SANTA CLARA UNIVERSITY
INSTITUTE OF SPORTS LAW AND ETHICS

CONCUSSION LegacyFoundation

**Safer Soccer White Paper**

***The Neurological Consequences of Heading in Soccer***

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## 1. Introduction

Soccer is the world's most popular sport, with 240 million participants, including eight million youth participants in the United States. Purposefully heading the ball is a legal and encouraged maneuver, and written guidelines from soccer governing bodies recommend introducing heading at age ten. However, the guidelines are not widely enforced, and soccer players have reported beginning to engage in heading as young as age three.[1]

The Concussion Legacy Foundation and the Institute of Sports Law and Ethics at Santa Clara University recently partnered to educate the public on the risks of heading in children. Research on the short and long-term consequences of concussions and subconcussive brain injury reveals that brain trauma can have significant neurological consequences, especially in youth.

We estimate that delaying the introduction of heading until age 14 would conservatively prevent over 100,000 concussions among middle school aged players registered with US Youth Soccer every three years.

Former Women's World Cup Champions Brandi Chastain, Cindy Parlow Cone, and Joy Fawcett no longer allow the players they coach, or their own children, to head the ball before high school. They have come to this conclusion based on the following evidence.

## 2. Risk of Concussions

Research has shown that over 30% of concussions in soccer are caused by heading the ball or by attempting to head the ball and colliding with a player, object, or the ground.[2] [3] 11% of children who suffer a concussion still have symptoms three months later.[4] Persistent post-concussion symptoms can be devastating. According to the Ontario Neurotrauma Foundation, persistent symptoms disrupt daily living and participation in school and activities.[5] Children/adolescents may:

- Miss weeks or even months out of the school year, affecting marks and risking on-time graduation.[6]
- Have attention and memory deficits, making schoolwork a challenge and requiring special accommodations to maintain required academic levels[7]
- Suffer worsened emotional symptoms due to social isolation during recovery.[8]

## 3. Changes in Brain Function and Structure

There is a growing body of literature showing that heading a soccer ball can result in problems with memory and attention, as well as structural and metabolic differences visible on advanced brain imaging, even in the absence of a symptomatic concussion.[9]

- A study of professional soccer players found those with more headers over a season had worse attention, visual memory, and verbal memory.[10]
- Research conducted with high school soccer players showed slower cognitive function than controls, related to how often they headed the ball.[11]
- In a recent study, 37 amateur soccer players found that as a player sustained more headers, structural brain changes and memory deficits became more pronounced.[12]
- A study comparing soccer players who had not sustained a concussion to athletes not exposed to any brain trauma (swimmers) found that the soccer players showed brain changes consistent with mild traumatic brain injury.[13]

**4. Age**

There is substantial evidence supporting the notion that young people may be more susceptible to damage resulting from repetitive concussive and sub-concussive brain trauma. Studies in boxing and football reveal that the earlier one is exposed to greater brain trauma, the greater their risk of long-term problems.

- A study of boxers found that for those with less education, psychomotor speed scores declined significantly with increasing years of fighting.[14]
- Research on professional football players has shown greater cognitive deficits for players that were subjected to repetitive head trauma before age 12 relative to those only exposed after age 12.[15]
- A study of college football players found a significant relationship between the number of years played and a smaller hippocampus, an area of the brain essential for creating new memories.[16]
- In younger children, the long term effects of brain trauma can become apparent years after injury, as normal developmental milestones are disrupted.[17]

**5. Neck Strength**

There is evidence that having a strong neck may help reduce risk of concussion by reducing head acceleration caused by an impact. Younger athletes typically have weaker necks, which could put an athlete at higher risk for concussion.

- A study of youth and adult athletes showed that greater neck strength significantly reduced both linear and angular head acceleration in response to impact loading.[18]
- A study of adolescent soccer players performing headers in a lab showed that subjects with weaker necks sustained greater head acceleration than those with stronger necks. [19]
- In a study of over 6,700 high school athletes, greater neck strength was significantly correlated with reduced risk of concussion, further supporting a role of neck strength in concussion risk.[20]

**6. Ability to Recognize and Report Concussion**

Other than for the uncommon loss of consciousness, there is currently no reliable, objective indicator of when an athlete has suffered a concussion. We often have to rely on the athlete

reporting their own symptoms, and even adults can have difficulty recognizing when they have suffered a concussion.

- Children will not report concussions if they do not understand concussions. A survey of ten-year-old ice hockey players found that 64% thought loss of consciousness is needed for concussion, and 45% could name zero or one concussion symptoms.[21]
- A study of college ice hockey players found that the medical staff only identified one out of every four concussions the players believed they suffered, primarily because the players did not think symptoms like headache or dizziness after an impact were serious enough to report to a coach or athletic trainer, and those symptoms were invisible to the medical staff.[22]
- A recent study on several hundred adult athletes suggests that, on average, athletes may not recognize up to half of concussions they sustain.[23]

**7. Medical Infrastructure**

Younger players are typically not provided professional medical supervision. About half of all high schools have access to an athletic trainer, but very few have an athletic trainer present on the sidelines to help identify concussions during play, and even fewer are present at the youth sports level.

- A national study of over 100 high schools showed that schools with athletic trainers may identify up to eight times as many concussions.[24]
- A study of ice hockey teams found that by placing a doctor in the stands to look for concussions, they were able to identify seven times more concussions than with an athletic trainer alone.[25]

**8. Other Sports**

Recognizing the risks associated with concussion in children, several other sports have modified rules to limit young athletes' exposure to purposeful, repeated brain trauma. These rule changes aim to reduce concussions and sub-concussive impacts in young players, and increase focus on skill development.

- USA Hockey has eliminated checking for 11-12 year old players, introducing intentional contact at age 13.
- US Lacrosse has made all hits to the head and neck area result in a penalty.

**9. Benefit to Soccer Skills**

In addition to limiting brain trauma, eliminating heading may produce better soccer players through focus on developing important foot skills early. Several experts have advocated this position.

- Brandi Chastain, a two-time FIFA Women's World Cup champion and two-time gold medalist believes "as a coach I would prefer my players had focused solely on foot skills as they develop their love of the game. I believe this change will create better and safer soccer."

- Cindy Parlow Cone, who also won two gold medals and a World Cup as a prolific header believes that "with good coaching, heading skills can be learned during the high school years. Up until the high school age, the focus should be on coordination, technical skills and spatial awareness. Delaying the teaching of heading skills, while still preparing players for heading by teaching jumping and landing and strengthening the neck, not only will help make the sport safer but also is developmentally appropriate."

**10. Estimated Concussions Prevented**

We estimate that delaying the introduction of heading until high school will result in the prevention of 100,000 concussions among middle school soccer players every three years. It is based on the following assumptions:

1. 6th to 8th grade players registered with US Youth Soccer: ~900,000[26]
2. Percent of athletes suffering concussions each year: 13%[2]
3. Percent of concussions caused by headers: 30.5%[2]

900,000 x 0.13 x .305 x 3 years = 107,055

**11. Conclusion**

The scientific evidence paints a clear picture that heading a soccer ball will result in more concussions and repeated subconcussive brain trauma, both of which can have long term neurological consequences for adolescents and adults. Younger players are also both more likely to suffer a concussion and have more long term symptoms than older players. Eliminating heading before high school provides a tremendous opportunity to both reduce brain injury and also improve soccer skill development.

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