Cadernos do GEEvH

http://geevh.jimdo.com/cadernos-do-geevh/

TECHNICAL NOTE

New data about sex and age-at-death based on the postcranial skeleton of the enslaved adult Africans found at Lagos, Portugal (15th-17th centuries)

Maria Teresa Ferreira[a,b]*, Catarina Coelho[a], João d'Oliveira Coelho[a,c], David Navega[a], Sofia N. Wasterlain[a,b]

[a] Laboratory of Forensic Anthropology, Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Portugal.

[b] CIAS – Research Centre for Anthropology and Health, Department of Life Sciences, University of Coimbra, Calçada Martim Freitas, 3000-456 Coimbra, Portugal.

[c] Institute of Cognitive & Evolutionary Anthropology, University of Oxford, UK.

*Corresponding author: mtsferreira@yahoo.com

Article received on the 1st of June of 2018 and accepted on the 26th of October of 2018

ABSTRACT

The excavation of an urban dump (15th-17th centuries) outside the walls of Lagos city (Portugal) allowed for exhumation of the skeletal remains of 158 individuals of sub-Saharan origin. Since fieldwork, the age-at-death and sex estimations of adult individuals have been problematic. However, these parameters are essential, not only to achieve this group's demographic profile, but also for future analyses, such as the study of trauma or degenerative lesions. This technical note aims to present the results of age-at-death and sex estimations on the basis of the postcranial skeleton using several metric and non-metric methods. The analysed sample is composed of every individual whose long bones' epiphyses were already fused with the diaphyses (N=103). Sex estimation was performed by applying a majority vote approach. To estimate age-at-death, a probabilistic approach was followed. The sex was estimated for 88 individuals (56.31% females, 29.13% males). Age-at-death was calculated for 91 individuals, most belonging to two age groups: 20-29.99 years (32.97%) and 30-39.99 years (39.56%). The sample's sex ratio is not known because 14.56% of individuals were of unknown sex. Concerning age distribution, 6.59% individuals were aged over 40 years, supporting the historical sources according to which younger people would be preferred.

Keywords: sex estimation; age-at-death estimation; postcranial skeleton; African ancestry; enslaved.

***

RESUMO

A escavação de uma lixeira urbana (séculos XV-XVII), fora das muralhas da cidade de Lagos (Portugal), permitiu a exumação dos restos esqueléticos de 58 indivíduos de origem Subsariana. Desde os trabalhos de campo que as estimativas da idade-à-morte e sexo se revelaram problemáticas. No entanto, tais parâmetros são essenciais, não apenas para desenhar o perfil demográfico deste grupo, mas também para análises futuras, tal como o estudo das lesões traumáticas e degenerativas. Nesta nota técnica pretende-se apresentar os resultados das estimativas do sexo e idade-à-morte obtidas através de vários métodos, métricos e não-métricos, baseados no esqueleto pós-craniano. A amostra analisada é composta por todos os indivíduos cujas epífises dos ossos longos se encontrem já fundidas com as diáfises (N=103). A estimativa do sexo foi realizada através de uma abordagem de voto maioritário. Para estimar a idade-à-morte optou-se por uma abordagem probabilística. O sexo foi estimado em 88 indivíduos (56,31% mulheres, 29,13% homens). A idade-à-morte foi calculada para 91 indivíduos, a maioria dos quais pertencendo a dois grupos etários: 20-29,99 anos (32,97%) e 30-39,99 anos (39,56%). O rácio sexual da amostra não é conhecido porque 14,56% dos indivíduos são de sexo desconhecido. No que respeita à distribuição etária, 6,59% dos indivíduos foram classificados como tendo mais de 40 anos, apoiando as fontes históricas, segundo as quais os indivíduos mais jovens eram preferidos.

Palavra-chave: estimativa do sexo; estimativa da idade-à-morte; esqueleto pós-craniano; ancestralidade Africana; escravos.

