

## Sexual Dimorphism and Discriminant Analysis of the Modern Human Femur

Keith A. Metzger\*, BA, Cherisse Lacoste, BA, 1211½ Broadway, Santa Cruz, CA 95062

---

The main objectives of this paper are:

- (1) Discussion and comparison of previous studies of sexual dimorphism and discriminant analysis in the human femur, and
- (2) Presentation of the results of a univariate and multivariate discriminant analysis conducted from a sample of 107 human femora.

Determination of sex from analysis of human skeletal remains has been a well-studied field with broad ranging applications extending beyond forensic anthropology, and into archaeology, paleoanthropology, and comparative anatomy. Studies specifically focusing on sexual dimorphism in the human femur have also been quite numerous (Pearson 1917-1919, Black 1978, DiBennardo and Taylor 1979, 1983, Van Gerven 1972, Dittrick and Suchey 1986, MacLaughlin and Bruce 1983) and have used either univariate or multivariate discriminant analysis, a statistical technique which has proven to have a high utility in studies of sex determination.

In studies of this nature, an underlying goal is to establish a method of discrimination that provides an accurate means of distinguishing between males and females and does so requiring the fewest osteometric measurements. The study presented here is a preliminary report of data collected from human femora from the National Museum of Natural History Terry Collection and the Howard University W. Montague Cobb Collection, both housed in Washington D.C. The results discussed in this study include both a univariate and a multivariate analysis based on the osteometric measurements taken and will serve as both a comparison to previous studies and as a means for establishing the utility of new techniques.

The sample was chosen from a large collection of skeletal materials from both the National Museum of Natural History and Howard University, in Washington D.C. Age at death, ancestry, and sex were known for all of the 53 males and 54 females included in this study. All of the individuals measured were designated as Caucasian in order to prevent the complication of an additional source of variability in the sample. The range of age at death of the specimens analyzed was from 20 to 91 years. Additionally, all individuals included had completed femoral growth, as evidenced by the complete fusion of the proximal and distal femoral epiphysis. Any femora exhibiting obscuring pathologies, such as cortical bone deterioration or extreme osteophytic activity, were excluded from the statistical analysis.

In total, nine measurements were taken from each of the 107 individuals. All measurements were taken either with an osteometric board, cloth measuring tape, or sliding calipers. Measurements included maximum length, midshaft circumference, midshaft anterior-posterior diameter, midshaft mediolateral diameter, maximum shaft circumference, maximum anterior-posterior shaft diameter, subtrochanteric anterior-posterior diameter, subtrochanteric mediolateral diameter, and maximum diameter of the femoral head. Although previous studies have shown no significant difference between measurements taken on left and right femora, only right femora were analyzed unless only the left was present. All measurements were taken and recorded by only one researcher in order to prevent potential inter-observer errors.

Statistical functions carried out included both univariate and multivariate discriminant analysis based upon the nine measurements. The entire sample was also analyzed in order to determine whether significant variation occurred in specimens of different age ranges, as well as whether or not specimens from the two collections varied to a significant degree.

Statistical testing conducted to determine differences in univariate measurement averages from the Terry and the W. Montague Cobb Collections showed no significant differences for all measurements, either in males or females, with a confidence level of 95%. A similar analysis conducted among males and females showed that in each group, there was no consistent difference for all measurements between individuals with an age at death of older than 55 years and those with an age at death of 55 years or younger. Univariate discrimination for all variables was set by taking the midpoint of the male and the female means for each variable. For all variables, males above the sectioning point were considered classified correctly and females below the sectioning point were considered classified correctly. Percentage of correctly classified males and females was calculated by applying the sectioning point to the raw data from both of these groups, and overall, there was no general trend regarding which group had higher correct classification percentages. Total percentage correctly classified was calculated in a similar manner, applying all data to the reported sectioning points.

Total percentage correctly classified range from 66.36% to 86.92% among the nine measurements. Of these classification percentages, three appeared to indicate a significant utility of the associated variable. Sectioning points

for midshaft circumference, maximum shaft circumference, and maximum head diameter produced total correct classification of 84.11%, 85.85%, and 86.92% respectively.

---

### **Sexual Dimorphism, Human Femur, Discriminant Analysis**