity of his symptoms using a 7-point Likert scale. The test “measures attention

span, working memory, sustained and selective attention time, non-verbal problem solving, and reaction time" ("ImPACT," 2018). The test is typically re-administered as the athlete progresses through treatment. Improvement in test scores can indicate progress during recovery. All information obtained from ImPACT tests is secured in a HIPAA compliant server (Schatz & Sandel, 2013).

The SCAT3 is another form of testing that can also be administered on the sideline. It is a comprehensive test which utilizes the Glasgow Coma Scale (Teasdale & Jennett, 1974) and Maddocks Questions (Maddocks, Dicker, & Saling, 1995) as well as evaluates the severity of symptoms on a zero to six point scale with six being the most severe. One section of the test examines cognitive function through the use of orientation questions, immediate memory recall, delayed recall, and concentration. During the SCAT3, the athlete's range of neck motion is examined, spots of tenderness are identified, if any, and upper and lower limb sensation and strength are observed. Additionally, the athletes' balancing abilities are tested in various stances using the Balance Error Scoring System. A coordination examination is also performed.

Instructions are provided in the testing packet for quick and helpful reference. In game and practice settings at the University of Mississippi, players suspected to be concussed are assessed using portions of the SCAT3 test to determine. This assessment can help determine if they are eligible to return to play or require further evaluation. The full SCAT3 examination is conducted by the team's physician following the game or practice in which the injury occurred.

To aid coaches, parents, and football staff in recognizing concussive events, some schools have implemented the use of sensors within football helmets or mouthguards to measure the magnitude of hits in real-time. A study at the University of Mississippi implemented the use of xPatch biosensors produced by X2 Biosystems in conjunction with X2's Integrated Concussion Examination (ICE) system to evaluate ten Ole Miss football players during the spring 2015 season. The ICE system "combines athlete concussion history, pre-season neurocognitive function, balance, and coordinate-performance data" which can be used as a baseline for comparison following injury. xPatch sensors record and store linear and rotational acceleration data about each axis as the players encounter impacts to the head. The patch then scores impact severity on a scale of 1-10 for analysis by authorized individuals and the athletes themselves. If injured, the data collected by the X2 system can aid in determining an athlete's return to play (RTP) eligibility. However, another use of the system allows athletes to visualize where they are making contact and how the impacts are affecting their bodies. This function illustrates the importance for players to alter their form to prevent future injury to both themselves and their opponents (Morrison & Daigle, 2015).

Many other companies also produce sensor technology for use in the sport of football including BRG Sports (Riddell), i1 Biometrics, Brain Sentry, Simbex, Jolt, GForce Tracker, and Head Case, among others. A study conducted by the NeuroTrauma Research Laboratory at the University of Michigan and the School of Biomedical Engineering and Sciences at Virginia Tech examined the effectiveness of such sensors (O'Connor, Rowson, Duma, & Broglio, 2017). Currently, many factors affect the

effectiveness of such technology. First, purchasing the sensors and accompanying software is expensive, and most schools do not have a budget for acquiring it each year. Additionally, the data collected by the sensors can be confounded by celebratory collisions, i.e. when two players leap into one another or bump their heads together. Third, analyzing the data may prove to be tedious and confusing. Furthermore, some schools are not equipped with computers, laptops, tablets, etc to view the data. And lastly, even if some schools do possess the technology and have an understanding of what the data indicates, many schools do not employ medical professionals to take action. The hope for these sensors in the future is to make them user- and cost-friendly tools that provide players, coaches, and trained medical officials at all levels of the sport accurate, easy-to-read data in real time. From the data they provide, major strides could be made in teaching players to make contact with their opponents in such a way that reduces the risk of concussion for both individuals. For those in the medical field, data from these sensors can provide better details of a player's injury. This can aid in diagnosis and the development of treatment plans.

Aside from the above methods, researchers are currently working to identify biomarkers that may indicate mTBI. Currently, biomarkers' role in normal brain function in comparison to post-injury is being investigated (Kawata et al., 2016). mTBI related changes in S100 β , neuron-specific enolase (NSE), neurofilament light chain (NFL), and tau protein levels can be assessed by analyzing a sample of cerebrospinal fluid (CSF) taken from a lumbar puncture. However, additional research is being conducted to determine if changes in the aforementioned proteins can be found in blood samples. A

2017 found acute increases in aldolase C (ALDOC), brain lipid binding protein (BLBP), and astrocytic phosphoprotein (PEA15) in blood samples taken from people who had suffered mTBI (Halford et al., 2017). Though more research must be conducted, tests examining levels of these proteins in injured athletes could someday be used to definitively diagnose concussion.

Once a diagnosis of concussion has been made, a treatment plan is developed. Treatment of concussion can be difficult because each brain and body reacts differently to injury, and there is no specific treatment route. Most physicians advise adequate rest, avoiding strenuous activity, and minimizing exposure to light and technological devices. As students, injured college athletes may have to limit their time spent on schoolwork. For those experiencing headache, over-the-counter pain relievers such as acetaminophen and ibuprofen may be recommended as well as the use of ice on the neck or head. However, some research now suggests that athletes who undergo forms of physical therapy or gradual activity while injured have better success in recovery. In a breakthrough study led by Dr. Jennifer Reneker, concussed athletes began physical therapy ten days post-concussion. In terms of the median number of days, athletes in the experimental group obtained medical clearance in 15.5 days and achieved symptomatic recovery in 13.5. However, for those in the control group, the median number of days for obtaining medical clearance and achieving symptomatic recovery was found to be 26 and 17, respectively. Reneker et. al concluded that stimulation from light exercises and activities can help the brain recover quicker than athletes who

followed a strict rest plan. Such research studies are new in the field, and further testing will be required to generate treatment plans in the future (Reneker et al., 2017).

The NCAA policy for all NCAA sanctioned sports establishes that “once a concussed student-athlete has returned to baseline level of symptoms, cognitive function and balance, then the return-to-play progression can be initiated.” This progression occurs in a five step fashion:

- 1.) light aerobic exercise,
- 2.) activities specific to the sport without impacts to the head,
- 3.) sport specific drills without contact and gradual resistance training,
- 4.) unrestricted training, and
- 5.) return to competition.

A concussed athlete is only allowed to advance to the next stage if they remain asymptomatic. If symptoms return and/or cognitive/clinical scores decline from baseline, the athlete must be reassessed by their physician who will determine if they should repeat the current or return to the previous stage in the return-to-play progression. The NCAA explains that the typical timeline is two weeks, but the actual length of time varies by the individual. For those student athletes with symptoms persisting longer than two weeks, short and/or long term academic arrangements can be made with the school’s disability services office to alter the student’s schedule, testing accommodations, etc (Concussion Diagnosis and Management Best Practices, 2017).

Highlighting the severe impacts of concussions in today's society, media coverage has increased in recent years and the topic of concussions has even breached the Hollywood movie scene. National news programs have reported numerous segments on concussion in various facets including specific cases of concussion and CTE, developing concussion technology, helmet modifications, and raising awareness to players, parents, and coaches, for example (Freydkin & Hiscock, 2018; Pawlowski, 2017; Rossen & Billington, 2017). A 2015 film, *Concussion*, portrays the groundbreaking work of Dr. Bennet Omalu and his discovery of CTE, the disease caused by repeated trauma on the brain characterized by startling changes in behavior, memory loss, and often erratic behavior. The film bridges Omalu's past work with that in which he is currently involved (Landesman, 2015). Today, Dr. Omalu's work examines the effects of football on the developing brains of children. From his findings, Dr. Omalu goes as far to say that allowing children to play football is "the definition of child abuse." Furthermore, he advises that no person under the age of eighteen should be allowed to participate in tackle football (Axson, 2017). Dr. Omalu has made numerous appearances on national news programs and produced several publications regarding what he has found in his research career. Additionally, a popular Frontline documentary, *League of Denial: The NFL's Concussion Crisis*, and a similarly titled book, *League of Denial: League of Denial: The NFL, Concussions and the Battle for Truth*, describe the NFL's so-called concussion crisis and its failure to adequately address the dangers of concussion (Fainaru-Wada & Fainaru, 2013; Kirk, 2013). Popular cultural presentations of concussion can be highly influential, and this study sought to examine how exposure to works such as these, and

others, have affected the perceptions of members of the Ole Miss community regarding the severity of concussions in the sport of football.

In our study, we sought to survey the perceptions of the Ole Miss community regarding their knowledge of the above information in addition to their perceptions of concussion in the sport of football as a whole. Given the passionate history of the powerhouse football program at the University of Mississippi, we set out to examine how participants' answers varied based on self-reported devotion, classification, and prior involvement in sports. We hypothesized that participants with higher University classification would be more educated about concussions, report concussions to have greater health consequences, and perceive concussions appropriately, if not slightly underreported in the news because such participants are older and potentially wiser. Due to their interest in the sport, we hypothesized that participants with moderate to high levels of devotion to Ole Miss football would perceive concussions to be overreported in the news and treated as a bigger issue than they should be. We believed males would indicate greater interest in Ole Miss football than females, based on observations in the general male population. Based on exposure to concussion protocol, we hypothesized that current and former athletes would be more knowledgeable about concussion symptoms, treatment, and recovery procedures.

II. Methods

Survey

The survey in this study was created by Madison Frerker under the direction of Dr. Nicole Ashpole with the assistance of Dr. Matthew Becker. The survey was approved by the Institutional Review Board (IRB) as Exempt under 45 CFR 46.101(b)(#2). It was generated using Qualtrics software which allows users to create surveys with a variety of question formats guided by customizable logic flow. Additionally, Qualtrics presents data collected from a survey graphically and in tables and offers a multitude of further data analysis options, including chi-square analysis of percentages. This particular survey utilized single and multiple answer multiple choice, multiple choice with text entry, simple text-entry, and true/false questions. Additionally, question logic was enabled to display relevant questions based on previous responses. Multiple choice questions regarding participants' opinions were written as 5- and 7-point Likert scales. Previous research has indicated that data collected from Likert items of less than 5 or more than 7 is significantly less accurate (Johns, 2010). 5,500 full-time students, faculty, and staff at the University of Mississippi received an email containing a link to the 42 question survey on November 30, 2017. Once participants completed the survey they were not contacted further. Those who had not yet completed the survey received reminder emails on the 5, 11, and 14 and of December 2017 which prompted them to follow the link and complete the survey. The last entry was collected on January 8, 2018. For a complete list of questions used in the survey, see Appendix (pg. 53).

Subjects

Out of the 5,500 individuals who received the survey, we received responses from 864 participants, two of which indicated they were not 18 years of age and were not eligible to complete the survey. Of the 862 remaining responses, some participants left one or multiple questions blank. For this reason, the number of responses varies with each question. Respondents providing their University classification included 177 freshman (21.61%), 138 sophomores (16.85%), 139 juniors (16.97%), 169 seniors (20.63%), 142 graduate students (17.34%), 33 faculty (4.03%), and 21 staff (2.56%). The average age of participants (22.45 ± 7.24 years) was calculated from the 487 that responded to the question, "Age:"

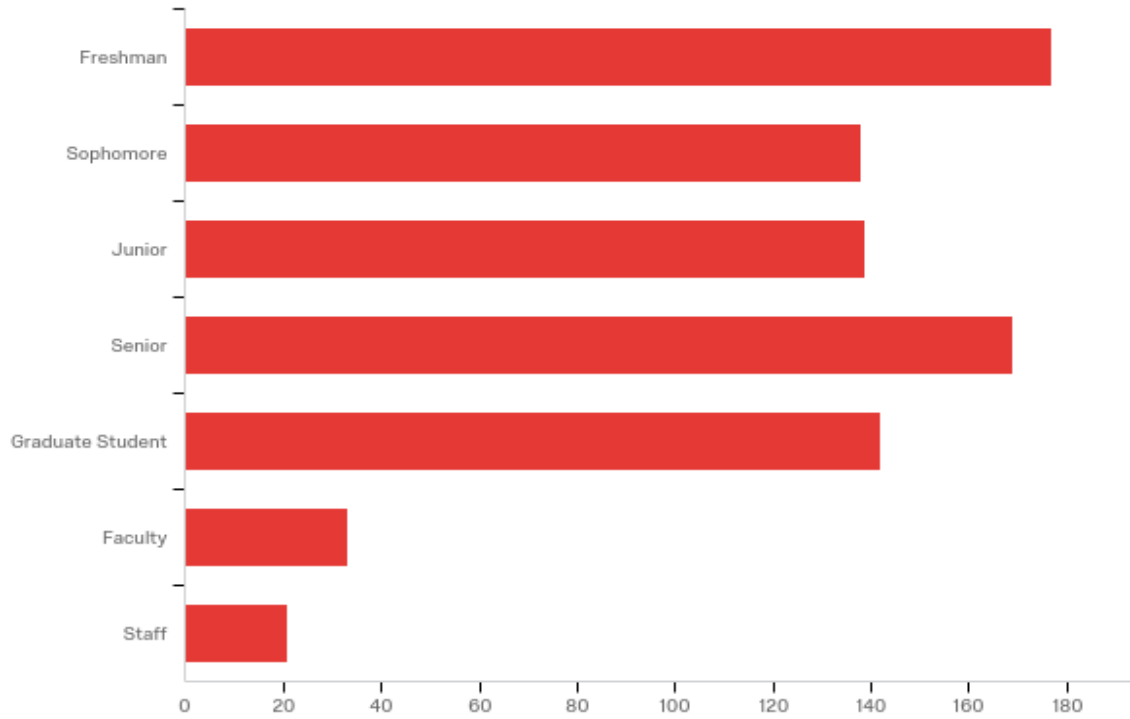
Data Analysis

Survey responses were analyzed using tools within the Qualtrics system, specifically chi-square analysis. Additionally, data was compiled into Excel for further analysis and comparison and graphed using SigmaPlot software. T-tests, chi-square tests, Fisher exact tests, and one way ANOVA with post-hoc and Bonferroni correction for family-wise error were performed when appropriate. Independent variables included reported University classification, level of devotion to Ole Miss football, status as a current, former, or non-athlete, and gender.

