Mild Traumatic Brian Injury and Chronic Traumatic Encephalopathy; The Potential Long-Term Effects on Law Enforcement

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Abstract

Chronic Traumatic Encephalopathy is widely documented as being responsible for negative outcomes for professional athletes and U.S. military personnel. These negative outcomes have been identified as neurocognitive diseases such as Alzheimer's, Parkinson's and dementia. More notably are the reported suicides by athletes and service members ultimately diagnosed with CTE. This paper explores the potential prevalence of CTE in law enforcement. The paper highlights the similarities between sworn law enforcement, athletes and service members. Understanding the long-term effects of CTE in law enforcement can assist with strategies to address the mental health of law enforcement professionals.

Introduction

In 2017, mild Traumatic Brain Injury (mTBI) and Chronic Traumatic Encephalopathy (CTE) was thrust into the news when the CTE Center housed at Boston University published its' first conclusions. At the time, the CTE Center studied the brains of 202 former football players with 111 of the athletes previously playing in the National Football League (NFL). Of the 111 NFL players brains examined, 110 were diagnosed with CTE. Since these first conclusions were published, the CTE Center's brain bank has become the largest depository for brains, reaching to more than 600 since its' inception in 2008 (CTE Center, 2019).

These findings were significant because they revealed potential causation and contributing factors to suicide and diminished decision makings skills. The first criteria that must be met when diagnosing CTE are the onset of a major or mild neurocognitive disorder caused by a traumatic brain injury. The Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V) is widely considered as the leading diagnostic text when identifying a mental disorder.

Although many factors outside the DSM-V should be considered when diagnosing a mental disorder, it is used and relied upon by medical and mental health professionals around the world. When considering the diagnosis of a traumatic brain injury, a certain set of criteria must be present. The first is identifying a concussive or sub-concussive impact to the head that causes the brain to move around within the skull accompanied by one or more secondary signs. In addition to the impact, the secondary effect that the person must also experience is a "loss of consciousness," loss of memory, "disorientation and confusion," or another neurological effect such as seizures or loss of vision (APA, 2013, p. 624).

After determining that someone suffered a TBI whether minor or major, a diagnosis of CTE could be considered. CTE is a degenerative brain disease found in people who have suffered concussive and/or sub-concussive hits to the head that trigger the protein Tau to form in the brain. Tau should not normally be found in the brain and deteriorates brain tissue that often leaves the patient with specific side effect like, "memory loss, confusion, impaired judgment, impulse control problems, aggression, depression, suicidality, parkinsonism, and, eventually, progressive dementia" (CTE, 2018).

At present, CTE can only be diagnosed post-mortem and relies upon participants who volunteer their brains to be studied after death. There is ongoing research being conducted by the CTE Center to one day diagnose CTE in living patients (CTE Center, 2019).

The CTE Center concentrated its' initial research on athletes, specifically professional football players, perhaps due to the well-publicized suicides of prominent players like Junior Seau and Aaron Hernandez.

Junior Seau was a star linebacker who played football as a boy and continued to play for 20 years in the NFL. He was 43 years old when he committed suicide by shooting himself in the chest. One of his last wishes was to have his brain donated to the CTE Center so it could be studied for signs and symptoms of CTE. The conclusion was reached that Seau suffered from CTE as a result of repeated TBI from concussive hits to his head (Boren, 2013).

Aaron Hernandez was a football star who grew up in Connecticut playing youth football. He played his college football at the University of Florida and went on to be a standout for the New England Patriots. After signing a contract extension for millions of dollars, it was discovered that he took part in many murders. He was eventually arrested, tried, convicted and sentenced to prison. While in prison he committed suicide by hanging and requested his brain be sent to the CTE Center. According to a Washington Post article, "Aaron Hernandez suffered the most severe case of chronic traumatic encephalopathy ever discovered in a person his age, damage that would have significantly affected his decision-making, judgment and cognition, researchers at Boston University revealed at a medical conference Thursday" (Kilgore, 2017). Hernandez was 27 years old when he died. The CTE Center found that this severe of a case of CTE wasn't previously diagnosed in anyone less than 46 years old.

The CTE Center expanded its research to include military personnel who have experienced concussive hits to their heads and eventually included sub-concussive hits. For example, Improvised Explosive Devices (IED's) detonated near military personnel may not have caused concussive hits. However, such explosions most certainly caused sub-concussive injuries in the form of concussions (CTE Center, 2019).

A question remains as to what impact does mTBI, TBI and/or CTE have on current and retired law enforcement? The author of this paper has not been able to locate any studies that tackle this question. A way to study this is to compare experiences that military personnel and law enforcement share in common and not in common. The average length of a military career is 14.7 years for enlisted and 11 years for officers (Landon, 2017). Law Enforcement officers usually have to work at least 20 years to collect a pension with most working between 25-30 years before being eligible to retire. Police psychologist Dr. Ellen Scrivner testified that the average police officer

experiences more tragedy and despair in his/her first three years in law enforcement that the average person experiences in a lifetime (Kirchman, Kamena, & Fay, 2014).

The following literature review will examine journal articles and publications that address mTBI, TBI and CTE.

Literature Review

The history of CTE is not a newly discovered neurodegenerative disease though it has gained national attention since the CTE Center began its' research in 2008. Dating back to 1928 the term punch drunk was used to describe boxers (McKee, Stein, Kiernan, & Alvarez, 2015). CTE has been used as a diagnosis since the 1940s and further studied in 1973 when a study was conducted on 15 boxers who developed parkinsonism after suffering from CTE (McKee et al., 2015).

CTE is not exclusively unique to athletes. Mckee et al. 2015 examined several cases where nonathletes were diagnosed with mTBI, TBI and/or CTE. In 1990 a woman who suffered years of physical abuse developed CTE, and in 1991 an autistic woman with a history of head banging also developed CTE.

There are four identified stages of CTE with the first stage being largely unremarkable. In this stage, microscopic analysis is utilized to identify and examine tau in the "frontal, temporal, insular, septal, and parietal cortices" (McKee et al., p., 356, 2015).

The second stage includes enlargement of the "frontal horns" with more tau present in the previously described areas of the frontal cortex (McKee et al., 2015). The third stage includes reduced brain weight in addition to increased severity in the previously described symptoms. The fourth stage is the most sever with even more reduced brain weight to include marked atrophy to the prefrontal cortex (McKee et al., 2015).

Mckee et al. 2015 also examined CTE in military personnel and concluded that CTE could not be solely based on exposure to blast-related injuries. The cause of CTE in the military was based on several factors. Most notably, those military personnel diagnosed with CTE were athletic in the past and/or received concussive or sub-concussive hits due to falls or accidents in addition to blast injuries. Additionally, the type of blast injury like in an open field or in a vehicle and the size of the explosive was also studied.

The historical perspectives of CTE were studied by (Ling, Neal, & Revesz, 2017) who concluded that the neuropathological concept was emerging in the field of scientific examination. The brain exhibits marked change in its' composition in the form of atrophy and enlarged ventricles. Ling et al. 2017 examine the correlation between CTE and Alzheimer's disease by examining the different areas that tau accumulates in the brain. For example, in regards to CTE, tau accumulates, "in superficial cortical layers" as opposed to Alzheimer's disease where the tau is found, "in the deeper cortical laminae" (Ling et al., p. 468, 2017).

