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Sex estimation using diagonal diameter measurements of molar teeth in African American populations

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ABSTRACT

Teeth are often recovered in forensic cases due to their postmortem longevity. The goal of the present research was to investigate the degree of sexual dimorphism in the permanent molars of African Americans using crown and cervical diagonal diameters. Discriminant functions developed from a modern Greek population were tested for accuracy of sex estimation in an African American population. One hundred and three (53 males and 50 females) individuals ranging in age from 16 years to 66 years old were used from the Robert J. Terry Anatomical Skeletal Collection. Four diagonal diameter measurements were taken for each of the left mandibular and maxillary molars: mesiobuccal-distolingual crown diameter, mesiolingual-distobuccal crown diameter, mesiobuccal-distolingual cervical diameter, and mesiolingual-distobuccal cervical diameter. The overall percentage of accuracy of the modern Greek discriminant functions when applied to the African American sample was between 53.8% and 63.6%. Males were more accurately classified (93.6%–100%) than females (0%–18.2%). The African American population specific direct discriminant functions showed accuracy rates from 72.6% to 100% for the original data and 40%–72.3% for the cross-validated data. The African American stepwise discriminant functions showed accuracy rates from 63.9% to 77.6% for the original and cross-validated data. Comparisons to other populations were made. The results suggest that, in teeth, there is variation in the degree of sexual dimorphism between populations and discriminant functions for sex estimation in dentition are population specific.

1. Introduction

Estimating the sex of an unknown individual is an important step in the identification of human skeletal remains. The osteological estimation of sex uses non-metric and metric methods. Non-metric methods use morphological features to estimate the sex of the individual. These methods are subjective and accuracy is dependent on observer experience.[1] Non-metric methods used with a complete skeleton show accuracy rates between 90% and 100%.[2–4] Metric methods use measurements and statistical analyses to objectively validate results. These methods remove observer bias of identifying the presence, absence, or prominence of characteristics that are utilized in morphological methods. Metric methods can also detect dimorphism in skeletal traits that may be characterized as ambiguous by morphological assessments.[5,6] The pelvis and skull have been shown to be the most accurate bones for the estimation of sex.[7–10]

Teeth are less susceptible to post-mortem damage and fragmentation than bone.[11,12] In forensic cases, when skeletal remains are fragmented or incomplete, the teeth may be used for sex estimation. Molars have been shown to be sexually dimorphic in the permanent dentition of males and females.[13–17] Specifically, male crown measurements tend to be larger than female values.[13,15,16,18] Canines and premolars show larger amounts of dentin in males, however females tend to have more enamel on the surface area of the crowns.[19] Eating habits, disease, and climate can influence tooth size.[13,20–24] For example, Calcagno and Gibson (1988) proposed that shifts to a softer and/or more cariogenic diet resulted in selection for smaller teeth. Oxygen enamel analysis of mammalian tooth enamel provides a record of climate change and provides important information about the response of human populations to

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Table 1
Description of diagonal diameter molar measurements.[a]

Measurement	Description[a]
Mesiobuccal-distolingual crown diameter (MBDL)	Maximum distance from the mesiobuccal corner of the crown to the distolingual corner.
Mesiolingual-distobuccal crown diameter (MLDB)	Maximum distance from the mesiolingual corner of the crown to the distobuccal corner.
Mesiobuccal-distolingual cervical diameter (cervical MBDL)	Maximum distance from the mesiobuccal corner of cement–enamel junction point to the distolingual corner.
Mesiolingual-distobuccal cervical diameter (cervical MLDB)	Maximum distance from the mesiolingual corner of cement–enamel junction point to the distobuccal corner.

[a] Modified from Hillson et al. (2005).

