H63 Estimating Body Mass From Bone Mineral Density of Human Skeletal Remains

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The goal of this presentation is to enable forensic anthropologists to estimate body mass from human skeletal remains.

This presentation will impact the forensic science community by showing a strong correlation between body mass and bone mineral density of the proximal femur and significant differences between different weight classifications for white females.

This research explores the relationship of body mass and bone mineral density of the proximal femur using Dual Energy X-ray Absorptiometry (DEXA). The ability to estimate body mass from the human skeleton has received considerable attention, but previous research has failed to take into account extremes of body mass due to the restraints of the research collec- tions. The William M. Bass Donated Skeletal Collection at the University of Tennessee, Knoxville offers a unique opportunity to study modern indi- viduals of known age, height and weight.

According to functional morphologists, bones need to be light enough for locomotion but strong enough for support. Bones must be strong enough to support the body mass of the ambulatory individual or otherwise fracture. As individuals become obese or emaciated, this relationship becomes exag- gerated. The authors propose that body mass will correlate well with bone mineral density and could be used to estimate the body mass of unidentified human remains.

Our research focuses on the proximal femur of a sample of skeletal remains of 23 modern white females between the ages of 32 and 84 with a mean age of 58. Height and weight data was available for all individuals to determine the body mass index (BMI)(kg/m2). All femora were cleaned and dried. Each femur was placed in a plastic container filled with dry white rice to a depth of approximately 12 cm. The rice served as a soft-tissue density equivalent for the DEXA scans, as suggested by GE, the producer of the DEXA Lunar scanner. A 2 cm thick cube of low-density foam was placed under the lesser trochanter to approximate anatomical position.

Standard measurements of bone mineral density (BMD)(g/cm2) were calculated automatically for the femoral neck, Wards triangle, the greater trochanter, proximal shaft and total BMD. The Pearson correlation coeffi- cient for total BMD and BMI is r = 0.73 and for the proximal femur and BMI, the correlation is r = 0.75. ANOVA and two-tailed paired t-tests were used to evaluate whether significant differences existed between different weight classifications. When comparing obese (BMI>30) individuals to emaciated (BMI<18) individuals, the results were significant ($p<0.05$) at all locations. When comparing obese to average weight individuals, higher values were found for total BMD, greater trochanter and for the proximal shaft.

In conclusion, bone mineral density has a strong correlation with body mass in the proximal human femur for white females. These results support previous research by the first author, which showed a strong correlation (r = .82) between BMI and cross-sectional area of the femoral mid-shaft. It was unexpected to get such a high correlation in the current research without controlling for age. Furthermore, there are significant differences in bone mineral density between different weight classifications in white females. This correlation may not exist in males, as males tend to have vocations or avocations that require heavy lifting. To simplify this analysis, we chose only white females. Future research will explore density patterns in males and non-whites.

When unidentified human remains are found, it is the responsibility of the forensic anthropologist to estimate age, sex, stature, and ancestry in order to narrow down the possible matches to missing persons. With the preva- lence of obesity in our society, the ability to estimate body mass from the skeleton would add one more useful tool for the forensic anthropologist to establish identification. Furthermore, this research could be applicable to the bioarchaeologist or paleoanthropologist to reconstruct past cultures.

Body Mass Estimation, BMD, DEXA

 ** Presenting Author*