Tagg et al., 2018 studied closed head injuries which often result in concussions in young adult males. These mTBI's/TBI's are in correlation to CTE. The four males were between 17 and 18 years old and died within four months of the TBI. These

brains were compared to males who died without suffering a recent TBI (control group). The brains from the control group did not show signs of CTE while the brains of the athletes who recently suffered a TBI did show early signs of atrophy. Two cases exhibit tau protein and one other case exhibited early onset CTE (Tagg et al., 2018).

Tagg et al., 2018 reproduced CTE in lab mice using similar types of closed head trauma seen in the young adult brains. The limitations in this study included the relatively small number of brains examined, how the injury occurred and the severity of the closed head injury.

The most common injury type in the military members deployed to Iraq and Afghanistan relating to head injuries is mTBI as a result of blasts (Mckee & Robinson, 2014). "Estimates of the prevalence of mTBI among returning service members range from 15.2% to 22.8%, affecting as many as 320,000 troops" (Mckee & Robinson, 2014, p. S242).

There is an ongoing debate as to the potential correlation between mTBI, CTE and post-traumatic stress disorder (PTSD). As previously detailed, CTE Center 2018, symptoms of mTBi and CTE are depression, confusion, memory loss and suicidality. According to the criteria outlined in the DSM-V (2013), PTSD includes negative emotional state, self-destructive behavior, inability to concentrate, anger and depression.

Further highlighting the connection between mTBI, CTE and PTSD, Mckee & Robinson 2014 studied incidents involving several service members. One such incident involved a 25-year-old Marine who suffered several mTBI's from blasts while serving in Afghanistan. After suffering the mTBI's, the Marine presented with symptoms of confusion, depression, aggression, and poor decision-making skills ultimately being diagnosed with combat-related PTSD. The Marine attempted suicide and was eventually honorably discharged from service. At 28, the Marine had a confrontation with law enforcement where he shot at the police who returned fire which ultimately led to the Marine's death. The Marine's brain was examined and found to have Stage IV CTE.

Another example Mckee & Robinson 2014 studied was the case of a 45-year-old Army veteran who received a TBI resulting from a blast injury. The service member did not lose consciousness but did manifest symptoms from disorientation immediately after the explosion to headaches, depression and irritability. The service member dies two years later from an aneurysm, and his brain was sent off for further examination. As part of the examination, the team of professionals completed a medical history on the veteran and learned that he suffered a TBI when he was eight years old as a result of a vehicle accident. The examination concluded that the veteran suffered from, "Stage II/IV) CTE (Mckee & Robinson, 2014, p. S246).

The study continued with more examples of veterans who ultimately suffered from CTE. One was a case where the veteran had no previous history of mTBI or TBI before being exposed to two blasts that caused a loss of consciousness. Another case was that of another service member who was exposed to a blast injury TBI without loss of consciousness. Both of these service members suffered from similar symptoms to include headaches, dizziness, irritability, memory loss and depression (Mckee & Robinson, 2014). As previously discussed, the DSM-V identifies symptoms of PTSD

similar to mTBI, TBI and CTE. These case example was one of many highlighted by the McKee & Robinson 2014 study.

The importance of the ethical use of lab mice to test and determine the cause and prevalence of mTBI and CTE cannot be understated. Although CTE has been extensively studied in humans posthumously, it is reactive due to diagnosis occurring post-mortem. Science cannot use a control group of humans and create injuries to potentially cause CTE with the purpose of future diagnosis (Vile & Atkinson, 2017). This study concluded that the primary result of CTE, the abnormal buildup of the protein tau, causes the brain to effectively die by causing holes and at present does not have a cure.

At the time of this paper, there are no long term studies that address the potential of CTE in law enforcement. There are studies that need to be considered and carried over from service members to law enforcement. The term breacher refers to people, commonly attributed to service members, assigned to a team that utilizes explosives and distraction devices when breaching a door for other team members to enter a structure. "Breacher's Brain is a complex of subjective symptoms including but not limited to headache, fatigue; a slowed thought the process and an increase in memory difficulties" (Kamimori, Reilly, LaValle, & Olaghere Da Silva, 2017, p. 837). Studies conducted often focus on the effects suffered by service members performing such task but must include law enforcement.

Kamimori et al., 2017, studied the effects of low-level blasts (LLB) in military and law enforcement and looked at data retrieved from explosive breaching, shotgun breaching and firearms discharges. Gunshots from firearms did not cause singular LLB damage to the brains of military and law enforcement personnel though the study raised concerns over the cumulative effects of prolonged exposure attributed to repeated firearms training. This study concluded that military and law enforcement personnel are exposed to LLB's during their career which could lead to long term health problems. Kamimori et al., 2017, suggests that a long term study needs to be conducted to measure the adverse effects of LLB's in military and law enforcement personnel.

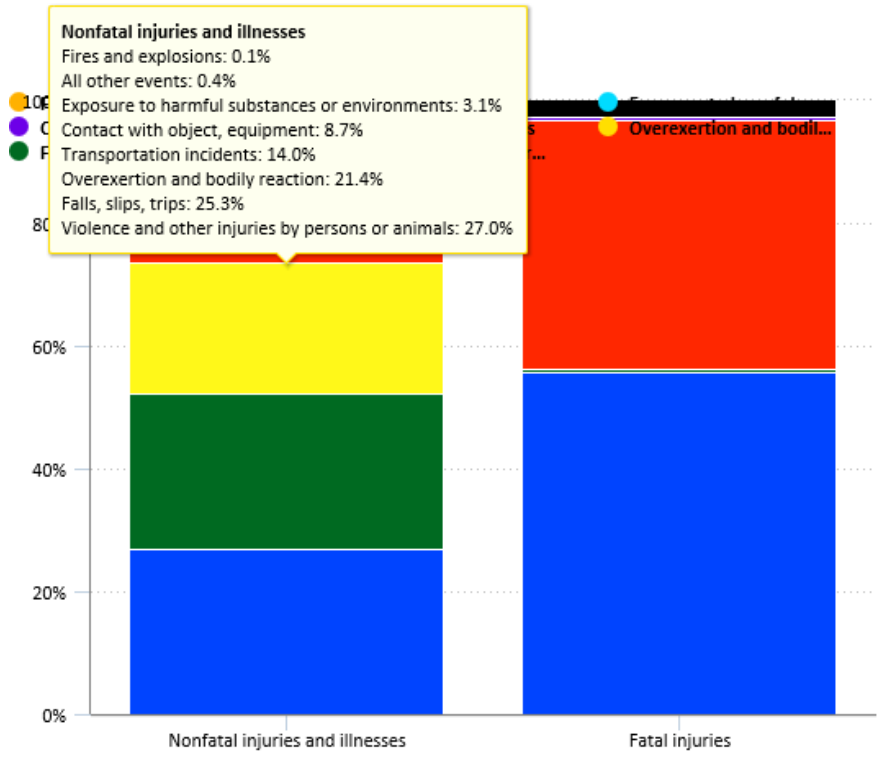
(Sullivan, 2016) Discussed the causes and effects that blast exposure had on tactical (SWAT) officers. The article highlighted five considerations for law enforcement personnel who experience TBI's. Sullivan, 2016, discusses concussions as one form of a TBI, how to recognize if the officer had a TBI, the risk of repetitive LLB exposure, that on TBI can have life lasting effects and that TBI can lead to CTE.