III. Results

To begin, participants were prompted to provide their age and indicate their Ole Miss classification as a student, faculty member, or staff member. We believed older participants, as implied by their reported age and University classification would tend to be more knowledgeable about concussion and indicate more severe consequences of concussion to an athlete's health. Additionally, we hypothesized that older participants would view concussions as appropriately reported, if not slightly underreported, in the news. 21.61% identified as freshman, 16.85% as sophomores, 16.97% as juniors, 20.63% as seniors, 17.34% as graduate students, 4.03% as faculty, and 2.56% as staff (Figure 1). Chi-square analysis of responses did not reveal significant differences in ratings of personal knowledge of concussion or perceived severity of concussions. No significant differences are found between responses indicating the percent of players experiencing concussion during their collegiate career (Figure 2). However, levels with which participants agreed or disagreed with the statement, "Cumulative hits in the sport of football can be as harmful as a single concussive incident" were significantly different (p -value < 0.05). Fisher exact analysis indicated that faculty and staff members tended to more strongly agree with the statement. Significant differences were also found in participant responses indicating if they would allow their child(ren) to play football ($p < 0.05$). Using a Fisher exact test, it was found that the majority of faculty and staff members indicated "No." Lastly, no significance was found regarding how participants perceived concussions to be reported in the news. Figure 3 illustrates a cross-tabulation of responses per each classification level.

What is your classification at Ole Miss?



#	Answer	%	Count
1	Freshman	21.61%	177
2	Sophomore	16.85%	138
3	Junior	16.97%	139
4	Senior	20.63%	169
5	Graduate Student	17.34%	142
6	Faculty	4.03%	33
7	Staff	2.56%	21
	Total	100%	819

Figure 1: Survey participants by classification at the University of Mississippi.

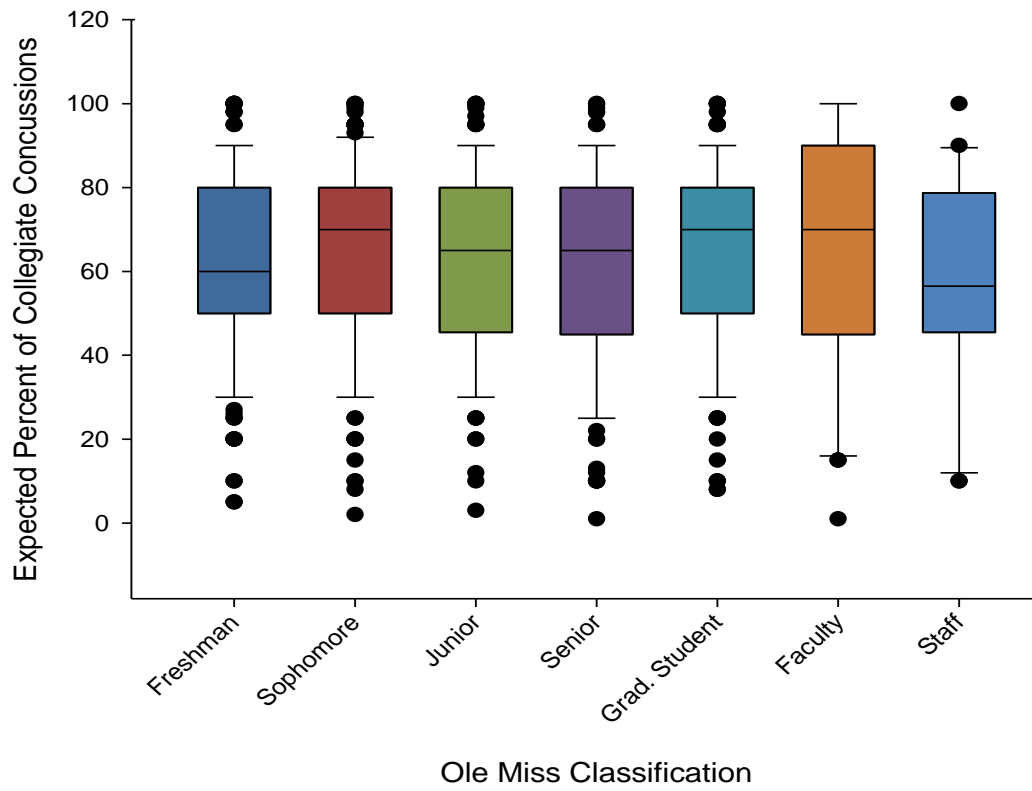


Figure 2: *Expected percent of collegiate football players who will experience concussion as reported by participant classification.*

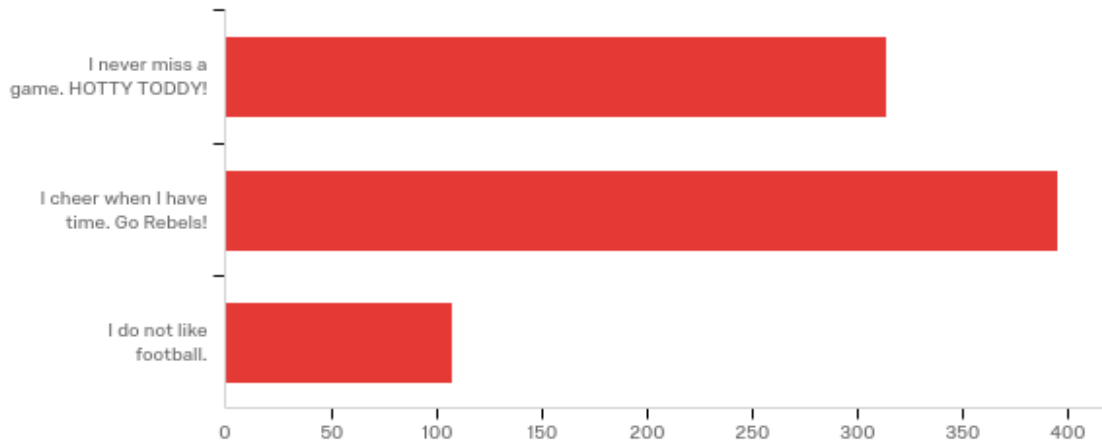
		What is your classification at Ole Miss?							
		Freshman	Sophomore	Junior	Senior	Graduate Student	Faculty	Staff	Total
How serious are the effects of concussion to a person's health?	Extremely dangerous	31.33%	30.83%	33.08%	33.33%	37.31%	40.63%	42.86%	33.67%
	Very dangerous	43.98%	41.35%	37.59%	46.91%	38.81%	34.38%	47.62%	41.87%
	Moderately dangerous	18.67%	21.05%	24.06%	16.67%	20.15%	15.63%	4.76%	19.33%
	Slightly dangerous	4.22%	5.26%	4.51%	1.85%	3.73%	6.25%	0.00%	3.84%
	Not at all dangerous	1.81%	1.50%	0.75%	1.23%	0.00%	3.13%	4.76%	1.28%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
How important is the person's personal input to concussion diagnosis if they become concussed?	Extremely important	40.61%	37.59%	43.61%	42.59%	36.57%	28.13%	38.10%	39.74%
	Very important	35.76%	36.84%	35.34%	36.42%	35.82%	40.63%	57.14%	36.79%
	Moderately important	17.58%	15.04%	16.54%	12.96%	17.91%	18.75%	4.76%	15.77%
	Slightly important	4.24%	6.02%	3.76%	4.94%	7.46%	9.38%	0.00%	5.26%
	Not at all important	1.82%	4.51%	0.75%	3.09%	2.24%	3.13%	0.00%	2.44%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Concussions are in the news.	Extremely overreported	1.35%	0.86%	2.54%	2.58%	3.91%	0.00%	0.00%	2.09%
	Moderately overreported	4.05%	6.90%	6.78%	7.74%	5.47%	0.00%	5.00%	5.86%
	Neither overreported nor underreported	27.03%	24.14%	16.10%	19.35%	17.97%	31.25%	20.00%	21.48%
	Moderately underreported	35.14%	36.21%	44.92%	35.48%	32.81%	31.25%	50.00%	36.82%
	Extremely underreported	19.59%	27.59%	23.73%	28.39%	28.91%	28.13%	10.00%	25.24%
	I do not know	12.84%	4.31%	5.93%	6.45%	10.94%	9.38%	15.00%	8.51%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Do you believe concussions are treated as a bigger issue than they should be? Why?	Yes	12.68%	20.72%	15.52%	17.81%	16.41%	6.45%	5.00%	15.71%
	No	87.32%	79.28%	84.48%	82.19%	83.59%	93.55%	95.00%	84.29%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
How would you rate your personal concussion knowledge?	Extremely educated	10.81%	5.17%	5.93%	8.44%	6.25%	3.23%	0.00%	7.13%
	Moderately educated	47.30%	52.59%	44.07%	47.40%	44.53%	67.74%	55.00%	48.25%
	Neither educated nor uneducated	23.65%	26.72%	25.42%	25.32%	16.41%	19.35%	30.00%	23.50%
	Moderately uneducated	12.84%	12.93%	19.49%	14.29%	23.44%	9.68%	10.00%	15.94%
	Extremely uneducated	5.41%	2.59%	5.08%	4.55%	9.38%	0.00%	5.00%	5.17%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Compared to other collegiate football teams, Ole Miss players are at risk of concussion.	Greater	7.30%	5.36%	4.46%	8.11%	5.88%	6.45%	5.26%	6.34%
	Equal	90.51%	92.86%	93.75%	89.19%	93.28%	93.55%	94.74%	91.89%
	Less	2.19%	1.79%	1.79%	2.70%	0.84%	0.00%	0.00%	1.77%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Cumulative hits in the sport of football can be as harmful as a single concussive incident.	Strongly disagree	8.03%	5.36%	1.79%	7.38%	6.67%	3.23%	0.00%	5.74%
	Somewhat disagree	5.84%	16.96%	6.25%	4.70%	5.83%	3.23%	5.26%	7.35%
	Neither agree nor disagree	13.87%	10.71%	16.07%	10.74%	14.17%	9.68%	5.26%	12.65%
	Somewhat agree	38.69%	23.21%	34.82%	37.58%	25.83%	29.03%	36.84%	32.50%
	Strongly agree	33.58%	43.75%	41.07%	39.60%	47.50%	54.84%	52.63%	41.76%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
If/When you have children, would you allow the child to play tackle football?	Yes	56.12%	53.10%	51.79%	47.30%	29.75%	9.38%	26.32%	45.32%
	No	11.51%	15.93%	10.71%	18.92%	30.58%	62.50%	47.37%	20.47%
	Unsure	32.37%	30.97%	37.50%	33.78%	39.67%	28.13%	26.32%	34.21%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%



Figure 3: Cross-tabulation chart of participants' responses based on classification at the University of Mississippi.

To determine interest in the sport, participants were asked to rank their devotion to Ole Miss football. We hypothesized that participants reporting greater devotion to Ole Miss football would tend to indicate that concussions are exaggerated in today's society. Additionally, we believed males would indicate greater devotion to Ole Miss football than females. As a whole, as presented in Figure 4, 38.43% of participants reported a high level of devotion, 48.35% reported moderate devotion, and 13.22% reported no devotion. Fisher exact analysis revealed that participants who reported no devotion to Ole Miss football were less likely to indicate that concussions were treated as a bigger issue than they should be ($p < 0.05$). Fisher exact testing also revealed that significantly more participants with no devotion indicated that concussions were extremely underreported in the news ($p < 0.05$). Additionally, participants reporting no devotion to Ole Miss football were found to identify as less educated in regards to their personal knowledge of concussion than participants with a moderate to high level of devotion, according to Fisher exact analysis. Graphical representation from SigmaPlot reveals that males and females reported an approximately equal level of devotion to Ole Miss football (Figure 5). A cross-tabulation chart (Figure 6) from Qualtrics highlights that of all participants who indicated concussions to be extremely overreported in the news, none of them identified as having no devotion to Ole Miss football; everyone who perceived concussions to be extremely overreported in the news claimed a moderate or high devotion to Ole Miss football. Chi-square analysis revealed that a significant number of participants with no devotion indicated that concussions are extremely underreported in the news.

