Estimation of living body weight based on measurements of anterior superior iliac spine breadth and stature

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ESTIMATION OF LIVING BODY WEIGHT BASED ON MEASUREMENTS OF ANTERIOR SUPERIOR ILIAC SPINE BREADTH AND STATURE

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Master of Arts

in

The Department of Geography and Anthropology

by

Jaime A. Suskewicz
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ABSTRACT

Standard identification criteria for creating a decedent’s biological profile typically include ancestry, sex, age, and stature, but not body weight. Body weight information may not only assist in creating a more complete biological profile but may also provide insight into other forensic considerations, such as taphonomy and body transport and disposal.

The current study seeks to establish multiple regression equations for the prediction of living body weight in skeletal remains. Specifically, the measurements of anterior superior iliac spine (ASIS) breadth and stature are assessed with regard to living weight.

Research was carried out on both a skeletal sample and a living population sample of modern black and white Americans. This two-pronged approach was an attempt to identify possible difficulties encountered in using the ASIS/stature technique in a forensic setting. The skeletal sample consisted of 92 individuals with weight data, upon whom ASIS breadth measurements and stature estimations were carried out. Height, weight, and ASIS breadth were subsequently recorded for the living population sample of 85 individuals.

Multiple regression analysis was performed on all subsamples showing significant correlations between weight and ASIS breadth and stature variables. Regression equations for weight prediction were then derived from the results of analyses. However, the resulting estimated weight values indicate that ASIS breadth and stature must account for more variation in weight if the technique is to be useful in forensic investigations.
CHAPTER 1: INTRODUCTION

Forensic anthropologists are involved in the analysis of human remains resulting from unexplained deaths. The primary objective of the forensic anthropologist is to provide information useful in obtaining positive identifications of deceased persons (Byers, 2002). Standard identification criteria for creating a decedent’s biological profile typically include ancestry, sex, age, and stature, but not body weight. Estimation of living body weight is a complicated endeavor because no accurate method for determining weight from skeletal remains has yet been devised. However, the inclusion of body weight in the biological profile introduces an additional component to search criteria and may, therefore, serve to narrow the range of possible identifications (Stubblefield, 2003).

Body weight information may not only assist in creating a more complete biological profile but may also provide insight into other forensic considerations. For example, “knowledge of individual body weight could inform patterns of degenerative joint disease and cardiovascular disease, body transport and disposal, and other taphonomic processes” (Stubblefield, 2003:262). Processes occurring during the postmortem interval may be strictly dependent on the body mass of the decedent.

Several attributes of body weight may depreciate its use as a profile characteristic. For example, body weight information is often underreported and may only be reliable from limited records, such as medical documents. Body weight is also subject to drastic fluctuation in short periods of time. In addition, a witness’s ability to recall a person’s weight with precision, as he or she may when recalling height, is questionable (Stubblefield, 2003). Clothing style may further complicate the process of remembering
a person’s weight if he or she wore concealing, baggy, or tight-fitting clothes. Obviously, body weight involves a variety of cultural and physical variables.

Despite these apparent shortcomings, body weight is an undeniable aspect of a decedent’s identity. The forensic anthropologist must take care to maximize the available information so that the chances of identification are increased. The purpose of the current study is to assess the utility of pelvic breadth and stature measurements in weight estimation. The goal of the project is to predict living body weight of deceased individuals from skeletal remains. The research presented here attempts to assess the usefulness of weight prediction in creating the biological profile and seeks to augment the battery of identification techniques already used by the forensic investigator.
A review of prominent and seminal textbooks in forensic anthropology yielded either passing or no references to body weight estimation. Krogman and İşcan (1986) and Stewart (1979) each dedicated a few pages on previously carried out research based on estimating bone weights (Ingalls, 1931; Matiegka, 1921; Trotter, 1954). However, the only reference to body weight is Krogman and İşcan’s (1986:388) brief remark that “no close correlation exists between bone weight and living weight except very broadly, i.e. a low bone weight betokens an individual of below average body weight.” Byers (2000:388) offered more information on techniques for estimating an individual’s weight by way of visual inspection of bones, but advised that only the “most experienced workers” endeavor to do so.

Early research dealing with the issue of weight focused primarily on the weight of the skeleton as opposed to total living body weight. Matiegka (1921) initiated such studies, successfully estimating the weight of the skeleton based on the maximum transverse diameters of the distal ends of the femur, humerus, forearm, and lower leg. Mildred Trotter (1954) later reexamined Matiegka’s approach with similar results. In addition to testing Matiegka’s methods, Trotter’s (1954:539) own study sought to “determine the reliability of estimation of the weight of the skeleton from data which can be gathered from the living (such as age and stature).” However, only one early twentieth century physical anthropologist made any suggestion of the prediction of antemortem body weight. Ingalls (1931:50) warns against attaching “undue significance” to body weight because of its extremely variable nature. Nevertheless, later in the article
Ingalls (1931:89) mentions that body weight and skeletal weight are “closely associated,” and would be more so if humans did not live in such “varied and artificial conditions.”

Forensic literature yields few references with regard to weight estimation. Most research relevant to the prediction of body weight from skeletal remains is either not concerned with modern populations or is not forensically oriented. However, several resources pertaining to body weight prediction in a medico-legal context (using skeletal remains) are available. The relevant studies discussed below are Baker and Newman (1957), Huxley (1992), May (1999), Sichta (2000), and Stubblefield (2002, 2003). In addition to studies using skeletal remains, a few researchers have performed measurements on living subjects. Such projects include those by Ruff et al. (1991), Sciulli and Pfau (1994), and Wheatley (1999).

Forensic Studies Using Skeletal Remains

The research of Baker and Newman (1957) focused on quantifying the relation between the skeletal weight and living weight of an individual. The authors argued that the living weight of a person is a potentially important piece of information in the process of identification. In citing a previous physiological study (Behnke et al. 1942), Baker and Newman claimed that bone mineral constitutes 5-7% of the fat-free weight of the body. This narrow range of percentages supports the authors’ assumptions that bone weight could act as a prediction variable for living weight.

Baker and Newman performed weight measurements on 125 skeletons of both white and black males. To establish a consistent measure of bone “dryness” in the sample, all bones were dried in large ovens for 12-15 hours. In addition, this study only used those remains that were skeletonized by natural factors and in which the fat had
already been leached out. Baker and Newman acknowledged, however, that differing soil conditions could lead to different leaching and decaying processes. Both total skeletal weight and weights of individual bones were assessed.

In considering that skeletal weight for men who died from nutritional deficiency might be drastically lower than those who died from other factors, the authors compared bone weights for the two groups. Baker and Newman established that no statistically significant difference existed between the two. However, the researchers did determine that the skeletons of black men were approximately 7% heavier than those of white men.