A research article studied preventative measures that could be implemented in reducing the effects of LLB exposure for SWAT officers. (Bonnette, et al., 2018) Studied the effects of wearing a jugular neck collar to reduce the negative outcomes when performing explosive entries. The study concluded that officers wearing the collar had little to no change in their brain while those who did not wear the collar experienced changes.

According to the (Bureau of Labor Statistics, 2016) (BLS) between 2009-2014 law enforcement personnel suffered non-fatal injuries at a much higher rate when compared to all other professions. The table below was extracted from the BLS which indicates what type of non-fatal injury law enforcement personnel suffer each year. Though it doesn't detail mTBI's or TBI's, such diagnoses must be considered.

Percent distribution of injuries and illnesses to police officers by event or exposure, 2014

Total nonfatal injuries and illnesses: 27,660
Total fatal injuries: 97



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

Methods

The purpose of this research was to define and discuss CTE and examine the likelihood of law enforcement officers suffering from CTE. The data collected may identify the need to request the CTE Center to conduct a study into whether or not CTE is diagnosed post-mortem in law enforcement personnel.

Data was gathered through surveys given to sworn members of the Florida Highway Patrol, Jacksonville Sheriff's Office, Jacksonville Beach Police Department, Okaloosa County Sheriff's Office, Altamonte Springs Police Department, Kenneth City Police Department, and Collier County Sheriff's Office.

Survey questions were designed to determine the amount of participants who suffered from m/TBI and TBI prior to and after they became certified officers.

Information about participants' past m/TBI and TBI prior to and after becoming a certified office was sought in an effort to discover the potential physical changes that may occur to sworn personnel's brains during their careers. The causes of the m/TBI and the TBI was also sought to help determine how the trauma occurred.

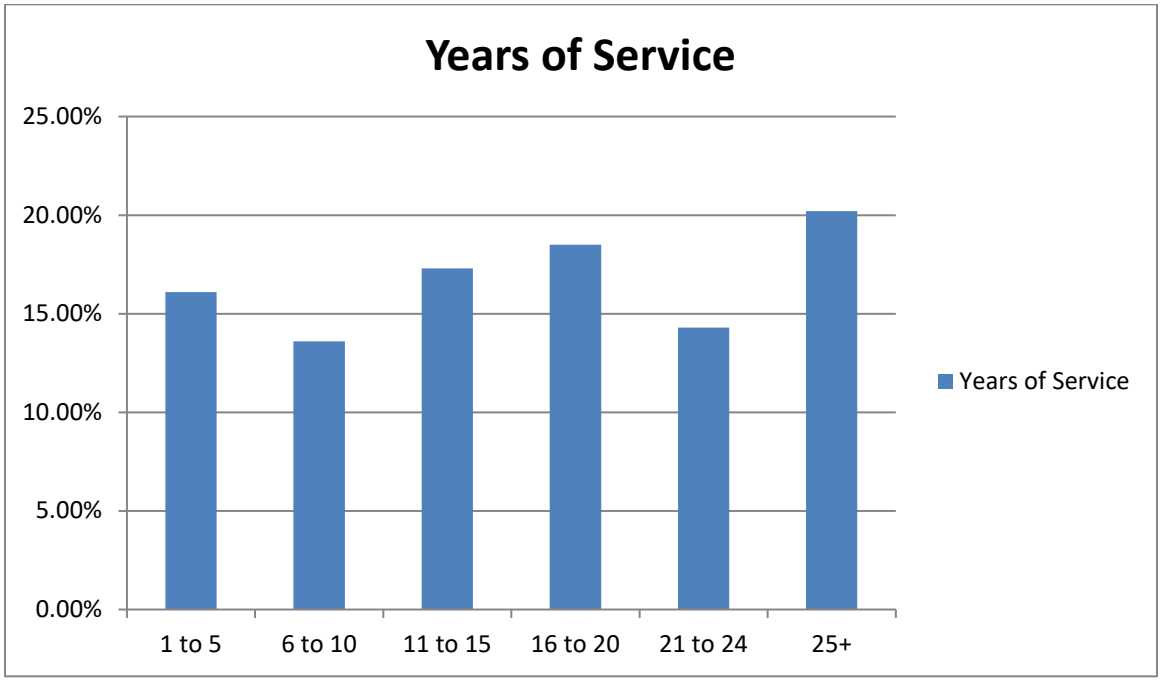
The survey was confidential and anonymous to encourage truthful answers with an increased response rate. An identified weakness in the data collected is recognizing the stigma attached to admitting to m/TBI and TBI with the fear that the data wasn't truly confidential and anonymous thus leading the participant to fear fitness for duty evaluations. The survey is attached as Appendix A.

Results

The survey was sent to 4,458 sworn law enforcement officers from large, medium and small agencies. I received 589 responses, resulting in a response rate of 13.2%. Of the 589 responses, some survey questions were skipped by the respondents. To maintain absolute anonymity, the respondents were not asked to identify their respective agencies.

The first question asked the respondents to identify how long they have been employed as a law enforcement officer. I received a 100% response rate from the 589 respondents. Ninety-five (16.1%) have been employed for 1-5 years, 80 (13.6%) for 6-10 years, 102 (17.3%) for 11-15 years, 109 (18.5%) for 16-20 years, 84 (14.3%) for 21-24 years, and 119 (20.2%) have been employed for 25+ years.

Table 1: Number of years of respondents

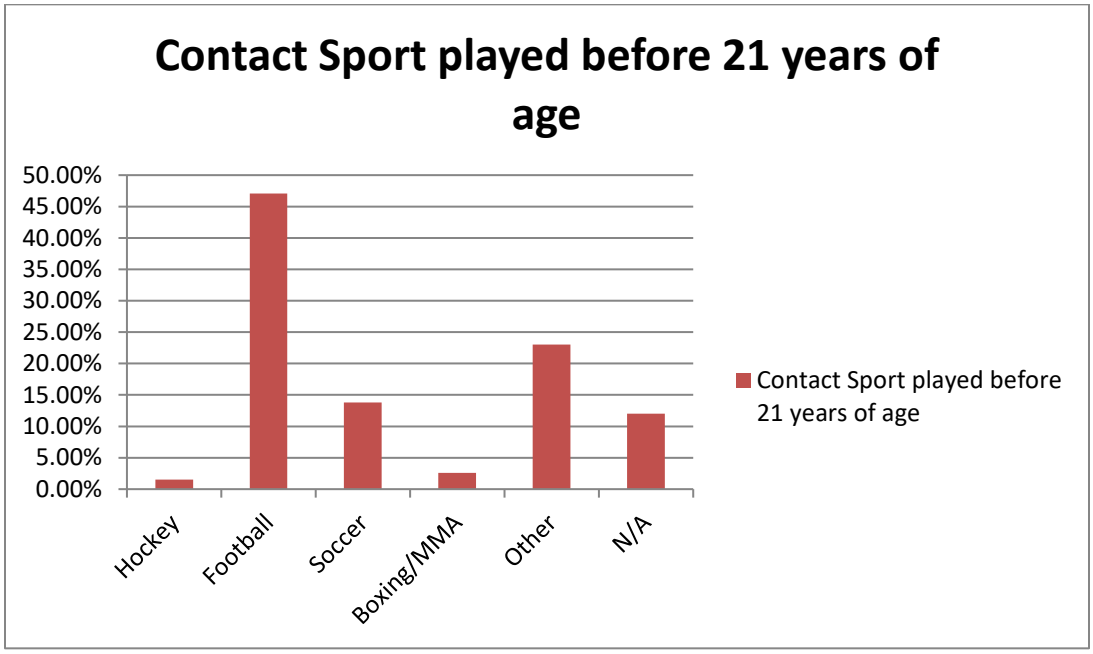


The next three questions asked the respondents about their sports participation prior to turning 21 years of age. The first of these three questions simply asked if the respondent played a sport prior to their 21st birthday. I received a 100% response rate that yielded 540 (91.7%) that disclosed that they did play a sport. Conversely 49 (8.3%) of the respondents did not play a sport.