Describe your devotion to Ole Miss football:



#	Answer	%	Count
1	I never miss a game. HOTTY TODDY!	38.43%	314
2	I cheer when we have time. Go Rebels!	48.35%	395
3	I do not like football.	13.22%	108
	Total	100%	817

Figure 4: *Self-reported level of devotion to Ole Miss football.*

Level of Devotion by Gender

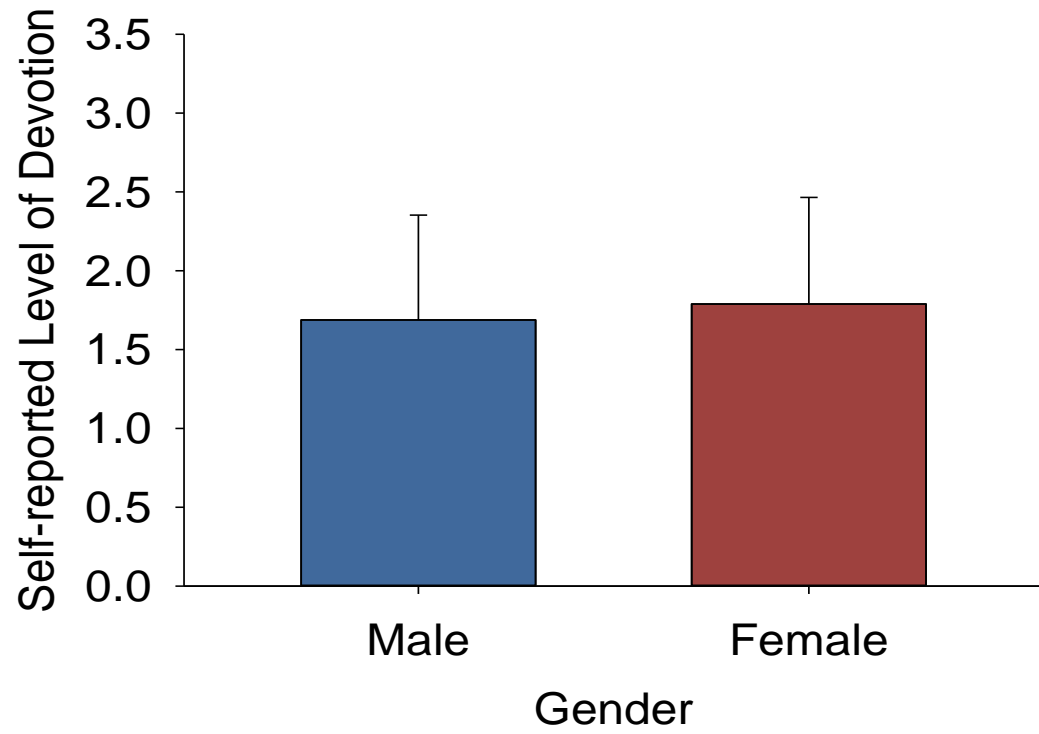


Figure 5: Average self-reported level of devotion to Ole Miss football by gender.

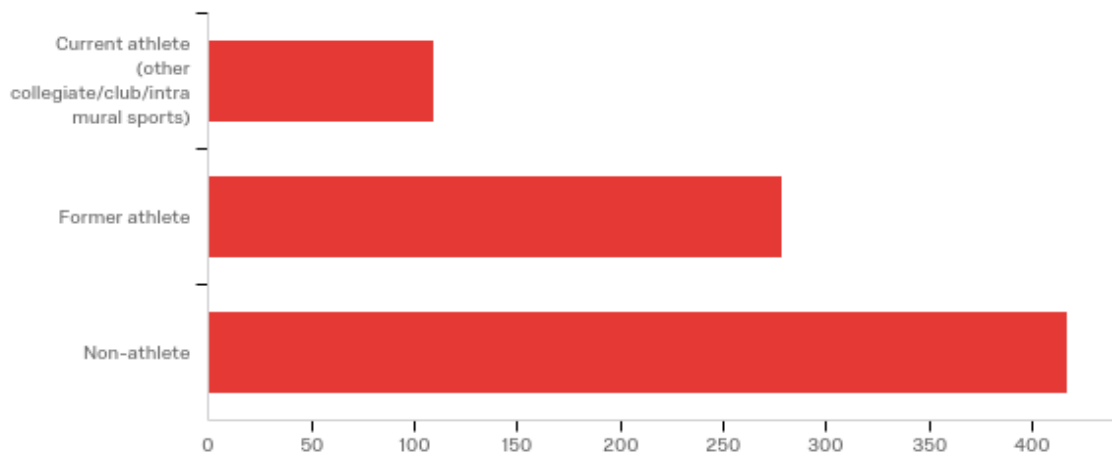
		Describe your devotion to Ole Miss football.			Total
		I never miss a game. HOTTY TODDY!	I cheer when I have time. Go Rebels!	I do not like football.	
How serious are the effects of concussion to a person's health?	Extremely dangerous	31.56%	33.69%	39.60%	33.63%
	Very dangerous	39.53%	44.30%	40.59%	41.98%
	Moderately dangerous	21.59%	17.77%	18.81%	19.38%
	Slightly dangerous	5.98%	2.92%	0.99%	3.85%
	Not at all dangerous	1.33%	1.33%	0.00%	1.16%
	Total	100.00%	100.00%	100.00%	100.00%
How important is the person's personal input to concussion diagnosis if they become concussed?	Extremely important	42.00%	39.26%	34.65%	39.72%
	Very important	38.67%	35.81%	35.64%	36.89%
	Moderately important	12.33%	17.77%	18.81%	15.81%
	Slightly important	5.00%	4.24%	9.90%	5.27%
	Not at all important	2.00%	2.92%	0.99%	2.31%
	Total	100.00%	100.00%	100.00%	100.00%
Concussions are _____ in the news.	Extremely overreported	2.94%	2.02%	0.00%	2.10%
	Moderately overreported	8.09%	4.90%	3.13%	5.87%
	Neither overreported nor underreported	29.41%	18.16%	10.42%	21.40%
	Moderately underreported	33.46%	40.06%	35.42%	36.92%
	Extremely underreported	20.59%	25.07%	39.58%	25.31%
	I do not know	5.51%	9.80%	11.46%	8.39%
	Total	100.00%	100.00%	100.00%	100.00%
Do you believe concussions are treated as a bigger issue than they should be? Why?	Yes	19.85%	14.07%	8.33%	15.46%
	No	80.15%	85.93%	91.67%	84.54%
	Total	100.00%	100.00%	100.00%	100.00%
How would you rate your personal concussion knowledge?	Extremely educated	9.56%	5.49%	5.21%	7.00%
	Moderately educated	57.35%	45.38%	33.33%	48.32%
	Neither educated nor uneducated	18.38%	26.59%	27.08%	23.53%
	Moderately uneducated	12.87%	17.34%	19.79%	15.97%
	Extremely uneducated	1.84%	5.20%	14.58%	5.18%
	Total	100.00%	100.00%	100.00%	100.00%
Compared to other collegiate football teams, Ole Miss players are at _____ risk of concussion.	Greater	7.66%	6.50%	2.15%	6.35%
	Equal	90.04%	91.95%	96.77%	91.88%
	Less	2.30%	1.55%	1.08%	1.77%
	Total	100.00%	100.00%	100.00%	100.00%
Cumulative hits in the sport of football can be as harmful as a single concussive incident.	Strongly disagree	5.36%	6.15%	5.38%	5.74%
	Somewhat disagree	8.05%	8.00%	3.23%	7.36%
	Neither agree nor disagree	13.03%	12.31%	12.90%	12.67%
	Somewhat agree	32.18%	33.23%	31.18%	32.55%
	Strongly agree	41.38%	40.31%	47.31%	41.68%
	Total	100.00%	100.00%	100.00%	100.00%
If/When you have children, would you allow the child to play tackle football?	Yes	61.22%	38.84%	23.66%	45.39%
	No	7.60%	23.85%	45.16%	20.50%
	Unsure	31.18%	37.31%	31.18%	34.11%
	Total	100.00%	100.00%	100.00%	100.00%

Figure 6: Cross-tabulation chart of participants' responses in regards to their self-reported level of devotion.

The third grouping of responses was made based on the participants' athletic status. We hypothesized that participants who report current or prior involvement in sports would be more knowledgeable about concussions. Of the sample, 10 participants or 1.22% identified themselves as an Ole Miss football players. Of those 10, 5 selected they would continue playing football at the professional level if given the opportunity. Of the remaining participants, 13.54% identified as current athletes in collegiate (other than football), club, and/or intramural sports, 34.66% as former athletes, and 51.80% as non-athletes (Figure 7). 21.74% of participants had previously or were currently participating in tackle football at a non-collegiate level. Of that group, 25.39% played little league, 36.79% played middle school, 33.16% played high school, and 4.66% played collegiate football (at a different institution). Participants identifying themselves as current or former athletes were prompted to select all sports other than football in which they participated (Figure 8). Participants selecting "Other" were asked to specify. Some participants erroneously listed football or entered sports that were already provided. Additional "other" responses included cheer, dance, band, and color guard. While concussions can result from any form of activity, the available answer choices to this question were the sports we considered to be most common and most likely to result in concussions. A significant difference can be found amongst the ratings of personal knowledge of concussions by participants of each athletic status ($p < 0.05$). Using a Fisher exact test, it was found that significantly more non-athletes identified as neither educated nor uneducated. Reviewing the cross-tabulation chart (Figure 9) of athletic status and ratings of personal knowledge, the majority of participants reporting

themselves to be either extremely or moderately educated identified as former athletes. Chi-square analysis also indicates a significant difference ($p < 0.05$) in responses from participants of different athletic statuses in regards to their devotion to Ole Miss football. According to Fisher exact analysis, non-athletes significantly report less devotion than current or former athletes. There was also a significant difference in participants who have or have not been diagnosed with concussion ($p < 0.05$). Significantly fewer non-athlete participants report prior medical diagnosis of concussions than participants in the current or former athlete categories, according to Fisher exact testing. It was also found that non-athletes significantly report that concussions are extremely underreported in the news when compared to both current and former athlete responses. Of all participants indicating concussions are underreported in the news, 56.42% identified as non-athletes. Lastly, chi-square analysis indicates significant difference ($p < 0.05$) in current, former, or non-athlete responses regarding if they would, would not, or were unsure if they would allow their child(ren) to play football. Of those participants indicating they would not allow their child(ren) to play football, 60.87% identified as non-athletes; non-athletes are significantly less likely to allow their child(ren) to play tackle football.

I am a:

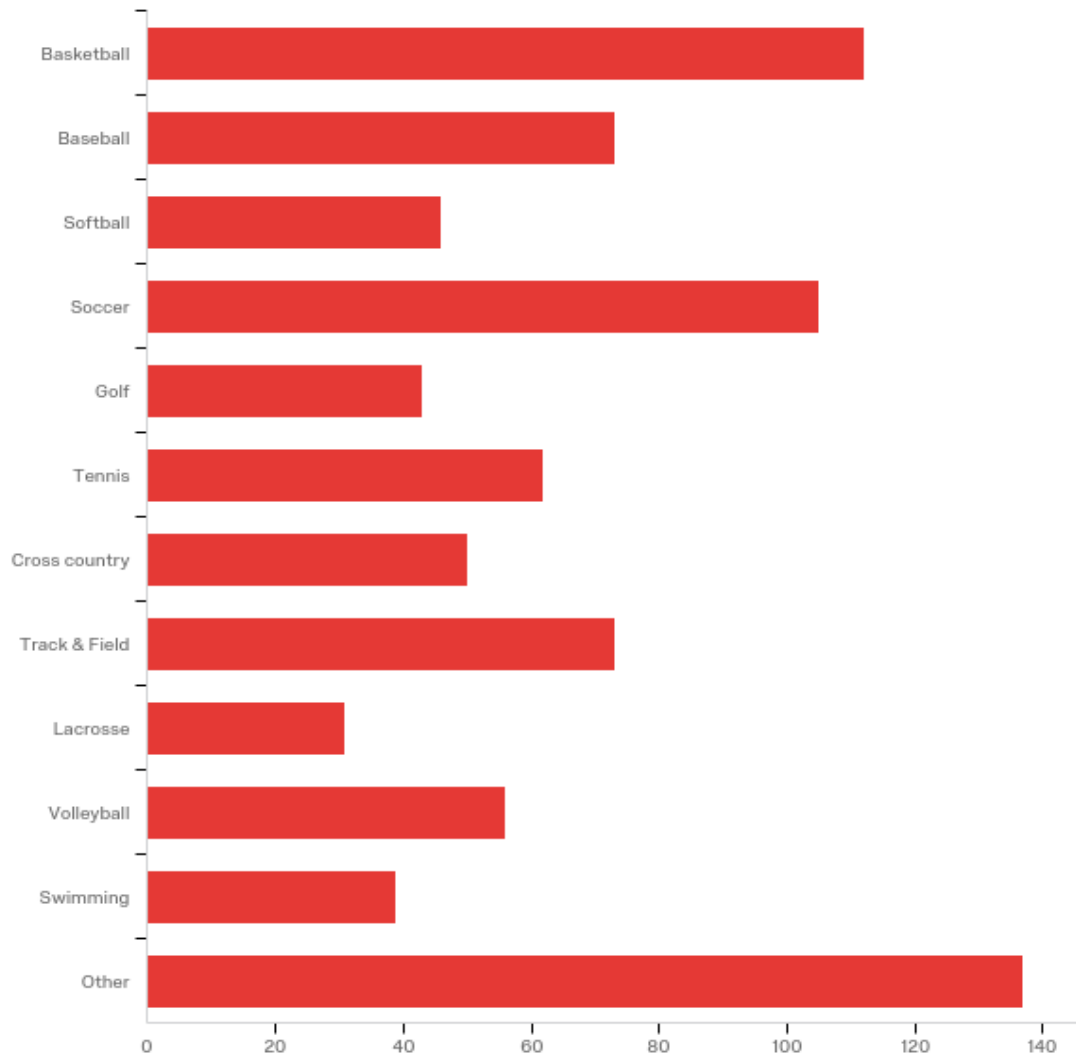


#	Answer	%	Count
1	Current athlete (other collegiate/club/intramural sports)	13.54%	109
2	Former athlete	34.66%	279
3	Non-athlete	51.80%	417
	Total	100%	805

Figure 7: Athletic status of participants.

a.)

In which sports were/are you a participant?



(See description below Part B)

b.)

#	Answer	%	Count
1	Basketball	13.54%	112
2	Baseball	8.83%	73
3	Softball	5.56%	46
4	Soccer	12.70%	105
5	Golf	5.20%	43
6	Tennis	7.50%	62
7	Cross country	6.05%	50
8	Track & Field	8.83%	73
9	Lacrosse	3.75%	31
10	Volleyball	6.77%	56
11	Swimming	4.72%	39
12	Other	16.57%	137
	Total	100%	827

Figure 8a, 8b: *Sports, other than football, in which participants who selected “current athlete” or “former athlete” are/were involved.*

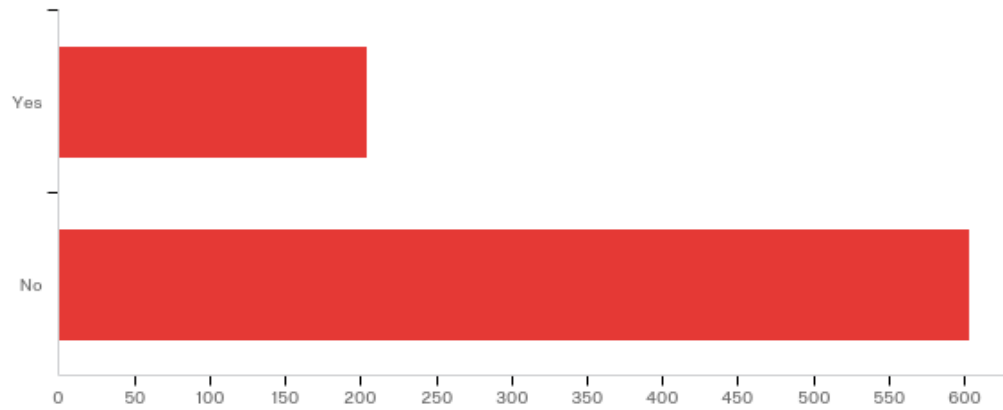


		I am a:			Total
		Current athlete (other collegiate/club/intramural sports)	Former athlete	Non-athlete	
Describe your devotion to Ole Miss football.	I never miss a game. HOTTY TODDY!	46.79%	46.24%	30.84%	38.38%
	I cheer when I have time. Go Rebels!	50.46%	45.88%	49.64%	48.44%
	I do not like football.	2.75%	7.89%	19.52%	13.20%
	Total	100.00%	100.00%	100.00%	100.00%
Have you been diagnosed with concussion?	Yes	36.11%	35.53%	15.35%	25.06%
	No	63.89%	64.47%	84.65%	74.94%
	Total	100.00%	100.00%	100.00%	100.00%
How serious are the effects of concussion to a person's health?	Extremely dangerous	32.69%	32.09%	35.00%	33.68%
	Very dangerous	41.35%	40.30%	43.50%	42.10%
	Moderately dangerous	24.04%	19.03%	18.25%	19.30%
	Slightly dangerous	0.96%	5.97%	2.75%	3.63%
	Not at all dangerous	0.96%	2.61%	0.50%	1.30%
Total	100.00%	100.00%	100.00%	100.00%	
How important is the person's personal input to concussion diagnosis if they become concussed?	Extremely important	42.72%	43.66%	36.75%	39.95%
	Very important	33.01%	34.33%	39.25%	36.71%
	Moderately important	14.56%	15.67%	16.25%	15.82%
	Slightly important	4.85%	4.10%	5.75%	5.06%
	Not at all important	4.85%	2.24%	2.00%	2.48%
Total	100.00%	100.00%	100.00%	100.00%	
Concussions are in the news.	Extremely overreported	2.08%	2.04%	1.36%	1.69%
	Moderately overreported	5.21%	9.39%	3.80%	5.92%
	Neither overreported nor underreported	28.13%	25.71%	17.39%	21.72%
	Moderately underreported	38.54%	35.51%	37.23%	36.81%
	Extremely underreported	21.88%	23.27%	27.45%	25.25%
	I do not know	4.17%	4.08%	12.77%	8.60%
Total	100.00%	100.00%	100.00%	100.00%	
How important is it to educate football players about concussion?	Extremely important	73.96%	71.84%	79.08%	75.88%
	Very important	23.96%	22.86%	18.21%	20.59%
	Moderately important	2.08%	4.90%	2.17%	3.10%
	Slightly important	0.00%	0.00%	0.00%	0.00%
	Not at all important	0.00%	0.41%	0.54%	0.42%
Total	100.00%	100.00%	100.00%	100.00%	
How would you rate your personal concussion knowledge?	Extremely educated	13.54%	11.02%	2.73%	7.07%
	Moderately educated	61.46%	55.10%	40.16%	48.23%
	Neither educated nor uneducated	12.50%	22.04%	27.60%	23.62%
	Moderately uneducated	11.46%	7.76%	22.68%	15.98%
	Extremely uneducated	1.04%	4.08%	6.83%	5.09%
Total	100.00%	100.00%	100.00%	100.00%	
The symptoms of concussion:	Are the same for everyone	4.17%	2.88%	3.28%	3.28%
	Vary by person	95.83%	97.12%	96.72%	96.74%
Total	100.00%	100.00%	100.00%	100.00%	
The length of recovery from concussion:	Is the same for everyone	0.00%	0.00%	1.37%	0.71%
	Varies by person	100.00%	100.00%	98.63%	99.29%
Total	100.00%	100.00%	100.00%	100.00%	
Compared to other collegiate football teams, Ole Miss players are at risk of concussion.	Greater	3.26%	6.41%	7.23%	6.40%
	Equal	95.65%	91.45%	91.04%	91.82%
	Less	1.09%	2.14%	1.73%	1.79%
Total	100.00%	100.00%	100.00%	100.00%	
Cumulative hits in the sport of football can be as harmful as a single concussive incident.	Strongly disagree	8.70%	4.72%	5.76%	5.80%
	Somewhat disagree	8.70%	5.58%	7.78%	7.14%
	Neither agree nor disagree	6.52%	16.31%	12.10%	12.80%
	Somewhat agree	42.39%	33.48%	29.39%	32.59%
	Strongly agree	33.70%	39.91%	44.96%	41.67%
Total	100.00%	100.00%	100.00%	100.00%	
If/When you have children, would you allow the child to play tackle football?	Yes	48.91%	56.60%	36.39%	45.12%
	No	15.22%	17.02%	24.07%	20.41%
	Unsure	35.87%	26.38%	39.54%	34.47%
Total	100.00%	100.00%	100.00%	100.00%	

Figure 9: Cross-tabulation chart of participants' responses in regards to their athletic status.

While nearly half of participants indicated current or prior participation in sports, only 25.28% of the sample reported being medically diagnosed with concussion (Figure 10). Those selecting yes were prompted to provide the number of medically diagnosed concussions they had experienced. The average number of reported concussions was calculated to be $.744 \pm 1.39$.

Have you been diagnosed with concussion?

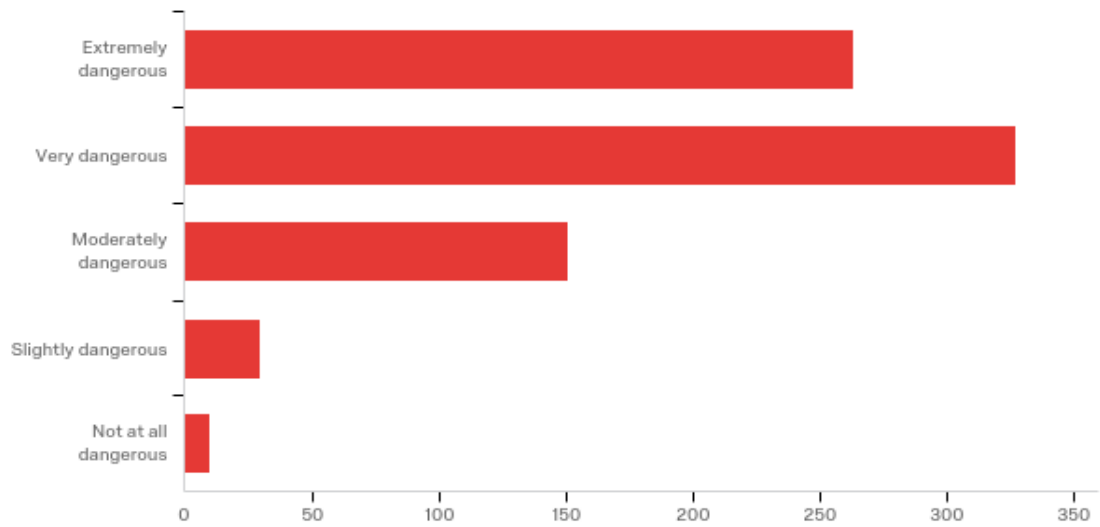


#	Answer	%	Count
1	Yes	25.28%	204
2	No	74.72%	603
	Total	100%	807

Figure 10: *Percent of participants reporting previous medically diagnosed concussion(s).*

We hypothesized that most people would indicate that concussions were dangerous to a person's health, but we sought to determine the degree with which such dangers were perceived. 33.67% of the sample rated concussions extremely dangerous to a person's health, 41.87% very dangerous, 19.33% moderately dangerous, 3.84% slightly dangerous. Only 1.28% of participants indicated that concussions were not at all dangerous to a person's health (Figure 11).

How serious are the effects of concussion to a person's health?

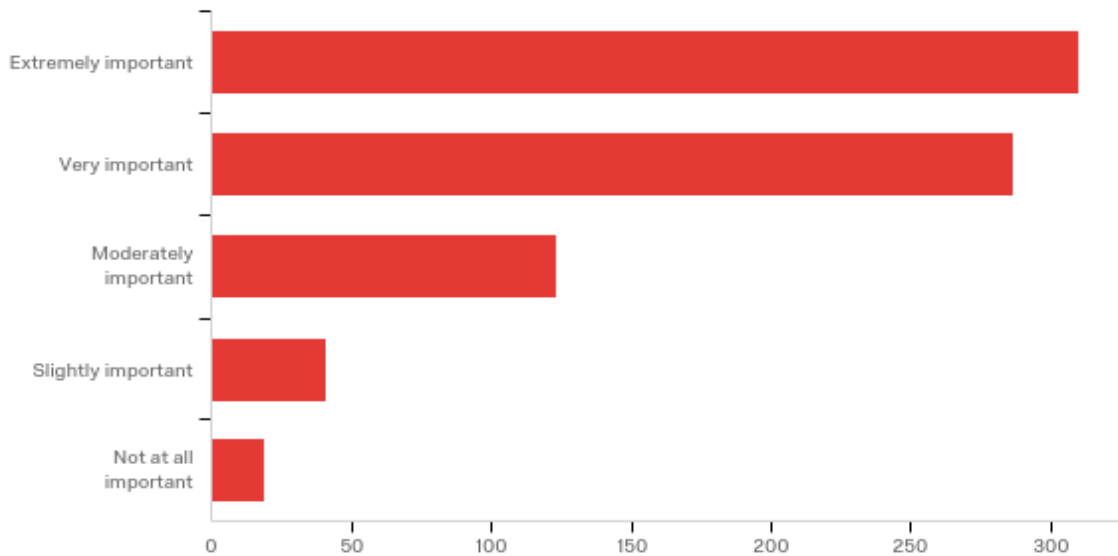


#	Answer	%	Count
1	Extremely dangerous	33.67%	263
2	Very dangerous	41.87%	327
3	Moderately dangerous	19.33%	151
4	Slightly dangerous	3.84%	30
5	Not at all dangerous	1.28%	10
	Total	100%	781

Figure 11: Responses indicating the seriousness of concussions in football.

