Head accelerations across collegiate, high school and youth female and male soccer players

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WHAT DID I DO?

I investigated (1) head acceleration during purposeful football heading across age and sex and (2) determinants of head impact severity.

WHY DID I DO IT?

Nearly 4% of the world's population plays football, including over 26 million women. Although there are unrefuted positive health effects of playing football,[1] chronic traumatic encephalopathy (CTE) has been identified in three football players,[2] including British player, Jeffrey Astle, causing concern about the long-term effects of repetitive heading. To prevent or mitigate the effects of repetitive football heading, I believe that we must understand the biomechanics and identify strategies for reducing head impact severity.[3] Currently, the little information on the biomechanical response to purposeful heading is limited to collegiate male football players, but these data may not be transferable to women and children, who have lower head mass, decreased neck muscle mass/strength and potentially underdeveloped heading skills.[4] With inadequate research on football heading biomechanics and modifying factors among women and children, I believe that there may be unknown consequences of frequent heading in these groups.

HOW DID I DO IT?

I recruited 100 football players (42 male, 58 female, 17.1±3.5 years, 168.5±20.3 cm, 61.5±13.7 kg) to complete 12 controlled football headers (footballs=size 5, 450 g, 9 psi; initial velocity=11.2 m/s; projection angle=40°).[5] For each participant, 10 determinants of head impact severity were identified. Head mass was defined as a percentage of total body weight. Neck girth was defined as the circumference above the thyroid cartilage. Sternocleidomastoid and upper trapezius isometric strength were measured using a handheld dynamometer. Trunk and head-to-trunk kinematics were determined using a motion capture system. Sternocleidomastoid and upper trapezius activity, peak and area were calculated from electromyography (EMG).

Comparison across age and sex

Peak linear and rotational head accelerations were compared by sex (female, male) and age (collegiate, high school, youth).

Determinants of head impact severity

Multiple regression analyses were conducted to determine if size (head mass and neck girth), strength (sternocleidomastoid and upper trapezius) or technique (kinematics and EMG activity) variables predicted the peak linear and rotational head accelerations.

WHAT DID I FIND?

Regarding comparisons across age and sex, I found that female football players produced higher peak linear and rotational head accelerations than male football players, but there were no significant differences across age (figures 1 and 2).

Determinants of head impact severity

- Size variables explained 22.1% of the variance (R^2=0.221, p<0.001) in peak linear head acceleration and 23.3% of the variance (R^2=0.233, p<0.001) in peak rotational head acceleration.
- Strength variables explained 13.3% of the variance (R^2=0.133, p=0.001) in peak linear head acceleration and 17.2% of the variance (R^2=0.172, p<0.001) in peak rotational head acceleration.
- Technique variables did not significantly predict peak linear (R^2=0.066, p=0.412) or peak rotational head acceleration (R^2=0.047, p=0.627).

WHAT IS THE MOST IMPORTANT CLINICAL IMPACT/PRACTICAL APPLICATION?

While football heading research is still in its infancy, my dissertation has helped to increase our understanding in the topic and from my work, these are the greatest implications:

- Under controlled heading conditions, female football players may be exposed to greater head accelerations.
- Greater head mass, neck girth and neck strength predict lower head accelerations and may contribute to the observed sex differences.
- Anthropometric and neck strength measurements should be considered when determining the minimum safe age to begin football heading. High-quality studies are needed to determine specific screening criteria for when to permit football heading.
- Female athletes, who experience higher head accelerations, may benefit from a cervical strengthening regimen to compensate for their smaller head masses and neck girths. Again, prospective, randomized control trials are needed to establish specific cervical strengthening programmes to reduce head accelerations.

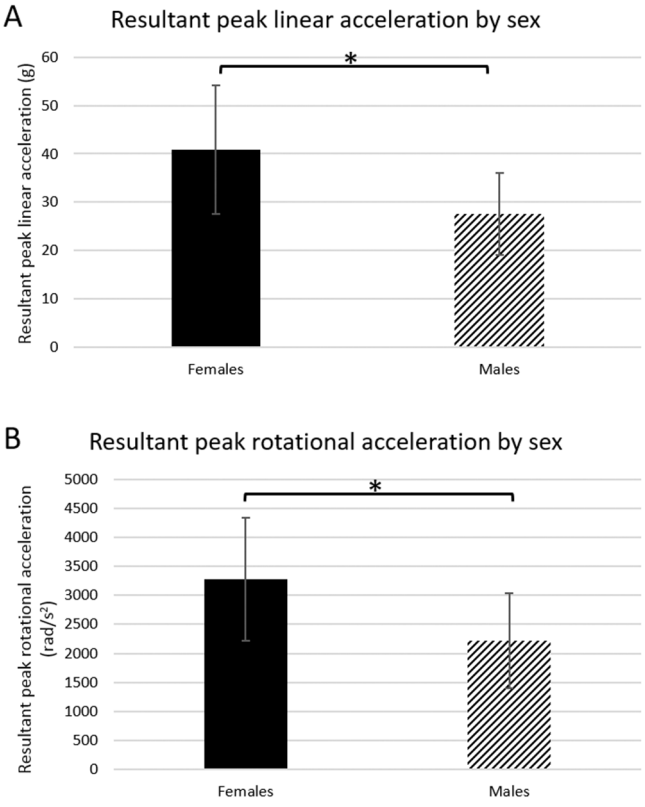

Figure 1 (A) Peak linear and (B) peak rotational head accelerations at head centre of gravity across sex. The error bars represent the ±SD.

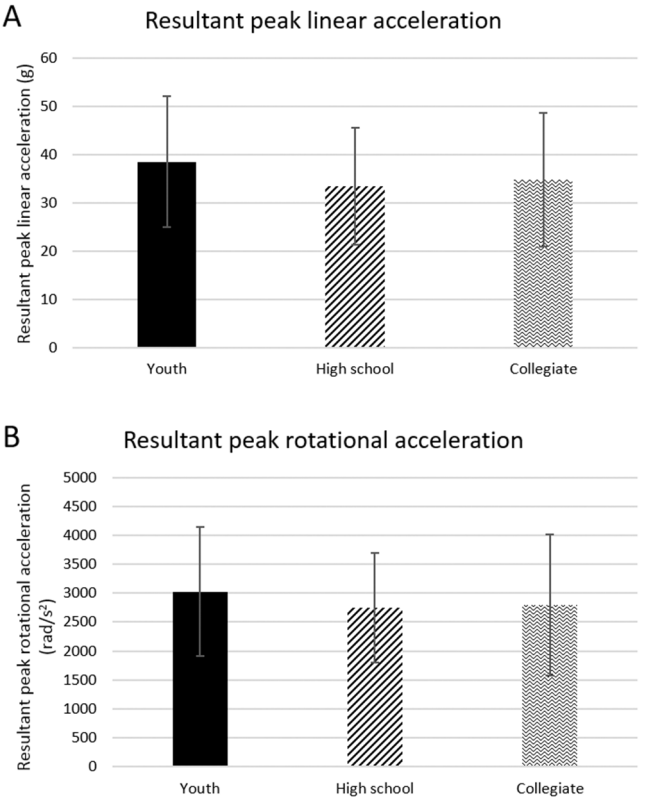

Figure 2 (A) Peak linear and (B) peak rotational head accelerations at head centre of gravity across age. The error bars represent the ±SD.

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