The second of the 3-question set asked the respondents if they participated in a contact sport. I received 588 responses for a 99.8% response rate to this question. Of the 588 responses, 406 (69%) responded that they did play a contact sport while 182 (31%) did not.

The last of the 3-question set asked the respondent to identify which contact sport they participated in and provided the following choices, hockey, football, soccer, boxing/mixed martial arts (MMA), other, or not applicable (N/A). I received 588 responses for a 99.8% response rate. Nine (1.5%) identified hockey, 277 (47.1%) identified football, 81 (13.8%) identified soccer, 15 (2.6%) identified boxing/MMA, 135 (23%) identified other, and 71 (12%) answered N/A.

Table 2: Contact Sport Played prior to 21 years of age



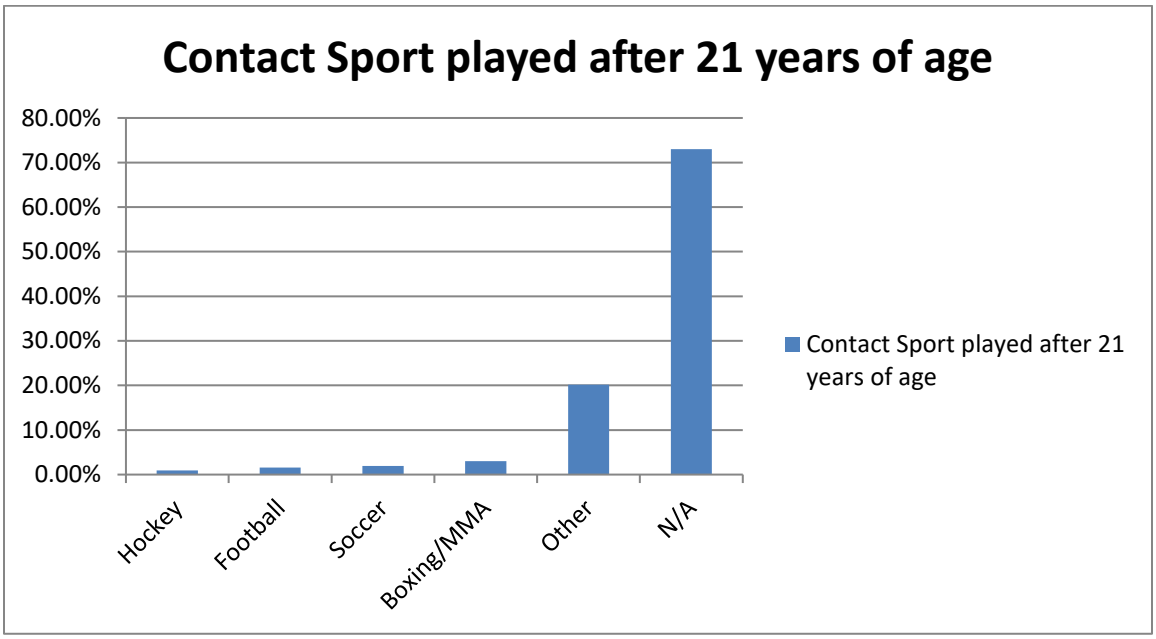
The next three questions asked the respondents about their sports participation after 21 years of age. The first of the 3-question set asked the respondent if they participated in a sport after their 21st birthday. I received a 100% response rate that yielded 294 (49.9%) that disclosed that they did play a sport. Conversely 295 (50.1%) did not play a sport after turning 21.

The second of the 3-question set asked the respondent if they participated in a contact sport after turning 21. I received 587 responses for a 99.6% response rate to

this question. Of the 587 responses, 118 (20.1%) answered yes while 469 (79.9%) answered no.

The last of the 3-question set asked the respondent to identify which contact sport they participated in and provided the following choices, hockey, football, soccer, boxing/mixed martial arts (MMA), other, or not applicable (N/A). I received 589 responses for a 100% response rate. Five (.9%) identified hockey, 9 (1.5%) identified football, 11 (1.9%) identified soccer, 18 (3%) identified boxing/MMA, 119 (20.2%) identified other, and 427 (72.5%) answered N/A.

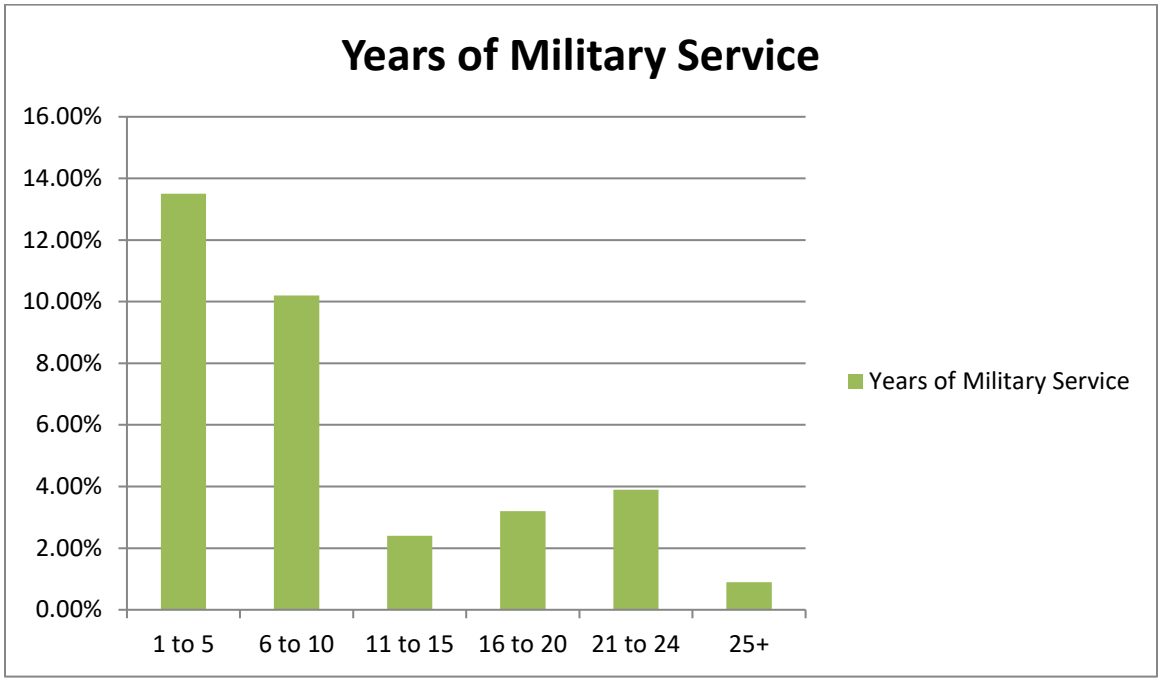
Table 3: Contact Sport played after 21 years of age



The next three questions asked the respondents about military service. The first of the 3-question set asked the respondent if they ever served in the military. I received 589 responses for a 100% response rate. Two hundred one (34.1%) served in the military while 388 (65.9%) did not.

