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# ORIGINAL

# LONG-TERM EFFECTS OF CONCUSSIONS ON COGNITIVE FUNCTIONS IN RETIRED FOOTBALL PLAYERS

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## ABSTRACT

Medically studying permanent cognitive outcomes from repeat concussions proves necessary because they happen often within football as well as similar athletic sports. This research examines the ongoing effects that head injuries inflict upon retired football players by analyzing the development of CTE and related effects on brain memory and processing ability and mood stability. Scientific findings reveal how brain structure modifications over time lead to early dementia but also trigger neurodegenerative diseases. Football players develop complete brain-related damage based on the cumulative impacts sustained at both intense and gentle levels throughout their sports careers. Research data indicates that we need improved guidelines for concussion management and preventative systems which will extend brain injury support beyond active sporting competitions. Athletic brain health requires complete solutions because findings demonstrate that players' mental competence demands protection after they stop playing sports. Analyses demonstrate that the frequent concussions affecting professional football players conclusively produce extensive negative impacts on brain performance. Multiple head impacts lead to the development of chronic traumatic encephalopathy (CTE) according to scientific evidence because this brain condition brings memory degradation alongside impaired judgment ability and executive function reduction. Sports athletes who stopped playing after multiple concussions encounter diminished learning memory capacity together with poor attention span along with reduced cognitive flexibility.

**KEYWORDS:** Concussions (CC), Cognitive Functions (CF), Retired Football Plyers (RFP)

## 1. INTRODUCTION

The term concussion means a type of brain injury that is mainly caused by a blow to the head resulting in brain movement back and forth inside the skull. It is proved that this type of traumatic brain injury can result in damage to brain cells and can also disrupt the normal functioning of the brain. There are some important causes of concussion which are sports injuries, falls, physical abuse, car accidents, and some other this kind of trauma. The most obvious symptoms which are seen in the case of concussion are headache, confusion, dizziness, memory loss, problems related to vision, sleep disturbance, hearing problems, and many others. Here we are going to discuss the long-term effects of concussion on Cognitive Functions in Retired Football Players(Jones et al., 2014). These symptoms are those which are mostly seen just after concussion but some important effects are mostly seen after some time. It is mostly observed that football players undergo repetitive concussions which may affect cognitive function in these players. The most important effect on Cognitive Functions is termed cognitive decline. In Cognitive decline, there are main aspects of memory loss, such as the inability to understand and analyze new information, problems related to concentration and focus, decreasing speed for processing and taking extensive reaction time, difficulty in problem-solving, and unable to have any decisive power in any case. Some important neurobehavioral changes are associated with concussion as well(Maddocks et al., 2017). Recent studies have shown that there is an increased risk of anxiety, depression, stress, and other such psychiatric disorders in football players because of repetitive concussions. The important neurobehavioral change that has been seen is mood swings from time to time. These players also show irritability and instability related to emotional regulation. The aspects of sleep disturbance and fatigue are also common. It has been seen that these players are more prone to personality disorders because of repetitive concussions. Some specific neurodegenerative diseases are linked with concussions in football players. One of these diseases is chronic traumatic encephalopathy which is abbreviated as CTE(Multani et al., 2016; Röst & Sadeghimanesh, 2023). It is an important type of degenerative disease related to the brain caused by repetitive trauma to the head. Parkinson's disease is also common in these football players after retirement. In the case of chronic traumatic encephalopathy, there are important symptoms of memory loss, depression, dementia, suicidal thoughts, and others. Because of this, it is mostly suggested that these retired football players must not live alone. It has also been seen that Alzheimer's disease is also common in these players which can affect the thinking behavior of these players. In this regard, there is a decline in cognitive functions in these players(McAllister & McCrea, 2017). In the case of Parkinson's disease, there is a disruption in body movement, balance, and coordination as well. These patients are usually unable to correctly analyze body positions because of this disease. The other important disease is amyotrophic lateral sclerosis which is abbreviated as ALS. As we know

