H11 What Matters - Size or Shape? Three-Dimensional Analysis of Craniofacial Sexual Variation Among American Populations

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After attending this presentation, attendees will understand the sexual dimorphic variation among different American populations, the various effects of allometry in assessing sexual dimorphism, and the impact of allometry on sex estimation from skeletal cranio-facial remains.

This presentation will impact the forensic community and/or humanity by demonstrating that shape is as an important factor as size in the assessment of sex estimation. It is further demonstrated that 3D analysis of the cranio-facial region, through the use of Generalized Procrustes Analysis, may be an important tool in sex estimation. Finally, it is shown that population specific standards are needed for size and shape assessment in the estimation of sex.

One of the four pillars of the anthropological protocol is the estimation of biological sex. The estimation of sex along with the estimation of ancestry are critical first steps in a biological profile, as other elements in the analysis of human skeletal remains, such as age and stature, are sex and ancestry specific and cannot be adequately determined without this very basic assessment. The standard protocol used consists of visually assessing individual skeletal morphological features of the cranium and mandible and the *Os coxae* based on a scale of 1-5, ranging from "Male" to "Indeterminate" to "Female." These morphological traits are then interpolated or "averaged" by the investigator to estimate sex. However, visual assessments of these traits are subjective and the weight given to any particular trait varies among observers based on training and experience. Further problems may arise when applying these methods to different populations, who may innately differ in stature, physique, or general robustness. Consequently, a skeletally robust female may appear to be "male," particularly in light of cross-population comparisons.

A study presented by Rosas and Bastir (2002, Thin-Plate Spline of Allometry and Sexual Dimorphism in the Human Cranio-Facial Complex, AJPA 117(3): 236-245) investigating allometry and sexual dimorphism among a Portuguese population, demonstrated that size and sex had a significant influence on the shape of the cranio-facial complex. They found that both size and sex independently influenced shape, demonstrating that there is a greater amount of information to be obtained than from the visual methods used to assess cranio-facial morphology.

The purpose of this study is to further examine the effect of size and sex on cranio-facial shape in Americans to better understand the allometric foundation of the skeletal traits currently used for sex estimation from the skeleton and to investigate possible cross-population differences.

For this project, 3D coordinates of 17 standard craniofacial landmarks were collected using a Microscribe-3DX digitizer. Data were collected for 118 White and Black males and females from the W.M. Bass Donated Collection and the Forensic Data Bank, University of Tennessee - Knoxville.

Raw coordinate data are not directly comparable as shape variables to compare specimens since each set is collected in its own coordinate system. The data must be translated and rotated to a common coordinate system and scaled to a common size. To undertake these transformations a generalized Procrustes analysis (GPA) was used that minimizes the sum of squared distances between landmarks of each skull and those of an iteratively-computed mean. The resulting shape variables and Centroid Size were then used in the subsequent multivariate analyses. A principal component analysis (PCA) of the covariance matrix was conducted on the GPA transformed variables to reduce the dimensionality of the data to meet the requirements of the parametric test. A multivariate analysis of covariance (MANCOVA) was performed using the PCA scores to test whether size and sex have significant effects on the average shape of males and females.

Concurring with Rosas and Bastir's study, no difference in the influence of size on shape between males and females (no significant size*sex interaction) is found. Thus, the shape differences observed between males and females are not solely dependent on their respective sizes. In this study, sex, controlling for size, had a significant influence on shape in both American Whites (F=2.90; df=39; Pr > F= 0.0024) and Blacks (F=2.81; df=37; Pr>F=0.0035). Interestingly, the size effect did not have a significant influence on shape in either Whites (F=1.69; df =39; Pr>F=0.08) or Blacks (F=1.09; df=37; Pr>F=0.40). These results show that sexual dimorphism is based on underlying unique sex differences not simply a matter of size.

Geometric Morphometry, Sexual Dimorphism, Americans