Introduction

The Portuguese maritime expansion and the subsequent Atlantic slave trade, which began in the first half of the 15th century, is a well-documented historical period, with intensively studied rich and abundant historical sources (Nogueira, 1990; Tinhorão, 1997; Fonseca, 2010; Caldeira, 2013, 2017; Costa, 2015; Russel, 2016; Marques, 2017). However, until the discovery and excavation of the Lagos osteological collection of African slaves, the skeletons of the most important protagonists of this trade were not known.

The excavation, carried out in 2009 in Valle da Gafaria (Lagos, Portugal), allowed the recovery of the skeletal remains of 158 individuals (men, women and children) from sub-Saharan Africa (Neves *et al.*, 2011; Martiniano *et al.*, 2014; Navega *et al.*, 2015; Wasterlain *et al.*, 2016; Coelho *et al.*, 2017). A comprehensive contextualization of this collection is available in Wasterlain *et al.* (2016).

Given that during the fieldwork, there were difficulties in estimating the sex and age-at-death of the individuals, the aim of this study is to re-evaluate these parameters for the adults based on the postcranial skeletons of this unique collection.

Material and Methods

Since the present work focuses in the sex and age-at-death estimation based on postcranial skeleton, the individuals represented only by the skull were excluded. Furthermore, all individuals whose long bones' epiphyses were not completely fused with the diaphyses were also excluded from the present analysis. So, of the 158 individuals exhumed from the deposit of urban waste in Valle da Gafaria (Lagos, Portugal) (Wasterlain *et al.*, 2016), a subset of 103 individuals constitutes the sample analysed here.

Skeletal measurements were obtained (in millimetres) in the left side of the skeleton whenever possible (being the right side used instead when the left was not available), using an osteometric board and a sliding calliper. The skeletal dimensions were measured blindly by one observer (MTF) in two different occasions, and once by a second observer (CC). The intra- and inter-evaluator errors were assessed by the Technical Error of Measurement (TEM) (Perini *et al.*, 2005). In the morphological approaches, all postcranial skeletons were examined under good lighting conditions by careful visual inspection by one observer (MTF).

Sex

For sexual diagnosis, both metric and morphological analyses were conducted. The height and breadth of the glenoid cavity of the scapula were measured in order to apply Macaluso (2011). The vertical diameter of the head and the epicondylar breadth of the humerus were taken for Steyn and İşcan (1999) method. To apply Asala (2001), the vertical and transverse diameters of the heads of the femurs were measured. For Asala *et al.* (2004) method, the following measures were obtained: vertical head diameter, minimum vertical neck diameter, anteroposterior and transverse subtrochanteric diameters of the femur. The iliac bones were analysed according to Phenice (1969). Other morphological features of the iliac bones were observed and recorded according to Buikstra and Ubelaker (1994) recommendations: great sciatic notch, preauricular sulcus and composite arch.

Several other data were taken into account, namely: the results obtained by Furtado (2012) through the application of the DSP metric analysis to the iliac bone (Murail *et al.*, 2005) and the morphological approach of Bruzek (2002) for 52 individuals; the genetic profile of three individuals (65, 125, and 166) made by Martiniano *et al.* (2014); and the assessment made by the first author after observing the whole postcranial skeleton.

Finally, all these results were taken into consideration by using a majority vote model, where each vote for either one of three options ("female", "male", or "unknown") was the final result of each method. This approach was chosen for the following reasons: there are no indications that any of the aforementioned method is better by itself than the others; there have been very few individuals that had inconsistent results between the different methods (if there is a tie, the final result was "unknown"); and, there are many incomplete skeletons, meaning that regions of interest for applying some of the methods might not be available, requiring a multiple methods approach.

Age-at-death

The age-at-death estimation was made from the fusion of the medial end of the clavicle and iliac crest (Webb and Suchey, 1985), the morphologic changes in the pubic symphysis (Brooks and Suchey, 1990) and in the auricular surface (Buckberry and Chamberlain, 2002) of the iliac bones.

