H19 Sex Determination: A Study of Sexual Dimorphism in Complete and Fragmentary Cuneiform Bones

Amber Y. Schmuhl, BS, Middle Tennessee State University, 1301 East Main Street, Murfreesboro, TN 37132; and Hugh E. Berryman, PhD, Department of Sociology & Anthropology, Middle Tennessee State University, Box 89, Murfreesboro, TN 37132*

After attending this presentation, attendees will understand how to use the cuneiform bones to aid in the estimation of sex in unknown individuals.

This presentation will impact the forensic science community by showing new measurements which will aid in the identification of sex in fragmented remains.

Accurate sex estimation is a necessary step in the identification process and sexing techniques that can be applied to all bones is advantageous. Since the 1970's, metric sexing techniques have been applied to the talus and calcaneus more than any other tarsal bone. Steele was one of the first researchers to examine sexual dimorphism of the talus and calcaneus.[1]

Other researchers including Barrett et al, Bidmos and Asala, Bidmos and Dayal, Gualdi-Russo, Murphy, and Wilbur repeated Steele's research and confirmed that the talus and calcaneus are useful in determining sex with accuracies as high as 96%.[2-10] These researchers not only verify that the talus and calcaneus are sexually dimorphic, but that the accuracy rates are repeatable and the techniques can be applied to different populations from the past and the present. Other than the talus and calcaneus, little research has investigated the utility of other tarsal bones, particularly the smaller bones of the foot, for their potential in estimating sex. In addition, most of these studies require the tarsal bones to be in good condition and that most, if not all, of the bone is present. Kidd and Oxnard added the navicular and the cuboid to their study of the talus and calcaneus, but failed to include the three cuneiforms.[11] Sheena Harris, using The William M. Bass Skeletal Collection and a mini-osteometric board, measured the maximum length, width, and height of all seven tarsal bones.[12] However, her measurements required the bones to be complete.

The present study examined cuneiform bones from 100 adult individuals (50 male and 50 female) including both Blacks and Whites from the William M. Bass Skeletal Collection for their potential in sex determination. This study not only examines the typical "maximum" measurements from complete cuneiform bones, but also devises new measurements that divides the bone into smaller segments (e.g., measurements involving articular surfaces and tubercles). Using a digital sliding caliper, this study examines eight new measurements each from the medial cuneiform, the intermediate cuneiform, and the lateral cuneiform. Previous researchers (Wilbur; Barrett et al, Bidmos and Asala), have shown that there is no significant difference between the right and left foot and therefore, only tarsals from the left side are used in this study.[10,2-4]

To test the accuracy of the new measurements, the data in this study was analyzed by importing all measurements into FORDISC 3.0 (Ousley and Jantz) and applying discriminant function analysis.[13] The results were positive and showed that not only were Harris' maximum measurements repeatable, but including smaller dimensions of the bones can be equally useful in determining sex. When all measurements are taken into account, the medial cuneiform was shown to exhibit the most dimorphism of the three with an accuracy rate of 94.2%, followed by the lateral cuneiform at 86.7%, and then the intermediate cuneiform at 84.7%. While some accuracies of the measurements fell below 75.0% when taken individually, the accuracy rate raised above 75.0% if they were combined with at least one other measurement. Three measurements (one from the medial cuneiform and two from the intermediate cuneiform) were excluded due to the fact that they were not useful in sex determination. When these measurements were excluded, the overall accuracy for the intermediate cuneiform increased from 84.7% to 88.3% while the medial cuneiform's accuracy decreased by 0.1%. This study has shown that while the cuneiforms are smaller and more difficult to side than other bones, they can be equally useful in the determination of sex. In addition, the use of new measurements developed for this study allows incomplete or fragmentary cuneiform bones to be used to determine sex.

References:

1. Steele DG. The estimation of sex on the basis of the talus and calcaneus. Am J Phys Anthropol 1976;45(3 pt. 2):581-8.
2. Barrett Ch, Cavallari W, Sciulli PW. Estimation of sex from the talus in prehistoric Native Americans. Coll Antropol 2001;25(1):13-9.
3. Bidmos MA, Asala SA. Discriminant function sexing of the calcaneus of the South African whites. J Forensic Sci 2003;48(6):1213-8.
4. Bidmos MA, Asala SA. Sexual dimorphism of the calcaneus of South African blacks. J Forensic Sci 2004;49(3):446-50.
5. Bidmos MA, Dayal MR. Sex determination from the talus of South African whites by discriminant function analysis. Am J Forensic Med Pathol 2003;24(4):322-8.
6. Bidmos MA, Dayal MR. Further evidence to show population specificity of discriminant function equations for sex determination using the talus of South African blacks. J Forensic Sci 2004;49(6):1165-70.
7. Gualdi-Russo E. Sex determination from the talus and calcaneus measurements. Forensic Sci Int 2007;171(2-3):151-6.

 ** Presenting Author*

8. Murphy AM. The talus: sex assessment of prehistoric New Zealand Polynesian skeletal remains. Forensic Sci Int 2002a;128(3):155-8.
9. Murphy AM. The calcaneus: sex assessment of prehistoric New Zealand Polynesian skeletal remains. Forensic Sci Int 2002b;129(3):205-8.
10. Wilbur AK. The utility of hand and foot bones for the determination of sex and the estimation of stature in a prehistoric population from West-Central Illinois. Int J Osteoarchaeol 1998;8(3):180-91.
11. Kidd RS, Oxnard CE. Patterns of morphological discrimination in selected human tarsal elements. Am J Phys Anthropol 2002;117(2):169-81.
12. Harris SM. Sexual dimorphism in the tarsals: implications for sex determination [thesis]. Raleigh (NC): North Carolina State University, 2009.
13. Jantz RL, Ousley SD. FORDISC, version 3.0. Knoxville, TN: University of Tennessee, 2005.

Sexual Dimorphism, Tarsals, Sex Determination

 ** Presenting Author*