voluntary muscles are those that are under control about movement. In the case of this disease, patients usually have affected nerve cells which affects movement and control of voluntary muscles in the body. Dementia is also associated with concussions in football players. Dementia is a broad term that is mainly related to a decline in cognitive functions in the body(Pearce et al., 2014). As we know the levels of stress and depression are increasing day by day which is affecting not only professionals but also laymen. In this regard, retired football players are also included in the list of affected people. Recent studies have shown that these players are at high risk of depression because of a variety of head traumas during performance. There are also important symptoms that are related to the period of concussion for example having persistent headache memory problems and dizziness. There are also some neuropsychiatric disorders common in Retired Football Players(Gallo et al., 2020). These disorders are bipolar disorder and schizophrenia. Bipolar disorder is a condition of mental health in which there are extremities of mood swings related to personality. Studies have shown that the physical and emotional demands of playing football result in these disorders in the retirement period. The most important reason is concussion which is traumatic and has long-term effects as well. The other important reason for bipolar disorder in retired football players is post-football life(Manley et al., 2017). Usually, these players move to a sedentary lifestyle which is mostly unstructured. In this way, there is a high risk of mood instability in these players which may cause bipolar disorder. These symptoms may become severe due to sleep disturbance in these players. Recent studies have shown that substance abuse is also a leading cause of bipolar disorder in Retired Football Players. Because of loneliness and a sedentary lifestyle, these players are more susceptible to substance abuse(Guskiewicz et al., 2005). For the treatment of bipolar disorder, it is mostly suggested that a sedentary lifestyle must be changed and there should be more interaction in society for the improvement of mental health. Schizophrenia is also common in Retired Football Players who may have a variety of symptoms. These symptoms include hallucinations in which there is seeing and hearing of such things that are not present there, disorganized thinking patterns, delusion, lack of any kind of motivation, poor attention, and others. Different case studies have shown that there is a high risk of schizophrenia in Retired Football Players. If we want to prevent or treat these long-term effects of concussion in retired football players, we need to work on it from the multi-faceted approach(Zhang et al., 2019). There are some important prevention strategies such as proper helmet fitting which will reduce the risk of head traumas. The other important preventive strategy is concussion protocols. It means that there will be leave from play in case of concussion and a gradual return to play to normalize the impacts of the previous concussion. There should be proper education and awareness related to concussion risks and ways of prevention as well. There should be Training related to such exercises which may strengthen the neck to reduce the risk of head traumas. There are some important treatment strategies

such as Cognitive rehabilitation, physical therapies, support for mental health, management related to sleep, proper nutrition, and medications as well. All of these strategies will help reduce the long-term effects of concussions on retired football players(Cunningham et al., 2020; Liu & Singh, 2024).

### 1.1 Research Objective

The main objective of this research is to understand the long-term effects of concussions on Cognitive Functions in Retired Football Players. These studies have convinced us that concussions are traumatic and have long-term effects on football players.

## 2. Literature Review

The inference of any exposure, that inference could be of an event development that can occur with time. Outcomes can be adverse which could be such type of outcomes that are healthy. Changes in behavior can also happen in this regard. All such phenomenon is usually discussed under the term of long-term effects. Let's discuss certain examples which are usually covered under the topic of long-term effects. One of them is the injuries. All those injuries which are traumatic can cause such types of effects which can have long-term effects like the loss of memory, anxiety also comes in this category along with depression(Broglio et al., 2012). One another example of long-term effects is the diseases that can become the reason for such types of health problems that last for a long period like all those diseases that are associated with the heart, diseases of the kidney, and all those issues that are interconnected with the foot. The addiction to drugs and alcohol also be the reason for such types of health problems which can last for a long period. The cancer of the liver is usually caused by to intake of alcohol(Vos et al., 2018). Certain other issues can also be caused due to the intake of drugs which can be liver cancer, pancreatitis, and issues of the kidney which will then lead to filtration problems and then kidney stones(Schaffert et al., 2020). The deprivation of sleep is also another reason that can lead to bringing reduction in the ability to reproduce. One should take the sleep of more than seven hours. Let's discuss certain effects of COVID-19, it can become the reason for causing long-term problems of health. The issues can be pulmonary, cardiovascular, and such types of complications which are neurological. Here are some other examples long long-term effects which can be infertility, obesity, and metabolic syndrome(Schaffert et al., 2022). Hypertension can also be caused for a long period. Adrenal rest is also one of them. Polycystic ovaries are also one of the dangerous diseases that come under the category of long-term effects. Osteoporosis is also one of them. All those procedures that are associated with mental abilities that can give this permission to people they think, learn, and remember come under the category of cognitive functions(Fields et al., 2020). The ability to perceive, pay attention, and the application of language comes under the category of