To achieve a final age-at-death estimation, a probabilistic approach was followed. However, only the method developed by Buckberry and Chamberlain (2002) allows for direct probabilistic age-estimation. To apply a homogeneous methodology for age estimation, a resampling/simulation approach was used to obtain data to fit a conditional density estimator for the remaining age estimation techniques. From conditional parameters (i.e. probabilities or mean and standard deviations) data was simulated. For the simulated datasets and the Buckberry and Chamberlain (2002) original data, the method proposed by Muller *et al.* (2002) was used to compute posterior distribution of age-at-death given observed skeletal trait under a uniform prior over age-at-death. This approach avoids projecting reference sample's age structure upon target sample. In addition, a simple logical rule was followed: if the medial end of the clavicle and the iliac crest were not completely fused, the age estimation was based only on these two skeletal traits. Given that the incomplete fusion of these traits is strongly suggestive of a young adult individual, combining the information obtained from the pubic symphysis and the auricular surface would be redundant.

Results

The TEM results for intra- and inter-evaluator errors proved satisfactory, being all measurements accepted (Table 1).

The results for sex and age-at-death estimations by individual are presented in Table 2. Despite the comprehensive approach, 15 individuals (14.56%) are classified as being of unknown sex. Of the remaining 88, 58 are females (56.31%) and 30 are males (29.13%). Age-at-death was not estimated for 12 individuals (11.65%). The Individual 58 (female) was the youngest one (12-19 years old) and Individual 135 (female) was the oldest one (36-66 years old). The results for sex estimation by age groups based on percentile 50 are presented in Table 3. The majority of individuals for whom it was possible to estimate age-at-death belong to two age groups: 20-29.99 years (32.97%) and 30-39.99 years (39.56%).

Discussion

During the fieldwork in Valle da Gafaria, the sex and age-at-death estimations experienced several difficulties. Although Furtado (2012) performed the sexual diagnosis based on the coxal bone using the Bruzek's morphological method (2002) and the DSP metric method (Murail *et al.*, 2005), two methods that are not population-specific, only 54 individuals were analysed, *i.e.*, around half of the adults' sample. Moreover, while the non-adult individuals had already been the subject of a detailed study regarding age-at-death (Wasterlain *et al.*, 2018), this had not yet been the case for adult individuals. During the fieldwork, these were only classified as adults on the basis of the third molar eruption. Although age-at-death was recently estimated through the pulp area/tooth area ratio on a sample of 39 individuals (Rodrigues, 2017), for future analysis it is necessary to ascertain the age-at-death, not only through the teeth, but also through the bones. Hereafter, a comparative study between the age-at-death estimations provided by teeth and bone maturation in the individuals whose dentition points to an age-at-death around 20 years but whose epiphyses were not completely fused to the diaphyses should be performed.

Table 1. Intra- and inter-evaluator relative TEM results for metric data.

Measurement	Intra-evaluator (%)	Inter-evaluator (%)
(scapula) height of the glenoid cavity	1.71	1.75
(scapula) breadth of the glenoid cavity	1.87	1.88
(humerus) vertical diameter of the head	0.80	1.74
(humerus) epicondylar breadth	0.68	1.21
(femur) vertical diameter of the head	0.52	1.38
(femur) transverse diameter of the head	0.53	1.41
(femur) minimum vertical neck diameter	2.41	2.79
(femur) antero-posterior subtrochanteric diameter	2.53	2.96
(femur) transverse subtrochanteric diameter	2.07	2.98

Table 2. Sex and age-at-death estimations by individual per percentile (%ile).

