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Discrepancies between reported and cadaveric body size measurements associated with a modern donated skeletal collection

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ABSTRACT

Body mass and stature estimation methods used in biological anthropology require materials with known body size information. There are several types of body size data that can be associated with skeletal collections. However, discussion regarding the reliability and suitability of these types of information for anthropological research is scarce. This paper focuses on differences between reported and recorded cadaver weights and heights associated with a modern donated skeletal collection, similar to these commonly used in anthropological research. In addition, the study identifies factors that may influence these discrepancies. The results show statistically significant differences between reported and cadaver body size information. Generally, reported weights, statures and body mass indices (BMI) were greater compared to the cadaver information in this sample. However, potential effects on these discrepancies varied depending on sex and information type. Age was found to influence stature discrepancy in females, and donation type had an effect on the female weight discrepancy. The results also show that body size range (weight, stature and BMI) can contribute to these discrepancies. Even though the differences between reported and cadaver data may not be significant at the population level, the individual variation can cause misclassifications of individuals depending on the data used. This study encourages researchers using modern documented collections and their body size information to openly acknowledge the types of weight and stature data used and to discuss potential problems associated with them.

Introduction

Body size is a variable commonly estimated from skeletal remains in bioarchaeology and forensic anthropology. Body size, in this paper, refers to measurements such as stature, weight and body mass index (BMI). In order to create reliable body size estimation methods, known stature and weight information is required. This information is also essential for studies that use body size measures as contributing factors to other biological processes such as aging or pathological conditions. This paper focuses on documented statures and weights associated with a modern skeletal collection, and reports potential discrepancies seen between different types of information.

Bioarchaeology and forensic anthropology estimate body size for slightly different reasons. Bioarchaeology focuses on reconstructing approximate weight and stature on a population level in order to understand geographical and temporal variation in

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body size (Grabowski et al., 2015; Ruff et al., 2005). The approximate body size usually refers to an ideal weight which a skeletal frame is built to endure rather than the actual weight of an individual (Ruff et al., 1991), and stature refers generally to the maximum stature reached before age-related reductions in old age. In forensic anthropology, the aim is to estimate body measurements that reflect the actual body size at the age-at-death including the possible changes due to old age, or the maximum body size that the individual was known for during life (Ousley, 1995; Wilson et al., 2010). Forensic anthropologists use body size, mainly stature, to help to identify the remains even though its main usefulness may be limited to extreme weights and stature (Rainwater et al., 2007; Steadman et al., 2006).

Documented body size information is not only needed for estimation methods. The increasing prevalence of obesity in modern populations has raised an interest in studying possible effects of body size and BMI on various aspects of human biology such as aging, pathological conditions and bone properties (e.g., Harrington and Wescott, 2015; Lorkiewicz-Muszyńska et al., 2013; Merritt, 2015; Moore, 2008; Reeves, 2014; Wescott and Drew, 2015; Zukowski et al., 2012).

Regardless of the context and the questions anthropologists want to answer, it is important that researchers are aware of the different types of body size data used in their studies. Some studies use measured dimensions obtained from living people through imaging methods (Ruff et al., 1991; Squyres and Ruff, 2015); however, when access to living samples is not available, documented skeletal collections are widely used to test and develop methods for stature and weight estimation (Grabowski et al., 2015; Raxter et al., 2006; Trotter and Gleser, 1952). The body size information usually associated with skeletal collections includes either reported (also called forensic) or cadaveric measurements. Accuracy concerns are evident with each type of body size, and this paper concentrates specifically on the differences between reported and cadaveric measurements.

Even though these differences are important, there are only a few publications reporting or discussing this issue and it mainly concentrates on stature (Cardoso et al., 2016; Ousley, 1995; Todd and Lindala, 1928a; Trotter and Gleser, 1952; Wilson et al., 2010), whereas weight variability has received less attention (Ruff et al., 1991; Todd and Lindala, 1928a). In fact, many studies may not clearly address the type of weight they are using or possible weaknesses of the recorded data (Agostini and Ross, 2011; Elliott et al., 2014; Godde and Wilson-Taylor, 2011; Moore and Schaefer, 2011; Wescott and Drew, 2015; Wheeler et al., 2015).

The current study examines the degree and direction of discrepancy between reported and cadaveric stature and weight in the W.M. Bass Donated Skeletal Collection (Bass collection). This collection is a contemporary documented skeletal collection at the University of Tennessee and it consists mostly of self- and family donations. Various antemortem and cadaveric information, including height and weight data, is associated with the skeletons. The extent and quality of information depends on the individual, donation type and the required paperwork, and intake procedures at the time of donation (see more in Materials and methods). The Bass Collection is widely used especially in forensically orientated research. Its use in this context is preferred over older documented collections, such as the Terry Collection and the Hamann-Todd Collection, because it helps to avoid possible secular change effects (Jantz and Meadows Jantz, 2000; Meadows Jantz and Jantz, 1999). The Bass Collection is one of the biggest collections still being added to, and its use in studies requiring body size data will likely increase in the future and critical discussion on its documented information is needed. It is also useful for studying the possible effects of biological factors (age, sex, weight, stature and BMI) and non-biological factors (donation type, time since reporting body size and time since death) on the differences between reported and cadaveric size measurements in general.

Body size information

Reported body size

Reported body size is often used in health care when actual measuring of an individual is not feasible. Reported body size in anthropological contexts can also be referred to as a forensic body size, especially forensic stature, which usually means a stature based on driver's license or other reported sources (Ousley, 1995; Wilson et al., 2010). The procedures vary from country to country or state to state and if the height information is included in the driver's license, it can be either measured living or self-reported, the latter of which is usually the case in the USA (Willey and Falsetti, 1991). Thus, reported information can be based on a measured living weight or height at some point during life but does not necessarily reflect the actual size at the time of reporting. This occurs, for example, when the individual is measured at the age of 17, but he still reports this measurement at the age of 35. Reported size can also be a rough estimate of the current weight or height.

Individuals tend to over-report their stature, but this is usually more common and more marked in males, short individuals and older individuals (Gunnell et al., 2000; Rowland, 1990; Willey and Falsetti, 1991). Self-reported weight is often underestimated (Krul et al., 2010; Rowland, 1990; Stunkard and Albaum, 1981; Yoong et al., 2013), but over-reporting has also been observed in different samples (Bowring et al., 2012; Cawley et al., 2015; Kuczmarski et al., 2001; Merrill and Richardson, 2009). The underestimation is more pronounced in obese individuals (Shields et al., 2008; Tang et al., 2016). The tendency of overestimation in stature and underestimation in weight may result in inaccurate BMIs (Gavriilidou et al., 2015; Krul et al., 2010; Kuczmarski et al., 2001; Merrill and Richardson, 2009; Shields et al., 2008; Shiely et al., 2013).

Body size information in modern skeletal collections can be reported by the donor before death or by family members after death. Family-reported body size information tends to follow the same pattern as self-reported data: stature is overestimated and weight underestimated (Reed and Price, 1998). In general, the third party reports, including family reports, are considered to be less accurate than self-reported data (Hendershot et al., 2006; Kahn et al., 2007). Misreporting of body size, especially in self-reports, is commonly attributed to factors such as a social desire towards lower body mass and taller stature, rounding of digits, and failure to update measurements with increasing age and thus a biased perception of one's own body size (Castro, 2015; Froehlich-Grobe et al., 2011;