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ORIGINAL ARTICLE

Estimation of gender from metacarpals and metatarsals in a Mexican population☆

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Forensic anthropology;
Gender estimation;
Human identification

Abstract
Introduction: The aim of this study was to obtain discriminant functions for estimating gender from direct measurements of the metacarpal and metatarsal bones for identification of unknown individuals.
Material and methods: An analysis was performed on metacarpal and metatarsals bones of 112 adult contemporary skeletons (49 females and 63 males). The sample belongs to the Autonomous University of Mexico (UNAM) Collection from the Physical Anthropology Laboratory, UNAM Faculty of Medicine. Five measurements were taken (maximum length and four widths) of each metacarpal and metatarsal bones employing a digital calliper.
Results: Fourteen discriminant functions were developed for metacarpals with percentages from 79.5% to 85.3% of correct gender classification. The second metacarpal was the most dimorphic of the sample. For metatarsals, five discriminant functions were obtained, ranging from 77.8% to 83.2% of certainty. In this case the first metatarsal was the most dimorphic. In general terms, the widths of both epiphyses were the most dimorphic measurements.
Conclusions: The discriminant functions of metacarpal and metatarsal bones obtained are generally above 80%, which is similar to reports from other populations. Therefore, it can be used in forensic contexts for human identification with complete or fragmented remains, in the cases where no other bone element is available, such as the pelvis.

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PALABRAS CLAVE
Funciones discriminantes;
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Estimación sexual;
Identificación humana

Estimación del sexo con metacarpos y metatarsos para población mexicana

Resumen

Introducción: El objetivo de este estudio fue la obtención de funciones discriminantes para estimación del sexo a partir de mediciones directas en metacarpos y metatarsos para contribuir en la identificación de individuos desconocidos.

Material y métodos: Se analizaron métricamente los metacarpos y metatarsos de 112 esqueletos adultos contemporáneos (49 femeninos y 63 masculinos) de la Colección-UNAM del Laboratorio de Antropología Física, Facultad de Medicina, UNAM. Empleando un vernier digital se tomaron 5 medidas (longitud máxima y 4 anchuras) en cada uno de los huesos del metacarpo y del metatarso.

Resultados: Se desarrollaron 14 funciones discriminantes para los metacarpos, con porcentajes del 79,5% a 85,3% de asignación sexual correcta, siendo el segundo metacarpo el hueso más dimórfico de la muestra. Para el caso de los metatarsos se obtuvieron 5 funciones que van del 77,8% al 83,2% de certidumbre, siendo el primer metatarso el hueso más dimórfico. De manera general, las anchuras en ambas epífisis fueron las medidas más dimórficas.

Conclusiones: Las funciones discriminantes de metacarpos y metatarsos obtenidas presentan, de manera general, porcentajes por encima del 80%, lo cual concuerda con lo reportado para otras poblaciones; por lo tanto, pueden ser utilizadas en contextos forenses para la identificación humana, en restos completos o fragmentados, en el caso de no contar con otro elemento óseo, como la pelvis.

Introduction

In forensic anthropology estimation of gender is one of the most essential tasks in the positive identification of unknown subjects.

The pelvis and cranium have been most commonly used in gender estimation, because they are the most sexually dimorphic. However, the use of other bone structures, such as the bones in the hands and feet have become a reliable alternative in recognition and inference in minimal parameters (sex, age, stature and biologic filiation) in human identification,[1,2] particularly in cases of isolated, comingled and/or fragmented bones.

For calculation of gender there are two main methods: morphoscopic and metric. However, it is known that the combination of metric methods and statistical procedures where quantitative analysis are used are more objective and replicable than morphoscopic methods.[3]

As a result of the above, several proposals have been developed around the world from analysis of metacarpals and metatarsals to analyse sexual dimorphism and the consequent construction of discriminating functions through consideration of the maximum lengths and widths of the base and head, obtaining percentages which range from 74% to 100% of correct sexual classification.[2,4–10]

In Mexico several proposals have been put forward for gender calculation in individuals of the contemporary population using analysis of the cranial bones and postcranial skeleton.[11–18] However, no studies have been conducted referring to gender calculation using metacarpals and metatarsals. The aim of this study was therefore to develop specific population discriminant functions for estimating gender from metacarpals and metatarsals combined in the process of human identification.