Individual ID	Sex	Age-at-death (years) per %ile 0.50	0.025	0.975	Individual ID	Sex	Age-at-death (years) per %ile 0.50	0.025	0.975	Individual ID	Sex	Age-at-death (years) per %ile 0.50	0.025	0.975
8	Female	21.00	15.50	29.50	53	Male	18.00	15.00	25.00	86	Female	31.00	19.50	44.25
9	Female	29.00	20.00	40.00	54	Male		Unknown		91	Male	38.50	24.50	50.50
10	Unknown	36.00	25.00	40.00	55	Male	25.00	17.75	37.00	92	Male	38.50	24.50	50.50
11	Female	37.75	24.25	56.25	56	Male	42.00	26.00	62.00	93	Female	31.25	20.50	43.00
12	Male	24.75	18.50	34.00	58	Female	14.00	12.00	19.00	94	Female	31.25	20.50	43.00
15	Male	18.00	15.00	25.00	60	Female	28.00	20.00	38.50	95	Female	27.00	18.50	36.25
16	Female	16.50	13.50	21.00	63	Male	43.33	27.33	57.33	96	Female	44.50	26.00	61.50
18	Female	18.50	15.00	24.00	65	Male	24.00	16.00	34.00	97	Unknow	34.33	23.33	47.00
20	Male	18.50	15.00	24.00	66	Male	33.25	20.00	47.25	98	Female	25.00	17.75	37.00
21	Female	21.00	15.50	29.50	67	Female	31.25	20.50	43.00	100	Female	29.00	20.00	40.00
27	Male	26.00	17.75	38.50	68	Female	35.00	21.50	50.50	101	Male	41.67	25.33	61.67
31	Unknown		Unknown		69	Female	18.50	15.00	24.00	102	Male	27.50	19.50	42.00
32	Male	37.75	24.25	56.25	72	Female	36.67	24.33	54.67	103	Male	47.00	31.00	57.33
38	Female	20.33	17.33	29.67	73	Female	18.50	15.00	24.00	104	Male	36.00	25.00	40.00
39	Female	25.00	17.67	36.67	75	Female	37.75	24.25	56.25	105	Unknow	36.00	25.00	40.00
41	Female	39.75	23.75	51.50	77	Male	33.25	20.00	47.25	107	Male	18.50	15.00	24.00
44	Female	30.33	21.33	41.33	78	Female	36.00	22.75	53.00	110	Female	18.50	15.00	24.00
46	Male	33.25	20.00	47.25	79	Female	35.00	21.50	50.50	111	Female	34.33	23.33	47.00
47	Male	18.00	15.00	25.00	80	Female	21.00	15.50	29.50	112	Unknow		Unknown	
48	Unknown		Unknown		81	Female	21.00	15.50	29.50	114	Female	23.75	18.00	31.75
49	Male	29.00	20.00	40.00	82	Female	29.00	20.67	38.67	115	Male	27.50	19.50	42.00
51	Male	35.75	22.25	50.50	84	Female	31.00	21.67	42.33	117	Male	29.33	17.67	45.67

Table 2 (cont.)

Individual ID	Sex	Age-at-death (years) per %ile			Individual ID	Sex	Age-at-death (years) per %ile			Individual ID	Sex	Age-at-death (years) per %ile		
		0.50	0.025	0.975			0.50	0.025	0.975			0.50	0.025	0.975
118	Female	22.75	17.25	34.00	136	Female	36.00	22.75	53.00	157	Unknow	31.00	19.50	44.25
119	Female	21.00	18.50	33.00	137	Unknown		Unknown		158	Female	18.50	15.00	24.00
120	Female	26.00	20.67	35.33	139	Male	38.00	21.67	54.00	159	Female	18.50	15.00	24.00
121	Unknown		Unknown		140	Unknown		Unknown		160	Male	37.75	24.25	56.25
123	Female		Unknown		141	Unknown		Unknown		162	Female	30.25	17.75	45.75
125	Female	18.50	15.00	24.00	143	Female	35.00	21.50	44.00	163	Female	18.50	15.00	24.00
127	Female	16.50	13.50	21.00	147	Unknown		Unknown		166	Female	29.75	21.50	41.75
129	Unknown	26.00	21.00	40.00	148	Female	28.00	17.25	42.75	167	Female	22.75	17.25	34.00
130	Male		Unknown		150	Female	37.75	24.25	56.25	168	Unknow	26.00	21.00	40.00
132	Unknown		Unknown		151	Male	31.25	20.50	43.00	169	Female	26.00	20.50	33.00
133	Female	16.50	13.50	21.00	152	Female	31.25	20.50	43.00	170	Female	33.00	22.00	46.25
134	Female	18.50	15.00	24.00	153	Female	33.00	22.00	46.25					
135	Female	57.50	36.00	66.00	154	Female	18.00	15.00	25.00					

Table 3. Sex estimation by age groups (based on point estimate).

