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Sample-specific sex estimation in archaeological contexts with commingled human remains: a case study from the Middle Neolithic cave of Bom Santo in Portugal

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ABSTRACT

Estimating sex on large assemblages of commingled skeletal human remains is challenging because it prevents the systemic observation of the skeleton and thus reduces the reliability of sex-ratio estimation. In order to tackle this problem, the applicability of sample-specific odontometric methods was assessed on the human skeletal remains from the Middle Neolithic cave necropolis of Bom Santo in Portugal. We present an approach that confirms some of the assumptions – the normal distribution of the data and the 1:1.5 sex ratio – indicated by Albanese et al. (2005) for the application of sample-specific methods. These assumptions are often difficult to assess in archaeological samples and thus prevent the use of sample-specific methods.

The mean bucco-lingual diameter of 51 lower right canine teeth was used as a cut-off point to discriminate between sexes within a sample from Bom Santo. Before that, Shapiro–Wilk statistics was used to confirm that the distribution of the data in a sample of 51 lower canine teeth was normal. In addition, the range and central tendency of the data were compared to other samples for which the sex of the individuals was known in order to confirm that those parameters were consistent with those of a sample presenting a balanced sex ratio. The canine sex estimations were then compared with the sex estimation obtained from mandibles where canine teeth were still *in situ* ($n = 8$). No clear disagreement between the two methods was found thus demonstrating good potential of this method for sex estimation and for the sex ratio estimation in commingled human skeletal remains. Results indicated that sex ratios in Room A and Room B at Bom Santo were quite different. This indicates that the two locations may have been used in a different way according to sex.

1. Introduction

One contribution of biological anthropology to archaeology is the estimation of the biological profile of the individual humans by analysing their remains, generally their skeletons. This profiling is paramount in order to interpret certain socio-cultural aspects of these populations, for example linking specific burials to specific age groups or sex (Mays, 1998; Molleson, 2006; Milner et al., 2008). Even with the advent of archaeogenetics (e.g.: Haak et al., 2008), skeletal analysis is still the quickest, cheapest and most practical way of assessing some parameters of the biological profile, especially when the human assemblage comprises many individuals. However, the methods adopted by biological anthropology are seldom completely reliable (Milner et al., 2008), especially when the analysis focuses on incomplete skeletons or commingled assemblages. Examples include the determination of their sex, a

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parameter for which successful estimation depends on which bones are available for examination.

The pelvis is the most sexually dimorphic part of the human skeleton and therefore the best predictor of sex. In fact, some methods based on the pelvis, specifically on the hip bone, may be almost 100% accurate (Bruzek, 2002; Albanese, 2003; Murail et al., 2005). Unfortunately however, this bone is often poorly preserved thus impairing its examination. Other methods, such as the ones based on cranial morphology or measurements of post-cranial bones, are not as reliable either because sexual dimorphism is less pronounced or because those variables tend to be more population-specific. The application of a population-specific method across populations usually decreases its accuracy due to inter-population differences in shape, size and sexual dimorphism (Işcan et al., 1998; Albanese et al., 2005; Cardoso, 2008). Consequently, no adequate referential samples are available for comparison with archaeological remains. Those are some of the problems that need to be considered when attempting to sex a skeleton. The difficulty is even greater when the human remains are poorly preserved and/or commingled. In these cases, often the number of individuals allocated to a specific sex is much smaller than the minimum number of individuals of that very same context and therefore may not give a clear picture of the sex distribution. As a result, any inferences regarding sex-ratio and any subsequent discussion about sex-related correlations with funerary locations, specific mortuary practices or particular sets of artefacts may be unreliable.

Albanese et al. (2005) propose a sample-specific approach to help solve this problem. Briefly, they argue that the osteometric mean of certain skeletal standard measurements obtained from a set of unknown individuals, could be used to carry out sex estimation on that very same set. This approach was developed using the humeral joint measurements, and provided significant correct sex allocation of all individuals (88–100%). Cardoso (2008) further explored this approach by testing it on human teeth and concluded that odontometrics are also useful for the development of sample-specific univariate methods. His results indicate that the buccolingual diameter (BLD) of the permanent canine provides the best sex allocation (100% for the upper canine and 86% for the lower canine). Others also found a very significant sexual dimorphism in the BLD of canines in samples of individuals of known-sex (Yamada and Sakai, 1992; Işcan and Kedici, 2003; Cardoso, 2008; Rai et al., 2008; Ruengdit et al., 2011; Zorba et al., 2011) and on an archaeological sample of individuals whose sex could be ascertained from their pelves and long bones (Ditch and Rose, 1972). In contrast, Vodanovic et al. (2007) failed to do this in a sample of medieval Croatians of unknown sex. However, this may have been due to the fact that sex estimation had been carried out on cranial features rather than on the hip bone. In addition, Harris and Nweeia (1980) also did not find significant sexual dimorphism on a sample of individuals from the Amerindian Ticuna population in Colombia and suggested that indigenous South Americans may be characterized by reduced sexual dimorphism. Although no statistical testing was done by Ling and Wong (2007), sexual dimorphism was apparently small in their sample of canines from southern Chinese people. It therefore seems likely that sexual dimorphism of human canines may vary geographically and therefore this tooth may not be useful for sex estimation in certain populations.

