H31 Estimation of Body Mass from Measurements of the Calcaneus and Talus

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The goal of this presentation is to introduce regression equations for the prediction of body mass from measurements of the calcaneus and talus.

This presentation will impact the forensic science community by presenting alternative skeletal elements for use in estimation of body mass, which typically relies on femoral head dimensions.

Estimation of body mass has been intermittently examined in the forensic anthropological context; however, body mass estimates are not a main component of the biological profile. In contexts outside the medicolegal field (e.g. paleoanthropological, bioarchaeological, ecological), estimation of "body size" from skeletal material is of interest. Allometric comparisons, for instance, are best made with reference to body mass.

The current study utilizes anthropometric data collected from white and black males and females from the Hamann-Todd Collection (HTH). The available anthropometric data (e.g., stature and weight) are combined with osteometric data from the foot in order to test proportionality and scaling consequences, as well as to generate predictive regression equations for body mass estimation. Measurement data for four variables, two from the calcaneus and two from the talus, were collected for a sample of 105 individuals (females: n=29; males: n=76) who exhibited clinically normal body mass indices (i.e., BMI=18.5 - 25.0). These four variables were entered into a Least Squares regression analysis using stepwise selection to choose the variable or combination of variables that best predict body mass. These elements both directly transmit the weight of the body during locomotion and are irregular bones comprised primarily of trabecular bone. This feature, as well as their functional relationship as articular joints, makes them ideal choices for estimation of body mass as they are not expected to vary in external dimensions with increasing or decreasing levels of activity, but are expected to correlate with overall size.

In a combined group analysis (n=105) forward stepwise selection identifies the maximum length of the calcaneus (body mass = (CALMAX * 0.813) – 3.279; r =0.643; Adj. r^2 = 0.408; SEE = 5.81 kg) as well as the combination of CALMAX and the maximum length of the talus (body mass = (CALMAX * 0.534) + (TALMAXL * 0.438) - 7.142; r = .0670; Adj. r^2 =0 .438; SEE = 5.66 kg) as the most useful predictors of body mass. These equations predict body mass in kg, though the bony variables are in mm. Tests of efficacy on the Least Squares regression equations were conducted using a separate HTH sample for which maximum lengths of the calcaneus and talus were made available. These tests of efficacy were also limited to individuals who fell in the range of a normal BMI (n=38). Three measures were used to evaluate the performance of these predictive models – percent prediction errors (%PE= [(observed-predicted)/predicted] *100), accuracy ($\sum$ |observed - predicted| / n) and bias ($\sum$ observed - predicted / n).

Using the CALMAX only equation, results in %PE ranges from -27.12kg to 15.44kg (mean = -4.60kg , SD = 10.11kg), accuracy is 5.63kg, and bias is -2.89kg. While using the model that incorporates both CALMAX and TALMAXL, results in %PE ranges of -26.21kg to 16.84kg (mean = -4.27kg, SD = 9.93kg), accuracy is 5.34kg, and bias is -2.69kg. The elements of the foot are on par with or superior to, existing methods for estimating body mass and may be considered superior for theoretical and empirical reasons. Based on the merits of the regression equation statistics and tests of efficacy, body mass estimation may not be as farfetched a goal as previously perceived in the forensic context.

Body Mass, Linear Regression, Biological Profile

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