H39 Sexual Dimorphism in Complete and Fragmentary Navicular Bones

Amber Schmuhl, BS, Middle Tennessee State Univ, 1301 E Main St, Murfreesboro, TN 37132; and Hugh E. Berryman, PhD, Middle Tennessee State Univ, Dept Sociology & Anthropology, Box 89, Murfreesboro, TN 37132*

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

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

Accurate sex estimation is an essential step in the identification of unknown skeletal remains. Expanding sexing methods to include previously unused or underused bones adds to the battery of available techniques and can increase the accuracy of such assessments. Such novel techniques may also be invaluable when sexing incomplete remains. In 1976, Steele was one of the first researchers to examine sexual dimorphism of the talus and calcaneus, and since then other researchers have repeated the work and confirmed that the talus and calcaneus are useful in determining sex with accuracies as high as 96%.[1-10]

These researchers have not only shown that the accuracy rates of the talus and calcaneus are repeatable, but also that the techniques can be applied to different populations from the past and the present. Other than the talus and calcaneus, little research has been done on the remaining five tarsals. In 2009, Sheena Harris, using The William M. Bass Skeletal Collection and a mini-osteometric board, measured the maximum length and width of all seven tarsal bones.[11] However, her measurements required the bones to be complete and she did not look at the smaller dimensions on the bones. In 2011, it was demonstrated that the three cuneiforms, whether complete or fragmented, are useful for sex determination.[12] This finding has shown there is a need for investigating the other tarsal bones for this purpose.

The current study examines the navicular bone from 100 adult individuals (50 male and 50 female), both Blacks and Whites, from the William M. Bass Skeletal Collection for their possible use in sex determination. This study first examined the “maximum” measurements following Harris from complete navicular bones and then created additional original measurements (such as measurements involving specific articular surfaces and tubercles) that divide the bone into smaller segments.[11] Digital sliding calipers were used to take 11 measurements (three following Harris and eight new measurements) of the left navicular bone.[11]

FORDISC 3.0 was used to perform Discriminant Function Analysis (DFA) in order to test multiple measurements for their efficiency in sex determination.[13] The results of this study (78.8% accuracy for the maximum height, 78.6% for maximum width, and 86.6% for maximum length) show that while Harris’ maximum measurements are fairly accurate, they may not be accurate enough to be used as the only deciding factor in sex determination, with the exception of the maximum length. Further, when a bone is incomplete, substitute measurements are also useful for sex determination. This study also demonstrates that if more than one measurement is present, all measurements should be included. Following the baseline suggested by Scheuer and Elkington, measurements (univariate) with an accuracy rate of 80.0% or greater were considered to be useful.[14] Four of the 11 variables used in this study meet or exceed that threshold. When multivariate approaches are taken into account, accuracies may be even higher. For instance, when all 11 measurements are used in a DFA, the overall accuracy rate is 87.4%. If the relative weight of these measurements are taken into account and the measurements with the lowest contributions to the model are systematically dropped, the accuracy then rises to 90.3%. While some of the individual variables have accuracy rates below 80%, the rate increased above 80.0% when combined with at least one other measurement. In conclusion, although the navicular is a small bone of the foot, it can be useful in sex determination whether the bone is complete or incomplete.

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Navicular, Sexual Dimorphism, Bones

 ** Presenting Author*