HOMO - Journal of Comparative Human Biology 62 (2011) 351–358

Contents lists available at SciVerse ScienceDirect

HOMO - Journal of Comparative Human Biology

journal homepage: www.elsevier.de/jchb

The reliability of osteometric techniques for the sex determination of burned human skeletal remains

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ARTICLE INFO

Article history:
Received 11 February 2011
Accepted 29 June 2011

ABSTRACT

The influence of heat-induced shrinkage on the osteometric sexual dimorphism of human skeletons is still poorly known. In order to investigate this issue, a sample composed of 84 Portuguese individuals cremated at a modern crematorium was examined using standard measurements from the femur, the talus and the calcaneus. In addition, sex determination of the sample was attempted by using osteometric standards developed from the Coimbra collection of identified skeletons. This was carried out to assess the extent of the effect of heat-induced shrinkage on the correct classification of known-sex skeletons while using standards developed on unburned skeletons.

Results demonstrated that sexual dimorphism was still observable in the sample of calcined bones despite shrinkage. However, the application of conventional osteometric standards was unsuccessful. As expected, shrinkage caused most females to be correctly classified according to sex, but the sex allocation of males was very poor for all standard measurements.

The results were obtained on a small sample but suggest that univariate metric techniques specifically developed for calcined bones may be valuable for sex determination. This would bring new methodological possibilities for biological anthropology and would enlarge the set of techniques regarding sex determination of burned skeletal remains.

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doi:10.1016/j.jchb.2011.08.003

RESUMEN

O efeito da redução de volume térmico-induzida no dimorfismo sexual de esqueletos está parcamente documentado. De forma a investigar esta questão, algumas medidas-padrão do fémur, do astrágalo e do calcâneo foram examinadas num conjunto de 84 indivíduos Portugueses cremados em crematório moderno. A juntar a isto, a determinação sexual da amostra recorrendo aos protocolos de análise osteométrica desenvolvidos a partir da coleção de esqueletos identificados de Coimbra foi também ensaiada. O objectivo deste procedimento consistiu em avaliar o efeito da redução de volume térmico-induzida no índice de classificação correcta de esqueletos – cujo sexo é conhecido – a partir de protocolos de análise desenvolvidos em esqueletos não-queimados.

Os resultados confirmaram a preservação de dimorfismo sexual em ossos calcinados apesar da redução de volume térmico-induzida. No entanto, a aplicação de referências osteométricas convencionais não foi bem-sucedida. Tal como esperado, a redução de volume conduziu à correcta classificação sexual da maioria das mulheres, mas a mesma operação obteve reduzido êxito no caso dos homens independentemente da medida-padrão testada.

Apesar de obtidos numa pequena amostra, os resultados sugerem que técnicas osteométricas univariadas especificamente desenvolvidas a partir de ossos calcinados podem contribuir para determinações sexuais fiáveis. A sua eventual confirmação trará novas possibilidades metodológicas ao campo da antropologia biológica e por conseguinte ampliará o conjunto de técnicas actualmente adoptadas para a determinação do sexo em restos humanos queimados.

Introduction

The analysis of burned skeletal remains is very challenging because heat-induced changes and fragmentation severely interfere with bone examination and hamper analytical methods commonly used for biological profiling (Fairgrieve, 2008; Piontek, 1975; Thompson, 2002, 2004). Osteometric techniques are especially affected by heat-induced changes on bones, in particular by shrinkage which is caused by dehydration, loss of organic components and by recrystallization followed by fusion of hydroxyapatite crystals (Bradtmiller and Buikstra, 1984; Dokladal, 1962; Hiller et al., 2003; Holden et al., 1995; Grupe and Hummel, 1991; Stiner et al., 1995; Thompson, 2004).

The prediction of sex using osteometric techniques is affected by the differential shrinkage that bones undergo during burning events. Several authors state that percentage of shrinkage is related to the extent of the combustion, being negligible at low temperatures and occurring mainly at temperatures higher than 700–800 °C (Buikstra and Swegle, 1989; Herrmann, 1977; Shipman et al., 1984; Thompson, 2004). At these temperatures, bones have experienced or are experiencing the four theoretical phases of heat-induced transformation: dehydration occurs at temperatures between 100 °C and 600 °C; decomposition is related to removal of organic components at 300–800 °C; inversion refers to removal of carbonates between 500 °C and 1000 °C; and shrinkage occurs during the fusion phase at temperatures above 700 °C. These temperature intervals have been revised by Thompson (2004) after Mayne Correia (1997). Buikstra and Swegle (1989) reported less than 6% of shrinkage at temperatures higher than 800 °C but values as high as 30% in size reduction have been observed by Grupe and Hummel (1991). Therefore, a considerable variation in the rate of shrinkage has been detected. This may be related to factors such as type of bone or bone mineral content (Herrmann, 1977; Mayne Correia, 1997).