The results of the above study indicated that there was low correspondence between living and skeletal weights for white and black men. Baker and Newman concluded, however, that the correspondence was enough to warrant broad predictions of living body weight. The authors stated that whatever relationship exists between total weight and bone weight is a function of the correspondence between the bone and the rest of the fat free tissue (muscle). Surprisingly, the method was most reliable when reversed, a process that improved the association between bone weights and living measurements. In other words, the most effective alternative approach for associating an unknown skeleton with a specific individual is the calculation of bone weight from living stature and weight.

Although the mineral and organic components of bone do not usually undergo radical change in the amount of time relevant to medico-legal investigations, assessing bone dryness is difficult. Lack of any standardized measurements or methods to determine dryness makes the Baker and Newman technique difficult to apply in forensic investigations. The drastic taphonomic, climatic, and geographic differences involved in
particular forensic situations require a more exacting method of body weight estimation. Further complicating the above method is the need for the presence of the entire skeleton, a condition often not found in forensic situations.

Some researchers have narrowed their scope to focus on a segment of the skeleton. Huxley (1992) examined the morphology of the talus as it relates to body weight. Huxley expected a correlation for the reason that the talus bears the majority of the body’s weight during locomotion and standing. Her sample consisted of 88 individuals with weight data from three different skeletal collections. However, some weight data were obtained from drivers’ licenses and “self-reports.” The problem with self-reported weight is discussed further below.

Huxley took 21 measurements of 49 right tali and performed statistical analyses, including Pearson’s correlations, F statistics, t-tests, and multiple regression. Her results yielded an adjusted $R^2$ of 0.21, indicating that the talar measurements only accounted for 21% of the total variance in estimated body weight. Non-significant Pearson’s correlations and multiple regression analyses led Huxley (1992:36) to conclude, “No correlation exists between any of the variables and estimated antemortem body weight.” Other studies (May, 1999; Wheatley 1999) have demonstrated a correlation between body mass and bone mineral density. May (1999) examined the remains of 73 individuals in the Terry Collection. Results of linear regression analyses indicated to May (1999:68) that, “Bone mineral density can indeed predict body mass but is not always better than current methods,” such as those using cranial or post-cranial elements. In addition, May (1999:67) claims that “bone mineral density from the 5th lumbar
vertebra and femoral length were the best predictors of body mass.” Also, the linear relationship between these variables weakens after age 60.

As with Huxley, Sichta (2000) focused on weight bearing elements of the skeleton. His study attempted to reconstruct antemortem body weight by exploring the differences in bone remodeling between the femur and humerus. Sichta (2000:29) argues that the majority of remodeling should occur in the legs because of their greater role in weight bearing, and that the differences in remodeling between the humerus and femur “should be quantifiable and should correlate with antemortem body weight.” Sichta (2000:29) attempts to establish, “indices and differences of analogous measurements from the humerus and femur,” expecting a higher amount of differentiation to indicate a person of heavier living body weight and vice versa.

Sichta performed six measurements (three on the humerus, three on the femur) on a skeletal sample of 189 individuals. The results obtained in the study supported Sichta’s (2000:67) hypothesis that “differential changes in the humerus will be significant, measurable, and will correlate to antemortem body weight.” However, the results failed to generate an accurate method of weight estimation.

Possible correlations of body weight with non-weight bearing bones have also been investigated. In a paper presented at the annual meeting of the American Academy of Forensic Sciences in Chicago, Stubblefield (2003) examined both the role of body weight prediction in the biological profile and the techniques used to assess body weight from skeletal remains. Stubblefield’s study focused on the cranial measurements of 147 adults from both the Terry Collection and recent autopsies. She compared her results to those of Aiello and Wood (1994) and Gauld (1996), paleoanthropologists who performed
the same variety of measurements on primate and human samples. Results of Stubblefield’s study were dissimilar to those of the paleoanthropologists. Measurements of cranial thickness were poorly correlated to body weight and none of the cranial measurements yielded correlation coefficients higher than 0.6. Stubblefield construed that these results are due to having a strictly human sample, the incomplete replication of cranial measurements between studies, and the use of only measured, not predicted, body weights.

Stubblefield also addressed the issue of body weight prediction in her 2002 dissertation. Stubblefield (2002:1) examined two hypotheses: the first, “that measurements of external cranial dimensions covary with body weight, and the second that cranial vault thickness measurements covary with body weight in relation to systematic skeletal robusticity.” Stubblefield used the same skeletal sample as above. She took sixteen ectocranial and seven cranial vault thickness measurements and measured cortical thickness at four locations on the clavicular shaft. Results of correlation and regression analyses revealed that no significant correlation existed between body weight and all measurements. Stubblefield (2002:xi) concluded, therefore, that the measurements were “largely unsuitable for body weight prediction.”

**Forensic Studies Using Living Subjects**

Research involving the extrapolation of data from living humans generally involves measuring and observing bones via x-rays, or radiographs. Ruff et al. (1991) used radiographs to measure proximal femoral dimensions of 80 living people with weight data. Their sample consisted of subjects between 24 and 81 years of age, equally divided between males and females, of which two-thirds were white and approximately
one-third were black. Results of the Ruff et al. (1991:397) study suggested “articular size does not change in response to changes in mechanical loading (body weight) in adults, while diaphyseal cross-sectional size does.” Ruff and colleagues established body weight estimation equations from the cross-sectional data, which yielded between 10% and 16% average percent prediction error for individual weights. In discussing the difficulty of body mass prediction from skeletal remains, Ruff et al. (1991:406) explains that the undertaking has proved difficult for humans “largely because of problems obtaining sufficiently accurate body masses individually associated with skeletal remains in a large, random, and representative sample.”

Sciulli and Pfau (1994) investigated the relationship between midshaft femoral diameter, age, and weight in children. Their sample consisted of 183 school children from central Ohio. All measurements were taken on live subjects by x-ray. Results of multiple regression analyses indicated that when used separately, both age and femoral diameters predict weight similarly, accounting for between 90% and 97.4% of the variation in weight. Furthermore, using both variables together resulted in 97.7% of the variation in weight explained for the entire sample. However, despite the promise of accuracy, the authors acknowledge that the method is unreliable in children over the age of six. The weight ranges given by a 95% confidence interval become “unacceptably large” as age increases (Sciulli and Pfau, 1994:1286). Sciulli and Pfau’s research has produced valuable data on childhood weight; however, the rapid growth experienced in youth makes any correlations with adult weight estimation improbable.

As mentioned above, Wheatley (1999) also reported some correlations between body mass and bone mineral density. Wheatley examined 42 live subjects using an x-ray
bone densiometer. He measured bone mineral density, minimum diameter of the femoral neck, and shaft diameter below the lesser trochanter of the femur. However, a potential problem with studies performed on live subjects, as in Ruff et al. (1991) and Sciulli and Pfau (1994), is the small degree of difference between wet and dry bone. The tendency of bone to shrink slightly when dry may skew prediction techniques established from wet bone measurements.