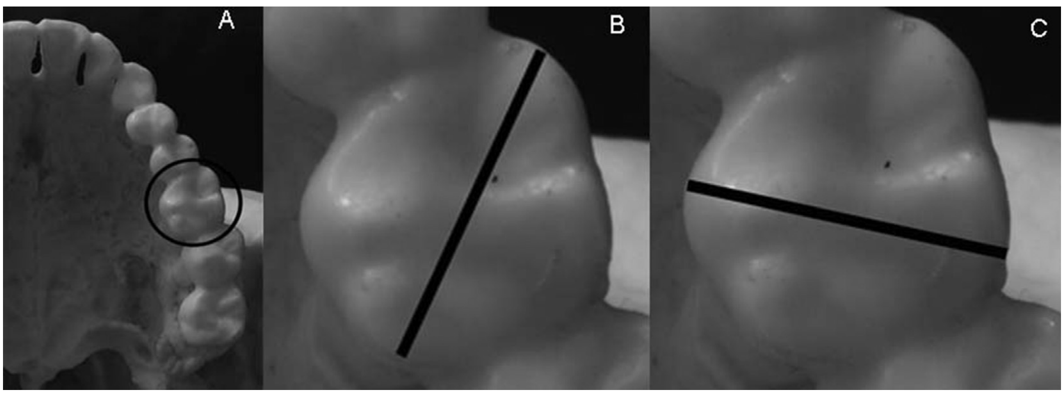

Fig. 1. Diagonal diameter dimensions used for the African American sample. (A) Left maxillary first molar, (B) Mesiobuccal-distolingual crown diameter, (C) Mesiolingual-distobuccal crown diameter.

Table 2
Descriptive statistics for the mesiobuccal-distolingual and mesiolingual-distobuccal crown dimensions in African American male and female molars.

Tooth[a]	Male				Female				% sexual dimorphism[b]	T-value	P-value
	N	Mean (mm)	S.D	C.V	N	Mean (mm)	S.D	C.V			
Mesiobuccal-distolingual crown measurements											
Max1 MBDL crown	50	12.84	0.55	4.25	44	12.14	0.60	4.96	5.77	5.83	0.000*
Max2 MBDL crown	50	13.05	0.97	7.43	48	12.32	0.70	5.65	5.93	4.35	0.000*
Max3 MBDL crown	43	12.17	0.75	6.18	35	11.30	0.91	8.02	7.70	4.58	0.000*
Mand1 MBDL crown	47	12.11	0.50	4.13	37	11.62	0.57	4.94	4.22	4.16	0.000*
Mand2 MBDL crown	51	12.35	0.73	5.90	46	12.02	0.73	6.10	2.75	2.20	0.031
Mand3 MBDL crown	42	11.78	0.81	6.91	41	11.60	0.87	7.50	1.55	0.96	0.339
Mesiolingual-distobuccal crown measurements											
Max1 MLDB crown	50	11.70	0.64	5.43	45	11.15	0.52	4.62	4.93	4.60	0.000*
Max2 MLDB crown	48	11.92	0.90	7.54	48	11.32	0.67	5.90	5.30	3.70	0.000*
Max3 MLDB crown	41	11.20	0.76	6.78	34	10.59	0.61	5.78	5.76	3.86	0.000*
Mand1 MLDB crown	45	11.88	0.48	4.01	38	11.38	0.52	4.52	4.39	4.57	0.000*
Mand2 MLDB crown	52	12.18	0.66	5.39	46	11.86	0.59	5.00	2.70	2.53	0.013
Mand3 MLDB crown	42	11.97	0.68	5.68	41	11.65	0.87	7.49	2.75	1.84	0.069

N = number of individuals.
S.D. = Standard Deviation.
C.V. = Coefficient of Variation.
* Measurements that displayed statistically significantly differences ($p \leq 0.002$, Bonferroni correction).
[a] Max = Upper Molar (Maxilla); Mand = Lower Molar (Mandible); 1 = first molar; 2 = second molar; 3 = third molar.
[b] Calculated as [(male mean − female mean)/female mean] × 100.