cognitive functions. The application of cognitive functions can be described as learning which is all about the achievement of knowledge and acquiring an understanding by the applications of thought and senses(Hume et al., 2017). One another application is memory which is all about the recalling of information. The application of logic to solve problems comes under the category of reasoning. The making of decisions can also be described as the choice of choosing a course which is all about action. The organization of activities to achieve the goals comes under the category of planning. The solution of problems can be found with the help of applying the logic(Strain et al., 2015). Paying attention to the specific thing that is usually found within the environment comes under the category of attention. The application of all those words which are all about communication comes under the category of language. Let's discuss the workings of cognitive functions. All the updated information will enter the brain by the application of the sensory system(Misquitta et al., 2018). The cortex which is known as the sensory cortex will process this information. All those parts that are involved in the phenomenon of cognition are the cerebral cortex, temporal lobes, and the limbic system. Let's discuss all those factors which can have a significant effect on all cognitive functions. Aging is one of these factors that can have strong effects on memory and reduction with age. The loss of neurons can also be associated with taking the stress and it can also affect the cognitive functions. The initiation of all those disorders which are cognitive can occur subtly but their progress can occur at the level of bringing impairment in the quality of life(McMillan et al., 2017). All those functions which are cognitive can be affected due to having a history of head injuries and concussions in football players who are retired in their life. This thing can also be described as an impairment which can be cognitive. Like the issues of memory and the issues of mental health. Mental health problems can be described as depression and anxiety. Let's discuss all those functions which are cognitive. One of them is memory as the players who are retired from the field of football will face the problems of memory loss, most specifically such type of memory which is verbal(Decq et al., 2016). All those functions that are executive in nature can also be affected due to the lifestyle of football players after their retirement. All those functions that are associated with the psychomotor can be carried out with very great difficulty within all those players who have retired from football history. The issue of attention can also be seen in all those players who are retired and are associated with the field of football(Gallo et al., 2022). The phenomenon of making decisions can also be carried out with very great difficulty by all those people who have retired football players in history. The abilities of language are also affected greatly by all those people who are retired football players. Let's discuss all those issues which are associated with mental health(Wright et al., 2016). The existence of depression among all those people who were football players in the past time and now have retired. Such retired football players will face great challenges of anxiety. The emotional issues can be found more in all those people who are retired

football players and they will face great difficulty in bringing satisfaction within them while all those activities which are social along with in their all relationships(Ruiter et al., 2019). There is a need for more research in tracking all that performance which is cognitive in all those players who were active in their previous time but they are moving towards challenges with time(Kemp et al., 2016). There is also a need for more investigation into all those effects which are long-term and are all about concussion along with headache attacks which can happen again and again in all those athletes who are now retired(Willer et al., 2021).

## 3. Applications of Studying Long-term Effects of Concussions on Cognitive Functions in Retired Football Players

### 3.1 Improved Safety Protocols in Sports

Research on chronic concussion consequences led to sports safety improvements that delivered enhanced protective equipment and revised game rules and expanded recovery protocols for preventing head injuries from multiple blows. Improved safety measures in football along with rugby and hockey arose from scientific evidence about long-lasting concussion problems. Research in protective equipment development has produced advances in helmets with next-generation materials that integrate shock-stop technology to minimize head traumatic injuries. The sport has implemented reshaped rules to minimize dangerous tackling actions and punishment exists for both off-balance maneuvers and head contact violations. Current league regulations require automatic concussion protocols to make players undergo total medical clearance before returning to play. Standardized concussion tests on sporting fields assess mental health while measuring balance functions as part of instantaneous brain injury identification. Professional athletes join referees and coaches as part of these programs to learn standardized concussion identification along with approved safety maintenance protocols. Safety plans enacted through sport organizations serve two essential purposes: to protect athletes from brain injuries that result from accumulated head impacts and to foster competitive environments that uphold athlete health resilience. The sports industry demonstrates robust dedication to protecting player safety alongside player long-term wellness through its concussion reduction initiatives.

### 3.2 Early Diagnosis and Intervention

Thus, allowing lawmakers to combine biomarkers with advanced imaging technologies to detect and track concussive brain damage quickly and over time. In addition to being responsible for counseling, early diagnosis and rapid intervention procedures are essential for long term cognitive protection afforded by concussions. Thanks to medical advances in functional MRI (fMRI) and diffusion tensor imaging (DTI), doctors now have powerful tools for triaging

subtle brain injuries beyond their standard scan results. The brain imaging methods show visual evidence of both functional and structural brain alterations to discover which regions have been traumatized. Researchers combine forces to develop blood-based biomarkers that detect proteins that arise when brain injuries occur such that such injuries are diagnosed without un invasive procedures. Early activation protocols involving rest periods with physical therapy and brain recovery-oriented cognitive rehabilitation avoid secondary neurological damage and constitute the treatment trajectory. Neuropsychological assessments are used by healthcare providers to discover memory disabilities and attention and executive functioning problems, and they create customized rehabilitation strategies. Wearable technology paired with impact sensors monitor head trauma instantaneously and rate for potential injuries. Athletes and coaches get education on what to look for if they suffer a concussion — important information that leads to athletes getting help quickly when they suffer dizziness, confusion, headaches or any other signs. The advances show how we can reduce compensation of concussion complications and proactive strategies in athlete brain health.

