# H101 Sex Estimation of Juvenile Human Skulls Using 3D Geometric Morphometric Assessment of Craniofacial Architecture

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After attending this presentation, attendees will gain an understanding of using 3D geometric morphometrics to analyze shape differences in the human skull, as well as how these subtle differences can be used to investigate sexual dimorphism and to discriminate between male and female juvenile humans.

This presentation will impact the forensic science community by contributing to current forensic anthropological research regarding sex estimation from juvenile human skeletal remains, specifically by adding insight into particular morphological and growth trajectory differences between the sexes during development.

Although there is a coherent body of literature and consensus on the morphological presentation of sexual dimorphism in the adult human skeleton, there is still debate about the ontogenetic origins and proper methodology for assessing sexual dimorphism and sex differences in the juvenile humans. Previous studies have focused on measuring sexually dimorphic skeletal elements and features that are commonly used to estimate sex in adults, but because these features are sex characteristics that are neither present nor complete until adolescence at the earliest, these methods enjoy less success when applied to immature skeletal remains. This lack of consensus is compounded by findings that the greatest amount of sexual dimorphism in the skull occurs in areas that attain adult size late in ontogeny. Therefore, applying methods for sex estimation built on adults is problematic for use on juvenile humans, and estimating the sex of a juvenile individual from skeletal material remains tenuous at best.

Using Enlow's mammalian craniofacial architectural relationships, Bromage demonstrated that there are statistically significant morphological differences in female and male juvenile chimpanzee crania.[1] These differences were measured using 2D lateral cephalograms and centered on the spatial relationship between the cranial base and the facial skeleton. In the present study, Bromage's methodology is modified and expanded to collect 3D data from juvenile human Cone Beam Computed Tomography (CBCT) scans. These data are then analyzed using geometric morphometrics in order to investigate craniofacial sexual dimorphism during ontogeny.

A sample of CBCT scans derived from Australians 6-13 years of age were analyzed ($n$=50 males and $n$=48 females). Three-dimensional landmarks for 46 craniofacial architectural points were measured, including 12 midline landmarks and 17 bilateral landmarks, using Analyze 11.0 software were the locations of all 46 points for the entire sample independently identified. Points that could not be agreed upon within 1.6mm — or 4 voxels on the 0.4mm/voxel image — were discarded from analysis.

Principal components analysis, discriminant function analysis, and regressions revealed that the craniofacial architecture of male and female juvenile humans in this sample is very similar, though often not statistically significantly different; however, there are appreciable trends in variation between the sexes and in different age groups that warrant further examination.

**Reference:**

1. Bromage TG. The ontogeny of *Pan troglodytes* craniofacial architectural relationships and implications for early hominids. J Hum Evol 1992;23:235-51.

**Geometric Morphometrics, Sexual Dimorphism, Juvenile Skull**