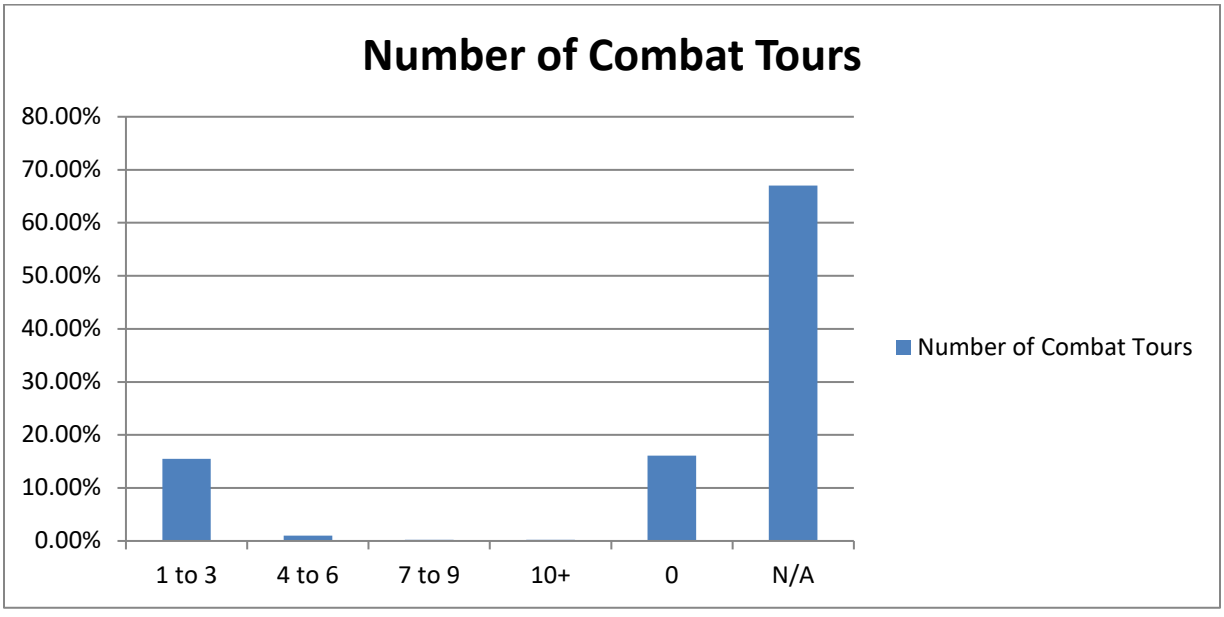
The second of the 3-question set asked the respondent how many years did they serve in the military and were given the following choices, 1-5, 6-10, 11-15, 16-20, 21-24, 25+ and N/A. I received 587 responses for a 99.6% response rate to this question. Seventy nine (13.5%) served between 1-5 years. 60 (10.2%) served between 6-10 years. 14 (2.4%) served between 11-15 years. 19 (3.2%) served between 16-20 years. 23 (3.9%) served between 21-24 years. 5 (.9%) served 25 years or more. 387 (65.9%) never served in the military.

Table 4: Years Military Service



The last of the 3-question set asked the respondents to identify how many combat tours they completed while serving in the military and were given the following choices, 1-3, 4-6, 7-9, 10+, 0, and N/A. I received 588 responses for a 99.8% response rate to this question. Ninety one (15.5%) served between 1-3 tours. 6 (1%) served between 4-6 tours. 1 (.2%) served between 7-9 tours. 1 (.2%) served 10+ tours. 95 (16.1%) served 0 tours. 394 (67%) answered N/A.

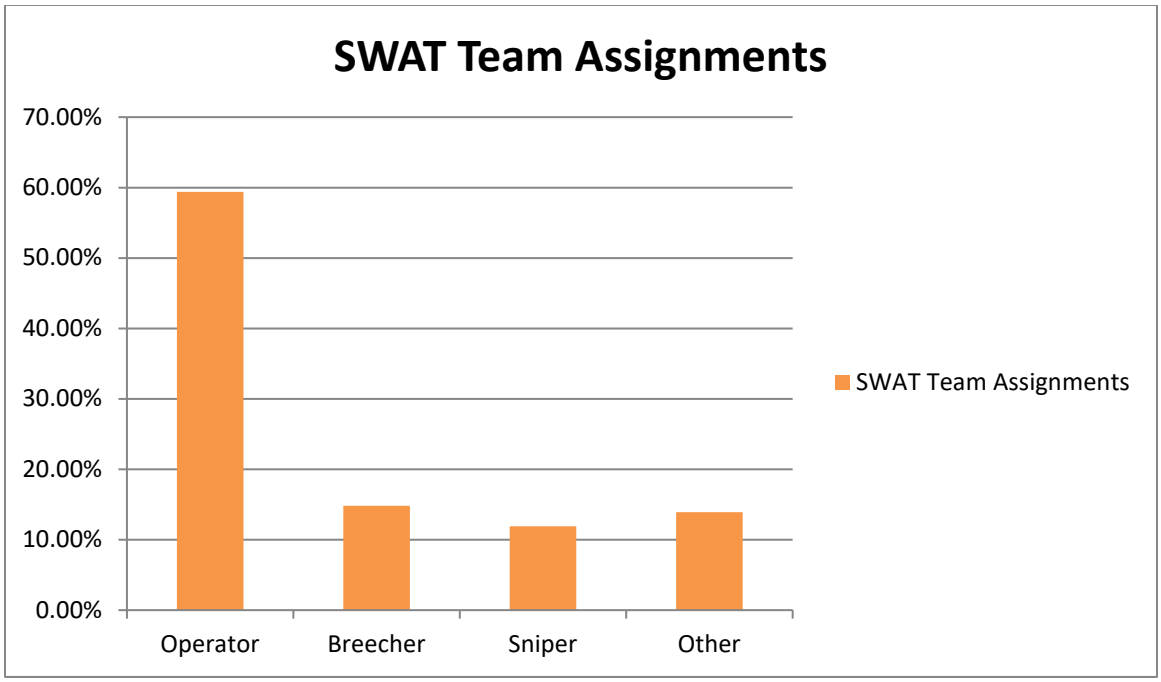
Table 5: Number of Combat Tours



The next three questions asked respondent about their Special Weapons And Tactics (SWAT) experience. The respondents were only allowed to check one answer. The first of the 3-question set asked the respondents if they ever served on a SWAT team. I received 585 responses for a 99.3% response rate. Of the 585 responses, 99 (16.9%) have previously served on a SWAT as opposed to 486 (83.1%) who have not.

