A43 Worldwide Population Variation in Skull Sexual Dimorphism

Alexandra R. Klales, PhD, Washburn University, Topeka, KS 66621; Stephanie J. Cole, MS, University of Nevada, Reno, Reno, NV 89557; Kyra E. Stull, PhD, University of Nevada, Reno, Reno, NV 89557; Heather M. Garvin, PhD, Des Moines University, Des Moines, IA 50312-4198; Matthew C. Go, MA, University of Illinois at Urbana-Champaign, Urbana, IL 61801; Antinea Menéndez Garmendia, MS, Universidad Nacional Autónoma de México, Mexico City 04510, MEXICO; Mackenzie Walls, Forensic Anthropology Program, Topeka, KS 66621; Gabriela Sánchez-Mejorada, PhD, Universidad Nacional Autónoma de México, Ciudad de México 04510, MEXICO*

Learning Overview: After attending this presentation, attendees will understand how five popular morphological traits of the skull utilized for sex estimation vary within and between populations.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a validation of the Walker method using multiple populations and providing new recalibrated population-specific equations, as well as a global equation that can be utilized when ancestry is unknown or inconclusive.[1]

Due to varying levels of sexual dimorphism between populations, sex is typically estimated after general age (i.e., adult vs. subadult) and ancestry estimation. The Walker method remains the most popular morphological method using the skull; however, validations of this method using different populations have varied.[1] To better examine worldwide variation in these morphological skull traits, a large global sample of 2,285 skulls were scored by this study using descriptions and illustrations of the nuchal crest, mastoid process, glabella, mental eminence, and supra-orbital margin provided by Walker.[1] Analyses were run to assess geographic population (e.g., United States, Nubian, South African, Philippines, and Mexico) differences. A Fisher's exact test with Monte Carlo simulation was used to test for sexual dimorphism in trait score frequencies between females and males for each trait within each geographic region. To further examine differences between geographic regions, a Kruskal–Wallis test was used and, if rejected, a Dunn's test using a Holm's stepwise adjustment was employed to determine which groups were significantly different from one another. Next, the external validity of Walker's method was tested by entering scores from each skull into the six logistic discriminant function equations provided by Walker.[1] Finally, recalibrated logistic regression equations were calculated for each geographic population and for the global (i.e., all groups combined) sample. Classification accuracies obtained using the recalibrated equations were compared to the validation results, as well as the classification accuracies generated using the global equation, to determine if population-specific equations were necessary.

Significant differences between males and females within groups were found for all traits (p-values≤0.016), except for the nuchal crest in Nubians (p=0.06) and mental eminence in South African Whites (p=0.80), indicating sexual dimorphism is present in nearly all traits across groups. Significant differences ($p < 0.001$) for both males and females for all five traits were found using the Kruskal-Wallis test and between pairwise comparisons of groups using the Dunn's test, which most notably indicated significant differences in the expression of glabella in United States White females and the mastoid process in Mexican males when compared to all other groups. Validation classification accuracies using Walker's equations ranged from 65.8% (United States Blacks, equation 5) to 88.2% (Philippines, equation 2), depending on the equation utilized and population examined.[1] Overall, equation 1, utilizing glabella, mastoid, and mental eminence, performed the best (77.3%–85.7%); however, sex bias was as high as 42.1%. As expected, classification accuracy typically improved with recalibration in nearly every group. Improved accuracy ranged between 0.1% (United States Whites, equation 6) and 16% (South African Whites, equation 4). Accuracy rates using a recalibrated global equation (i.e., all geographic regions) resulted in accuracy rates ranging from 74.1% (equation 5 using the orbit and mental eminence) to 81.8% (equation 1 using glabella, mastoid, and mental eminence). Some groups performed better in the global equation than the group-specific equations, most notably so with the Mexican sample. However, this increased accuracy often came at the expense of a higher sex bias. In conclusion, this work highlights the complexity of sexual dimorphism in different populations and the need for population-specific equations for these skull traits in the Walker method; however, when ancestry (or geographic region) is unknown or inconclusive, a global equation can be utilized with acceptable accuracy rates.[1]

Portions of this research were funded by National Institute of Justice (NIJ) grants. Opinions, points of view expressed in this research, and products discussed represent a consensus of the authors and do not necessarily represent the official position, policies, or endorsement of the United States Department of Justice (DOJ) or NIJ. Data collection for the Filipino sample was also funded by the Social Sciences and Humanities Research Council of Canada.

Reference(s):

1. Walker P.L. Sexing Skulls Using Discriminant Function Analysis of Visually Assessed Traits. *Am J Phys Anthropol*. 2008; 136:39-50.

Walker Method, Sex Estimation, Population Variation