Materials and method

The materials used in this study belong to the UNAM collection from the Physical Anthropology Laboratory of the Department of Anatomy of the Faculty of Medicine of the National Autonomous University of Mexico.

The UNAM collection comprises skeletons from recent times (1990–2010 chronological range of years from death) belonging to unclaimed bodies, from forensic institutes, public hospitals, psychiatric institutions and hostels in the City of Mexico. The majority of the individuals were recorded with pre-death data such as sex and age, and in some cases also with their name, cause of death and origin.[19]

This bone collection contains 240 individuals of both sexes, with an average age of 53.1 years (standard deviation: 17.4) for the female sex and 49.4 years for the male sex (standard deviation: 18.2).

For this study 5 metacarpals and metatarsals from both sides were analysed in a sample of 112 adult individuals (49 female and 63 male), with an age range of between 18 and 79 years for the female sex and between 18 and 85 for the male sex. They were included because they did not present with any deformity diseases or any conditions from the effects of taphonomy, and the epiphyses were completed fused. All statistical analysis was performed by grouping both sides because no significant differences were found between the sides (data not shown); this also enabled individual bilateral variation of bones to be recorded.

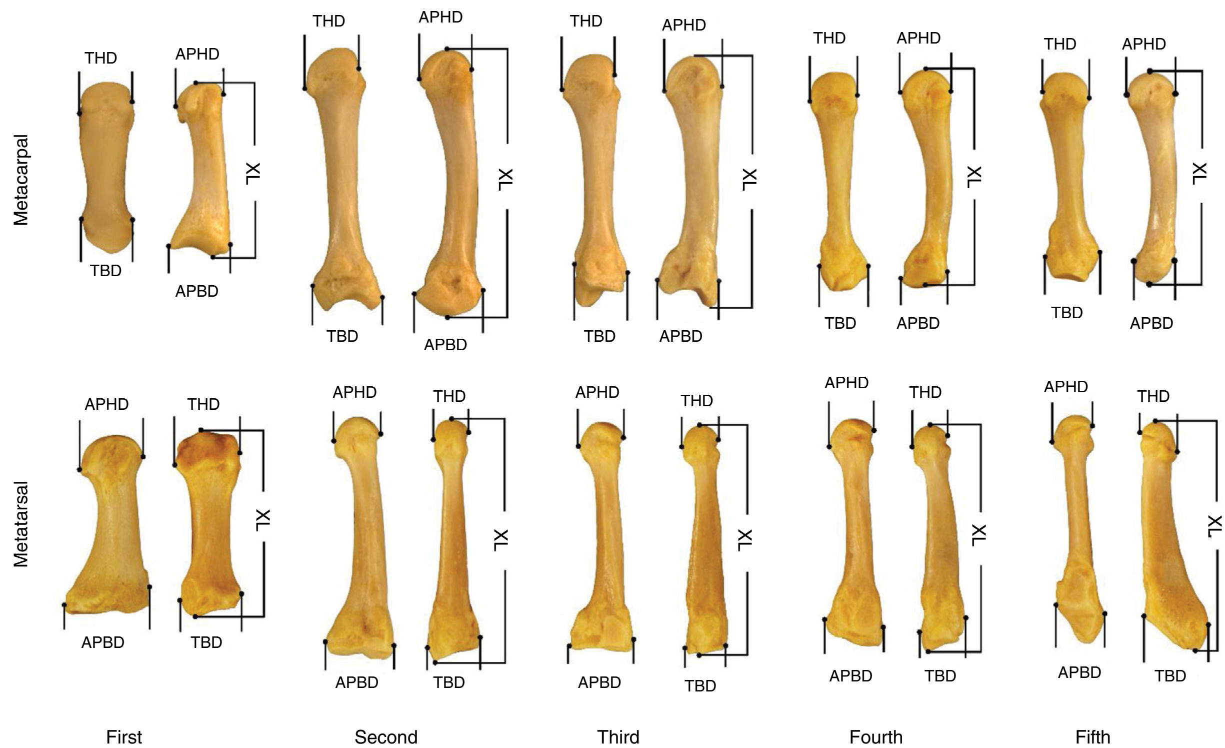

Figure 1 Measurements of metacarpals and metatarsals.
APBD: anteroposterior base diameter; APHD: anteroposterior head diameter; TBD: transverse base diameter; THD: transverse head diameter; XL: maximum length.