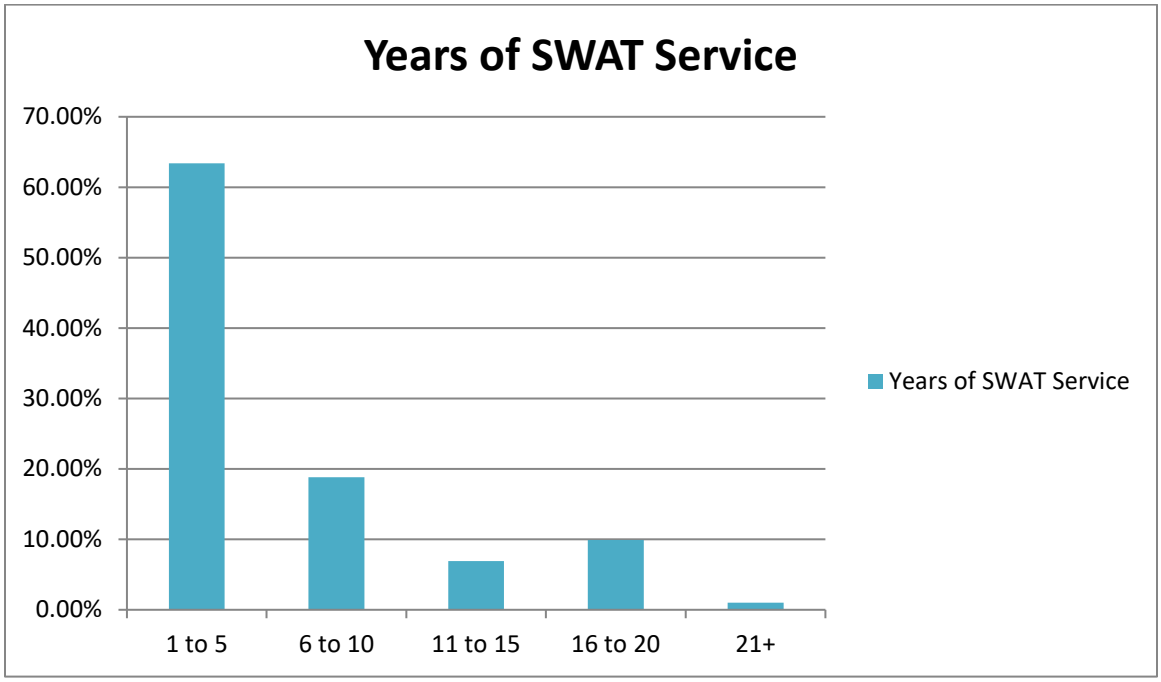
The second of the 3-questions set asked the respondents what SWAT assignment they had and were given the choices of operator, breecher, sniper, other, and N/A. I received 585 responses for a 99.3% response rate. 484 (82.9%) answered N/A which is two less than the first of the 3-question set. Removing the respondents who have never served on a SWAT team the results are as follows. Of the 101 responses, 60 (59.4%) served as an operator, 15 (14.8%) served as a breecher, 12 (11.9%) served as a sniper, and 14 (13.9%) served in another capacity.

Table 6: SWAT Team Assignments



The last of the 3-question set asked the respondents to identify the years of service they dedicated to the SWAT team and were given the following choices, 1-5 years, 6-10 years, 11-15 years, 16-20 years, 21+years, and N/A. I received 583 responses for a 99% response rate. Of the 583 responses, 482 (82.3%) answered N/A which reflects the respondents who never served on a SWAT team. Of the 101 affirmative responses the years of service were as follows, 64 (63.4%) served between 1-5 years, 19 (18.8%) served between 6-10 years, 7 (6.9%) served between 11-15 years, 10 (9.9%) served between 16-20 years, and 1 (.99%) served 21 years or more.

Table 7: Years of SWAT Service

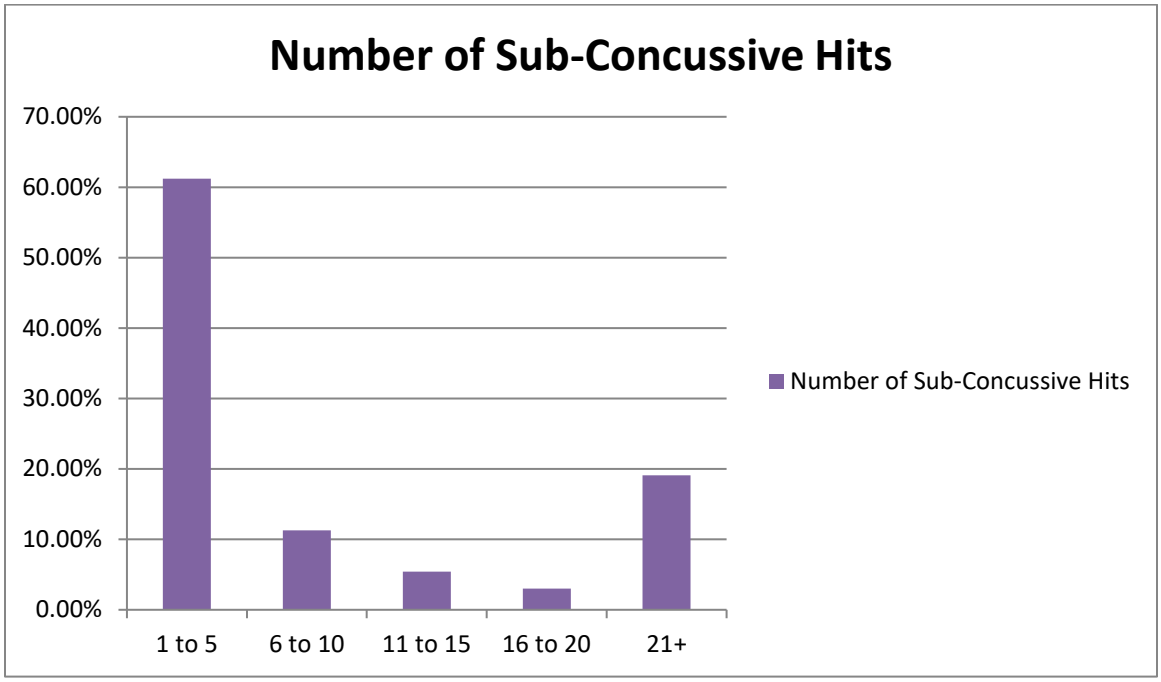


The next two questions asked the respondents about receiving sub-concussive hits to the head. A sub-concussive hit was defined as a mild traumatic brain injury from a head impact that doesn't result in a clinically diagnosed concussion. Examples of sub-concussive hits are "heading" a soccer ball or being exposed to or in the proximity of low level blasts such as distraction devices (Flashbangs) or other explosions such as gunshots.

The first of the 2-question set asked if the respondents ever experienced a sub-concussive hit to the head. I received 587 responses for a response rate of 99.7%. Four hundred nine (69.7%) answered yes while 178 (30.3%) answered no.

The second of the 2-question set asked the respondents to identify the number of sub-concussive hits to the head they received and were given the following choices, 1-5, 6-10, 11-15, 16-20, and 21+. I received 497 responses for a, 84.4% response rate. 92 respondents skipped this question. Of the responses received, 304 (61.2%) reported 1-5, 56 (11.3%) reported 6-10, 27 (5.4%) reported 11-15, 15 (3%) reported 16-20, and 95 (19.1%) received 21more.