Age-at-death	Sex			Total
	Female	Male	Unknown	
< 20	14	5	0	19
20-29.99	20	8	2	30
30-39.99	21	11	4	36
40-40.99	1	4	0	5
>50	1	0	0	1
Unknown	1	2	9	12
Total	58	30	15	103

It is extremely important to clearly identify which individuals have completed their skeletal development for subsequent analyses purposes, such as those regarding traumatic lesions (ongoing investigation), occupational stress markers, and degenerative pathology. Only after such bioanthropological analyses are completed, the concepts of "biological adult" vs. "social adult" may be discussed, which is a matter of great relevance in the slavery's context (Campbell *et al.*, 2006; Lovejoy, 2006; Mendes, 2009). So, the aim of the present study was to estimate the sex and age-at-death of adult individuals based on the postcranial skeleton.

The greatest problem with the application of the existing methods for age-at-death and sex estimation is the representativeness of population of the sample (Martrille *et al.*, 2007). There is some misconception that "African populations" have low morphological diversity and thereby a method developed on the basis of a specific subpopulation could be used in all the others from that continent. In fact, both anthropological and genetic literature indicate the very opposite: Africans have the richest biological diversity (Campbell and Tishkoff, 2008; Nordling, 2017). However, identified skeletal collections (a mandatory tool to develop and test new methods) of African origins are scarce, with the exception of the South-African ones: the Raymond A. Dart Collection of Human Skeletons (Dayal *et al.*, 2009); the Cape Town Documented Skeletal Collection (Ginter, 2005); and the Pretoria Bone Collection (L'Abbé *et al.*, 2005). Moreover, South African "blacks" had origin in several regional tribes, most of which are from Zulu groups (Steyn and İşcan, 1999), that do not belong to Bantu population, the group of origin of the Lagos's individuals (Coelho *et al.*, 2017; Martiniano *et al.*, 2014; Wasterlain *et al.*, 2016). This spatial problem is followed by a temporal bias. The samples used to develop new methods do not reflect the secular changes that those populations have passed through, which might be particularly damaging for metric-based approaches. Although there is no optimal technique to bypass this problem, there are some more generalizable methods than others. Unfortunately, this problem has not been thoroughly investigated yet, so there are no guarantees about which methods can be used amongst different populations without loss of accuracy. For these reasons, an approach based on several methods was adopted in the current investigation.

Regarding sex estimates, more than half of the individuals were females. However, these results should be read with caution, since 15 individuals (14.56%) were classified as unknown sex. As for age-at-death, although the Lagos sample comprises individuals of all ages, most adults (72.53%), regardless of sex, were aged 20-39 years. According to the historical sources, in the 15th century, the Portuguese bought slaves of both sexes and ages at the African coast (Caldeira, 2013; Marques, 2017). Later, during the transatlantic trade, a slave selection could occur, depending on its intended use. For example, for the hard work in the sugar mills of Brazil or for the Spanish Empire's mines of South America, young robust men were preferred. On the other hand, for domestic work young men were not advisable because they were considered more dangerous and difficult to control (Caldeira, 2017; Marques, 2017). In the present sample, only six individuals (6.59%) were aged over 40 years, supporting the historical sources according to which older people would not be desirable for common slave labour.

Acknowledgments

The authors thank the Centre for Functional Ecology, the Centro de Investigação em Antropologia e Saúde, and Grupo Dryas Octopetala. The co-author Maria Teresa Ferreira was financed by Gerda Henkel Foundation. The co-authors David Navega (SFRH/BD/99676/2014) and João d'Oliveira Coelho (SFRH/BD/122306/2016) were financed by Fundação para a Ciência e Tecnologia. The co-author Catarina Coelho was financed by the University of Coimbra ("Forensic Anthropology project"). The co-author Sofia N. Wasterlain was financed by national funds by FCT – Fundação para a Ciência e Tecnologia, under the project with the reference UID/ANT/00283/2013. The authors also acknowledge the anonymous reviewer whose valuable comments and suggestions allowed us to improve the manuscript.