The means used in this study were proposed by Scheuer and Elkington[4] and Case and Ross[2] for the metacarpal and by Robling and Ubelaker[6] for the metatarsal. As a result, a total of 5 measurements were obtained for each bone comprising the maximum length and the diameters or widths in anteroposterior direction and transverse direction of the head and base (Fig. 1). All the measurements were recorded in millimetres using an electronic digital calliper (Mitutoyo©, Absolute).

Statistical analysis

In order to eliminate sources of error the measurements were made by a single observer (GTR). The technical measurement error (TME) was calculated in a subsample of 30 individuals and to perform interobserver analysis, for analysing the replicability of the measurements, the same subsample was measured by the second observer (AMG) (Table 1).

The statistical procedure included obtaining descriptive parameters (minimum, maximum, mean and standard deviation) and the contrast of the normal distribution using the *Shapiro—Wilk* test. After this, the significant differences were verified between the measurements of each sex with the Student's *t*-test for independent samples. In addition to this, the discriminant analysis was performed using the inclusion methods in steps aimed at obtaining more discriminant functions depending on the combination of variables. Finally, in each variable which demonstrated statistically significant differences the cut-off point was estimated or the centroid value (average means of each gender) and the correct sexual classification percentage was calculated. In this study the discriminant functions were reported as were the centroid values which possessed an aprioristic probability of correctly classifying approximately 80% of sexes. All statistical analyses were performed using the SPSS© v.21 software.

The study was conducted in compliance with the regulations established in articles 4 and 5 of chapter III of the *Regulation on safety and coordination in health research matters* at the UNAM of university legislation.

Results

From intraobserver analysis the maximum percentage of TME obtained with the metacarpals was 2.55% for the variable of anteroposterior diameter of the head and the minimum percentage of .52% with the maximum length. Regarding the metatarsals, the maximum margin of error variation was observed for the transverse diameter of the head with 4% and the minimum in the maximum length with .86%. Regarding the interobserver error, a maximum percentage of TME was observed, which was 2.70% in metacarpals with the transverse diameter variable of the base and the minimum of .60% in the maximum length. In the case of the metatarsals a maximum percentage of 3.12% was observed with the transverse diameter of the head and a minimum of .75% again in the maximum length (Table 1).

Average values of the total variables (maximum length, anteroposterior and transverse widths of the head and base)

Table 1 Technical error of measuring the intra and interobserver metacarpals and metatarsals.

Variable			Intraobserver		Interobserver	
			TME	% TME	TME	% TME
Maximum length	Metacarpal	XLMC	.287	.522	.332	.605
Transverse head diameter		THDMC	.202	1.686	.235	1.955
AP head diameter		APHDMC	.322	2.552	.325	2.569
Transverse base diameter		TBDMC	.318	2.319	.369	2.708
AP base diameter		APBDMC	.269	1.949	.362	2.625
Maximum length	Metatarsal	XLMT	.576	.861	.506	.755
Transverse head diameter		THDMT	.452	4.009	.350	3.128
AP head diameter		APHDMT	.286	1.882	.299	1.971
Transverse base diameter		TBDMT	.402	2.608	.437	2.833
AP base diameter		APBDMT	.257	1.289	.313	1.575

The technical measurement error (TME) may be interpreted as the margin of error allowed for each of the measurements. Considering that only one case (XLMT = .576) surpassed the highest error of .5 mm, when a decimal caliper was used to measure the metacarpals and metatarsals it could be recommended to consider .5 mm as the maximum error permitted, whilst if an osteometric slide caliper (without decimal value) had been used the technical error of the maximum measurement expected should be 1 mm. Acceptable errors of measurement were obtained in this study. The percentage of technical measurement error (%TME) may be interpreted as the amount of variability in each of the measurements which is due to the measurement error and not to biological variability. In this study the measurement error percentages were not above 5%.

analysed in metacarpals and metatarsals show that the male subjects present with a larger size than the females (Tables 2 and 3). The *Shapiro–Wilk* test showed normal distribution of the total variables (data not shown).

