



A91 The Use of Femoral Neck Axis Length to Estimate Sex and Ancestry

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After attending this presentation, attendees will be familiar with the Femoral Neck Axis Length (FNAL) measurement as well as how FNAL can be used to estimate sex and ancestry from skeletal remains.

This presentation will impact the forensic science community by providing a new, simple, reliable method of sex estimation using the FNAL measurement, including an equation that can be used to estimate sex from FNAL with ~86% accuracy.

Having multiple reliable methods of estimating sex and ancestry from various skeletal features increases the likelihood of identifying an unknown individual from skeletal remains. Measurements of the proximal femur have received some attention in the forensic anthropological literature for sex and ancestry estimation, due in part to the survivability of this region in forensic contexts as well as noted quantifiable variation. FNAL is a measurement of the proximal femur that represents the distance from the base of the greater trochanter (the point directly inferior to the greatest lateral projection of the greater trochanter) to the apex of the femoral head. FNAL and related hip measurements (typically obtained from Dual-Energy X-Ray Absorptiometry (DXA) scans) are often utilized by bone densitometrists and other skeletal health experts in assessing hip fracture risk in living individuals and have been shown to vary by sex and ancestry. This research measured FNAL directly from skeletonized remains and investigated its potential use in forensic anthropological applications to estimate sex and ancestry of unknown individuals.

FNAL was measured on 286 femora from skeletally mature adults, free of visible anomalies potentially affecting the measurement. The sample included female and male American White, American Black, and Native American skeletons. One-way Analysis of Variances (ANOVAs) were used to evaluate the relationships between FNAL and sex and ancestry. Multiple univariate Discriminant Function (uDFA) and Logistic Regression (LR) equations were calculated to test the efficacy of FNAL for sex and ancestry estimation.

A random subset of 50 femora was measured by a second observer for the purpose of inter-observer error assessment. Results showed low inter-observer error in the measurement, with a Technical Error of Measurement of 0.33mm and a Coefficient of Reliability of 0.99, indicating that the FNAL measurement is well defined, easily recognizable, and reproducible.

Significant differences in FNAL were found between females and males, with male FNAL being significantly larger than female FNAL. An LR model using FNAL and sex-pooled samples performed very well. For an individual of unknown sex and ancestry, the following LR equation is applicable: $Sex = -3.89 + (FNAL) * 0.0426$. A negative value indicates that the unknown is female and a positive value indicates that the unknown is male. Using this equation, sex will be correctly classified in ~86% of all cases.

Significant differences in FNAL were found between American Black, American White, and Native American groups, with American Whites having the largest FNAL, followed by American Blacks, then by Native Americans. Post-hoc comparisons showed that American White FNALs are not statistically different from American Black FNALs, but both are significantly larger than Native American FNALs; however, correct classification of ancestry was found to be much lower and more complex than for sex, and the value of FNAL to ancestry estimation is currently considered limited. A uDFA performed moderately well (57% cross-validated correct classification) at classifying the ancestry of males and may therefore have some utility in certain forensic contexts.

FNAL is a measurement that has not been previously utilized by anthropologists, but has been shown to vary significantly by sex and ancestry. This research shows that sex estimation using FNAL measured from skeletonized femora is highly reliable, correctly predicting sex at a rate of ~86%. Further analyses with larger samples of additional ancestral groups may help clarify the relationship between FNAL and ancestry.

These results highlight the benefits of information sharing and collaboration between forensic anthropologists and other scientists and skeletal health experts.

Femoral Neck Axis Length (FNAL), Sex Estimation, Ancestry Estimation