

CTE found in 99% of studied brains from deceased NFL players

cte explainer sanjay gupta orig mg_00005826

(CNN)Chronic traumatic encephalopathy, known as [CTE](#), was found in 99% of deceased NFL players' brains that were donated to [scientific research](#), according to [a study published Tuesday in the medical journal JAMA](#).

The neurodegenerative brain disease can be found in individuals who have been exposed to repeated head trauma. The disease is pathologically marked by a buildup of abnormal tau protein in the brain that can disable neuropathways and lead to a variety of clinical symptoms. These include memory loss, confusion, impaired judgment, aggression, depression, anxiety, impulse control issues and sometimes suicidal behavior.

5 things to know about CTE

It can only be formally diagnosed with an autopsy, and most cases, although not all, have been seen in either veterans or people who played contact sports, particularly American football.

"There's no question that there's a problem in football. That people who play football are at risk for this disease," said Dr. Ann McKee, director of Boston University's CTE Center and coauthor of the new study. "And we urgently need to find answers for not just football players, but veterans and other individuals exposed to head trauma."

The JAMA study is the largest of its kind and all of those studied were required to have football as their primary exposure to head trauma. The criteria for submitting a brain was based on exposure to repetitive head trauma, regardless of whether that individual exhibited symptoms during their lifetime.

The study points out potential bias because relatives of these players may have submitted their brains due to clinical symptoms they noticed while they were living. It also acknowledges the lack of a comparison group that represents all individuals exposed to college-level or professional football. Without that, the study lacks an overall estimate on the risk of participation in football and its effects on the brain.

Out of 202 deceased former football players total -- a combination of high school, college and professional players -- CTE was neuropathologically diagnosed in 177, the study said. The disease was identified in 110 out of 111 former NFL players. It was also found in three of the 14 high school players and 48 of the 53 college players. The study included brains of individuals who have been publicly confirmed to have had the disease, including [Ken Stabler](#), [Kevin Turner](#), [Bubba Smith](#) and [Dave Duerson](#).

"The medical and scientific communities will benefit from this publication and the NFL will continue to work with a wide range of experts to improve the health of current and former NFL athletes," the NFL told CNN in a statement, noting that "there are still many unanswered questions relating to the cause, incidence and prevalence of long-term effects of head trauma such as CTE."

In 2016, the NFL publicly acknowledged for the first time [a connection between football and CTE](#). In June 2015, a federal judge approved a class-action lawsuit settlement between the NFL and thousands of former players, providing up to \$5 million per retired player for serious medical conditions associated with repeated head trauma.

"The NFL is committed to supporting scientific research into CTE and advancing progress in the prevention and treatment of head injuries," the NFL statement on the study said. "In 2016, the NFL pledged \$100 million in support for independent medical research and engineering advancements in neuroscience related topics. This is in addition to the \$100 million that the NFL and its partners are already spending on

medical and neuroscience research."

Questions raised

The study examined both the brain pathology -- which is the behavior of the disease in the brain -- and clinical history of every participant. It identified four stages of pathological CTE severity among the brains, based on amounts of tau buildup and distribution. Stages one and two are considered to be mild and stages three and four are considered severe.

Inflammation in the brain linked to CTE

Individuals who were reported to have experienced more behavioral mood symptoms during their lifetime were more likely to have findings indicative of mild disease as opposed to severe. These symptoms occurred in 96% of mild cases and 89% of severe cases. People with a mild build up and distribution of tau were also more likely to have died by suicide. Those with a more severe build up, on the other hand, were more likely to have experienced cognitive symptoms, such as memory loss.

The behavioral and mood symptoms in people with mild disease evidence may be the result of other influences, such as neuroinflammation or axonal injury, which is an injury to the brain cells, McKee said. The question of pathology's relationship to clinical symptoms is one they're hoping to answer in future studies, she said.

Dr. Jeffrey Kutcher, national director of the Sports Neurology Clinic at the Core Institute, who was not involved in the study, agreed with the need to further understand this relationship.

"Just because we are describing the same CTE pathology, the collection of tau and the distribution that's consistent with CTE, that doesn't mean it's the only pathological process," Kutcher said. "There could be others that we are yet to identify. So I think it's important that we don't just focus on one pathology, and that we start looking for others."

Seeking help

Studies like this have the potential to create a powerful narrative for football players who read them, but may not have a full understanding of the science or the bias in the sample, Kutcher said. This could lead players to believe that they are damaged and that there is no use in seeking help, he said.

"To me, that is one of the biggest issues we have right now," Kutcher said. "Not emphasizing that people should seek treatment for their problems."

Although the disease cannot be formally diagnosed until after death, many of the symptoms of CTE that may be experienced during a lifetime, such as depression or anxiety, are treatable, Kutcher said. That is why its important for someone experiencing these symptoms to access a comprehensive evaluation by a neurologist, and work with them to figure out a treatment plan.

Kutcher said its also important to consider that the brains examined in the study came from players who played decades ago. Most of the participants with CTE played football during the 1950s, '60s, '70s, '80s and '90s, McKee said, with the rest having played in the 2000s and 2010s.

The experiences of the majority were different from those who play the sport today, Kutcher said, and there was not the same awareness, medical protocols or equipment to prevent brain injuries.

"My rule as a physician, as a neurologist, is to protect and promote the brain health of my patients over the course of a lifetime, no question about that. You have to look at the total person though," Kutcher said. "You have to understand why people play sports. It's an individual decision, everybody gets different things out of it. You also have to understand what the arc of their life is going to be, what their health is going to be at the end of their career."

Next steps

McKee and her colleagues are currently working to understand more about

CTE and who is most susceptible to it. They are looking at the lengths of exposure to head trauma, the age of first exposure, the lengths of playing careers and how that relates to the risk of CTE and its pathological severity, she said.

"It certainly can be prevented and that's why we really need to understand how much exposure to head trauma and what type of head trauma the body can sustain before it gets into this irreversible cascade of events," she said.

They are also using the 177 donated brains with CTE to try and see if there are any genetic risk factors of the disease.

"For the first time, we've established this really rich resource, not only of data, both the clinical symptoms and the pathological features, but also a tissue resource to enable future research in CTE," McKee said. "And we know that this study doesn't answer many of the very important questions in CTE, but the resource will help us understand the molecular underpinnings, will help us develop biomarkers and therapies by understanding the pathological features of the disease."

An earlier version of this story incorrectly stated that this is Concussion Awareness Week. It is Major League Lacrosse Concussion Awareness Week.