The results of Cardoso (2008) study are encouraging and suggest that it may be relatively easy to sex commingled skeletons. First, his method avoids the use of metric references that are not specific to the context that is being examined. Second, his method is based on teeth which are often the most common and well preserved parts of the skeleton and thus usually provide the highest minimum number of individuals. Third, and taking into consideration the results from some authors like Garn et al. (1977) and Cardoso (2008), it seems to allow for the quite successful sex estimation of subadult individuals because mineralization of the crown of the permanent canine is complete long before adulthood is attained (Smith, 1991). Unfortunately, sex estimations based on sample-specific univariate methods are usually less reliable than sex estimations based on the systemic examination of the skeleton. However, in the case of odontometrics, the use of several teeth and measurements did not improve the sex allocation estimates obtained on the canine tooth alone (Cardoso, 2008).

The aims of this article are to: 1) assess the applicability of the sample-specific method of Albanese et al. (2005) and Cardoso (2008) by using commingled human remains from the Middle Neolithic cave-necropolis of Bom Santo (Alenquer, Portugal); and 2) provide a more comprehensive portrait of the sex-ratio present in Bom Santo. The mean sex-pooled BLD of the lower canine obtained from this sample was used to allocate individuals according to sex. It is not possible to confirm sex estimation results by examining the pelvis of the respective individual when dealing with commingled remains, so the mandible – which does present some sexual dimorphism (Ferembach et al., 1980; Buikstra and Ubelaker, 1994) – was used as a measure of concordance. In addition, no specific burial practices or associated artefacts provided any corroborative information concerning the sex of the individuals. The results we present may contribute towards a discussion of the usefulness of the sample-specific method proposed by Albanese et al. (2005) and Cardoso (2008).

2. Material and methods

The material used in this study was recovered from Bom Santo, a Middle Neolithic burial cave located on the eastern slope of the Montejunto Mountain, 350 m a.s.l., some 50 km north of Lisbon, Portugal (Fig. 1). Discovered intact in 1993 during a spelaeological survey, it was immediately recognized as an important archaeological site. Such a conclusion was based, among other things, on the vast cemetery complex it contains. The cave comprises several galleries and corridors subdivided into 11 distinct sectors, totalling 285 m^2, in which a provisionally estimated minimum number of 121 individuals were present - both adults and sub-adults. They lie on the surface of the cave (Duarte, 1998). Furthermore, the absence of multi-stratified archaeological deposits indicates a relatively brief occupation, between 3800 and 3400 cal BC, according to available radiocarbon determinations (Carvalho et al., 2012). This conclusion is also supported by a very homogeneous material culture, composed mostly of knapped flint blades and microliths, and polished axes and adzes made of metamorphic rocks. There are also some bone tools -mainly awls or points – and personal adornments such as beads, pendants and bracelets made of shell or stone. There are also four pottery vessels. Such a scant number of pots is also observed in other Middle Neolithic cemeteries in caves, hypogea, and megalithic tombs, which seems to indicate common funerary practises.

Four seasons of systematic survey and excavations were undertaken between 1994 and 2001, in so-called Rooms A and B (Fig. 1), under the direction of Cidália Duarte (in collaboration with J. Morais Arnaud in the 1994 season of excavations). Given the scientific and historical importance of this archaeological site and its contents, a research project is underway to assess and study the human remains and other material recovered during the excavations. The material is housed in the *Museu Nacional de Arqueologia* (Lisbon). Data on human biological profile, palaeopathology as well as palaeoisotopes were analysed and are currently being published (see among others, Carvalho et al., 2012; Carvalho and Petchey, 2013; Carvalho, 2014).