**Figure 1:** Rehabilitation Programs

### 3.3 Rehabilitation Programs

This scholarly work leads to giving former athletes currently going through cognitive and mental problems with rehabilitation programs that contain brain therapy components together with movement treatment methods and mental health assistance protocols for healthcare professionals (Figure 1). Rehabilitation programs help people get better from concussive brain injury effects as well as to get better in their emotional state while also improving physical and cognitive abilities. Traumatic brain injuries can involve problems that cause memory loss and attention deficits plus reduced motor coordination ability and these programs customize recovery protocols to meet those needs. The main therapeutic component of the rehabilitation programs is through

Cognitive rehabilitation therapy (CRT) teaching athletes to improve their problem solving and memory functions along with executive functioning through directed methods. Physical therapy, incorporating balance education to stabilize coordination skills and physical stability, allows for physical stability while tending to achieve physical stability that is free of future injuries. Because a patient can experience depression as well as anxiety and post-traumatic stress disorder (PTSD) after multiple concussions, it's the medical protocol to seek mental health support when performing a proper history and physical for concussions. Mindfulness training and psychotherapy together with counseling sessions helps those individuals learn great emotional coping strategies. Virtual reality applications and neurofeedback potentials integrate ever improving technologies to deliver rehabilitation therapies with higher patient engagement and monitoring treatment outcomes. Community programs in which treatment services are combined with peer group sessions allow veteran athletes to find assistance and form departmental solidarity and social bonding. Holistic rehabilitation-based relief programs adapt the treatment to cure both structural and mental health conditions that have emerged from brain concussion to make patients live a life of quality and have future physical ability.

**Figure 2:** Public Health Awareness

### 3.4 Public Health Awareness

Public awareness of concussion related risks has risen through research discovery of concussion risk and has been brought to a wide spectrum from pro sports through to amateur leagues in the younger set to improve concussion prevention methods and care practices (Figure 2). Strong practices to prevent head injuries and get rapid medical response cannot be developed without building widespread knowledge of the concussion related long term consequences. Athletes, parents, coaches and society members are informed with educational campaigns on these head injury risks, as well as proper identification of headache symptoms, which include dizziness and confusion

and memory loss, alongside those of headaches. These initiatives encourage athletes to choose well-being over winning in the battle to overcome stigma that surrounds concussion reporting. Evidence for CTE and early dementia from repeated head trauma is used in social media campaigns, school-based programs and public service television broadcasts to show just how dangerous athletes' lives truly are. By working together with major organizations in healthcare and advocacy groups, proper step by step return to play protocols following rest and recovery according to medical assessments is supported. As part of the "Heads Up" and "Stop Sports Injuries" resources developed by the CDC, coaches and parents now have access to everything they need to make youth sports safer. Increased law enforcement affecting the spread of knowledge of sporting concussion has made it mandatory that schools and amateur sports leagues have concussion management protocols. Public health awareness programs work to support communities to have knowledge and resources and then use these together to lessen the frequency of lasting cognitive and psychological concussion effects.

### 3.5 Policy and Regulation Development

Policymakers have approved of athlete safety regulations (including mandatory concussion procedures and concussion tracking systems) based on the findings of scientists developing concussion studies of long-term effects. The new rules have been put in place to protect athletes while decreasing the risks of head related injuries, as we have an enhanced understanding of persistent concussion impacts. The NFL and FIFA are examples of professional sports that developed very strict concussion safety protocols that dictate a certain player be immediately removed from the game and be treated with post evaluation medical services and go through a complete return to play process. The result is that youth sports organizations now operate with 'if in doubt sit them out' policies that protect their players from harm while prohibiting dangerous early returns to play. In the United States on monetary legislature, coaches and students plus parents have to learn about concussion risks and certain medical clearances etc., and sports have to regain their power. Athletes have to get healthcare approval before still playing their sports. Helmet development standards based on regulatory standards established by NOCSAE or other organizations conform with testing procedures established to minimize impact hazards in sports activities. Concussion treatments' standardization methods created through International Consensus on Concussion in Sport operate internationally. They facilitate the implementation of these policies which lead to enhance athlete safety, promote research initiatives for analytics projects, create massive awareness programs and prevention techniques. Fundamental guidelines to both fight concussion after effects and to protect all athletes at every level of competition combine the proper mix of science, healthcare services and sports regulatory action.