Because the symptoms of concussion are unique to each individual, it is important for players to communicate their health with coaches and trained medical professionals. Without proper communication, many concussions go unreported. This could be due to fear of letting down the team, the influence of high adrenaline levels, or ignoring the symptoms. Some players consider their symptoms to be “normal” and not serious enough for evaluation. In a game environment, players may not honestly report the severity of their symptoms for fear of removal from play. This creates a difficult dynamic between players, coaches, and health officials. Because of this, we wanted to examine the perceived importance of a concussed player’s input to concussion diagnosis. We believed that the majority of participants would assign importance to a player’s communication of their injuries. Figure 12 illustrates that 39.74% of participants believed personal input to be extremely important, 36.79% very important, 15.77% moderately important, 5.26% slightly important. Only 2.44% indicated that it is not at all important.

How important is the person's personal input to concussion diagnosis if they become concussed?



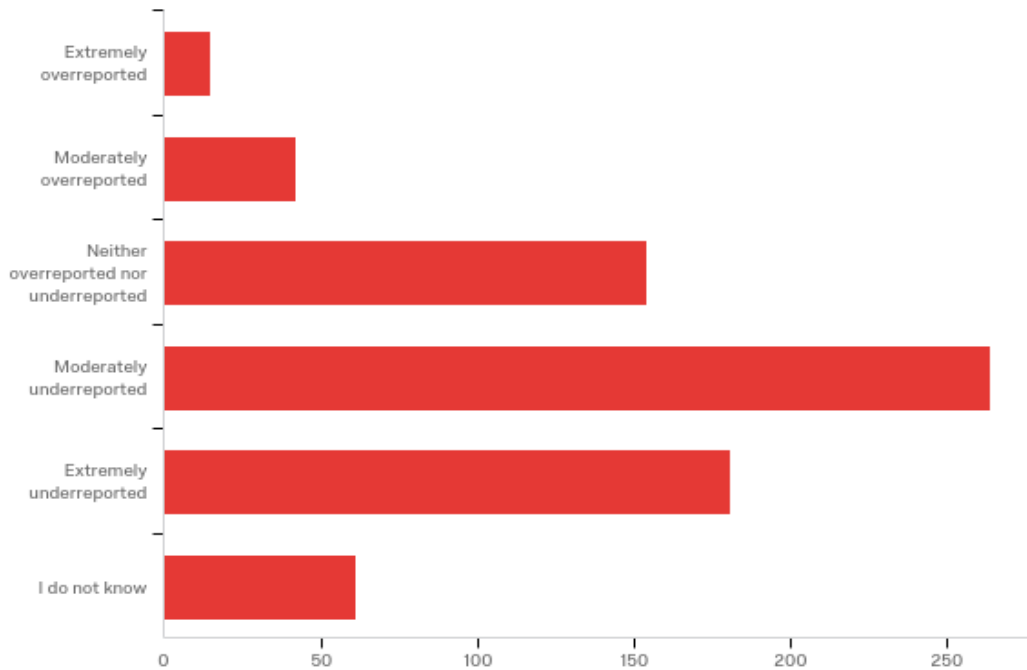
#	Answer	%	Count
1	Extremely important	39.74%	310
2	Very important	36.79%	287
3	Moderately important	15.77%	123
4	Slightly important	5.26%	41
5	Not at all important	2.44%	19
	Total	100%	780

Figure 12: Reports indicating the importance of a player's personal input to diagnosis.

In order to make diagnoses, medical professionals may use a variety of tools to examine a player's memory, balance, and cognitive function, and 95.51% of the sample believed there were methods to assess an athlete for concussion. 2.51% and 1.39% correctly identified the use of ImPACT or SCAT testing, respectively. Many text-entry responses cited the use of MRI (10.14%) or CT (11.53%) scans, assessing the pupils/eyes (20.48%), and examining balance abilities (2.98%). Of the 503 text-entry responses, "memory" was mentioned 704 times. While many participants were aware that diagnostic methods existed, several wrote "I do not know" or "not sure" when asked to list specific methods.

In regards to the media, we believed participants would indicate concussions are overreported by the media because of recent increases in concussion coverage. However, results show that the majority of participants believe concussions to be moderately to extremely underreported. Represented in Figure 13, 2.09% believed concussions to be extremely overreported, 5.86% moderately overreported, 21.48% neither overreported nor underreported, 36.82% moderately underreported, 25.24% extremely underreported in the news; 8.51% did not know. Additionally, 15.71% of responses indicated that concussions are treated as a bigger issue than they should be in general. In numerical terms with 1 being "extremely overreported" and 6 being "I do not know," the average response was 4.03, implying that participants perceive concussions to be moderately underreported in the news.

Concussions are _____ in the news.

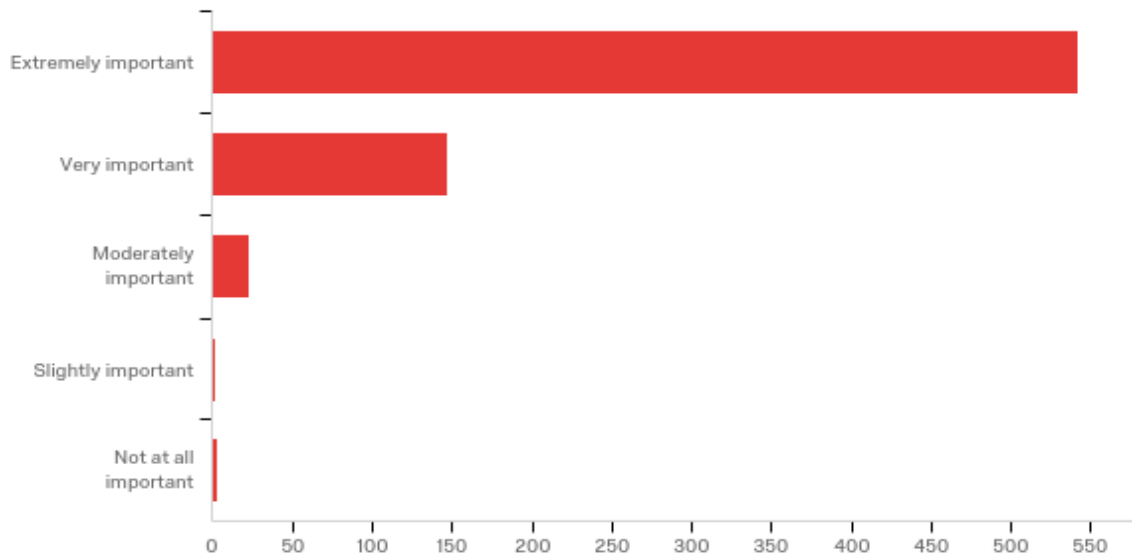


#	Answer	%	Count
1	Extremely overreported	2.09%	15
2	Moderately overreported	5.86%	42
3	Neither overreported nor underreported	21.48%	154
4	Moderately underreported	36.82%	264
5	Extremely underreported	25.24%	181
6	I do not know	8.51%	61
	Total	100%	717

Figure 13: Responses regarding reports of concussion by the media.

Given the widespread concussion discussion, we also sought to collect responses regarding the importance of educating football players about the injury. We hypothesized that, in general, participants would assign importance to education. 75.59% of participants felt it was extremely important, 20.50% very important, 3.21% moderately important, 0.28% slightly important, and only 0.42% not at all important (Figure 14).

How important is it to educate football players about concussion?

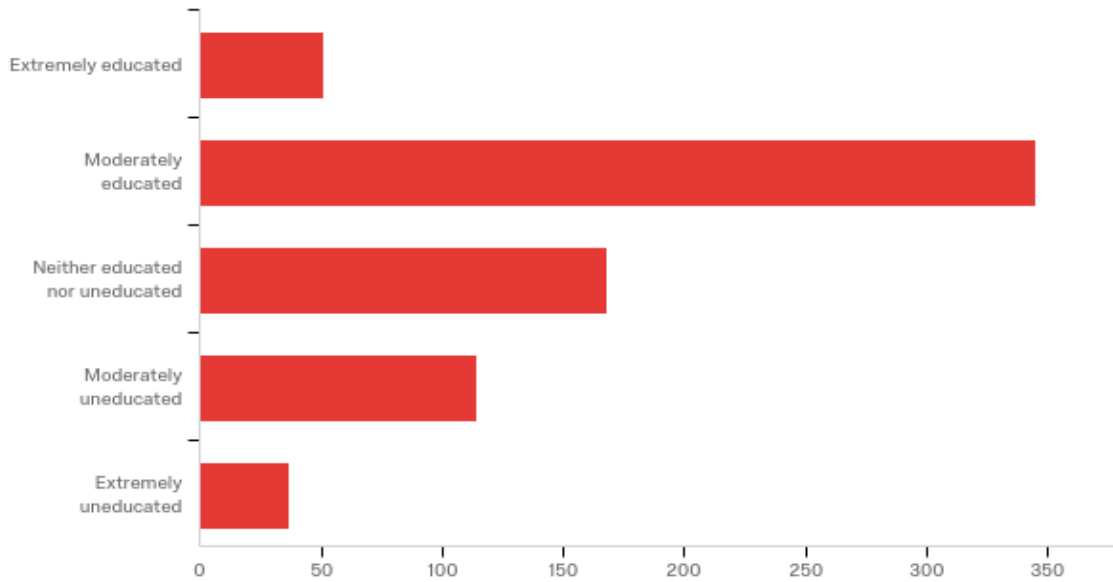


#	Answer	%	Count
1	Extremely important	75.59%	542
2	Very important	20.50%	147
3	Moderately important	3.21%	23
4	Slightly important	0.28%	2
5	Not at all important	0.42%	3
	Total	100%	717

Figure 14: Participant responses regarding the importance of educating football players about concussion.

To account for the participants' confidence in their answers, we asked them to rate their personal knowledge of concussions; 7.13% felt they were extremely educated about concussion, 48.25% moderately educated, 23.50% neither educated nor uneducated, 15.94% moderately uneducated, and 5.17% extremely uneducated (Figure 15).

How would you rate your personal concussion knowledge?



#	Answer	%	Count
1	Extremely educated	7.13%	51
2	Moderately educated	48.25%	345
3	Neither educated nor uneducated	23.50%	168
4	Moderately uneducated	15.94%	114
5	Extremely uneducated	5.17%	37
	Total	100%	715

Figure 15: *Self-reported education level.*

The majority of participants (95.53%) correctly identified that concussions can occur from both a single, forceful concussive incident AND an accumulation of smaller, repetitive tackles/hits. Furthermore, 41.76% of responses support that cumulative hits can be as harmful as a single concussive incident. Additionally, 96.77% of participants correctly indicated that symptoms of concussion vary by the individual, and 99.30% reported that the length of recovery from concussion also varies by the individual. During the recovery period, injured athletes can experience a wide array of symptoms, as previously explained in the introduction section. In this study we sought to examine if participants could identify common symptoms of concussion. Because they are head injuries, we expected participants to include headache as a symptom of concussion, and 98.46% did so. However, 21.26% of participants also selected diarrhea and 37.20% selected elevated heart rate as common symptoms of concussion. While recent research has indicated a transient increase in heart rate following concussion, further testing is required to confirm such findings (Dobson, Yarbrough, Perez, Evans, & Buckley, 2017). We found no such research indicating diarrhea as a symptom of concussion. The number of participants selecting each symptom is provided in graphical form in Figure 16.

What are common symptoms of concussion? (Select all that apply.)