**Paleoanthropological Studies**

Most research in the area of reconstructing body weight has been carried out in a largely non-forensic arena. Paleoanthropologists have attempted to reconstruct the behavior and biology of extinct hominid species for quite some time. According to McHenry (1992:407) hominid body mass is related to many variables, including “metabolic costs, mobility, thermoregulation, brain size, longevity, predator-prey relationship, home-range size, diet, and foraging behavior.” The results of paleoanthropologists’ endeavors have provided us with several viable options regarding techniques for estimating body weight in modern humans. In addition, many paleoanthropological studies are comparative in nature and include data for modern populations.

One study with particular relevance to the research presented here was carried out by Ruff (2000). Ruff estimated body size of hominids based on comparisons of skeletal frame size in modern Olympic athletes. Using data from a previous study (Ruff, 1994), Ruff established body mass estimation equations derived from 56 sex/population-specific sample means broadly representative of the world’s living populations. Ruff explained that while these equations are based on population sample means, they also work
reasonably well in predicting the body mass of modern individuals. However, Ruff’s data were collected from literature sources dating from 1951 to 1989 and did not include any modern American samples.

The variables Ruff chose to include in his prediction equations were bi-iliac breadth and stature. He followed the approach of the “cylindrical model” of the human body, where the breadth of the cylinder is the bi-iliac breadth of the pelvis and the height of the cylinder is stature (Ruff, 1991:83). Ruff chose the measurements of bi-iliac breadth and stature because they are closely comparable in living people and skeletal remains. The author argued that multiple regression equations could successfully be created and “applied to skeletal samples where stature can be estimated and bi-iliac breadth is known or can be estimated” (Ruff, 2000:508).

In order to test the accuracy of the equations, Ruff applied the technique to two different modern human samples of young adults - New Guinean Karkar Islanders and U.S. Marine recruits. Ruff’s results indicated that body weight of modern individuals could be estimated with reasonable accuracy in cases of known stature and bi-iliac breadth.

For the purposes of hominid body mass estimation, Ruff also applied the equations to a sample of Olympic athletes. Ruff based this rationale on the likelihood that extreme athletes may have a body type more representative of the degree of physical conditioning characteristic of earlier populations. Results revealed only an average 3% prediction error, indicating the body mass equations may be useful in estimating the weight of early hominids.
Although Ruff’s results exhibit low prediction error when stature is known, the technique may also be useful in situations of estimated stature, as is usually the case in forensic situations. The potential of Ruff’s equations for great accuracy makes it worthwhile to test a similar method on a modern American population of average fitness and various ages.

Other paleoanthropological studies have used a variety of techniques to estimate body weight. Allometric studies have incorporated many different skeletal features as variables in estimation analyses. The main areas of interest concerning useful skeletal measurements have focused on the following: postcranial studies involving long bone dimensions and cross-sections (McHenry, 1992; Ruff, 1991, 1994, 2000); partial skeletal weight (Steudel, 1980); and cranial dimensions (Aiello and Wood, 1994; Gauld, 1996; Hartwig-Scherer and Martin, 1992).

Steudel (1980:63) used a series of variables found to have “very high correlations with body size and low standard errors across living Old World higher primates, including man,” to estimate body mass of early hominids. Steudel first tested 25 variables to determine which ones had the highest correlations with mass across a range of primate and human samples. The author used partial skeletal weight to represent body mass because she mistrusted weight values recorded at the time of death. As with Baker and Newman (1957), Steudel also recognized the difficulty of assessing bone dryness, a drawback of using bone weight instead of body weight. Of the 25 variables tested for correlation with body mass, four exhibited correlation coefficients of over 0.96, including palate breadth, bi-zygomatic breadth, orbital breadth, and circumference of the femur just below the lesser trochanter. Using these variables, Steudel calculated body mass
estimates for gracile and robust early hominids. Steudel’s study suggested the potential of postcranial variables as valuable predictors of body mass. However, the accuracy of methods such as the above is difficult to prove, given that the weight of early hominids is unknowable.

McHenry (1992) also focused on the postcranial skeleton to estimate body weight of several hominid species. In particular, the study used a comparative data set including humans of small-stature (with known weight) and a fossil data set. McHenry (1992:408) referred to previous comparative studies that have used “relatively large-bodied individuals,” despite the fact that many fossil hominids were small bodied. As with Ruff (2000), McHenry chose to select an appropriate modern human body type that was more closely comparable to early hominid body type.

McHenry performed 13 postcranial measurements on each subject within the two data sets and assessed the relationship between the variables and body weight by regression analysis, including least squares regression, major axis, and reduced major axis methods. The results produced a series of 78 equations for the prediction of body weight. Using the equations, McHenry estimated body weight for several hominids, including Australopithecus afarensis, A. africanus, A. robustus, A. boisei, and Homo habilis. From these values, McHenry was also able to predict average male and female body weights and body size variation within each species.

Other studies concerned with early hominids have focused on cranial variables as possible predictors of body mass (Aiello and Wood, 1994; Gauld, 1996; Hartwig-Scherer and Martin, 1992). Hartwig-Scherer and Martin (1992) used a combination of cranial dimensions and long bone measurements in a study designed to illustrate the problems
with intervening variables and to identify the best size indicators. Five species of hominids (n=295; with weight data) were further subdivided into adults and subadults in order to determine both static and ontogenetic allometric relationships, respectively. The adult human sample yielded low correlations between weight and cranial variables; however, the subadult sample showed a correlation of 0.93 between basicranial length and body weight. The nonhuman hominoids showed high correlations (r = 0.90 to 0.98) between basicranial length and body weight, indicating a strong contrast between adult humans and adult apes in the accuracy of cranial variables in body weight estimation. The authors were able to derive 12 predictive equations per species (based on age ranges) from a total of 25 predictor variables.

Aiello and Wood (1994:409) recognized that the majority of hominid fossils are “cranio-dental remains that are unassociated with postcranial materials.” Although most previous studies have relied on postcranial variables, Aiello and Wood attempted to estimate body mass based on 15 cranial variables. The authors analyzed data from 23 species of nonhuman primates and modern humans using regression techniques of reduced major axis, major axis, and least squares. Cranial measurements were tested against postcranial measurements based on the values of the standard error of the estimate and percent prediction error. According to their analyses, the best cranial predictors of mass were orbital area, orbital height, and bi-porionic breadth. However, the authors found that the best predictor variable often depended on the species in question and that postcranial variables tested in previous studies were still more accurate.

Lastly, Gauld (1996) measured thickness of the cranium at five locations in a sample of 235 extant anthropoids. She hypothesized a possible relationship between
cranial thickness and body mass because of existing high correlations between postcranial bone thickness and body mass. Gauld compared the results of regression analyses, involving least squares, reduced major axis, and major axis. All variables produced correlation values between 0.75 and 0.98. Gauld (1996:422) concluded, therefore, that vault thickness “shares a primary relationship with body size,” but that the relationship varies according to species.

