



A44 The Effects of Cranial and Pelvic Asymmetry on Accurate Sex Classification

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After attending this presentation, attendees will better understand how asymmetry impacts non-metric sex estimation methods.

This presentation will impact the forensic science community by examining the potential and actual impacts of the presence, frequency, and type of asymmetries on the classification accuracies of two methods based on cranial and pelvic markers: the original Walker and the Klales et al. methods.^{1,2} This presentation will also provide recommendations for the application of these methods in asymmetrical individuals.

Sex estimation is one of the most important aspects of the biological profile, as a reliable estimation of this parameter allows for the application of more accurate sex-specific methods for the estimation of age, ancestry, and stature. Sex estimation still relies to a large extent on non-metric evaluation of the pelvis and skull, as these areas are both strongly dimorphic and geometrically complex, with subtle morphological traits and differences that are hard to capture metrically. By convention, forensic anthropological protocols typically suggest using the left side when estimating sex from bilateral traits; however, if asymmetry is common, this criterion could introduce fundamental biases and compromise accuracies. For example, if the population displays directional asymmetry, by preferentially selecting the left side, a systematic decrease in the classification accuracy for either females or males would occur, depending on whether that side is the one favored or disfavored by the directional trend. Even if the asymmetry does not consistently favor one of the sides, more asymmetrical individuals could be reflecting systemic effects, such as increased developmental stresses, affecting the accuracy of not only one, but both sides of the individual. In this case, the presence of asymmetry should be factored when reporting the corresponding sex estimates, as asymmetrical individuals would be expected to render lower accuracies than reported for the overall method.

An experienced observer blindly collected ordinal score data for the two bilateral cranial traits in the Walker method (Mastoid (M) and Supra-Orbital (SO) margin) as well as for the three bilateral pelvic traits in the Klales et al. method (Ventral Arc (VA), Subpubic Contour (SPC), and Medial Aspect (MA) of the ischio-pubic ramus). Data were also collected for the three unilateral Walker traits in order to test the classification accuracy of the method equations. The left and right sides were scored from a sample of 1,310 individuals (523 females, 787 males) from the Bass, Terry, and Hamann-Todd donated skeletal collections, as well as from the Texas State Operation ID collection.

Asymmetry was observed in 55.6% of individuals in at least one of the two cranial traits and in 59.8% of individuals in at least one of the three pelvic traits. With a frequency of 40.4%, the M was significantly more asymmetrical than the remaining traits ($p < 0.001$), well above SO and VA (31.0% in both cases; $p = 0.734$), while two of the Klales et al. traits, MA and SPC, were the least asymmetrical (27.2%; $p = 0.427$); although the difference between the two pairs SO-VA and MA-SPC ($p = 0.018$) is not significant after Bonferroni/Holms correction.



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Even though asymmetries are common, the intra-class correlation coefficient revealed high levels of agreement between the left and right trait scores of individuals (M 0.849, SO 0.859, VA 0.952, SPC 0.984, and MA 0.932) with the vast majority of asymmetries consisting of only one score point difference. Directional asymmetries were detected, with males being right dominant for all traits ($p < 0.05$), while females only displayed directional asymmetries at the 0.05 α -level for the cranial variables, also exhibiting right dominance for the two traits.

As expected from the presence of directional asymmetries, selecting always the left side resulted in some cases in increased accuracies for females, at the expense of lower ones for males. Although, also as expected from the high intra-class correlations, the effect sizes of these between-sex discrepancies in accuracy were basically negligible in most cases (with the notable exception of Walker's equation 6). These results recommend reporting both the presence of asymmetries and the estimates for both sides when asymmetries are present.

Reference(s):

1. Walker P.L. Sexing skulls using discriminant function analysis of visually assessed traits. *Am J Phys Anthropol.* 2008;136:39-50.
2. Klales A.R., Ousley S.D., Vollner J.M. A revised method of sexing the human innominate using Phenice's nonmetric traits and statistical methods. *Am J Phys Anthropol.* 2012;149:104-114.

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