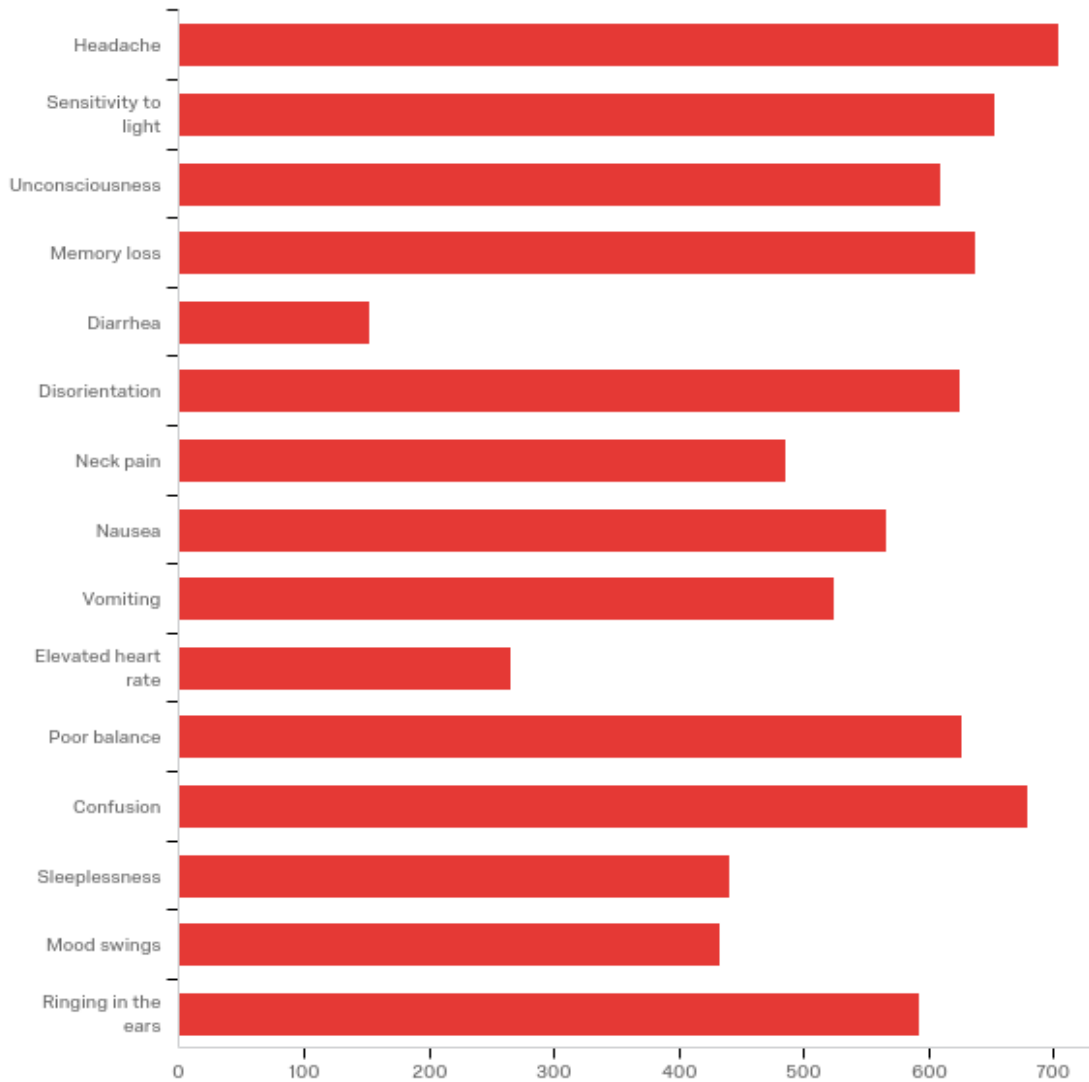
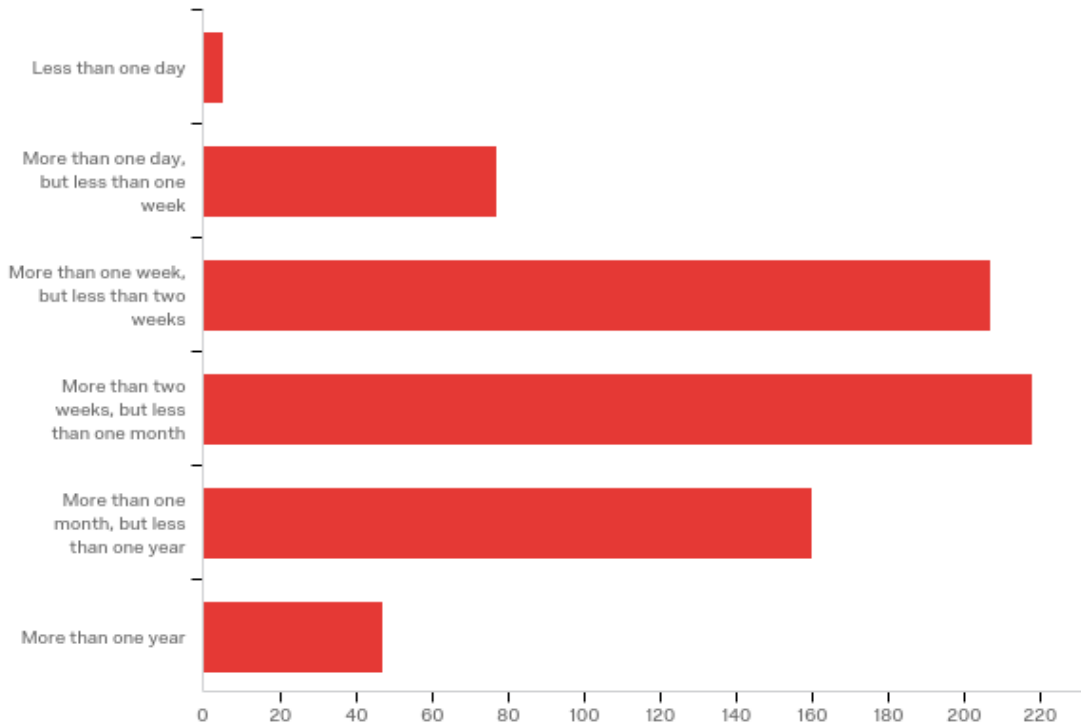


Figure 16: Common symptoms of concussion, as selected by participants.

In terms of length of recovery for a concussed collegiate football player, 0.70% believed the average length to be less than one day, 10.78% more than one day, but less than one week, 28.99% more than one week, but less than two weeks, 30.53% more than two weeks, but less than one month, 22.41% more than one month, but less than one year, and 6.585 more than one year (Figure 17). The participants' responses indicated that most believe the average recovery period to last more than one week, but less than one month. Regarding athletic status, participants identifying as non-athletes tended to indicate longer periods of recovery following concussion (Figure 18). Current research by the NCAA aims to better determine the average length of recovery amongst concussed athletes. A 2017 study explains that not all athletes consent to be included in research studies, and this has proved challenging to provide accurate results (Broglia et al., 2017). At a minimum, some websites advise the injured athlete should sit out a minimum of seven to ten days before returning to play (Okragly, 2018). It is important to remember that a recovery timeline is specific to each individual. Progression through the NCAA's step-wise return-to-play procedure is dependent upon cessation of symptoms.

On average, it takes _____ for a concussed college football player to recover.



#	Answer	%	Count
1	Less than one day	0.70%	5
2	More than one day, but less than one week	10.78%	77
3	More than one week, but less than two weeks	28.99%	207
4	More than two weeks, but less than one month	30.53%	218
5	More than one month, but less than one year	22.41%	160
6	More than one year	6.58%	47
	Total	100%	714

Figure 17: Reported length of recovery period.

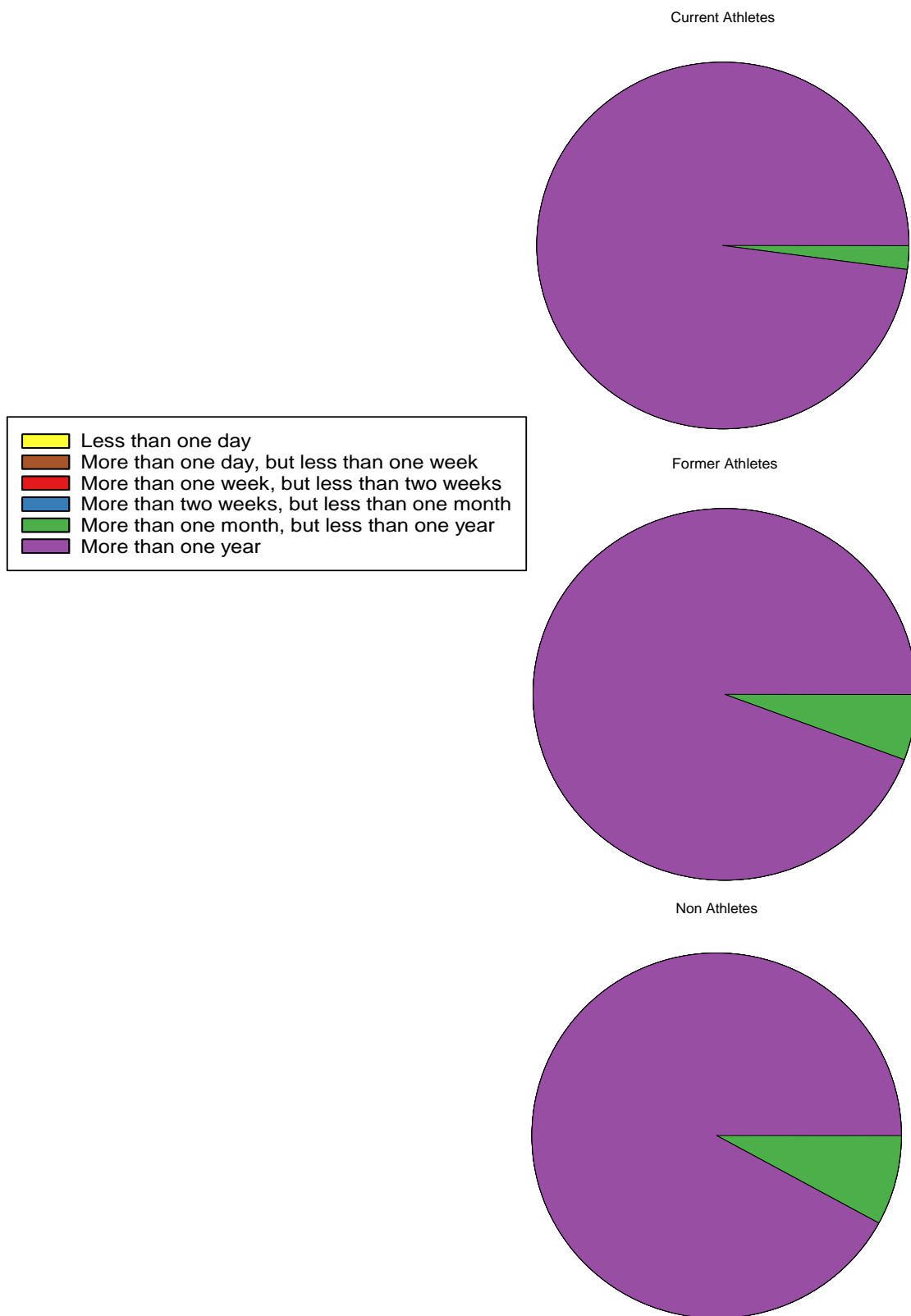


Figure 18: *Reported length of recovery period by current, former, and non-athletes.*

An original goal of our study was to determine which positions were perceived to be at greatest risk of concussion. 80.50% of participants believed offensive and defensive players to be at equal risk of concussion. Additionally, we asked participants to identify which offensive position they felt was at greatest risk. Based on the nature of the position and reported numbers of concussions, we hypothesized that participants would identify wide receivers to be at greatest risk because they run downfield routes with high velocity. They often leap to make catches and have less control should an opponent make contact with them. While the largest percent of respondents selected the wide receiver to be at greatest risk, many also identified quarterbacks. This indication could be due in part to familiarity with the position; people who do not play/enjoy/understand football can likely recognize the quarterback position. On offense, as illustrated in Figure 19, 24.37% of participants felt wide receivers were at greatest risk while 20.03% selected quarterbacks, 16.03% offensive tackles, 10.68% centers, 6.18% tailbacks, 5.34% halfbacks, 4.84% fullbacks, and 3.01% tight ends.