The above studies have found positive correlations between body weight and several skeletal dimensions. Continuing research in this area is important for both paleoanthropology and forensic anthropology because specific skeletal elements present for any one individual vary greatly. Body weight estimation is by no means exact but has great potential to be refined, particularly in the study of modern humans. Expanding the body of knowledge on body weight estimation can offer investigators a larger repertoire of techniques to employ in a given circumstance.

**Accuracy of Self-Reported Weight**

Consideration must be given to the validity of weight records available to the forensic investigator. Such records might include medical reports, weight established at autopsy, and/or identification cards. Personal identification cards, such as drivers’ licenses, may not present accurate data because people often misreport their physical attributes.

Several studies have documented the tendency of people to underestimate their own weight (Palta et al., 1982; Rowland, 1990). Such underestimation is clearly a problem since most identification cards display only self-reported weight values. Also, Palta et al. (1982) and Rowland (1990) have noticed a gender bias in reporting error.
Palta et al. determined that 3.1% of women under-report their weight, whereas only 1.6% of men underestimate. The percentages are small, but may testify to discrepancies in weight data from sources such as drivers’ licenses. In addition, Rowland has observed that heavier people tend to under-report their weight to a greater extent and more often than lighter people. Palta et al. also claimed that as people get older, the tendency to underestimate decreases.

Ousley (1995) has noted a bias in reported versus actual stature as well. Not only is this measurement overestimated more by men than women, but also shorter people tend to overestimate more often than taller people (Ousley, 1995). Therefore, a reasonable assumption would be that this behavior extends to self-reporting of weight. Lastly, values of weight and stature on drivers’ licenses may not be updated for many years, lending to higher degrees of inaccuracy.

**Age Related Weight Changes**

Researchers have acknowledged that the age of an individual may have an effect on body weight. Stevens et al. (1991) documented these age-related weight changes by examining the changing measurements of 370 American black and white men and women over a 25-year period. Stevens et al. reported that a person’s weight increases up until age 46, and then gradually begins to decrease again around the age of 55. The authors found that mean weight increased 2.45 lbs in people 37-46 years old and decreased by about 1.18 lbs in those in the 55-74 year age range. The authors also identified differences in the way black and white males and females fluctuate in weight throughout their adult lives. In the same study, Stevens et al. observed an increase in abdominal girth with age for all groups. The estimated increases for white women, black
women, white men, and black men were 2.8 cm, 6.6 cm, 6.3 cm, and 7.5 cm, respectively.

**Weight Estimation Today**

Generally, most attempts at weight estimation from skeletal remains have been derived from nonmetric observations. Factors including sex, stature, muscle attachment rugosity, and skeletal robusticity are used in order to infer living weight (Byers, 2002). Specifically, once stature is assessed using forensic methods the measurement can be applied to standard weight by height charts (Nelson et al., 1994). The resulting weight value is then adjusted to reflect the other observed factors. For example, a male would likely be heavier than a female of the same height because of greater muscle mass. Likewise, an individual with rougher areas of muscle attachment would probably weigh more than one with smoother bone surfaces. Greater skeletal robusticity may also indicate a heavier individual due to bone mass increase in order to support extra weight (Byers, 2002). A body weight toward the upper or lower end of a given range may be assigned depending on observations.

Finally, the subjective nature of nonmetric observations inhibits any precise estimation and requires an expert eye. Therefore, the usefulness of the current study lies in the attempt to find a more accurate method of weight prediction that is based on objective measurements.
CHAPTER 3: MATERIALS AND METHODS

As in Ruff (2000), the study presented in this paper focuses on the pelvis because of its weight bearing function in support of the upper body (Emmons, 1913). However, in this study, anterior superior iliac spine (ASIS) breadth (Figure 1) was substituted for bi-iliac breadth because the variables are closely correlated. The relationship between the two measurements is only two to three centimeters, not a meaningful difference (Emmons, 1913). Also, ASIS breadth as an index of body width is easily located and measured both in skeletal remains and in living humans. Furthermore, ASIS breadth, as it relates to bi-iliac breadth, is based on “well-defined bony landmarks” and exhibits very little sexual dimorphism regardless of ancestry (Ruff, 1991:83).

Figure 1. Anterior Superior Iliac Spine (ASIS) Breadth Measurement.
In the current study, stature is determined by maximum long bone length and the dimension of pelvic breadth, as stated above, is represented by ASIS breadth. If both stature and ASIS breadth are significantly correlated with body weight, then regression equations for prediction will be formulated.

Specifically, the ASIS/stature method is tested for accuracy in a two-pronged approach. First, a skeletal sample is assessed in a simulated forensic situation when the pelvis and at least one long bone are present. Second, anthropometric measurements are carried out on a living population sample of black and white modern Americans. In a sense, the living subject study is an effort to “troubleshoot.” Since the origins of the weight data in the skeletal study are questionable, the living population study seeks to compare ASIS breadth and stature with actual living weight. If both studies reveal the same results with regard to correlations between variables and accuracy of prediction equations, then the negative influence of imprecise weight data on the results may be ruled out. However, if there is a significantly higher correlation between the two variables and weight in the living study than in the skeletal study, then a possible explanation is that faulty weight data may have obscured results. The same or similar results should be expected from both studies. Any dissimilarity may point to a problem with the methodology, the data collection process, inaccurate stature estimation in the skeletal study, or complications due to the differences in obtaining measurements from skeletal and living human remains.

**Skeletal Study**

All data for the skeletal portion of this project were collected using the William M. Bass Donated Collection at The University of Tennessee, Knoxville (UTK). Dr. Lee
Jantz serves as curator of the Donated Collection and aided in the acquisition of all case information pertaining to this research. The collection consists of skeletal remains for a broadly representative sample of modern Americans. However, the individuals chosen for measurement were only those with weight and stature records, along with data on sex, age, and ancestry. Only remains with undamaged hipbones and sacrum, and at least one undamaged long bone were considered. The resulting sample included skeletal material from 92 black and white individuals.

The demographics of the sample were as follows: two black females, 13 black males, 15 white females, and 62 white males. The age range was between 25 and 84, with 60% over the age of 50. Information obtained from all subjects included age, weight, height, race, sex, ASIS breadth, and maximum lengths of the humerus, tibia, and femur. According to Dr. Jantz, weight data for the sample were gathered from a variety of sources (Personal communication, 6/9/2003). Medical records, autopsy reports, and personal records (drivers’ licenses and other identification cards) were the most likely sources, although this information was not included in the database specifically.

The sacrum and hipbones were rearticulated easily with the use of a large rubber band so that ASIS breadth could be assessed. All ASIS measurements were taken with GPM spreading calipers to the nearest millimeter. No allowance was made for soft tissue in the pelvic measurements. According to De Souza (1913:502), “The thickness of the soft parts (i.e. connective tissue and flesh)…does not, however, affect the inter-spinous diameter for which, therefore, no correction is required.”

