A routine soccer skill sets off brain injury signals, and the blood shows it fast

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Amateur soccer players who headed the ball showed immediate increases in blood biomarkers linked to neural damage. Credit: Stephen Leonardi for Pexels

The iconic header goal scored by Cristiano Ronaldo in a Manchester United vs. Real Madrid Champions League game was a marvel to watch.

While heading a soccer ball can help a team climb the rankings, studies suggest it may also increase the risk of neural damage.

A recent study involving 302 male amateur players who regularly participated in organized matches investigated whether soccer heading exposure is linked to an acute rise in blood biomarkers of neural damage, and if this response increases with greater exposure.

Tracking the biomarkers revealed that heading a soccer ball caused an immediate spike in neurotransmitters that act as alarms for brain cell stress and injury. The more headers a player performed, particularly high-impact headers from long distances, the higher these chemical levels rose in the blood.

The findings are published in *JAMA Neurology*.

Louder chemical alarms

Contact sports like football, American football and rugby have long been studied for their association with a higher risk of brain diseases. Studies have shown that former professional soccer players face a two- to three-fold increased risk of neurodegenerative disease, and scientists believe that exposure to repetitive head impacts is suspected to contribute to this risk.

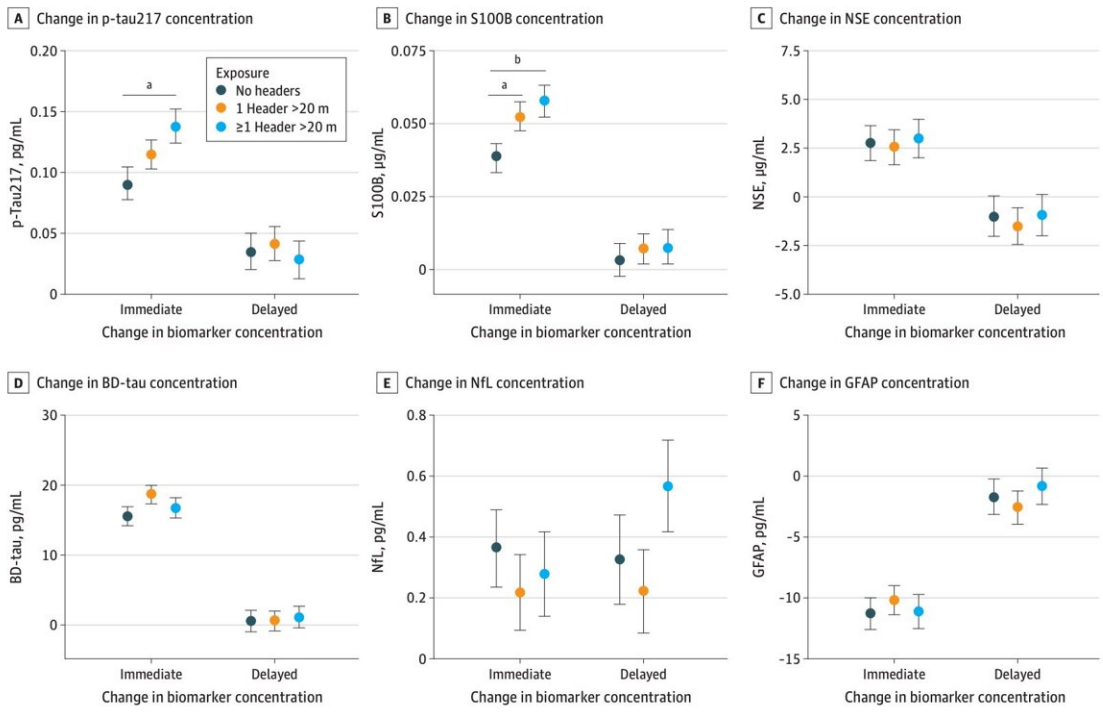
Most studies in this field have focused on traumatic brain injury (TBI), leaving an unclear picture of whether there is a direct link between soccer heading and neurodegenerative disease, or whether any negative effects are limited to injury alone.

Two imaging studies by Columbia researchers, published in 2025, revealed that the junction between white and gray matter in the brain's outer layer, just behind the forehead, was most affected by heading, and

that this damage was associated with cognitive deficits. The researchers in this study wanted to see if they could detect similar evidence of brain impact in the blood.

They designed the study to track changes in biomarkers of neural damage before and after soccer matches. To establish a baseline for each player, blood samples were collected before the match. A second sample was taken within an hour of the final whistle to capture immediate effects, followed by a third sample 24 to 48 hours later to determine whether the changes were short-lived or persisted.

They found that players who headed the ball showed immediate increases in the concentrations of two proteins called S100B and p-tau217. S100B is a calcium-binding protein that is found specifically in glial cells, which provides physical and metabolic support to neurons.



Dot plots showing change in biomarker concentrations after match participation in relation to the high-impact headers. Credit: *JAMA Neurology* (2026). DOI: 10.1001/jamaneurol.2026.1224

S100B is typically released into the bloodstream when these cells are under stress. p-tau217 is a phosphorylated protein—an abnormal, tangled version of the essential tau protein that maintains the structure and function of neurons—that is strongly associated with Alzheimer's disease and TBI.

The results also revealed a clear dose-response pattern, with chemical markers rising steadily as the number of headers increased. The changes in the biomarkers became statistically significant after just more than two headers. High-impact headers, where the ball traveled more than 20 meters (22 yards) before contact, also triggered much larger spikes in these brain-stress signals.

"This study adds to the emerging evidence that even modest head impacts elicit a negative response from brain tissue," said Dr. Peter Theobald, Reader in Biomedical Engineering at Cardiff University.

He added that the finding aligned with a recent study from his lab, which showed that even a relatively small number of headers, in this case 10, was enough to induce changes in the brain within 24 hours after a match, and the findings were evident even six months after this single intervention.

In this study, however, the chemical changes did not sustain as the biomarker levels returned to normal within 24–48 hours after the match.

Many studies have already linked repetitive head impacts to

neurodegenerative disease. Building on both previous knowledge and new results, the researchers noted that even amateur-level heading may affect neural integrity.

Future investigations should focus on understanding the long-term consequences of heading at different levels of soccer, as the findings could be crucial for informing soccer policies and safety guidelines regarding heading frequency.

More information: Marloes I. Hoppen et al, Amateur Soccer Heading and Acute Elevations in Blood-Based p-Tau217 and S100B, *JAMA Neurology* (2026). DOI: 10.1001/jamaneurol.2026.1224