H43 Body Weight Estimation in Forensic Anthropology

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The goals of this presentation are to explore the role of body weight prediction in the biological profile and to examine techniques of body weight prediction from skeletal remains.

Although estimates of stature, age, ancestry, and sex are assumed components of the biological profile, estimation of body weight is not. Investigators at a crime scene will ask for body weight but this author has never formally addressed the request within the report of the osteological examination. Searches of the forensic literature reveal very few references to body weight estimation. The purpose of this presentation is to explore the role body weight estimation has in the biological profile, if any, and to examine techniques for estimating body weight.

Body weight has several features that make it an undesirable component for a biological profile. The purpose of the biological profile is to recover details from the skeletonized decedent that can be compared to a persistent record, such as photographs, identification cards, and medical records and films. In American society body weight is recorded in medical records and more infrequently for identification cards, so the possibility of identification is dependent on limited records. Weight is such a sensitive issue that, like stature, it is broadly subject to inaccuracy when self-reported. Weight differs from stature in that a witness might easily reconstruct the latter by comparing an individual to his or her height, but be reluctant to perform the same analysis for weight with any precision. The most detracting feature is that weight defies record keeping by being capable of dramatic change over relatively short periods.

Despite that body weight is a component of the identity of the deceased, the handicaps make it seem inappropriate for analysis. Yet at the very least the anthropologist would be providing information that helps the investigator refine a search image. Also, while the relationship between body weight and biological parameters such as life span or feeding behavior is understood on the species level for many animals, its effect on individual humans in a forensic context is not well explored. Knowledge of individual body weight could inform patterns of degenerative joint disease and cardiovascular disease, body transport and disposal and other taphonomic processes. The objection that weight is too nebulous to define is countered with the fact that given sufficient skeletal material (a restriction that applies to all components of the biological profile) a minimum range of weights would be obtainable simply from standards of weight for height. Then additional observations may be applied, such as clothing size if available, the trend to gain weight with age, or the circumstances of body disposal, to suggest an upper limit.

If body weight is included in the biological profile, how can it be reconstructed from human skeletal remains? Several options, most derived from palaeoanthropology, seem available. Palaeoanthropology and forensic anthropology both cope with the winnowing effect time and nature have on skeletal material, but the former subfield's focus on reconstructing the biology of extinct species has generated a larger toolkit for estimating body weight. However only a few of the techniques are applicable to modern humans. An early study by Baker and Newman (1957)[1] suggested dried bone weight be used to estimate body weight, but arriving at a standardized level of bone dryness made this technique difficult to apply. For measurements of several long bones and vertebrae McHenry (1992)[2] and Hartwig-Scherer (1994)[3] showed strong relationships (suggesting good predictive power) to body weight for modern humans. Aiello and Wood (1994)[4] and Gauld (1996)[5] have shown similarly strong relationships between measurements of the cranium and body weight. This study will focus on the cranial studies in order to illustrate the considerations involved in estimating body weight from skeletal measurements.

Aiello and Wood and Gauld both demonstrated high ($r > .90$) correlations between some cranial measurements and body weight in mixed primate (human and nonhuman) samples. Aiello and Wood focused on external measurements of the face and vault, while Gauld used vault thickness measurements. In addition to having a mixed primate sample these authors also relied on predictions for specimens not having recorded weights. Results were not reported for the strictly human parts of their samples, so this author designed a study with applicability to modern humans. One hundred forty-seven adults of recorded body weight (100 drawn from the Terry collection at the Smithsonian National Museum of Natural History and 47 from recent autopsies) were sampled for nine ectocranial and seven cranial vault thickness measurements. No prior effort was made to exclude emaciated individuals from the Terry collection; rather individuals were sorted during the analysis. Effort was made to adjust for fatness in the autopsy sample using triceps and subscapular skinfold measurement to estimate lean body weight. The correlation coefficient (Pearson's r) was calculated for each measurement and body weight.

The results of this study did not resemble those from Aiello and Wood or Gauld. Whether considered as separate samples (autopsy or skeletal) or one combined sample, none of the cranial measurements produced correlation coefficients higher than .6. The results did not improve when individuals below 100 pounds were removed from the Terry sample. The cranial thickness measurements were particularly poorly correlated to body weight, such that only one of the seven measurements (at lambda)

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produced a significant correlation. These contrasting results are likely the product of 1) having a strictly human reference sample, 2) incomplete replication of the cranial measurements between this and the previous studies, and/or 3) using only measured not predicted body weights. This current study indicates that while resources are available for estimating body weight from postcranial material, more research is needed into the feasibility of using cranial measurements.

1 Baker, PT and Newman, RW (1957) The use of bone weight for human identification. Am. J. Phys. Anthropol. 15:601-618

2 McHenry HM (1992) Body size and proportions in early hominids. Am. J. Phys. Anthropol. *87*: 407-431.

3 Hartwig-Schere S and Martin RD (1992) Allometry and prediction in hominoids: a solution to the problem of intervening variables. Am. J. Phys. Anthropol. *88*:37-57.

4 Aiello LC and BA Wood (1994) Cranial variables as predictors of hominine body mass. Am. J. Phys. Anthropol. *95*:409-426.

5 Gauld SC (1996) Allometric Patterns of Cranial Bone Thickness in Fossil Hominids. Am. J. Phys. Anthropol. 100: 411-426

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