A111 A Validation Study of the Langley Decision Tree Model for Sex Estimation

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After attending this presentation, attendees will be more knowledgeable regarding the performance of a zygomatic extension scoring method and sex estimation decision tree presented by Langley et. al.[1]

This presentation will impact the forensic science community by demonstrating if and how this method can be incorporated into forensic anthropological casework in light of the *Daubert* and National Academy of Sciences (NAS) Report recommendations.

Walker presented a sex classification method based on the ordinal scoring of five morphoscopic traits of the skull: glabella, mastoid, nuchal, supraorbital margin, and the mental eminence.[2] He provides six logistic regression equations that include combinations of two and three traits for sex estimation. The Walker method has been quickly incorporated into forensic casework both in the United States and internationally; however, studies have indicated high levels of intraobserver and interobserver disagreement for some traits (e.g., mental eminence).[2] Stevenson et al. modified the Walker method by incorporating the same five traits into a decision tree model developed using a chi-square automatic interaction detection.[2,3] Given the many reliability studies that indicate low levels of observer agreement for the mental eminence, the inclusion of this trait into these sex estimation methods is problematic. Seeking to eliminate this issue, among others, Langley et al. developed a decision tree for sex estimation that utilized only the two most reliable of the five cranial traits (glabella and mastoid scores) and included a new trait: zygomatic extension.[1] This study sought to test the reliability of the zygomatic extension scoring method presented in Langley et al. and validate their sex estimation decision tree method.[1]

Ordinal score data were collected from a total of 281 male and female United States White and Black individuals from the Bass Donated, Hamann-Todd, and Terry skeletal collections. Glabella, mastoid, nuchal, supraorbital margin, and mental eminence expressions were scored for each individual from the physical specimens following Walker as part of a previous study.[2] The zygomatic extension was scored from 3D surface models of the specimens following the descriptions, photographs, and diagrams provided by Langley et al.[1] For a subset of 30 individuals, zygomatic extension was scored, then re-scored by this study. Intraobserver agreement was assessed using Intraclass Correlations (ICC) and a weighted Kappa analysis was used to evaluate interobserver agreement. As Langley et al. appear to accidentally present two conflicting decision trees (Figure 2 and Figure 4) in their publication, both trees were tested.[1] These results were compared to results obtained using Walker and Stevenson et al.[2,3]

Intraobserver and interobserver agreement was high for the zygomatic extension (*ICC*=0.839, *wK*=0.716 and *ICC*=0.745, *wK*=0.585, respectively), suggesting that this trait can be reliably scored, although both observers noted some areas of subjectivity in the scoring procedure. The decision tree presented in Figure 2 resulted in only a 55.9% correct sex classification of the pooled sample.[1] If restricted to only the Bass sample (the same collection from which the method was derived), only 50.0% of the individuals were sexed correctly. In contrast, the decision tree presented in Figure 4 resulted in an overall 71.5% correct sex classification (77.4% for the Bass sample).[1] Based on these results and the fact that Langley et al. discuss details about the Figure 4 decision tree in the text, this is assumed to be the correct tree.[1] Still, results obtained were not as high as those reported by Langley et al. and a strong sex bias favoring female classification was observed (94.2% accuracy for pooled females; 49.3% accuracy for pooled males).[1] Male correct classifications ranged from 31.3% to 65.0%, depending on the sample. The method performed only slightly worse on the Black samples compared to the White samples, and similar results were obtained between historic and modern samples. The Walker mastoid/glabella equation and Stevenson et al. European-American decision tree produced higher accuracy rates (80.8% and 82.6%, respectively for the pooled sample), although sex bias remains an issue.[2,3] The results of this study indicate that there is room for further improvement both in cranial trait scoring methods and statistical methods of analysis.

Reference(s):

1. Langley N.R., Dudzik B., Cloutier A. A decision tree for nonmetric sex assessment from the skull. *J Forensic Sci.* 2017: early view doi: 10.111/1556-4029.13534.
2. Walker P.L. Sexing skulls using discriminant function analysis of visually assessed traits. *Am J Phys Anthropol.* 2008:136:39-50.
3. Stevenson J.C., Mahoney E.R., Walker P.L., Everson P.M. Prediction of sex based on five skull traits using decision analysis (CHAID). *Am J Phys Anthropol.* 2009:139:434-441.

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