After applying the Student's *t*-test for independent samples it was possible to verify the existence of significant differences ($p < .05$) in all contrasted variables between sexes (Tables 2 and 3).

In this study a total of 14 discriminant functions were reported for the metacarpals, which correctly classified approximately 80% of sexes. It was thus possible to appreciate that the first discriminant function (F1) for the first metacarpal (MC1) obtained a correct sexual assignation percentage of 83.3%with just the transverse diameter of the head (THD), whilst the second function comprising the 5 variables considered in the study and obtained 84% accuracy. In the case of the second metacarpal (MC2) 4 functions with different combinations of variables obtained the highest correct classification percentages of the study, from 82.2% to 85.3%. The highest percentage was that of F3 which considered 3 variables. It is notable that all functions involved the transverse base diameter (TBDMC), and this was the most sexually dimorphic measurement in the sample (Table 4).

The percentages obtained for the third metacarpal (MC3) were of 81% for the first function with a single variable and 83.5% for both the second with 2 variables and the last function which includes all the variables.

With the fourth metacarpal (MC4) accurate classification percentages of between 79.5% and 84.2% were obtained.

Finally, with the fifth metacarpal (MC5) an accurate gender classification of 79.8% was obtained.

With regard to the metatarsals in Table 4 the 5 developed discriminant functions were shown. The first discriminant function (F1), with a percentage of 78.8% only with the transverse base diameter (TBD), the second (F2) comprising the TBD and the anteroposterior base diameter (APBD) with correct classification of 83.2%, and finally the third function (F3) which uses all the variables and presents with a percentage of 82.9%. The function created for the second metatarsal (MT2) uses all the variables obtaining a percentage of 77.8%. Lastly, the function of the fifth metatarsal (MT5) achieves a percentage of 78.9% with 2 variables, maximum length and APBD (Table 4).

In addition, in Tables 2 and 3 the cut-off points and correct classification percentage may be observed, for a total of 5 measurements (maximum length, THD, anteroposterior head diameter, TBD and APBD) for each metacarpal and metatarsal bone. These cut-off points may be used as fairly reliable guidance for sexual estimation (a priori 64–83% of correct classification) when bone fragments are involved.

Discussion

Sexual diagnosis is one of the essential elements for the creation of a biological profile in the area of forensic anthropology. Traditionally the cranium and the pelvis have been the most commonly used references in this diagnosis but it has been observed that other elements of the skeleton may be used for the estimation of gender, with favourable results.[14,15,17–20]

Furthermore, the opportunity to work with the bone collections referred to has enabled different elements of the human skeleton to be tested and developed. As a result, the contribution and development of these methodologies in the forensic context for the identification of human bone remains is of major importance since specific population standards are essential these days.

In this research the morphometric characteristics of the metacarpals and metatarsals of adult subjects from the UNAM collection were analysed. The use of metric techniques and considering 30 variable per hand and 30 per foot, made it possible to identify the epiphysary areas both proximal and distal, and the areas with the highest dimorphism between sexes.

Table 2 Statistics of the metacarpal measurements.

