

## Activity Levels During Adolescence Determine Hip Shape: A Cross-Sectional Cohort Study of 210 Individuals Aged 9-18

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### INTRODUCTION:

Cam morphology is increasingly thought to develop during adolescence in association with intense sporting activity. However, evidence to date is inconsistent and not all studies demonstrate differences between elite athletes and control populations. Epiphyseal extension is proposed as a mechanism of developing cam morphology, but studies have only identified a weak association. It remains unclear if exercise volume or intensity is more important and whether there is a safe level of activity. In addition, it is not known whether specific sports are more likely to increase the risk of developing cam morphology. There is a very high prevalence of cam morphology among professional football (soccer) players, and we compared hip development in male academy football players aged 9–18 years from an English Premiership Football Club with an age-matched control group of males and females in a cross-sectional study to better understand cam morphology pathogenesis.

### METHODS:

Footballers were randomly selected from each age group and invited to participate in the study (n=103). An age-matched general population cohort of males (n=52) and females (n=55) was recruited through public engagement events. Assessments were performed mid-season and included morphological MRI of both hips at 3T (WATSf). Morphological measurements were performed on 30 degree radial slices using custom-designed software. Measurements included cartilage alpha angle and physeal extension (distance from medial femoral head to lateral extent of physis parallel to neck divided by head diameter) to assess cam morphology. Physeal tilt was measured to identify evidence of slipped upper femoral epiphysis (SUFE).

### RESULTS:

Alpha angle and physeal extension increased most rapidly between ages 12-14 with no statistically significant increase thereafter. Highest absolute values and the greatest increase in alpha angle and physeal extension were co-localized at the 1 o'clock position. Mean maximum alpha angle in individuals with a closed physis was 80.2 degrees (SD 15.4) for footballers, 77.6 degrees (SD 11.3) for male controls, and 60.6 degrees (SD 11.0) for female controls. Analysis of covariance was used to predict maximum alpha angle with age, sex, and activity level as covariates. Maximum alpha angle increased with age and was on average 6.66 degrees greater in males than females (p=0.005). Compared with individuals who play no regular sport, alpha angles were 4.03 degrees higher in individuals who play sport for a school or club (p=0.041) and 7.73 degrees higher in individuals who compete at a national or international level (p=0.035). General activity levels measured with the Physical Activity Questionnaire, BMI, leg dominance, and type of sport did not predict alpha angle. There was a strong association between alpha angle and adjacent physeal extension in males (r<sup>2</sup>=0.50) but not in females. There was no evidence of subclinical SUFE.

### DISCUSSION AND CONCLUSION:

Sporting activity during adolescence increases the risk of developing cam morphology. Activity intensity, measured as competitive level, appears to be more important than activity volume, measured using the Physical Activity Questionnaire. The action of kicking a ball did not increase the risk of cam morphology. Although there are many causes of cam morphology, physeal extension is a salient mechanism, especially in young active males. There remains insufficient evidence to recommend activity modification during adolescence at this time and the cardiovascular benefits of exercise are likely to outweigh any detrimental effect on hip morphology. Athletes may warrant surveillance due to an increased risk of developing cam morphology and secondary osteoarthritis.

Maximum Alpha Angle for Each Activity Level