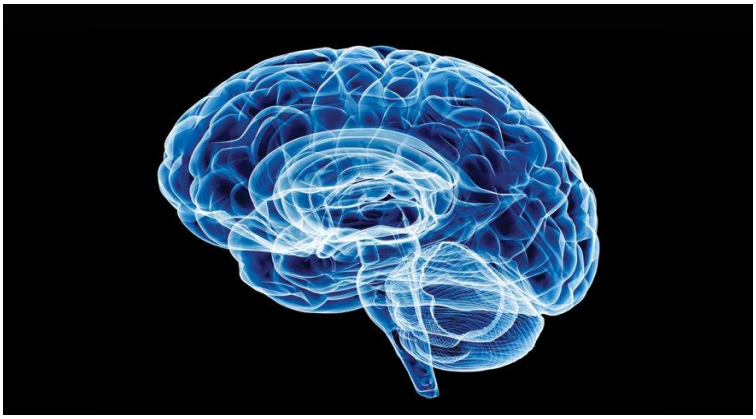

**Figure 3:** Advancements in Neuroscience

### 3.6 Advancements in Neuroscience

Through studies of concussion related brain injury, researchers collect invaluable neuroscience data on concussion related brain injuries that increase our knowledge of traumatic brain injury (TBI) to come up with better treatment methods for other related conditions. Neuroscience has advanced the study of the prolonged impacts of concussions through research focused on how concussions change brain architectural patterns and transformational processes and restoratives (Figure 3). Advanced imaging technologies, such as functional MRI (fMRI), diffusion tensor imaging (DTI), and positron emission tomography (PET) are used by scientists to detect microstructural brain changes that occur as a consequence of multiple head injuries. The exposure of damage to white matter connections in this noninvasive way shows that critical regions such as the hippocampus and prefrontal cortex shrink, and that neural systems experience structural disturbance. Research in molecular neuroscience has pioneered biomarkers that include measures of tau proteins and neurofilament light chain to monitor brain deterioration in chronic traumatic encephalopathy (CTE), and assist medical professionals in tracking such deterioration in the living. Studies of brain reorganization following injury helped develop more treatment strategies which aim to increase neural repair and also help patients recover cognitive functions. With the advances in illuminating the effect that inflammation and oxidative stress have on concussions, there has been advanced in creating anti-inflammatory medications as well as protective brain agents to reduce persistent damage to the brain. They are using artificial intelligence and machine learning to break down concussion information so users can predict results and plan their own recovery programs. New innovations in the field of brain concussion effects come from research progress and elucidate a number of preventive approaches to brain injury that aid in better outcomes in cases of brain injury.

### 3.7 Insurance and Compensation Programs:

The creation of such systems gives financial support to retired athletes

in the case that they develop medical consequences from their brain trauma in order to receive care and rehabilitation, since the academic research findings validate that. The use of insurance with compensation systems serves as the way to access the needed support for persons with concussion after effects but more particularly, post-retirement athletes that have had several traumatic events to their heads. Several sports organizations work with insurance companies to deliver specialized programs to finance medical treatment as well as rehabilitation and long-term care. Professional athletes usually have help from these programs when they are unable to work due to things like a concussion that led to chronic traumatic encephalopathy (CTE) and other cognitions limitations. In addition to that, leagues that are partaking have formed their independent compensation programs so that former players who lived sufficient medical benefits do not have this in their active playing careers. Medical funding programs pay for ongoing concussion treatment of therapy and targeted therapy and mental health services to help people manage concussion complications. Yet, only legal settlements like in the NFL concussion resolution offer both financial help to their families and compensation of their healthcare bills, as it provides superior support to athletes who later developed serious brain's diseases. Some concussion programs join psychological counseling with vocational training alongside explaining how to deal with better your social and emotional struggles. This combination of measures promotes awareness and changes for future protection of athlete through insurance and compensation programs to help patient recover from concussion related healthcare issues through insurance and compensation programs.

