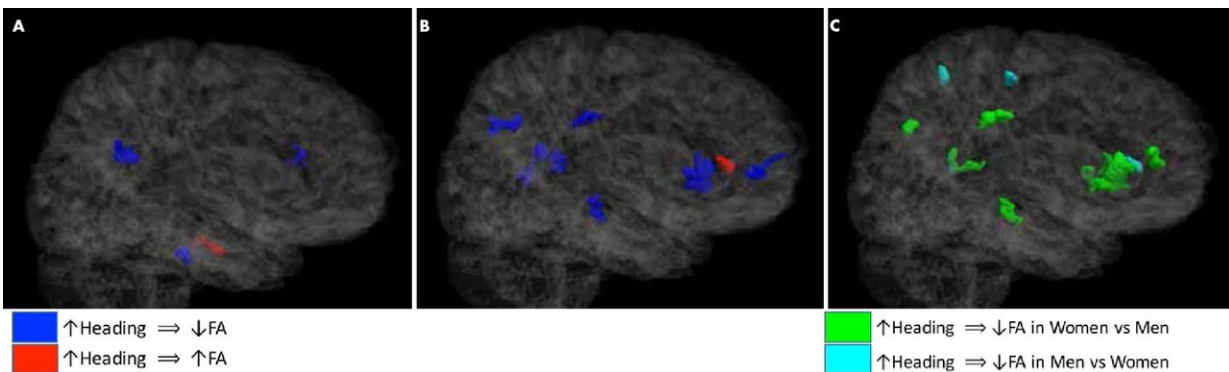


# Soccer heading worse for women's brains than for men's

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A, B, Three-dimensional semitransparent images of the Johns Hopkins University template brain oriented facing the right hemisphere in, A, male, and, B, female soccer players demonstrate that lower fractional anisotropy (FA) is associated with heading more extensively in women than in men. Fewer regions of significant association of FA with heading are detected in men than in women. C, Image shows that significant differences in association of heading and FA between men and women are predominantly co-located with areas where women, but not men, show significant association of heading and FA. Credit: Radiological Society of North America

Women's brains are much more vulnerable than men's to injury from repeated soccer heading, according to a new study by researchers at Albert Einstein College of Medicine, part of Montefiore. The study found that regions of damaged brain tissue were five times more extensive in female soccer players than in males, suggesting that sex-

specific guidelines may be warranted for preventing soccer-related head injuries. The results were published online today in *Radiology*.

"Researchers and clinicians have long noticed that women fare worse following head [injury](#) than men, but some have said that's only because women are more willing to report symptoms," says study leader Michael L. Lipton, M.D., Ph.D., professor of radiology and of psychiatry and behavioral sciences at Einstein and medical director of MRI Services at Montefiore. "Based on our study, which measured objective changes in [brain](#) tissue rather than self-reported symptoms, women do seem more likely than men to suffer brain trauma from heading soccer balls."

About 30 million women and girls play soccer worldwide, according to the International Federation of Association Football, known as FIFA, the international governing body of soccer.

## Measuring Brain Changes

In the study, Dr. Lipton and his colleagues performed diffusion tensor imaging (DTI), a form of MRI, on 49 male and 49 female amateur [soccer players](#) enrolled in the Einstein Soccer Study. Both groups ranged in age from 18-50 with a median age of 26, and both groups reported a similar number of headings over the previous year (an average of 487 headings for the men and 469 for the women).

DTI detects subtle brain damage by measuring the direction of the diffusion of water in [white matter](#) (the deep [brain tissue](#) that coordinates communication between brain regions). The more uniform the diffusion of water—measured on a zero-to-one scale called fractional anisotropy (FA)—the better the microstructural integrity of the tissue. Finding a low-FA brain region indicates structural damage to the brain.

Assessment of FA in players' brains showed that the volume of damaged

white matter in women soccer players was five times greater than for male players. The women had eight brain regions where greater levels of heading were associated with lower FA compared with only three regions in men, the study found.

"Our study is larger and more evenly balanced between the sexes than any prior imaging study of sex and brain injury," says lead author Todd G. Rubin, M.S., an M.D.-Ph.D. student in the Translational Neuroimaging Laboratory at Einstein. "The findings add to the growing body of evidence that men and women express distinct biological responses to brain trauma."

## Can Players Reduce Risks?

Just why women might be more sensitive to head injury than men isn't known. Researchers speculate that differences in neck strength, sex hormones or genetics could play a role. The changes in FA were subclinical, meaning they didn't produce overt clinical findings such as altered thinking ability. But those FA changes are still cause for concern.

"In various brain injuries, including chronic traumatic encephalopathy [a degenerative brain disease found in athletes, military veterans, and others with a history of repetitive [brain trauma](#)], subclinical pathology develops before we can detect brain damage that affects function," says Dr. Lipton. "So before serious dysfunction occurs, it's wise to identify risk factors for cumulative brain injury—such as heading if you're female—so that people can act to prevent further damage and maximize recovery."

For more than a decade, Dr. Lipton has studied the effects of mild brain injury and the cumulative effects of repetitive subconcussive injury on the brains of amateur athletes and combat veterans. He previously found that frequent soccer ball heading is a common and under-recognized

cause of concussion symptoms and that worse cognitive function in soccer players stems mainly from frequent ball heading rather than from unintentional head impacts due to collisions.

Should soccer players stop heading? "We have carried out several studies showing that most players seem to tolerate some level of heading," says Dr. Lipton. "Rather than ban heading altogether—which probably isn't realistic—we'd like to get a better handle on how many headers will get players into trouble. What is important about this study is that men and [women](#) may need to be looked at differently."

Soccer organizations may ultimately want to adopt preventive measures like Pitch Smart, a program sponsored by USA Baseball and Major League Baseball that recommends pitch counts and rest periods for players of different ages, Dr. Lipton suggests. "Limits on pitch counts have dramatically reduced the incidence of upper extremity repetitive stress injuries," he says. "Limiting the number of headers allowed in [soccer](#) might have similar benefits in preventing head injuries. But we can't recommend specific numbers at this point. Fully understanding the risk of heading will take a lot more work."

The paper is titled, "MRI-defined White Matter Microstructural Alteration Associated with Soccer Heading Is More Extensive in Women than Men." The other contributors are: Roman Fleysler, Ph.D., Liane E. Hunter, M.S. and current Einstein M.D.-Ph.D. student, Naomi Lubin, B.A., Mimi Kim, Sc.D., and Richard B. Lipton, M.D., all at Einstein. Additional authors include Walter F. Stewart, Ph.D., at Sutter Health, Walnut Creek, CA and co-first author Eva Catenaccio, M.D., formerly of Einstein and now at Johns Hopkins University, Baltimore MD.

Provided by Albert Einstein College of Medicine

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