

# Proper Heading is Safe

...But there are precautions to be taken, especially with children

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The sport of soccer is growing rapidly around the world and in the United States. Approximately 120 million players are registered worldwide, with 16 million of those being in the United States alone (Jordan et al., 1996).

Soccer is highly competitive and aggressive, resulting in injuries that range from muscle strains and ligament sprains to broken bones to head injuries. In soccer, head injuries account for between 10% and 13% of all injuries, and concussions account for 20% of head injuries (Baroff, 1998). In contrast to most other sports, soccer uses the head as a means of advancing and passing the ball and scoring goals.

There has been a growing concern about the role of heading the soccer ball because recent studies have claimed that repeated soccer heading could lead to neurologic impairment and, as a result, decreased performance on standardized tests. A recent study at the University of North Carolina found that there in fact was no neurocognitive deficit in college soccer players. Other studies question the role of heading and instead point the finger more at head injuries, concussions in particular, as the culprit in any neurologic impairment.

## Designing the study

These disagreements in the soccer heading literature led us to design a study to look at different factors that might increase the chances of children sustaining head injuries. The major concerns in soccer heading literature revolve around: 1) whether purposeful heading is dangerous; 2) whether accidental head impacts are dangerous; 3) whether having the ball over-inflated increases the chances of sustaining a head injury, and 4) whether the size of the ball and, as a result, its mass increases the risks of head injuries.

We used a mathematical model to look at the effect of ball inflation pressure, ball speed when it contacts the head, ball size and the mass of the

child who was heading the ball on peak force at ball contact with the head. This also allowed us to determine at what ball velocities different age children could safely head both with a prepared and unprepared head based on current safety standards. The model was used to determine all of the above information for a size 3, 4 and 5 ball. The age groups were defined as 6-9-year-olds (who would use a size 3 ball), 10-13-year-olds (who would use a size 4 ball) and 14-18-year-olds (who would use a size 5 ball).

As long as the inflation pressure of the ball is within the limits stated on the ball (10-14 psi), any change in inflation pressure has no effect of the peak force seen at the head at the point of impact. In addition, when using the correct size ball for their age group, the mass of the child whether in the upper (97th percentile) or lower (3rd percentile) end of the growth chart did not affect the peak force seen at the head immediately prior to ball contact. However, the mass of the ball, and as a result the size of the ball, did have an effect on the peak force at ball contact. With an increase in ball size, an increase in the peak force was observed.

## Accidental vs. purposeful

We estimated the impact force for both accidental and purposeful head to ball contact. Purposeful contact was determined by using the mass of the head plus the trunk in the model (when the neck muscles are contracted fixing the head to the trunk). For an accidental contact, we used only the mass of the head (i.e. neck muscles not contracted). Both the mass of the head and the mass of the trunk were determined as a percentage of the body mass of a child in the 50th percentile on the growth chart. For a child using the correct size ball for their age, it could be dangerous for them to be hit in the head with the ball when they are not expecting the contact or when they are not properly heading the ball, i.e. accidental contact. For example, it could be considered dangerous for a 13-year-old boy playing with a size 4 ball to be accidentally struck

with a ball traveling over 19 mph. For a girl of the same age it could be unsafe at 20 mph, speeds that might be seen during a game. Similarly, for an 18-year-old, accidental ball contact at approximately 17 mph and 20 mph for the girls and boys respectively might be dangerous. The decrease in the safe velocity of an accidental ball contact results from a decrease in the mass of the head as a percentage of total body mass with age.

In addition, the safety of ball to head contact when the player had a prepared head was also estimated. For the same ages as discussed above, a 13-year-old could now safely head the ball, with a prepared head, at velocities of about 80 and 81 mph for the boys and girls respectively. For the 18-year-old they could safely head the ball at velocities less than 108 mph and 92 mph for the boys and girls respectively. The reported ball velocities seen in professional (up to 60 mph) and unskilled (up to 45 mph) soccer games are well below what we report here for safe heading with a prepared head, but are above the safe velocities for an accidental impact (Levendusky and Armstrong, 1987).

### **Coaching points**

While our estimates show that the necessary velocity of a ball to cause injury to a player who is

prepared to head the ball are well above the velocities seen in a soccer game, there are some important coaching points that need to be stressed. Always make sure that children are both playing and practicing with the correct size ball for both their age and weight. Using an incorrect ball size creates a dangerous situation that could lead to head injuries.

Teaching correct technique is critical so that the timing of all the coordinated events in heading occur at the proper time to fix the head to the trunk, making the impacting mass well above the ball mass. As demonstrated by this study, players can safely withstand much higher ball velocities when they are prepared to head the ball and are using their entire trunk instead of just their head.

In coaching, the focus needs to be on proper heading mechanics and not just on the player's ability to move the ball around the field or score goals with the head. Finally, it is not dangerous for children to head a soccer ball if it is done with proper technique and they are using the correct size ball for both their age and weight. Perhaps with younger children much softer balls (Nerf balls) can introduce the skill so that confidence is built before a regulation ball (under-inflated at first) is introduced.

### References:

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