Humeral, tibial, and femoral lengths were established with the use of an osteometric board also to the nearest millimeter. Stature calculations were performed for
each individual using standard formulae based on maximum long bone length (Bass, 1995). For the purposes of increased accuracy in stature estimation, the mean value of the results of calculations for all three long bones was used. (Using the mean value is not typically recommended in stature estimation; however, in this study, the mean provided the most accurate estimation in over fifty percent of the cases.) Although stature was known for all cases, the process of height calculation was necessary in order to determine the usefulness of body weight equations in forensic circumstances.

The sample as a whole was broken down into three subsamples: black males, white males, and white females. As there were only two black females, a subsample category was not considered. Results are also included for the entire sample as a whole.

**Living Study**

The second part of this project involved performing anthropometric measurements on a living population sample. The Institutional Review Board (IRB) at Louisiana State University granted approval of project parameters. IRB regulations and procedures for studies involving living subjects were adhered to at all times.

The living population sample consisted of 85 volunteers residing in Baton Rouge, Louisiana, and included black and white males and females. The specific demographics of the group were as follows: 18 black females, 16 black males, 27 white females, and 24 white males. The age range was between 20 and 85, with a mean age of 32.17 years. All volunteers signed a consent form (Appendix A) and filled out a questionnaire (Appendix B) before submitting to measurement.

Measurements of height, weight, and ASIS breadth were performed on each individual. A standard Cardinal Detecto physician’s scale with height rod was used to
assess stature and weight. Metric tree calipers were used in the measurement of pelvic breadth to the nearest millimeter. After removing both shoes and any excess weighty items (jackets, heavy jewelry), all subjects were weighed to the nearest pound and stature was measured to the nearest inch. All English measurements were later converted into metric units (pounds to kilograms, inches to centimeters). In order to obtain a measurement of ASIS breadth, each volunteer was asked to designate with his or her fingers the forward most projection of their hip bones.

For data analysis, the population sample was further divided into four subsamples. The subsamples are black males, black females, white males, and white females. Results are also included for the entire sample as a whole.

**Statistical Analysis**

All statistical analyses were carried out using SPSS 11.0, including descriptive statistics, Pearson’s correlation coefficients, and multiple regression analysis. For Pearson’s correlations, the variables tested for a relationship with weight in the skeletal portion of the data were ASIS breadth, recorded stature, and estimated stature. All correlations were assessed at the 5% level of significance. In the living population study, ASIS breadth and actual stature were tested for correlation with actual weight. In both skeletal and living studies the above variables were assessed for correlation with body weight in an “all groups” category, including the total cases for all subsamples, then for each individual subsample. If correlations between variables were determined to be significant, multiple regression analysis was run for that particular group.

The coefficient of multiple determination ($R^2$) and its value adjusted for sample size (Adjusted $R^2$) were selected for all regression analyses in order to assess the amount
of variation in weight accounted for by the independent variables. In addition, the difference between the estimated weight values and actual or recorded weight was computed. The purpose of this calculation was to identify a mean difference in order to aid in the overall assessment of the accuracy of the prediction equations. Standard errors of the estimate (SEE), mean percent prediction errors (%PE), and mean absolute percent prediction errors (|%PE|) were also calculated for this purpose. Determination of %PE followed Ruff et al. (1991), using the formula \([(\text{Observed} - \text{Predicted})/\text{Predicted}] \times 100\). Likewise, |%PE| was calculated using the absolute value of the same equation, 

\[|[(\text{Observed} - \text{Predicted})/\text{Predicted}] \times 100|\] (Ruff, 1991).

The directional bias of the predicted values is measured by %PE. Therefore, a positive %PE indicates an underestimate of actual weight, whereas a negative value indicates an overestimate (Ruff et al., 1991). Absolute error in predictions, on the other hand, was measured by |%PE| (Ruff, 1991). Thomas (1976:362) explained that SEE is of value because “a large SEE warns that the relationship is only weakly linear, and hence description by a straight line lacks accuracy.”

Lastly, with regard to the living population portion of the data, additional statistics included the average amount of weight lost or gained in a six-month period and the mean difference between actual weight and weight reported on drivers’ licenses. The results of these particular calculations are further discussed in Chapter 5.
CHAPTER 4: RESULTS

Descriptive statistics computed for both skeletal and living population studies (Tables 1a, 1b) included the mean, standard deviation, and minimum and maximum values of all variables per sample. The greatest difference observed in mean values between the two samples was in the “age at death” (51.40 years) and “age” (32.22 years) categories.

Table 1a. Descriptive statistics for skeletal study

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>recorded weight (kg)</td>
<td>92</td>
<td>42.64</td>
<td>167.38</td>
<td>78.60</td>
<td>24.03</td>
</tr>
<tr>
<td>age at death</td>
<td>85</td>
<td>20</td>
<td>86</td>
<td>51.40</td>
<td>15.07</td>
</tr>
<tr>
<td>recorded stature (cm)</td>
<td>92</td>
<td>147.3</td>
<td>195.0</td>
<td>174.80</td>
<td>8.72</td>
</tr>
<tr>
<td>estimated stature (cm)</td>
<td>92</td>
<td>148.8</td>
<td>190.4</td>
<td>173.50</td>
<td>7.44</td>
</tr>
<tr>
<td>ASIS breadth (cm)</td>
<td>92</td>
<td>16.5</td>
<td>28.4</td>
<td>22.68</td>
<td>2.23</td>
</tr>
</tbody>
</table>

Table 1b. Descriptive statistics for living population study

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>actual weight (kg)</td>
<td>85</td>
<td>44.45</td>
<td>142.43</td>
<td>75.19</td>
<td>17.02</td>
</tr>
<tr>
<td>age</td>
<td>85</td>
<td>20</td>
<td>80</td>
<td>32.22</td>
<td>13.51</td>
</tr>
<tr>
<td>stature (cm)</td>
<td>85</td>
<td>147.32</td>
<td>193.04</td>
<td>172.72</td>
<td>9.16</td>
</tr>
<tr>
<td>weight lost/gained (kg)</td>
<td>85</td>
<td>0</td>
<td>25</td>
<td>3.73</td>
<td>5.65</td>
</tr>
<tr>
<td>ASIS breadth (cm)</td>
<td>85</td>
<td>20.0</td>
<td>30.0</td>
<td>24.88</td>
<td>1.99</td>
</tr>
</tbody>
</table>

Skeletal Study

Table 2 presents the results of correlation analysis for the skeletal study. ASIS breadth, recorded stature (RECSTAT), and estimated stature (ESTSTAT) were tested to measure the variables’ degree of relationship to body weight. All correlations between weight and ESTSTAT were nonsignificant. However, the “all groups” category (total cases in all subsamples) approached significance at $r = 0.142$ ($P = 0.088$). ASIS breadth
follows in general weakness of association, with the only significant correlations exhibited by white males ($r = 0.228$) and the all-inclusive category ($P = 0.247$). RECSTAT exhibited the highest degree of correlation with weight in white males, black males, and the all-inclusive group at 0.503, 0.545, and 0.432, respectively.