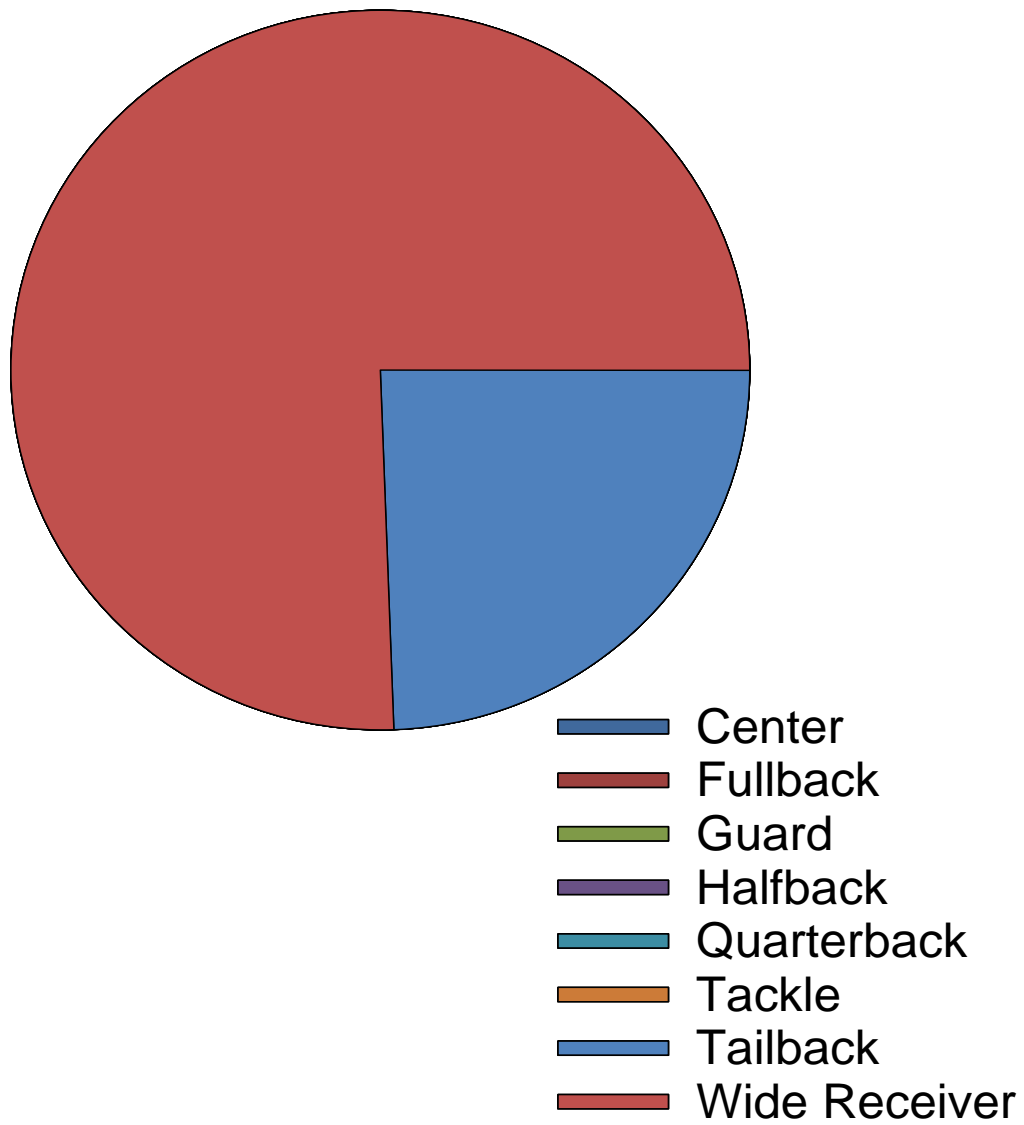


Figure 19: *Offensive position perceived to be at greatest risk of concussion.*

For similar reasons as the offensive position, we hypothesized that participants would perceive cornerbacks to be at greatest risk of concussion. Cornerbacks oppose wide receivers. They are quick, agile, and accelerate toward their opponents. However, the largest percentage of participants identified linebackers to be at greatest risk next followed by defensive tackles (Figure 20). 43.81% felt linebackers were at greatest risk of concussion while 35.05% indicated defensive tackles, 7.55% defensive ends, 7.40% safeties, and 6.19% cornerbacks.

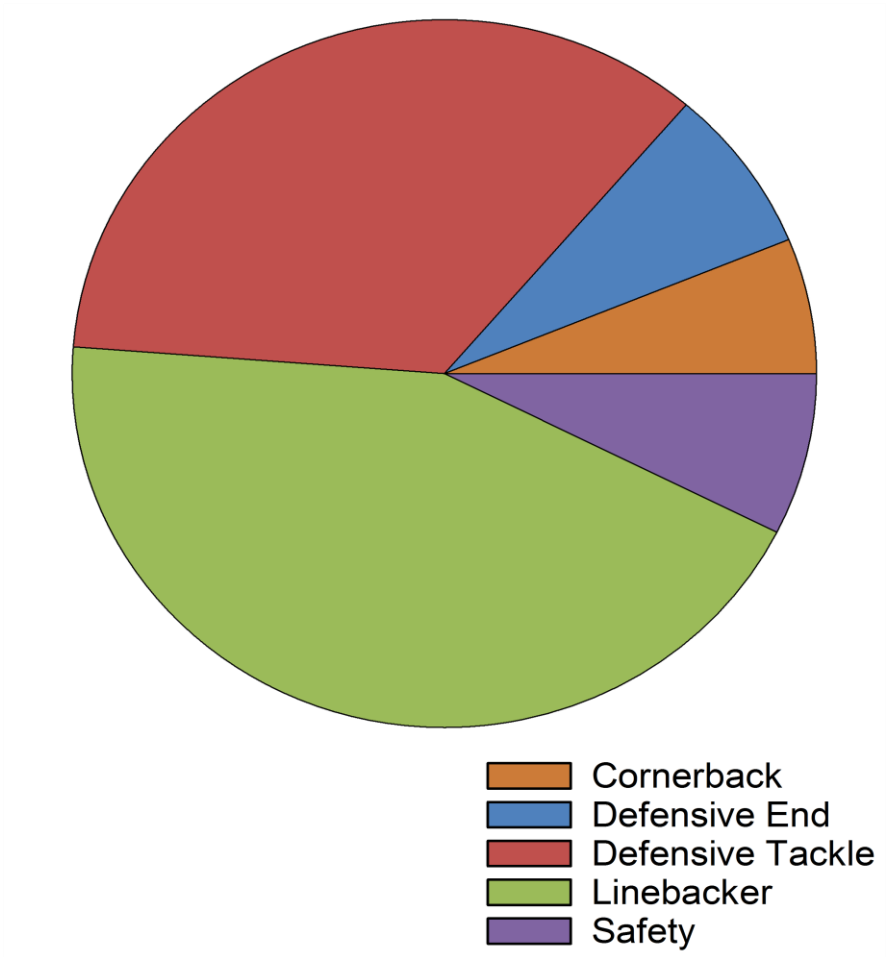


Figure 20: *Defensive position perceived to be at greatest risk of concussion.*

As we hypothesized, the majority (91.89%) of participants indicated approximately equal risk of concussion for Ole Miss football players compared to other collegiate programs.

Continuing on, areas responsible for emotion, coordination, learning, and planning can all be affected by concussion, and 95.45%, 98.39%, 97.65%, and 96.60% of respective responses were in agreement with this statement. Results for this finding are presented in Figure 21.

Percentages of Participants Indicating True When Asked if Concussions are Damaging to Brain Regions Responsible for Emotion, Coordination, Learning, and Planning

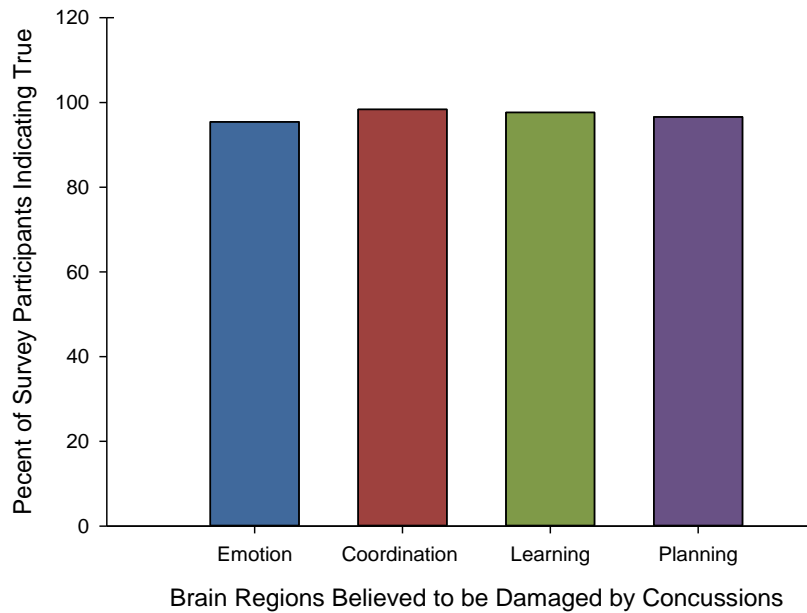
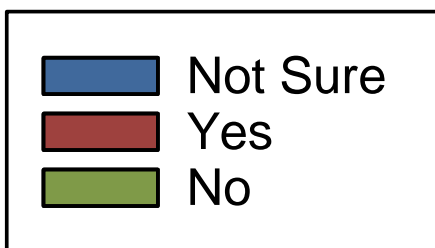
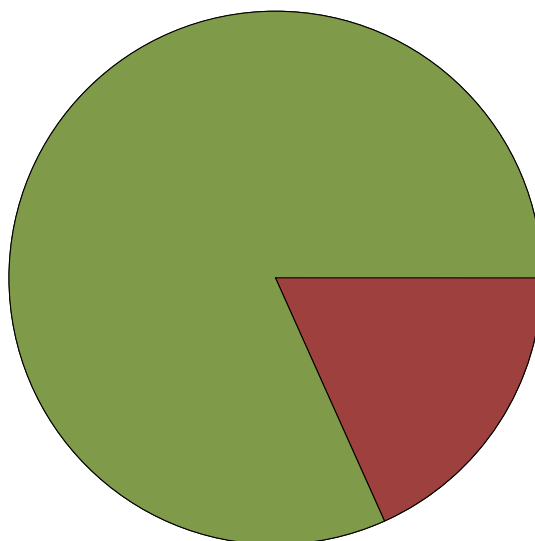


Figure 21: *Percent of participants indicating that regions of the brain responsible for emotion, coordination, learning, and planning can be affected by concussion.*

Regarding whether or not they would allow their child(ren) to play football, we hypothesized that more males than females would select “Yes.” As a whole, if/when they have them, 45.32% of respondents would allow their child(ren) to play football, 20.47% would not, and 34.21% were unsure. Fisher exact analysis of responses by gender reveals significance ($p < 0.05$) in participant responses. Figure 22 shows that more than half of male participants and only roughly an eighth of female participants selected “Yes.” Furthermore, roughly a quarter of male participants and more than half of female participants indicated they were “Not sure.”

Male Responses to Allowing Their Child(ren) to Play Football



Female Responses to Allowing Their Child(ren) to Play Football

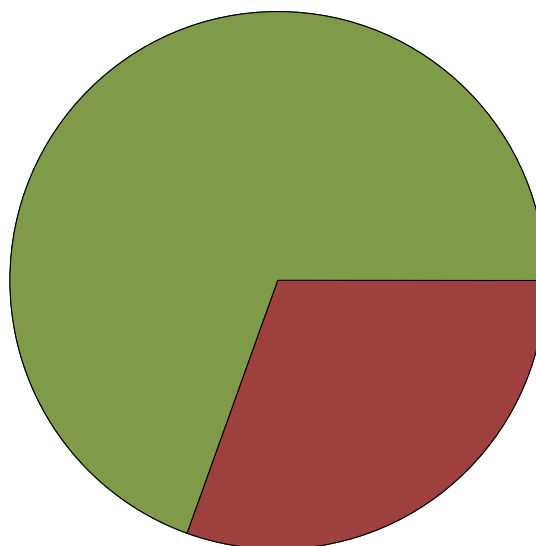


Figure 22: Percentages of male and female participants reporting if they would, would not, or did not know if they would allow their child(ren) to play football.

IV. Discussion

Hypotheses in this survey were made based on several factors including: University classification, self-reported devotion to Ole Miss football, and status as a current, former, or non- athlete. Additionally, hypotheses were formed for responses by participants' gender and for responses as a whole. We hypothesized that older participants, as implied by their classification, would be more knowledgeable about concussions, report more severe effects, and indicate adequate, if not slightly inadequate, coverage by the media than younger participants. Data analysis supports our hypothesis regarding severity, but does not support our hypotheses relating to self-rated knowledge or coverage in the news. Additional analysis indicates that participant classification does not significantly affect beliefs of what percent of players experience concussion during their collegiate career.

In regards to devotion, we believed participants reporting moderate to high level devotion to Ole Miss football would tend to report concussions to be overreported by the media when compared to those who had little to no devotion to the sport. This hypothesis was supported as all participants who perceived concussions to be extremely overreported in the news claimed moderate to high levels of devotion to Ole Miss football. This finding could be because those who claim to be devoted to Ole Miss football are more aware of concussion coverage in the media. Participants with a moderate to high level of devotion are more likely to watch segments on television or read publications in print relating to Ole Miss football, regardless of the media's positive or negative presentation.