Table 8: Number of Sub-Concussive Hits to the Head

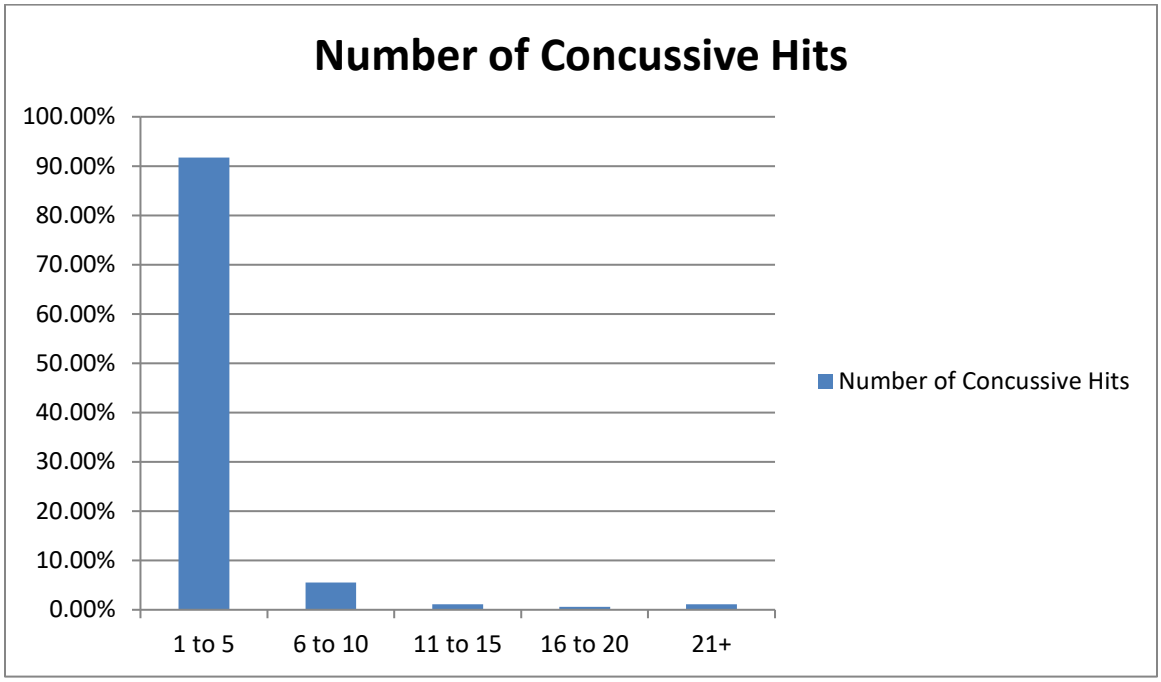


The next two questions asked the respondents about receiving concussive hits to the head. A concussive hit to the head was defined as a traumatic brain injury caused by a blow to the head resulting in symptoms including but not limited to, a headache, loss of consciousness, dizziness, confusion, slurred speech, loss of memory, and ringing in the ears.

The first of the 2-question set asked if the respondent ever experienced a concussive hit to the head. I received 578 responses for a response rate of 98.1%. Three hundred eleven (53.8%) answered yes while 267 (46.2%) answered no.

The last of the 2-question set asked the respondent to identify the number of concussive hits to the head the received and were given the choices of, 1-5, 6-10, 11-15, 16-20, and 21+. I received 469 responses for a 79.6% response rate with 120 respondents skipping this question. Of the received responses, 430 (91.7%) reported 1-5, 26 (5.5%) reported 6-10, 5 (1.1%) reported 11-15, 3 (.6%) reported 16-20, and 5 (1.1%) reported 21+.

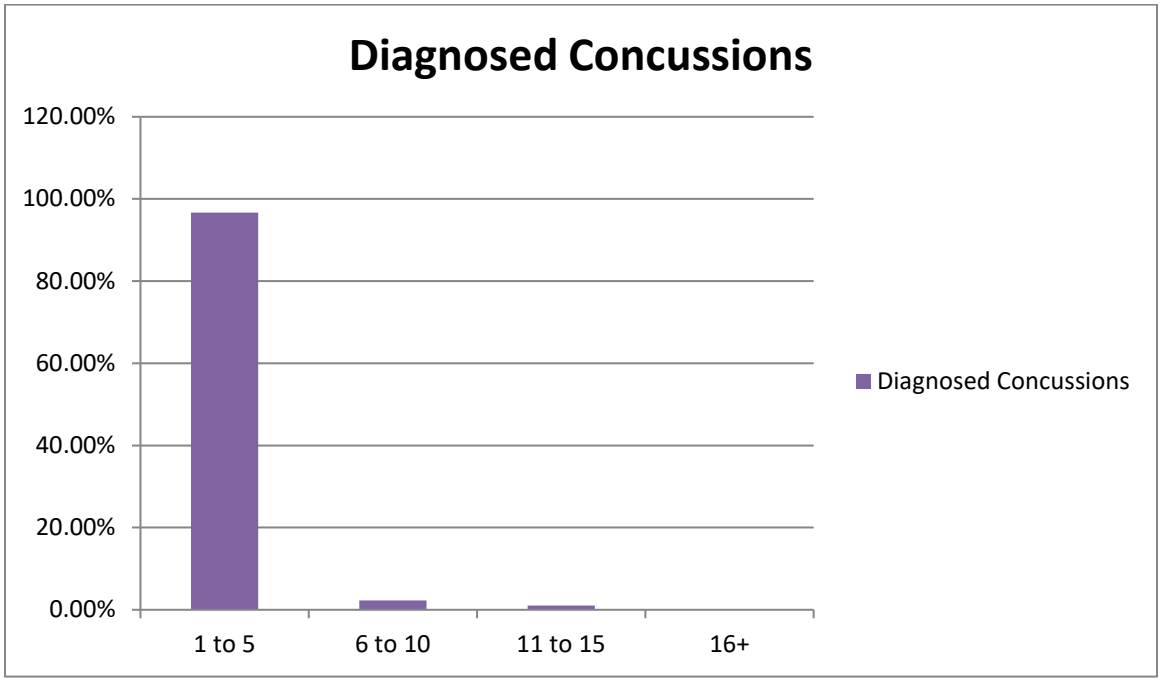
Table 9: Number of Concussive Hits to the Head



The next 2-questions set asked about the respondents about clinically diagnosed concussions. The first of the 2-question set asked the respondent if they have ever been diagnosed with a concussion. I received 583 responses for a 99% response rate while 6 skipped this question. Of the responses received, 182 (31.2%) answered yes and 401 (68.8%) answered no.

The last of the 2-question set asked the respondents to identify the number of concussions they have been clinically diagnosed with and were given the choices of 1-5, 6-10, 11-15, 16-20, 21+, and N/A. I received 578 responses for a 98.1%response rate with 11 respondents skipping this question. Three hundred ninety five (68.3%) responded N/A which aligns with the previous question. Of the 182 affirmative responses received, 176 (96.7.5%) reported 1-5, 5 (2.3%) reported 6-10, 2 (1%) reported 11-15, while 0 were reported for 16-20, and 21+.

Table 10: Number of Diagnosed Concussions



Discussion

CTE has been diagnosed in athletes and service members who experienced repetitive TBI's and mTBI's, through concussive and sub-concussive hits to the head. Currently the only avenue to diagnose CTE is through a post-mortem exam when the brain can be dissected and studied to determine the presence of tau-protein. The theory that CTE needs to be studied in relation to sworn law enforcement officers was attempted in this research.

A survey was constructed utilizing past research conducted in athletes and service members to include sports participation, and exposure to blasts and low level blasts. The occurrence of CTE in both athletes and service members causes concern for sworn law enforcement officers due to the officer's potential participation in contact sports and exposure to blast and low level blasts over the course of a 30 year career.