	Descriptives										Contrast		Classification			
	Female					Male					*T*-test	Sig.	P.C.	% classification		
	N	Min.	Max.	Mean	SD	*N*	Min.	Max.	Mean	SD				Fem	Male	Total
XLMC1	97	34.94	46.49	41.13	2.35	125	37.34	51.30	44.50	2.94	−9.49	.00	42.80	77	66	72
XLMC2	97	55.15	67.59	61.39	2.94	125	57.10	77.30	65.56	3.68	−9.115	.00	63.50	77	74	75
XLMC3	97	55.36	66.86	60.65	2.66	125	55.27	75.89	64.69	4.20	−8.755	.00	62.70	78	66	72
XLMC4	97	46.32	57.86	52.19	2.58	125	46.96	66.27	55.66	3.74	−8.17	.00	53.90	71	73	72
XLMC5	97	40.91	52.57	47.83	2.45	125	44.59	59.87	51.30	3.15	−9.237	.00	49.60	76	71	74
THDMC1	97	10.99	14.77	12.30	1.01	125	11.41	17.65	14.29	.96	−14.86	.00	13.30	79	87	83
THDMC2	97	10.10	14.55	12.00	1.12	125	10.98	16.07	13.36	.99	−9.404	.00	12.70	72	76	74
THDMC3	97	9.79	14.61	11.92	1.10	125	11.18	15.24	13.35	.91	−10.35	.00	12.60	70	74	72
THDMC4	97	8.43	12.20	10.26	.75	125	9.22	14.28	11.18	.80	−8.64	.00	10.70	68	77	72
THDMC5	97	8.70	11.97	10.08	.74	125	9.02	13.94	11.08	.87	−9.096	.00	10.60	69	76	73
APHDMC1	97	10.12	14.69	11.74	.98	125	10.78	16.20	13.30	1.14	−10.72	.00	12.50	81	76	79
APHDMC2	97	10.88	14.67	12.55	.99	125	11.51	16.39	13.98	.84	−11.4	.00	13.30	70	78	74
APHDMC3	97	10.56	14.81	12.82	1.01	125	12.48	17.08	14.33	.87	−11.68	.00	13.60	73	82	77
APHDMC4	97	9.86	14.02	11.48	.80	125	10.94	14.62	12.70	.92	−10.57	.00	12.10	84	70	77
APHDMC5	97	9.24	12.90	10.59	0.63	125	9.60	14.14	11.56	.82	−9.695	.00	11.10	80	76	78
TBDMC1	97	11.43	15.87	13.69	.96	125	11.50	17.57	15.10	1.08	−10.13	.00	14.40	80	78	79
TBDMC2	97	13.64	19.27	15.79	1.02	125	14.91	21.24	17.83	1.27	−13.28	.00	16.80	88	77	82
TBDMC3	97	10.41	15.43	12.65	1.06	125	11.26	16.68	14.12	1.10	−9.966	.00	13.40	75	76	76
TBDMC4	97	8.71	12.14	10.26	.75	125	9.33	14.22	11.66	1.01	−11.83	.00	11.00	81	78	80
TBDMC5	97	10.4	15.45	12.17	1.13	125	11.01	16.87	13.91	1.17	−11.19	.00	13.04	74	81	78
APBDMC1	97	11.46	16.28	13.94	1.09	125	12.24	19.52	15.52	1.10	−10.72	.00	14.70	79	84	82
APBDMC2	97	13.75	17.72	15.41	.85	125	14.10	20.43	17.36	1.40	−12.87	.00	16.40	91	74	82
APBDMC3	97	12.71	17.55	14.77	.85	125	13.98	19.22	16.49	1.08	−12.89	.00	15.60	80	82	81
APBDMC4	97	9.01	12.04	10.63	.67	125	9.60	14.90	11.99	1.01	−11.98	.00	11.30	84	73	78
APBDMC5	97	8.66	11.44	9.84	.71	125	8.75	14.19	10.99	.95	−9.946	.00	10.40	75	75	75

SD: standard deviation; Fem: female; Male: male; Max.: maximum; Min.: minimum; *N*: number of sample; CP: cut-off point; Sig: significance; *T*-test: results from the Student's *t*-test.

Table 3 Statistics of metatarsal measurements.