Table 2. Correlation of ASIS breadth and stature measurements with body weight in the skeletal sample

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Subsample</th>
<th>N</th>
<th>ASIS$^a$</th>
<th>Sig.$^b$</th>
<th>RECSTAT$^c$</th>
<th>Sig.$^b$</th>
<th>ESTSTAT$^d$</th>
<th>Sig.$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skeletal</td>
<td>1 (WM)</td>
<td>62</td>
<td>.228</td>
<td>(P=.038)</td>
<td>.503</td>
<td>(P&lt;.001)</td>
<td>-.010</td>
<td>(P=.469)</td>
</tr>
<tr>
<td></td>
<td>2 (WF)</td>
<td>15</td>
<td>.031</td>
<td>(P=.456)</td>
<td>.254</td>
<td>(P=.181)</td>
<td>-.029</td>
<td>(P=.458)</td>
</tr>
<tr>
<td></td>
<td>3 (BM)</td>
<td>13</td>
<td>-0.049</td>
<td>(P=.437)</td>
<td>.545</td>
<td>(P=.027)</td>
<td>-.147</td>
<td>(P=.315)</td>
</tr>
<tr>
<td></td>
<td>All Groups$^e$</td>
<td>92</td>
<td>.247</td>
<td>(P=.009)</td>
<td>.432</td>
<td>(P&lt;.001)</td>
<td>.142</td>
<td>(P=.088)</td>
</tr>
</tbody>
</table>

$^a$Anterior superior iliac spine breadth

$^b$Level of significance (one-tailed)

$^c$Recorded stature

$^d$Estimated stature

$^e$Includes two black females

Regression Equations Using Recorded Stature

Regression analysis was performed on those groups exhibiting significant correlations between weight and both ASIS breadth and RECSTAT. Therefore, equations were derived for the white male subsample and the “all groups” category. Estimated body weight (ESTWT) was the dependent, or predicted variable, and ASIS breadth and RECSTAT were the independent, or predictor variables. The two prediction equations established are as follows:

Subsample 1: White Males (N = 62)

$$\text{ESTWT} = 0.643 \times (\text{ASIS}) + 1.773 \times (\text{RECSTAT}) - 247.60 \quad (P < 0.001)$$
All Groups (N = 92)

\[ \text{ESTWT} = 1.384 \times \text{ASIS} + 1.085 \times \text{RECSTAT} - 142.419 \quad (P < 0.001). \]

Table 3 summarizes the results of the above prediction equations using ASIS breadth and RECSTAT as independent variables and ESTWT as the dependent variable. Adjusted \( R^2 \) values indicated that 23% of the variation in weight was “explained” by ASIS breadth and RECSTAT in white males, whereas 18.4% of the variation in weight was accounted for in the all-inclusive group. The level of significance for both equations was \( P < 0.001 \), although large SEE and mean |\%PE| values suggested low accuracy of predictions. Additionally, mean %PE values indicated that weight was underestimated in both white males and the all-inclusive group.

| Subsample       | N   | \( R^2 \) | Adjusted \( R^2 \) | Mean Diff | SEE \( ^b \) | Mean %PE \( ^d \) | Mean |\%PE| \( ^e \)  |
|-----------------|-----|-----------|-------------------|-----------|------------|--------------|----|----|
| 1 (WM)          | 62  | .255      | .230              | 16.31     | ±21.91     | .2523        | 19.66 |

\(^a\)Adjusted \( R^2 \)
\(^b\)Mean difference between estimated and recorded weight (kg)
\(^c\)Standard error of the estimate (kg)
\(^d\)Mean percent prediction error
\(^e\)Mean of absolute values of percent prediction error

Regression Equation Using Estimated Stature

A regression equation was also derived using ASIS breadth and ESTSTAT as the independent variables and ESTWT as the dependent variable. Of all subsamples, only the “all groups” category demonstrated a correlation approaching significance with
regard to the ESTSTAT variable (r = 0.142). Despite the fact that the correlation
between ESTSTAT and weight in the “all groups” category merely “approached
significance,” an equation was derived because a strong correlation between weight and
ASIS breadth was also observed. The prediction equation established using this
arrangement of variables is as follows:

All Groups (N = 92)

\[ \text{ESTWT} = 2.459 \times \text{ASIS} + 0.137 \times \text{ESTSTAT} - 0.933 \quad (P = 0.057). \]

Table 4 summarizes the results of the equation using ASIS breadth and ESTSTAT
as predictor variables. Adjusted R\(^2\) was nonsignificant and the level of significance for
the equation was P = 0.057. Low accuracy of the equations was also reflected in high
SEE and mean |%PE| values. Mean %PE indicated that underestimation occurred in
weight prediction.

| Subsample        | N  | \( R^2 \) | Adj R\(^2\) | Mean Diff\(^b\) | SEE\(^c\) | Mean %PE\(^d\) | Mean |%PE|\(^e\) |
|------------------|----|----------|-------------|----------------|---------|----------------|------|------|
| All Groups       | 92 | .025     | -.170       | 11.91          | ±16.52  | .056           | 17.20|

\(^a\)Adjusted \( R^2 \)  
\(^b\)Mean difference between estimated and recorded weight (kg)  
\(^c\)Standard error of the estimate (kg)  
\(^d\)Mean percent prediction error  
\(^e\)Mean of absolute values of percent prediction error
Living Study

Correlations of ASIS breadth and stature measurements with body weight are summarized in Table 5. As shown, ASIS breadth was significantly associated with weight in both female subsamples (r = 0.664 [BF] and 0.623 [WF]) but not in either male group (r = 0.216 [WM] and 0.005 [BM]). Additionally, stature was significantly correlated with weight in white males (r = 0.535) but not in white females (r = 0.162). Black females, however, showed the highest correlation between stature and weight (r = 0.780). The “all groups” category also displayed high levels of correlation between weight and both variables (r = 0.287 [ASIS] and 0.589 [Stature]).

Table 5. Correlation of ASIS breadth and stature measurements with body weight in the living sample

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Subsample</th>
<th>N</th>
<th>ASIS*a</th>
<th>Sig.b</th>
<th>Stature*c</th>
<th>Sig.b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living</td>
<td>1 (WM)</td>
<td>28</td>
<td>.216</td>
<td>(P=.135)</td>
<td>.535</td>
<td>(P=.002)</td>
</tr>
<tr>
<td></td>
<td>2 (WF)</td>
<td>23</td>
<td>.623</td>
<td>(P=.001)</td>
<td>.162</td>
<td>(P=.230)</td>
</tr>
<tr>
<td></td>
<td>3 (BM)</td>
<td>16</td>
<td>.005</td>
<td>(P=.492)</td>
<td>.322</td>
<td>(P=.112)</td>
</tr>
<tr>
<td></td>
<td>4 (BF)</td>
<td>18</td>
<td>.664</td>
<td>(P=.001)</td>
<td>.780</td>
<td>(P&lt;.001)</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>85</td>
<td>.287</td>
<td>(P=.004)</td>
<td>.589</td>
<td>(P&lt;.001)</td>
</tr>
</tbody>
</table>

*aAnterior superior iliac spine breadth  
*bLevel of significance (one-tailed)  
*cActual stature

Regression Equations

Based on strength of correlations between ASIS breadth, stature, and weight, regression analysis was performed on black females and the all-inclusive group. Only one prediction equation was created for each relevant subsample in the living subject study for the reason that stature was known and was not estimated. ASIS breadth and
actual stature were the predictor (independent) variables and estimated weight was the predicted (dependent) variable.