The authors state that they do not have any conflict of interest to declare.

References

Asala, S. A. 2001. Sex determination from the head of the femur of South African white and blacks. *Forensic Science International*, 117: 15-22.

Asala, S. A.; Bidmos, M. A.; Dayal, M. R. 2004. Discriminant function sexing of fragmentary femur of South African blacks. *Forensic Science International*, 145: 25-29.

Brooks, S.; Suchey, J. M. 1990. Skeletal age determination based on the os pubis: A comparison of the Acsádi-Nemeskéri and Suchey-Brooks methods. *Journal of Human Evolution*, 5: 227-238.

Bruzek, J. 2002. A method for visual determination of sex, using the human hip bone. *American Journal of Physical Anthropology*, 117: 157-168.

Buckberry, J. L.; Chamberlain, A. T. 2002. Age estimation from the auricular surface of the ilium: a revised method. *American Journal of Physical Anthropology*, 119: 231-239.

Buikstra, J. E.; Ubelaker, D. H. 1994. *Standards for data collection from human skeletal remains*. Arkansas, Arkansas Archaeological Survey Research Series.

Caldeira, A. M. 2013. *Escravos e traficantes no Império Português: o comércio negreiro português no Atlântico durante os séculos XV a XIX*. Lisboa, A Esfera dos Livros.

Caldeira, A. M. 2017. *Escravos em Portugal: das origens ao século XIX. Lisboa*, A Esfera dos Livros.

Campbell, G.; Miers, S.; Miller, J. C. 2006. Children in European systems of slavery: introduction. *Slavery & Abolition*, 27: 163-182.

Campbell, M. C.; Tishkoff, S. A. 2008. African Genetic Diversity: Implications for Human Demographic History, Modern Human Origins, and Complex Disease Mapping. *Annual Review of Genomics and Human Genetics*, 9: 403–33.

Coelho, C.; Navega, D.; Cunha, E.; Ferreira, M. T.; Wasterlain, S. N. 2017. Ancestry estimation based on morphoscopic traits in a sample of African slaves from Lagos, Portugal (15^{th}-17^{th} centuries). *International Journal of Osteoarchaeology*, 27: 320-326.

Costa, J. P. O. 2015. *Henrique, o precursor da Globalização. Lagos,* Direcção Regional de Cultura do Algarve.

Dayal, M. R.; Kegley, A. D.; Strkalj, G.; Bidmos, M. A.; Kuykendall, K. L. 2009. The history and composition of the Raymond A. Dart Collection of Human Skeletons at the University of the Witwatersrand, Johannesburg, South Africa. *American Journal of Physical Anthropology*, 140: 324-35.

Fonseca, J. 2010. *Escravos e Senhores na Lisboa quinhentista*. Lisboa, Edições Colibri.

Furtado, M. 2012. *A diagnose sexual de escravos africanos: estimativa sexual a partir de os coxae da colecção osteológica negróide de PAVd'09 (Valle da Gafaria, Lagos)*. Dissertação de Mestrado em Evolução e Biologia Humanas, Departamento de Ciências da Vida, Faculdade de Ciências e Tecnologia, Universidade de Coimbra.

Ginter, J. K. 2005. A test of the effectiveness of the revised maxillary suture obliteration method in estimating adult age at death. *Journal of Forensic Science*, 50: 1303-9.

L'Abbé, E. N.; Loots, M.; Meiring, J. H. 2005. The Pretoria Bone Collection: A modern South African skeletal sample. *HOMO – Journal of Comparative Human Biology*, 56: 197-205.

Lovejoy, P. 2006. The children of slavery – the transatlantic phase. *Slavery & Abolition*, 27: 197-217.

Macaluso, P. J. 2011. Sex discrimination from the glenoid cavity in black South Africans: morphometric analysis of digital photographs. *International Journal of Legal Medicine*, 125: 773-778.

Marques, J. P. 2017. *Escravatura, perguntas e respostas*. Lisboa, Guerra e Paz.