Strengths of this research were discovered. The results of the survey illustrate that law enforcement officers share similarities with athletes and service members. Many LEOs participated in contact sports and have been exposed to blasts and low level blasts. It is alarming that more than 84% of the LEOs reported sub-concussive hits with 20% suffering from a range of 6 to 20 and 19% suffering from 21 or more. More alarming is that 79% reported suffering concussive hits to the head with more than 97% identifying between 1-5 concussive hits. It should be concerning that LEOs who reported suffering from sub-concussive hits and concussive hits were largely self-reporting with a small number being clinically diagnosed with concussions. Only 32% reported being diagnosed with at least one concussion.

As previously discussed, signs and symptoms of CTE and PTSD resemble each other such as depression, confusion, memory loss, suicidality, negative emotional state, self-destructive behavior, inability to concentrate, anger, and depression.

The suicide rate in law enforcement has been reported to be 1.5 times higher than that of the general population, often times linked to depression and PTSD. The results of this survey highlight the possibility that LEOs experience physical changes to their brains which may aid in understanding and explaining, suicide, failed relationships, substance abuse, excessive force complaints and a variety of neurocognitive diseases.

Limitations of this research have been discovered. The relatively low response rate of 13% can cause concern as to the accuracy across the broader spectrum of LEOs. Some questions in the survey did not provide adequate answers. For example, conformation bias was noted in questions 15 and 17 where the total number of sub-concussive and concussive hits asked. There was assumptions made that every respondent experienced one or both because the answers of 0 or N/A were not provided. This forced the respondent to either skip the question of provide an inaccurate answer.

Recommendations

CTE has had detrimental effects to the person suffering from CTE and to the family and friends of that person. CTE needs to be formally studied in law enforcement to determine the rate in which CTE impacts the law enforcement community. Three recommendations are proposed to address the potential long term effects of mTBIs, TBIs and CTE.

If CTE can be established as occurring in law enforcement, medical interventions can be implemented to assist LEO's who have been determined to be at high risk of developing CTE. Senate Bill 376 was introduced making PTSD in first responders a primary medically qualifying event for retirement. The bill was passed and made enacted into law in 2018. Florida State Statute 112.1815 establishes certain situations where a PTSD diagnosis enables the LEO to medically retire under workman's compensation. This was considered a win for all first responders to remove the stigma of suffering from PTSD.

This law was meant to provide for the first responder and their family should the affected LEO be diagnosed with PTSD. A requirement of this law was that the first responder must be diagnosed with PTSD within 365 days of the qualifying event as outlined in the statute.

As a result of this research and the correlation between CTE and PTSD, it is recommended that any diagnosis during the LEO career be eligible for medical retirement under worker's compensation. The effects of sub-concussive and concussive hits to the head may take years to manifest into signs and symptoms of PTSD and ultimately CTE. Because CTE can only be diagnosed post-mortem, diagnosed PTSD with a history of sub-concussive and concussive hits to the head should be considered as a precursor to CTE. This ultimately should provide lifelong medical insurance to the affected LEO.

Law enforcement agencies should implement Critical Incident Management/Peer Support Teams to assist the agencies' members in times of crisis. This can result in increased self-awareness and a more productive work force. Agencies should consider employing in-house licensed mental health professionals to facilitate the peer support

groups as well as provide mandatory counseling for the LEOs. Mandatory counseling for the LEOs serve as a way to remove the stigma associated with receiving mental health counseling. The peer support team and employing mental health professionals also serves as an early intervention for LEOs who may be suffering from signs and symptoms of PTSD and CTE. This in turn will likely reduce the number of suicides, failed marriages and self-destructive behavior like substance misuse.

Lastly, training to include PTSD, CTE and mental health should be implemented as a mandatory block of instruction in the basic academy curriculum. Continued training in this area should also be part of mandatory training during the course of the LEOs career. LEOs should be educated in the PTSD law so they can recognize signs and symptoms in them and their colleagues. LEOs should advocate for an expansion of the PTSD law to include a PTSD diagnosis during any part of their career.

Matt Walsh is beginning his 23rd year in law enforcement, beginning his career with the Lee County Sheriff's Office in Fort Myers, Florida. He was assigned to various positions to include patrol, street crimes, homicide and SWAT. In 2003, Matt accepted a position as a FDLE special agent where he investigated homicide, organized crime and public integrity cases. Matt has worked and lived in Sebring, Fort Myers, Naples and now Jacksonville. Matt is the Assistant Special Agent in Charge overseeing all investigations spanning the 13-county region that the Jacksonville Regional Operations Center services. Matt earned a Bachelor of Science degree in Criminal Justice from Southern Vermont College and is currently working on his Master of Social Work degree from FSU.

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Appendix A

Survey

1. How many years have you been a law enforcement officer?
   A. 1-5
   B. 6-10
   C. 11-15
   D. 16-20
   E. 21-24
   F. 25+

2. As a child and until you turned 21, did you play a sport?
   A. Yes
   B. No

3. Did you play a contact sport?
   A. Yes
   B. No

4. Which sport did you play?
   A. Hockey
   B. Football
   C. Soccer
   D. Boxing/MMA
   E. Other

5. After 21 years old, did you ever play a sport?
   A. Yes
   B. No

6. Do you currently participate in a sport?
   A. Yes
   B. No

7. Which sport do you currently participate in?
   A. Hockey
   B. Football
   C. Soccer
   D. Boxing/MMA
   E. Other

8. Did you ever serve in the military?
   A. Yes
   B. No

9. How many years did you serve in the military?
   A. 1-5
   B. 6-10
   C. 11-15
   D. 16-20
   E. 21-24
   F. 25+

10. How many combat tours did you complete?
   A.1-3
   B. 4-6
   C. 7-9
   D. 10+

11. Did you ever serve on a SWAT team?
   A. Yes
   B. No

12. What was your assignment on the SWAT team (check all that apply)?
   A. Operator
   B. Breecher
   C. Sniper
   D. Other

13. How many years did you serve on the SWAT team?
   A. 1-5
   B. 6-10
   C. 11-15
   D. 16-20
   E. 21+

14. In your lifetime, did you ever suffer from a sub-concussive hit to the head?
    A sub-concussive hit is defined as a mild traumatic brain injury from a head impact that doesn't result in a clinically diagnosed concussion. Examples of sub-concussive hits are "heading" a soccer ball or being exposed to and in proximity of low level blasts such as distraction devices (Flashbangs) or other explosions such as gunshots (.50 caliber rifle).
    A. Yes
    B. No

15. How many sub-concussive hits to the head have you suffered?
    A. 1-5
    B. 6-10
    C. 11-15
    D. 16-20
    E. 21+

16. In your lifetime, did you ever suffer from a concussive hit to the head?
    A concussive hit is defined as a traumatic brain injury caused by a blow to the head resulting in symptoms including but not limited to, a headache, loss of consciousness, dizziness, confusion, slurred speech, loss of memory, and ringing in the ears.
    A. Yes
    B. No

17. How many concussive hits to the head have you suffered?
    A. 1-5
    B. 6-10
    C. 11-15
    D. 16-20
    E. 21+

18. Have you ever been diagnosed with a concussion?
    A. Yes
    B. No

19. How many concussions have you been diagnosed with?
    A. 1-5
    B. 6-10
    C. 11-15
    D. 16-20
    E. 21+