Subsample 4: Black Females (N = 18)

\[ \text{ESTWT} = 2.507 \text{ (ASIS)} + 1.116 \text{ (STATURE)} - 182.792 \quad (P < 0.001) \]

All Groups (N = 85)

\[ \text{ESTWT} = 1.547 \text{ (ASIS)} + 1.031 \text{ (STATURE)} - 141.306 \quad (P < 0.001). \]

Results generated from the living study regression equations are outlined in Table 6. Weight was predicted best in black females, as indicated by the low values of the SEE, mean difference between estimated and recorded weight, and mean |%PE| variables. Black females also had the highest Adjusted \( R^2 \) (62.2%), illustrating that variation in weight was best “explained” in this subsample. Weight was overestimated in both the black female and “all groups” categories. Equations for both groups demonstrated similar levels of significance at \( P < 0.001 \).

Table 6. Results summary of equations using ASIS breadth and actual stature as independent variables and actual weight as the dependent variable.

| Subsample | N   | \( R^2 \) | Adj \( R^2 \) | Mean Diff\(^b\) | SEE\(^c\)  | Mean %PE\(^d\) | Mean |\(|%PE|\)^e |
|-----------|-----|----------|--------------|-----------------|----------|---------------|------|----------|
| 1 (WM)    | 28  | .307     | .252         | 9.65            | ±13.84   | .1467         | 11.37|
| 2 (WF)    | 23  | .409     | .350         | 10.22           | ±13.95   | .0764         | 14.58|
| 4 (BF)    | 18  | .666     | .622         | 6.02            | ±7.68    | -.0353        | 9.17 |
| All Groups| 85  | .379     | .364         | 9.93            | ±13.57   | -.0876        | 13.00|

\(^a\)Adjusted \( R^2 \)

\(^b\)Mean difference between estimated and actual weight (kg)

\(^c\)Standard error of the estimate (kg)

\(^d\)Mean percent prediction error

\(^e\)Mean of absolute values of percent prediction error
CHAPTER 6: DISCUSSION AND CONCLUSION

The current study examined the utility of ASIS breadth and stature measurements in antemortem body weight estimation. Ruff’s (2000) study exhibited a low percent prediction error of only 3%, indicating that a technique such as his might be practical for other areas of anthropology. However, the low adjusted $R^2$ values, high mean absolute percent prediction values, and high standard error of the estimate values exhibited in this study indicate that the ASIS/stature technique is not useful in the estimation of living body weight from modern American skeletal remains. The regression equations did allow for weight prediction; however, the high degree of inaccuracy renders the equations impractical for use in forensic investigations. ASIS breadth and stature do not account for enough variation in weight values to be adequate variables in weight prediction.

Additionally, estimated stature performed poorly as a prediction factor in the skeletal study. In fact, the prediction equation using estimated stature and ASIS breadth accounted for none of the variation in weight. Estimated stature was also nonsignificantly correlated with weight for all subsamples. If the pelvic breadth/stature technique were to have value to forensic anthropologists, estimated stature would have to be a stronger predictor of weight.

Aside from the inadequate predictive power of ASIS breadth and estimated stature on weight, other factors may provide explanations for the results attained. Data characteristics such as subsample size and demographics and source of weight data may have prevented accurate estimation. Results for both skeletal and living studies are considered separately below.
Skeletal Study

Regression equations were established for white males and the “all groups” categories using ASIS breadth and RECSTAT and for just the “all groups” using ASIS breadth and ESTSTAT. Overall, weight prediction was most successful when ASIS breadth and RECSTAT were coupled as predictor variables.

Despite the fact that the total sample mean for estimated stature was only 1.3 cm less than that of the recorded stature mean, the difference for individual cases was often times much higher (results not presented). Estimated stature may have performed so poorly as a prediction variable because of inaccurate stature calculations. The results of the present study demonstrate that the closer an estimate is to actual stature, the more efficient it will be in predicting antemortem weight. Dissimilarity in correlation between the two stature measurements might also imply incorrect stature records in the database at UTK.

As suggested previously, origin of weight records may have affected the results of analysis on the skeletal sample. The weight data in the William M. Bass Donated Collection were acquired from a variety of sources, including medical records, autopsy reports, and drivers’ licenses (Personal communication with Dr. Jantz, 6/9/2003). However, the database did not specify which type of record the weight information came from per case. As a result, those individuals with potentially faulty weight data could not be excluded from the study and may have affected the results.

As indicated by Palta et al. (1982) and Rowland (1990), drivers’ licenses and ID cards clearly present a problem when used as a source of information on living weight.
The data collected by questionnaire in the living portion of this study further illustrate this point and support the observations of the previously mentioned authors. While the difference between actual stature and stature recorded on drivers’ licenses (or state ID cards) was usually only one or two inches, the average difference in weight values was 9.84 lbs. Whether the difference is due to weight fluctuation, outdated records, or under-reporting is unclear, but obviously a problem exists in relying on weight data from such sources. In addition to problems with identification cards, Aiello and Wood (1994) warn against relying on weights established at autopsy, as postmortem dehydration may result in lower than normal body weights.

Age related weight changes might also have complicated the attempt to create equations useful for all age groups. Since the majority of individuals represented in the sample used for the skeletal portion of this study were over the age of 50, naturally declining weight may have been a factor in the results (Stevens et al., 1991).

The results of this study may also have been biased by sex and ancestry. A disproportionate number of the individuals measured were white males, with black males, and white and black females largely underrepresented. Only two black females with weight data were included. Inclusion of the two black females in either an “all female,” or “all black” subsample was not carried out because weight studies have identified differences in the way black and white males and females fluctuate in weight throughout their adult lives (Stevens et al., 1991).

**Living Study**

White females showed a similarly high correlation between ASIS breadth and weight ($r = 0.623$) when compared to black females, but displayed a nonsignificant
relationship between weight and stature ($r = 0.162$). Compared to the female subsamples, white males exhibited a higher correlation between weight and stature ($r = 0.535$), and nonsignificant correlation between weight and ASIS breadth ($r = 0.216$). However, only the black female and “all groups” subsamples warranted regression analysis, as they demonstrated significant correlations between weight and both independent variables.