	Descriptive										Contrast		Classification			
	Female					Male					*T*-test	Sig.	P.C.	% classification		
	N	Min.	Max.	Mean	SD	*N*	Min.	Max.	Mean	SD				Fem	Male	Total
XLMT1	97	49.42	66.63	57.40	3.60	125	54.13	72.13	61.18	3.87	−7.43	.00	59.30	71	74	73
XLMT2	97	60.21	80.48	69.29	4.23	125	65.23	86.50	74.53	4.38	−8.98	.00	71.90	75	75	75
XLMT3	97	55.30	74.83	64.59	3.87	125	59.47	85.64	69.61	4.50	−8.75	.00	67.10	72	72	72
XLMT4	97	54.59	72.05	62.86	3.87	125	55.10	80.82	68.19	4.51	−9.29	.00	65.50	88	74	81
XLMT5	97	53.96	75.16	62.78	4.34	125	57.28	80.91	69.24	5.10	−9.99	.00	66.00	79	71	75
THDMT1	97	15.90	22.17	19.53	1.48	125	18.66	25.36	21.58	1.25	−10.89	.00	20.60	75	81	78
THDMT2	97	8.02	11.32	9.75	.70	125	8.89	12.63	10.50	.74	−7.58	.00	10.10	70	70	70
THDMT3	97	6.44	9.68	8.48	.68	125	7.39	10.54	9.19	.62	−8.15	.00	8.80	64	74	69
THDMT4	97	6.27	9.89	8.36	.78	125	7.70	10.85	9.25	.67	−9.22	.00	8.80	66	77	71
THDMT5	97	6.58	9.95	8.46	.65	125	7.79	11.52	9.36	.75	−9.41	.00	8.90	73	73	73
APHDMT1	97	15.00	21.93	18.95	1.43	125	16.91	24.50	20.80	1.46	−9.39	.00	19.90	74	73	74
APHDMT2	97	11.76	16.46	14.20	1.02	125	13.29	18.97	15.41	.99	−8.93	.00	14.80	68	71	70
APHDMT3	97	11.65	15.30	13.64	.97	125	12.79	17.22	14.90	.95	−9.70	.00	14.30	71	72	72
APHDMT4	97	10.50	14.95	12.95	1.08	125	11.13	16.32	14.29	.96	−9.59	.00	13.60	64	76	70
APHDMT5	97	8.27	15.55	11.81	1.24	125	11.12	15.57	13.33	1.05	−9.89	.00	12.60	73	76	75
TBDMT1	97	14.21	20.39	17.65	1.51	125	16.39	23.71	20.15	1.34	−12.88	.00	18.90	75	83	79
TBDMT2	97	11.73	16.56	14.04	.96	125	12.94	17.72	15.32	1.07	−9.22	.00	14.70	74	70	72
TBDMT3	97	9.92	14.80	12.21	1.15	125	11.03	16.74	13.51	1.34	−7.62	.00	12.90	70	69	69
TBDMT4	97	8.87	13.69	10.80	.95	125	9.46	14.56	11.42	.96	−4.75	.00	11.10	61	66	64
TBDMT5	97	12.52	21.93	18.11	2.01	125	16.67	23.82	20.24	1.51	−8.75	.00	19.20	67	74	70
APBDMT1	97	21.98	30.60	26.40	1.77	125	24.28	34.44	29.36	1.73	−12.52	.00	27.90	79	78	79
APBDMT2	97	16.22	21.78	19.22	1.30	125	18.26	24.95	20.97	1.22	−10.31	.00	20.10	76	78	77
APBDMT3	97	15.61	21.17	18.55	1.52	125	16.56	24.24	20.40	1.40	−9.29	.00	19.50	71	77	74
APBDMT4	97	13.20	19.43	16.13	1.41	125	15.55	21.50	18.06	1.26	−10.78	.00	17.10	77	73	75
APBDMT5	97	11.00	16.04	13.62	1.24	125	13.13	17.30	15.13	.96	−9.90	.00	14.40	73	70	72

SD: standard deviation; Fem: female; Male: male; Max.: maximum; Min.: minimum; *N*: number of sample; CP: cut-off point; Sig: significance; *T*-test: results of the Student's *t*-test.

Table 4 Discriminant functions (summary) obtained from the metacarpals and metatarsals in skeletons of the contemporary Mexican population.