Relating to athletic status, we hypothesized that participants identifying as current or former athletes would be more knowledgeable about concussions and perceive concussions to be somewhat underreported by the media when compared to non-athletes. This hypothesis was supported as significant differences were found between the responses of current, former, and non-athletes. As expected, current and former athletes indicated greater knowledge of concussions. Interestingly, it was found that of all participants reporting a high level of devotion, current athletes contributed the smallest percent. It is possible that these participants' dedication to their own sport outweighs their devotion to Ole Miss football. Another finding was that non-athletes form the majority of participants who perceive concussions to be extremely underreported in the news. This could be due to their lack of knowledge surrounding media coverage; those who are not athletes may not have interest in sport-related news. In regards to allowing their children to play football, it was found that of all participants indicating they would not allow their child(ren) to play football, more than half identified as non-athletes. This answer choice could have been selected because of the participants' lack of personal athletic involvement, perceived risks of concussion, other perceived risks in the sport of football, or decision to not allow their child(ren) to play any sport, among others. Such reasoning behind the selection of "Yes" or "No" could be of interest in future studies.

Furthermore, some responses were separated by gender of the participant. We hypothesized that males would report greater devotion to Ole Miss football than females, but this was not supported as males and females reported approximately equal

devotion. We also hypothesized that females would be less likely than males to allow their child(ren) to play football; this hypothesis was supported. The majority of females selected “Not sure” when asked if they would allow their child(ren) to play football while the majority of males selected “Yes.” Given the current stance of many experts in this field, like Dr. Bennet Omalu, we are curious to see how responses to this question could change in the coming years.

Regarding responses as a whole, our hypothesis that participants would identify wide receivers to be in a position at greatest risk of concussion was supported. However, our hypothesis regarding the cornerback as the defensive position to be at greatest risk of concussion was not. The problem with identifying a single position as the one at greatest risk is that it is difficult to generalize them. Each position has unique tasks. Linemen may experience many small sub-concussive events as they make blocks or rush the quarterback. Offensive and defensive skills positions may experience fewer impacts, but they occur with higher velocity and magnitude. Tight ends are somewhat of a hybrid position as they can block but also run to make long range catches. Special teams positions spend a smaller amount of time on the field and usually have limited contact, with the exception of the kickoff and kick return teams (Baugh et al., 2015). Participants, in general, indicated that an injured athlete’s personal input was moderately important to concussion diagnosis. This concept can be difficult implement in practice and games, though, as athletes may *understand* that it is up to them to report their symptoms but may not *take action* to be assessed. For example, athletes

may not believe their symptoms are significant, be overcome by high adrenaline levels, or fear letting down the team (Davies & Bird, 2015).

The results of this study provide interesting insight into current perceptions of the Ole Miss community. As a whole, we feel that the information obtained in this survey is an important tool for continuing to improve public and player education regarding concussions in the collegiate sport of football at the University of Mississippi and beyond.

V. Limitations and Future Studies

Future studies surrounding concussions in the sport of football must be conducted. This survey, or one similar, could be administered annually to the students, faculty, and staff at the University of Mississippi to determine how perceptions change over time. Moving forward, it could be beneficial to develop a flyer to be distributed across campus to educate the Ole Miss community about the risks of concussion. The flyer could list common symptoms of concussion and the importance of reporting them. Furthermore, the flyer could include contact information of places to seek treatment if someone were to become concussed, regardless if they are an athlete or not. Additionally, the flyer could include links to information published by the NCAA as well as to links specific to Ole Miss policies and procedures.

Regarding changes that could be made to this survey in future uses, question wording and answer choices could be reconsidered. It was found that the majority of participants who indicated they would not allow their child(ren) to play football

identified as non-athletes. A follow-up question could be presented for the participant to provide reasoning for their answer. In its current format, it cannot be determined *why* the participant selected his/her answer for this question and several others.

Requesting answer logic from the participant could provide valuable insight.

Additionally, a future survey could remove the “Not sure” options. Rather than asking participants to select all that apply, it could be requested that participants list common symptoms of concussion in a text-entry format. Re-structuring such questions could serve to better illustrate participants’ response logic.

Lastly, as was the original intent of this study, Ole Miss football players could be examined using ImPACT and SCAT3 tests before, at checkpoints during, and after the conclusion of the season to evaluate how their cognitive/clinical scores vary over the course of the season. As part of testing, players could complete a survey similar to the one presented here. An additional survey could be distributed to students, faculty, and staff at the University of Mississippi, and comparisons could be made between the two populations. A study such as this could provide useful information regarding the effects of rest between games on cognitive function as well as illustrate discrepancies between responses of football players and the general public.

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APPENDIX

Concussion Survey, Madison Frerker SMBHC '18

Start of Block: Default Question Block

I certify that we am 18 years of age or older.

- I am 18 years of age or older. (1)
- I am NOT 18 years of age. (2)

Skip To: End of Survey If we certify that we am 18 years of age or older. = we am NOT 18 years of age.

Purpose: Madison Frerker (SMBHC '18) is seeking to collect responses from the people of the University of Mississippi regarding their perceptions surrounding concussions in the sport of college football.

Participation: This survey that should take less than fifteen (15) minutes to complete. Your answers will remain anonymous, but the research team will have access to all answers provided. Participation is voluntary, and there are no consequences for choosing not to participate. You may withdraw from the survey at any time.

Possible Risks: There are no risks involved in completion of this survey.

Benefits: There are no personal benefits from participation in this survey. However, you might experience satisfaction from contributing to scientific knowledge.

IRB Approval: This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

By selecting "I consent" from the options below, we certify that we have read the above information and consent to participate in this study.

- I consent (1)
- I do NOT consent (2)

Skip To: End of Survey If Purpose: Madison Frerker (SMBHC '18) is seeking to collect responses from the people of the Univ... = we do NOT consent

Age:

What is your classification at Ole Miss?

- Freshman (1)
 - Sophomore (2)
 - Junior (3)
 - Senior (4)
 - Graduate Student (5)
 - Faculty (6)
 - Staff (7)
-

Describe your devotion to Ole Miss football.

- I never miss a game. HOTTY TODDY! (1)
 - I cheer when we have time. Go Rebels! (2)
 - I do not like football. (3)
-

I play NCAA football at the University of Mississippi.

- Yes (1)
- No (2)

Skip To: Q38 If we play NCAA football at the University of Mississippi. = No

Display This Question:

If we play NCAA football at the University of Mississippi. = Yes

How many seasons have you played in games at Ole Miss? (Include the current season.)

Display This Question:

If we play NCAA football at the University of Mississippi. = Yes

If possible, would you continue playing at the professional level?

- Yes (1)
 - No (2)
-

How at risk do you (personally) believe you are of receiving a concussion while playing football?

- Extremely at risk (1)
 - Moderately at risk (2)
 - Slightly at risk (3)
 - Not at all at risk (4)
-

Display This Question:

If we play NCAA football at the University of Mississippi. = Yes

Select your offensive position(s) that apply.

- Not applicable (1)
 - Quarterback (2)
 - Halfback (3)
 - Fullback (4)
 - Wide Receiver (5)
 - Center (6)
 - Guard (7)
 - Tackle (8)
 - Tight End (9)
 - Long Snapper (10)
 - Punter (11)
 - Kicker (12)
 - Other (13) _____
-

Display This Question:

If we play NCAA football at the University of Mississippi. = Yes

Select your defensive position(s) that apply.

- Not applicable (1)
- Defensive Tackle (2)
- Defensive End (3)
- Linebacker (4)
- Cornerback (5)
- Safety (6)
- Kick Return (7)
- Other (8) _____

Display This Question:

If we play NCAA football at the University of Mississippi. = No

I am a:

- Current athlete (other collegiate/club/intramural sports) (1)
- Former athlete (2)
- Non-athlete (3)

Skip To: Q39 If we am a: = Non-athlete

In which sports were/are you a participant?

- Basketball (1)
 - Baseball (2)
 - Softball (3)
 - Soccer (4)
 - Golf (5)
 - Tennis (6)
 - Cross country (7)
 - Track & Field (8)
 - Lacrosse (9)
 - Volleyball (10)
 - Swimming (11)
 - Other (12) _____
-

Did you or do you currently participate in tackle football at a level other than the NCAA collegiate level?

- Yes (1)
- No (2)

Skip To: Q39 If Did you or do you currently participate in tackle football at a level other than the NCAA colledi... = No

Display This Question:

If Did you or do you currently participate in tackle football at a level other than the NCAA collegi... = Yes

At what age did you start playing tackle football?

I have participated in football at the _____ level. (Select all that apply.)

- Little League (1)
- Middle School (2)
- High School (3)
- Collegiate (4)

Have you been diagnosed with concussion?

- Yes (1)
- No (2)

Display This Question:

If Have you been diagnosed with concussion? = Yes

I have been medically diagnosed with _____ concussions. (Enter numerical value.)

How serious are the effects of concussion to a person's health?

- Extremely dangerous (1)
 - Very dangerous (2)
 - Moderately dangerous (3)
 - Slightly dangerous (4)
 - Not at all dangerous (5)
-

What percent of collegiate football players do you believe experience concussion in their college career? (Enter numerical answer.)

How important is the person's personal input to concussion diagnosis if they become concussed?

- Extremely important (1)
 - Very important (2)
 - Moderately important (3)
 - Slightly important (4)
 - Not at all important (5)
-

Are there methods to assess an athlete for concussion? (i.e. tests used to aid diagnosis)

- Yes (1)
- No (2)

Skip To: Q35 If Are there methods to assess an athlete for concussion? (i.e. tests used to aid diagnosis) = No

Which diagnostic method(s) are you aware of?

Concussions are _____ in the news.

- Extremely overreported (1)
 - Moderately overreported (2)
 - Neither overreported nor underreported (3)
 - Moderately underreported (4)
 - Extremely underreported (5)
 - I do not know (6)
-

Do you believe concussions are treated as a bigger issue than they should be? Why?

- Yes (1) _____
 - No (2) _____
-

How important is it to educate football players about concussion?

- Extremely important (1)
 - Very important (2)
 - Moderately important (3)
 - Slightly important (4)
 - Not at all important (5)
-

How would you rate your personal concussion knowledge?

- Extremely educated (1)
 - Moderately educated (2)
 - Neither educated nor uneducated (3)
 - Moderately uneducated (4)
 - Extremely uneducated (5)
-

Concussions:

- Can ONLY occur from a single, forceful concussive incident (i.e. a single hard tackle/hit) (1)
 - Can ONLY occur from an accumulation of repetitive, less forceful tackles/hits (2)
 - Can occur from BOTH a single, forceful concussive incident AND an accumulation of smaller, repetitive tackles/hits (3)
-

The symptoms of concussion:

- Are the same for everyone (1)
- Vary by person (2)



What are common symptoms of concussion? (Select all that apply.)

- Headache (1)
 - Sensitivity to light (2)
 - Unconsciousness (3)
 - Memory loss (4)
 - Diarrhea (5)
 - Disorientation (6)
 - Neck pain (7)
 - Nausea (8)
 - Vomiting (9)
 - Elevated heart rate (10)
 - Poor balance (11)
 - Confusion (12)
 - Sleeplessness (13)
 - Mood swings (14)
 - Ringing in the ears (15)
-

The length of recovery from concussion:

- Is the same for everyone (1)
 - Varies by person (2)
-

On average, it takes _____ for a concussed college football player to recover.

- Less than one day (1)
 - More than one day, but less than one week (2)
 - More than one week, but less than two weeks (3)
 - More than two weeks, but less than one month (4)
 - More than one month, but less than one year (5)
 - More than one year (6)
-

Who is at greatest risk of concussion?

- Offensive players (1)
- Defensive players (2)
- Offensive and defensive players are at equal risk (3)

Skip To: Q26 If Who is at greatest risk of concussion? = Defensive players

Skip To: Q25 If Who is at greatest risk of concussion? = Offensive players

On offense, players at the _____ position are at the greatest risk of concussion.

- Quarterback (1)
 - Tailback (2)
 - Halfback (3)
 - Fullback (4)
 - Wide receiver (5)
 - Center (6)
 - Guard (7)
 - Tackle (8)
 - Tight end (9)
-

On defense, the players at the _____ position are at the greatest risk of concussion.

- Defensive tackle (1)
 - Defensive end (2)
 - Linebacker (3)
 - Cornerback (4)
 - Safety (5)
-

Compared to other collegiate football teams, Ole Miss players are at _____ risk of concussion.

- Greater (1)
 - Equal (2)
 - Less (3)
-

Cumulative hits in the sport of football can be as harmful as a single concussive incident.

- Strongly disagree (1)
 - Somewhat disagree (2)
 - Neither agree nor disagree (3)
 - Somewhat agree (4)
 - Strongly agree (5)
-

Concussions can damage areas of the brain responsible for emotion.

- True (1)
 - False (2)
-

Concussions can damage areas of the brain responsible for coordination.

- True (1)
- False (2)

Concussions can damage areas of the brain responsible for learning.

True (1)

False (2)

Concussions can damage areas of the brain responsible for planning.

True (1)

False (2)

If/When you have children, would you allow the child to play tackle football?

Yes (1)

No (2)

Unsure (3)

End of Block: Default Question Block