In contrast with the skeletal study, the number of black females in the living study was sufficient to include them in analysis. The black female subsample demonstrated the lowest mean $|\%PE|$ (9.17%), SEE (7.68 kg), and mean difference between estimated and recorded weight (6.02 kg). Also, black females showed the highest correlations between weight and both ASIS breadth ($r = 0.664$) and stature ($r = 0.780$). Amount of variation accounted for by the independent variables was also highest in black females, at 62.2%. The all-inclusive category exhibited a slightly higher mean difference between estimated and recorded weight, SEE, and $|\%PE|$. Both groups were also characterized by negative $\%PE$ values, indicating that weight was overestimated.

The living population sample was more equally representative of sex, ancestry, and age group than the skeletal sample, but other difficulties arose in the process of data collection. In the living study, volunteers were asked to identify the forward-most projection of their hipbones with their fingers. Most people had no problem palpating their hipbones and finding the proper points, but some individuals with excess abdominal flesh had difficulty identifying the projections. Although all insisted they had found the bony landmarks eventually, there was no way to validate their claims. Specifically, measuring the pelvic area in living subjects proved difficult because there was no comfortable or respectable way to “feel around” the area. This researcher had to rely on
the volunteer’s assessment of where his or her ASIS was in order to comply with IRB guidelines.

One characteristic of weight that may complicate prediction efforts is its fluctuation, be it natural or due to dieting. In the questionnaire, all subjects were asked if they had lost or gained five or more pounds in the last six months. Of 35 people who answered affirmatively, the average loss or gain was 9.06 pounds, with a range between five and 25 pounds. The ability of a model to predict accurately may depend on its ability to account for fluctuation in weight. According to Nelson et al. (1994), “normal” fluctuation of weight over a several-year period ranges between five and ten pounds. However, the weight values predicted in this study often fell outside of the five to ten pound range, perhaps due to more drastic weight fluctuation.

**Comparisons/Implications of Skeletal and Living Results**

Overall, weight was more accurately predicted in the living population study. The two living study subsamples for which regression equations were derived exhibited lower mean differences between estimated and actual weight, lower mean absolute percent prediction errors, and higher adjusted $R^2$ values than the two skeletal samples that were analyzed. The disparity between results for the living and skeletal studies may have been due to the same dissimilarities in subsample size and characteristics as discussed above. For example, the mean age of individuals measured in the skeletal study was 51.4 years, while the living study exhibited a younger mean age of 32.22 years.

Finally, results may also have been affected by the difference between measurements taken on dry versus wet bone. Descriptive statistics (see Tables 1a and 1b) for both studies indicate that ASIS breadth experienced slightly smaller values in the
skeletal study, which may attest to some shrinkage in the dry bone. Mean ASIS breadth was 22.69 cm in the skeletal study and 24.88 cm in the living samples. Although DeSouza (1913) argues that no correction is required for “soft parts” in the inter-spinous measurement, perhaps a small correction for the pubic symphysis or excess abdominal flesh would make some difference in the results.

Conclusion

Aside from issues of age and weight records, body weight may defy accurate estimation because of its inherent qualities. Body weight in America is often dictated by culture and upbringing; it is a product of lifestyle and popular culture. Today we are witness to a multitude of often conflicting factors affecting weight, such as the “fast food culture,” the push for more exercise, and fad diets. However, if normal fluctuation in weight throughout a lifespan can be accounted for in prediction models, then perhaps an accurate technique can be discovered. Until then, using a combination of nonmetric observations is probably the best method for predicting body weight from skeletal remains.

The combined measurements of ASIS breadth and stature are not adequate predictors for living body weight. Although correlations exist between the aforementioned variables, they are not enough to generate accurate estimations. However, further research in the area of weight estimation would benefit from an equal representation of sex, ancestry, and age groups. Lastly, future researchers may wish to consult the wide body of data established by paleoanthropologists, as many useful models have arisen from that area of science.
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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVED CONSENT FORM

1. STUDY TITLE: Estimation of Living Body Weight Using Measurements of Bi-iliac Breadth and Stature.

2. PERFORMANCE SITE: Baton Rouge, Louisiana

3. INVESTIGATOR: The following investigator is available for questions about this study, M-F, 10:00pm – 5:00pm.

   Jaime Suskewicz  jasusk@yahoo.com

4. PURPOSE OF THE STUDY: To assess the usefulness of bi-iliac breadth and stature measurements in the determination of living body weight from skeletal remains.

5. SUBJECT INCLUSION: Individuals between the ages of 20 and 90.

6. NUMBER OF SUBJECTS: 100

7. STUDY PROCEDURES: The first segment of this study requires the participant to complete a short questionnaire pertaining to their age, race, and biological gender. In the second segment of the study the investigator will perform the measurements of bi-iliac breadth (width between hip bones), height, and weight on the subject. The entire process should take approximately 5 minutes.

8. BENEFITS: Subjects will be contributing to a body of knowledge intended to aid in the identification of deceased individuals.

9. RISKS: The only study risk is the inadvertent release of sensitive information found in the questionnaire regarding weight. However, every effort will be made by the investigator to maintain the confidentiality of your study records.

10. RIGHT TO REFUSE: Subjects may choose not to participate or to withdraw from the study at any time.

11. PRIVACY: Results of this study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless law requires disclosure.

12. SIGNATURES:

The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigator. If I have questions about subject’s rights or other concerns, I can contact Robert C. Matthews, Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and acknowledge the investigator’s obligation to provide me with a signed copy of this consent form.

Signature of Subject: X ____________________________ Date: __________
APPENDIX B
LIVING STUDY QUESTIONNAIRE

Gender:  M  F

Race:  B  W  Other (specify)_______

Age:

Have you lost or gained 5 pounds or more in the last 6 months?  Y  N

If yes, please specify amount lost or gained:
Lost: ______ Gained: ______

Please record your height and weight as it is listed on your driver’s license (or ID):
Height: ______ Weight: ______

By initialing this form, I acknowledge:
• The above information is correct to the best of my knowledge;
• I give my consent that all information may be used as data in the Body Weight Estimation Research Project;
• My name will not be used; it is an anonymous study.

Initials: _____

Thank you for participating!
VITA

Jaime Suskewicz received a Bachelor of Arts degree in anthropology from Rutgers, The State University of New Jersey, in 1998. After graduation she was employed as a field technician in the cultural resource management company, Richard Grubb and Associates, Inc. in Cranberry, New Jersey. In 2002, Jaime was accepted to the graduate program in anthropology at Louisiana State University (LSU).

While at LSU, Jaime worked in the Forensic Anthropology and Computer Enhancement Services (FACES) Laboratory assisting with casework and performing various laboratory duties. She also acted as Educational Outreach Coordinator for the FACES Laboratory during 2003-2004. Jaime’s future plans involve pursuing a career in forensic anthropology and earning a doctoral degree.