A59 An Outline Analysis of Ancestry and Sex Differences in Cranial Shape

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The goal of this presentation is to introduce a new approach to the estimation of sex and ancestry from skeletal remains as a part of the formation of a biological profile. Attendees will understand the utility of cranial outlines in the estimation of ancestry and sex from the skull. Further, attendees who are accustomed to visually analyzing non-metric traits will learn that geometric morphometric outline analysis can also capture the overall variation in trait expression and help identify cranial traits that are responsible for the most variation between ancestry and sex groups.

This presentation will impact the forensic science community by introducing a new method for studying human cranial variation that is capable of increasing the objectivity of traditional non-metric techniques used to estimate the biological profile from skeletal remains.

Forensic anthropological techniques that utilize non-metric skeletal traits to estimate sex and ancestry have historically been criticized for their subjectivity and replicability; however, non-metric traits have proven to be valuable tools in identifying remains in forensic investigations. In this study, geometric morphometric analyses of cranial outlines (lateral, posterior, and superior views) were performed to assess population and sex variation in a sample of modern humans. 3D scans of 198 crania were collected from the Hamann-Todd and Terry skeletal collections. 2D images of the left lateral, superior, and posterior outlines were subsequently captured from these scans. These three views were chosen for analysis because they are most likely to capture the variation of cranial traits traditionally used to estimate sex and ancestry, such as glabella projection, frontal bossing, dolichocephaly, and facial prognathism. Elliptical Fourier analysis was utilized to define the cranial outlines and principle component analysis was performed on the elliptical Fourier descriptors to quantify shape variables into uncorrelated numerical values. Two-way Multivariate Analysis of Variance (MANOVA) analyses were performed on the principle components to test for sex and ancestry differences in outline shape. Two-way Wilk's lambda discriminant function analyses were also performed to determine the utility of these cranial outlines in discriminating between sex and population groups.

Results indicate that cranial outlines are able to differentiate between American Blacks and Whites, as well as American males and females, with high accuracy. Discriminant function analysis performed on the lateral view between Blacks and Whites performed extraordinarily well, resulting in a 92.4% cross-validated correct classification. The first principle component (39.8%) appears to reflect changes in vault shape (brachiocephalic vs. dolichocephalic) and degree of maxillary prognathism. These results support the traditional hypothesis that Black individuals tend to have a more elongated cranial vault and more prognathic face, while White individuals tend to have more rounded crania with less prognathism. The lateral view was also the best at differentiating between males and females. Principle component four, which only accounted for 5.53% of the variation within the sample, actually performed the best when differentiating between the sexes. The shape changes occurring in this principle component include glabella projection, with males possessing larger, more pronounced glabellae than females. Overall, results indicate that significant sex and population differences in cranial shape do exist and follow traditional qualitative descriptions. Outline analysis may provide a more objective means of estimating sex and ancestry from these traits, thereby increasing estimation accuracy (as high as 93% between ancestry groups).

Forensic Anthropology, Morphometric Outline Analysis, Non-Metric Traits