**Figure 4:** Design of Preventive Training Programs

### 3.8 Design of Preventive Training Programs

The results of research provide us with information that coaching staff can use to develop training curricula focused on the fundamental head impact reduction techniques to reduce the playing styles in contact sports. Essential steps in reducing concussion and protecting the cognitive health of athletes

through valid preventive training programs. The aim is to teach sports training programs alongside with the coaches and trainers the fundamentals of how to decrease head trauma hazards and make safer sports techniques. This is why rugby and football contact athletes are trained in how to shoulder to shoulder tackle instead of ineffective helmet to helmet contact, lowering the likelihood of head injuries. Coaches are trained to spot the early warning signals of concussions among these teachers because these educators force detailed filing systems to combat quick comeback after injuries by athletes. Physical conditioning exercises are added to training programs to reinforce neck muscles and the core region that helps decrease brain impact forces, which is really the function of this head stabilization. Today, sports organizations systematically include concussion education into their athletic development plans because it is added to the standard training framework of the sport organizations. Helmet sensors that measure actual impact forces through real time monitoring to trainers to assess how severe and how often the attack on the head. Trainers can make safety-oriented decisions by watching system output and find ongoing patterns that need more preventive measures. It is a comprehensive approach, preventive training, that assists athletes to develop their mental readiness using educative measures, health maintenance and mental focus. Thorough educational content supplemented by practical preventive tools result in a reduction of concussions and safe, secure athletic settings to protect athletes' cognitive health for the long haul.

### 3.9 Influence on Other Industries

This research contributes to the area of safety protective standards for workplaces where brain injuries are commonly acquired, including military service and construction, through the development of guidelines for protective equipment and concussion response systems. As concussions became the talk of the Sports world, sweeping policy, design and practice changes occurred in hospitals, technology, manufacturing and beyond. Following the pressure on health care professionals to address brain injury concerns, the healthcare industry created concussion clinics and rehabilitation programs to help those who suffered these traumatic brain injuries (TBI). Diagnosis of concussion has been spurred by growing market demand and advances in innovative ways to diagnose concussion using blood biomarkers and imaging systems, enabling healthcare providers to assess the damage to the human brain from workplace hazards and military communities. Today, wearables in the technology industry are also creating devices using sensor technology that capture head strike data in order to monitor athlete health through data measurement as well as concussion assessment prior to awareness of symptoms. Modern sporting equipment design has spawned technological innovations that pervade industries, to use wearable tracking systems to assess workplace safety by monitoring potential accident hazards in a construction site or a manufacturing

facility. Improved padding materials for protective gear in cycling and motorsports, and military operations have updated helmets; concussion prevention advancements have been adopted across safety equipment development, its manufacturers. Birth of Expanded Coverage for Concussion Caused Cognitive Disorders Insurance Providers: As people began to learn about concussion caused cognitive disorders, insurance providers began to provide expanded coverage for traumatic brain injury during sports and non-sports activity. This model then shared schools and universities set concussion protocols for managing brain injuries and developed classroom programs to teach students how to manage head injury risks, then reached fan of the training in workplace across healthcare education. Though research on concussions has increased, awareness has as well, and now industries are implementing preventive safety protocols and also pursuing longitudinal health outcomes for society. These translational insights of this study allow for the creation of safer conditions and more improved health results for those that have been exposed to traumatic brain injuries.

## 4. Conclusion

The main objective of this research is to understand the topic of Long-term Effects of Concussions on Cognitive Functions in Retired Football Players. This research will prove very helpful while practical working. Football players who experience concussions demonstrate significant and concerning cognitive impairment throughout their post-playing careers. Repetitive head injuries that cause serious erosion in quality of life over time progressively build certified conditions involving CTE, together with memory dysfunction, impaired decision-making ability and mood disorders. Continuing deterioration of these intellectual capabilities necessitate that player safety be prioritized and improve concussion detection procedures as well as research to reduce these threats. Preventative measures and education campaigns, along with vigorous athlete health care allow the sports community to mitigate dangers associated with concussion, thereby making for better player health at work and in competitive environments. A study finds that students that experienced multiple concussions have increased rate between mood disorders that lead to depression and anxiety. Results of brain imaging show demographic data, which indicate that the regions associated with memory and decision making, like hippocampus and prefrontal cortex, have lower gray matter volume. Over time research shows that cognitive deficits build on themselves until it leads to the early onset dementia and Alzheimer’s disease. Due to the number and severity of sustained brain injuries and their impact on brain health throughout the course of an athlete's career, sports related concussions create long term risks that are increased exponentially. And that is why preventive care has to begin before that first head collision in sport.

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