Martiniano, R.; Coelho, C.; Ferreira, M. T.; Neves, M. J.; Pinhasi, R.; Bradley, D. G. 2014. Genetic Evidence of African Slavery at the Beginning of the Trans-Atlantic Slave Trade. *Scientific Reports*; 4: 5994.

Martrille, L.; Ubelaker, D. H.; Cattaneo, C.; Seguret, F.; Tremblay, M.; Baccino, E. 2007. Comparison of Four Skeletal Methods for the Estimation of Age at Death on White and Black Adults. *Journal of Forensic Sciences*, 52: 302-307.

Mendes, A. A. 2009. Child slaves in the Early North Atlantic trade in the fifteenth and sixteenth centuries. In: Campbell, G.; Miers, S.; Miller, J. C. (eds.) *Children in Slavery through the Ages*. Athens, Ohio University Press: 19-34.

Muller, H.; Love, B.; Hoppa, R. D. 2002. Semiparametric method for estimating paleodemographic profiles from Age Indicator Data. *American Journal of Physical Anthropology*, 117: 1–14.

Murail, P.; Bruzek, J.; Houët, F.; Cunha, E. 2005. DSP: a tool for probabilistic sex diagnosis using worldwide variability in hip-bone measurements. *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, 17: 167-176.

Navega, D.; Coelho, C.; Vicente, R.; Ferreira, M. T.; Wasterlain, S. N.; Cunha, E. 2015. AncesTrees: ancestry estimation with randomized decision trees. *International Journal of Legal Medicine*, 129: 1145-1153.

Neves, M. J.; Almeida, M.; Ferreira, M. T. 2011. História de um arrabalde durante os séculos XV e XVI: “o poço dos negros” em Lagos (Algarve, Portugal) e o seu contributo para o estudo dos escravos africanos em Portugal. In: Matos, A. T.; Costa, J. P. (eds.) *A Herança do Infante*. Lagos, Câmara Municipal de Lagos: 29-46.

Nogueira, F. 1990. *Os grandes descobrimentos portugueses e a expansão mundial da Europa*. Lousã, Verbo.

Nordling, L. 2017. Putting genomes to work in Africa. *Nature*, 544: 20–22.

Perini, T. A.; Oliveira, G. L.; Ornellas, J. S.; Oliveira, F. P. 2005. Technical error of measurement in anthropometry. *Revista Brasileira de Medicina do Esporte*, 11: 81-85.

Phenice, T. W. 1969. A newly developed visual method of sexing the os pubis. *American Journal of Physical Anthropology*, 30: 297–301.

Rodrigues, C. 2017. *Estimativa da idade através do rácio área polpar/área do dente numa amostra de esqueletos de escravos Africanos (Lagos, Portugal)*. Dissertação de Mestrado em Evolução e Biologia Humanas, Departamento de Ciências da Vida, Faculdade de Ciências e Tecnologia, Universidade de Coimbra.

Russel, P. 2016. *Henrique, o navegador*. Lisboa, Livros Horizonte.

Steyn, M.; İşcan, M. Y. 1999. Osteometric variation in the humerus: sexual dimorphism in South Africa. *Forensic Science International*, 106: 77-85.

Tinhorão, J. R. 1997. *Os Negros em Portugal: uma presença silenciosa.* 2ª ed. Lisboa, Editorial Caminho.

Wasterlain, S. N.; Neves, M. J.; Ferreira, M.T. 2016. Dental modifications in a skeletal sample of enslaved Africans found at Lagos (Portugal). *International Journal of Osteoarchaeology*, 26: 621-632.

Wasterlain, S. N.; Costa, A.; Ferreira, M. T. 2018. Growth faltering in a skeletal sample of enslaved nonadult Africans found at Lagos, Portugal (15th–17th centuries) *International Journal of Osteoarchaeology*, 28: 162-169.

Webb, P. A. O.; Suchey, J. M. 1985. Epiphyseal union of the anterior iliac crest and medial clavicle in a modern multiracial sample of American males and females. *American Journal of Physical Anthropology*, 68: 457-466.