H76 Prediction of Shoe Size From Tarsals and Metatarsals

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The goals of the presentation are to explore the relationship between various elements of the foot and overall foot length, to create regression equations for prediction of foot length in unknown cases, and to assess the correlation of predicted foot length with reported shoe size.

This presentation will impact the forensic community by showing how estimation of shoe size can potentially be a valuable addition to the standard biological profile. Notably, it can help limit the number of antemortem searches required to narrow a pool of potential individuals. It will also assist with issues such as commingling as well as re-associate material evidence from recovery scenes to specific individuals.

Regression formulae have been derived using a sample of white and black males from the Hamann-Todd Collection (HTH) housed at the Cleveland Museum of Natural History. These formulae were tested for efficacy on a subsample of individuals identified at the JPAC-CIL for whom the proper antemortem records and postmortem measurements were available. Currently, footwear vendors provide tables that correlate maximum foot length to shoe size. Although there is some variability in the size of ones' shoe due to manufacturing and stylistic differences, investigators can confer with specific manufacturers to account for such differences in size.

Bony foot elements were measured on a sample of 123 white and black males from the Hamann-Todd Collection for whom antemortem foot length data was available. Twenty-four measurements of various foot elements were collected on the HTH sample for ongoing research projects involving sexual dimorphism and ecogeographical patterning. Logistic regression (LR) was used to create population specific (white or black) and generic (combined white and black) regression models for the prediction of overall foot length. These formulae were then evaluated to determine which single element or combination of elements provided the best predictions of foot length.

For the current study, variable selection from the 24 available measurements followed a heuristic protocol. Elements of the foot are commonly well preserved in archeological and forensic contexts. Among the best preserved elements of the foot typically encountered in JPAC-CIL cases are the calcaneus, first metatarsal, and the cuboid. For example, each of these elements are present in at least 15 individuals out of a 20 individual subsample of identified CIL accessions. This subsample includes foot size data (via shoe size recorded in the individual's medical records) and postmortem bony measurement data. This sample involves individuals from a variety of distinct time periods and, as such, it was used to evaluate the regression equations and assess its broad utility. The potential variable list was further shortened by the requirement of having a high correlation coefficient with foot length.

While all of the metatarsals were found to have higher correlations than tarsals, it is desirable to include a model that incorporates hind, midfoot, and forefoot components. These three components then can be summed, entered using stepwise LR, or used independently in the absence of better correlated elements. The maximum lengths of the calcaneus, cuboid, and first metatarsal were all found to be well correlated with overall foot length. For instance, in the white and black male combined sample the two-tailed Pearson correlations are 0.639, 0.563, and 0.773 respectively. All are statistically significant correlations at the 0.01 level. Using the sum of the cuboid and first metatarsal lengths (sumcubfstmax) the following equation is derived:

> Predicted foot length = -6.046 + (sumcubfstmax) 1.333 (r^2 = .63, Inaccuracy = 7.16 mm, Bias = -8.85 mm, standard error of model = 9.964). Standard errors of the models as well as correlations are typically improved with population specific equations.

Regression methods for estimating foot length and subsequently shoe size data have been found to be statistically viable. Standard errors of the equations are on par with estimates of stature from tarsals which has proven to be highly useful in variety of forensic and archeological contexts. It is anticipated that prediction of shoe size can become a useful forensic tool within the investigators toolkit if proper antemortem records are available.

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Logistic Regression, Biological Profile, Pedal Analysis

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