	Discriminant function	Wilks Lambda	% classification
MC1			
Function 2	$y = .027\,XL + .839\,THD + .168\,APHD + .080\,TBD - .045\,APBD - 15.04$	.487	84
Function 1	$y = 1.020\,THD - 13.69$	.496	83.3
MC2			
Function 4	$y = .054\,XL - .259\,THD + .391\,APHD + .454\,TBD + .332\,APBD - 18.53$	.5	83.6
Function 3	$y = .300\,APHD + .434\,TBD + .341\,APBD - 16.98$	.506	85.3
Function 2	$y = .537\,TBD + .430\,APBD - 16.20$	.517	84
Function 1	$y = .855\,TBD - 14.48$	.569	82.2
MC3			
Function 3	$y = .001\,XL + .107\,THD + .417\,APHD + .115\,TBD + .562\,APBD - 17.51$	.522	83.5
Function 2	$y = .515\,APHD + .653\,APBD - 17.31$	.527	83.5
Function 1	$y = 1.013\,APBD - 15.94$	.57	81
MC4			
Function 4	$y = .012\,XL - .193\,THD + .389\,APHD + .508\,TBD + .561\,APBD - 15.30$	.55	84.2
Function 3	$y = .345\,APHD + .489\,TBD + .515\,APBD - 15.46$	.553	83.5
Function 2	$y = .625\,TBD + .645\,APBD - 14.26$	.567	82.9
Function 1	$y = 1.100\,TBD - 12.15$	.628	79.5
MC5			
Function 2	$y = .585\,TBD + .558\,APBD - 13.55$	.593	79.8
MT1			
Function 3	$y = -.025\,XL + .175\,THD - .120\,APHD + .420\,TBD + .320\,APBD - 16.70$	.492	82.9
Function 2	$y = .434\,TBD + .309\,APBD - 16.95$	.501	83.2
Function 1	$y = .706\,TBD - 13.46$	.563	78.8
MT2			
Function 1	$y = .073\,XL + .069\,THD + .182\,APHD + .262\,TBD + .349\,APBD - 19.63$	.611	77.8
MT5			
Function 1	$y = .121\,XL + .560\,APBD - 16.16$	.602	78.9

In the case of the metacarpal the THD and transverse base diameter stand out (TBD) as the variables with the highest participation in construction of functions, projecting their results in the first 2 matacarpals (MC1 and MC2) above 80% and reaching 85.3% of certainty in sexual assignation. For the third (MC3), fourth (MC4) and fifth (MC5) metacarpal, the same occurs as for the fifth metatarsal (MT5), the transverse base diameters (TBD) and/or anteroposterior base diameters (APBD) are the variables with the highest contribution, providing classification percentages which range from 78.9% to 84.2%, but it is the first metatarsal (MT1) which presents with the highest variation between sexes, especially the width of its base, assessed with the TBD variable and providing percentages of up to 83.2%.

In the sample used in this study all the male values are higher than the female ones, which is not a functional determinant but is a constant of the sexual dimorphism pattern presented by the order of primates.[21] The highest differences were given in the distal (head) epiphysis region. This type of anatomical characteristic has already been reported by several authors where the ends of the long bones express a higher difference by sex for the male gender.[22–24]

Another variable which has been reported in the literature, and which has been linked to sexual dimorphism, is the length of the second digit compared with the fourth. In this respect the second metacarpal has been described as eco-sensitive in prenatal periods to oestrogen and testosterone and in the period of adolescence to anabolic steroids, with manifestation of a greater total length in the second digit in adults.[25–27] It should be stated that both in this research and in several others[8,9,28] both the maximum and physiological length of the metacarpal and metatarsal is not usually a variable that has any great potential to differentiate between sexes.

However, in general, good correct classification percentages were obtained, above 80%, both for females and males in the contemporary Mexican population sample.

We should highlight that the sample used in this study corresponds to the contemporary population of the City of Mexico, for which the functions developed may be used for the reconstruction of the biological profile in complex forensic contexts when there are isolated or fragmented bones.

Conclusions

From the data obtained in this study it is possible to conclude that the average values found between the 2 groups analysed are higher in males than in females, which is consistent with the sexual dimorphism pattern described for several contemporary populations.

The results of the functions point to the epiphysary regions as the ones with the highest differences between sexes and consequently as the variable with the highest power of discrimination. The 14 functions reported for metacarpals are found with values approximate to or above 80% of correct sexual assignation, whilst the 5 functions developed for the metatarsals present values ranging from 77.8% to 83.2%, with the first of this set being the bone which indicates a greater dimorphism. We should stress that the potential and the use of these functions for forensic contexts where the bony elements may be found isolated or fragmented, is not limited, since its application from univariate analysis provides the opportunity to obtain results above 80% of certainty for metacarpals and 78% for metatarsals.

Finally, we wish to mention the limits of our study due to the need to contrast the results obtained in other skeletal series of reference, both belonging to the contemporary Mexican population and to other populations.

Conflict of interests

None.

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