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A COMPARISON OF THE HAMANN-TODD AND TERRY COLLECTIONS

ABSTRACT: Both the Terry and Hamann-Todd skeletal collections in the United States have served as data bases for numerous studies. The question raised in this paper is whether or not they are comparable and can be interchangeably used in osteological analysis. The author cross-tested current techniques for assessment of sex, race, and stature from the pelvis, femur, and tibia using 400 specimens from the Terry and 224 from Hamann-Todd. Results indicated that stature and long bone lengths were somewhat greater in Terry individuals but the difference was not significant, and available race formulae were better in males. Stature was better estimated from the tibia for Blacks and the femur for Whites. Based on the greater size of the antero-posterior diameter of the pelvic inlet, Terry individuals were probably healthier. In conclusion, Terry-based formulae can more often than not be successfully applied to Hamann-Todd and other roughly contemporaneous individuals. However, temporal changes may preclude their use on modern populations.

KEY WORDS: Hamann-Todd Collection — Terry Collection — Sex determination — Race assessment — Stature estimation.

INTRODUCTION

The Terry Collection (TC) at the Smithsonian Institution and Hamann-Todd Collection (HTC) at the Cleveland Museum of Natural History have been used extensively for the development of demographic techniques, many of which have formed the foundation of skeletal anthropology. While these two collections are among the best available, there are several issues that must be addressed in order to ascertain the representativeness and potential accuracy of demographic standards derived from them.

The purpose of this paper is to compare the two collections by applying TC derived osteometric techniques to HTC specimens. Emphasis is placed on the degree of inter-applicability of the sex, race, and stature determination techniques.

MATERIALS AND METHODS

To test the applicability of studies based on the TC, postcranial measurements were taken from 224 HTC skeletons (56 White males, 55 White females, 52 Black males and 61 Black females). Measurements were selected to maintain the comparability of this study with previously published techniques used for the determination of sex, assessment of race, and estimation of stature.

Sexing discrimination was assessed using methods from the femur and tibia (DiBennardo and Taylor 1982; İşcan and Miller-Shaivitz 1984). Race assessment was tested according to İşcan's standards from the pelvis (1981). Finally, comparisons of statural estimations were carried out using regression formulae on the femur and tibia (Trotter and Gieser 1952, Trotter 1970). All formulae were derived from TC samples and were tested using

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the appropriate standard osteometric measurements (Table 1) on HTC specimens (Krogman and İşcan 1986).

RESULTS

Table 1 shows descriptive statistics for TC and HTC skeletons. Black male TC specimens had longer femora and tibiae than HTC Blacks, but the shaft dimensions were about the same. Among White males, shaft dimensions were slightly larger in HTC specimens. However, none of these differences were statistically significant.

Females in the White samples were considerably older in the TC than the HTC. Both TC White and Black females had longer femora and tibiae. But again, these differences were not statistically significant. Black females of the TC were, on the average, older than the rest of the Blacks, had larger biiliac breadth, femoral transverse and tibial antero-posterior diameters, and

exhibited shallower antero-posterior depth in the pelvic inlet. In Blacks, these differences between the collections were statistically significant.

Table 2 presents discriminant function formulae (S1–S3) for the tibia (İşcan and Miller-Shaivitz 1984). The left half of this table lists the comparative prediction accuracy for sex determination from the tibia in Whites. All of these formulae were found to assess sex better on HTC Whites than TC specimens.

Discriminant function sexing formulae from TC Blacks and the results of their application to HTC long bones appear in Table 3. The right half of this table reveals that femur-based equations determined sex even better in HTC skeletons. The same results were obtained from tibial formulae, with the exception of S6. The best functions obtained from the tibia were S4 for males (with an accuracy of 84.3%) and S5 for females (with an accuracy of 88.5%).

In order to test the interchangeability of racially derived formulae, the equations in Tables 2 and 3 were cross-tested. The results of applying White-based formulae to Blacks appear in the right half of Table 2, and Black-based formulae to Whites in the left half of

Table 1. Means and standard deviations of the Terry (TC) and Hamann-Todd (HTC) Whites and Blacks.

Variables (mm) ¹⁾		Males				Females			
		Whites		Blacks		Whites		Blacks	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Hamann-Todd	HTC	N 56		52		55		61	
Terry	TC	N 40		40		39		40	
Age (years)	HTC	56.6	11.73	42.9	10.44	56.7	17.04**	43.8	13.39
	TC	57.5	12.48	44.4	14.56	66.2	16.67	51.3	19.48
PELVIS									
Biiliac br.	HTC	274.4	17.02	256.3	14.76	271.1	19.95	250.8	17.27*
	TC	274.8	18.27	257.3	14.31	276.2	13.79	257.3	15.58
Trans.br.	HTC	124.7	7.60	114.9	8.13	132.7	9.05	121.9	7.17
(brim)	TC	124.2	8.48	113.3	7.60	131.5	6.73	121.0	6.69
A-P. ht.	HTC	106.5	8.58	103.5	8.41	118.4	17.76	117.3	9.04**
(brim)	TC	107.0	9.16	102.0	8.54	116.6	10.51	110.8	9.68
FEMUR									
Length	HTC	452.2	22.30	477.7	25.12	424.9	23.81	437.8	24.24
	TC	455.8	30.07	481.6	32.56	431.3	25.76	439.5	25.65
A-P. dia.	HTC	29.1	2.64	29.9	3.07	26.1	2.38	27.0	2.02
(midshaft)	TC	28.8	2.63	30.6	4.23	26.7	2.39	27.8	2.28
Trans.dia.	HTC	29.3	2.73	28.2	3.01	26.1	2.15	25.2	2.00**
(midshaft)	TC	28.6	2.11	29.6	4.87	26.2	2.46	26.5	2.14
Circum. ²⁾	HTC	91.3	4.72	91.1	6.08	82.2	5.29	82.5	4.93
(midshaft)	TC	—	—	89.0	5.60	—	—	83.0	5.30
TIBIA									
Length	HTC	363.8	17.88	399.0	25.43	341.8	21.35	361.9	21.10
	TC	371.0	24.65	404.5	34.15	350.2	25.04	365.6	21.34
A-P. dia.	HTC	35.6	3.03	36.2	3.77	30.6	3.08	31.0	3.06*
(nutr.for.)	TC	34.6	3.30	35.5	2.71	30.6	2.73	32.4	2.69
Circum.	HTC	98.4	4.82	101.5	8.35	86.0	6.22	89.0	6.21
(nutr.for.)	TC	96.1	5.84	100.4	6.63	86.4	7.87	90.1	6.09

1) From İşcan and Miller-Shaivitz (1984) based on the TC sample unless indicated. HTC data are original to this study.

2) Femoral circumference for the Terry Blacks is from DiBennardo and Taylor (1982), (N=65 males and 62 females).

* and ** indicate significant (at $p < 0.05$ and $p < 0.01$, respectively) difference between the means of the same sexes of the HTC and TC.

Table 3. In Blacks evaluated by White-based formulae, females were incorrectly classified much more often than males (Table 2). For example, the White S1 function gave a 92.2% accuracy for Black males and only 68.9% for females. The opposite was true when Whites were judged by Black-based formulae (Table 3). For example,

Black function S2 in this table provided 75.0% accuracy for males and 82.2% for females.

Discriminant function formulae for race determination in males (R1_m–R4_m) and females (R1_f–R4_f) appear in Table 4. Equations R1–R3 were developed by the author (1983) and R4 by İşcan and Cotton (1985).

Table 2. Sex prediction accuracy of Terry derived discriminant function formulae for Whites from the tibia on Hamann-Todd specimens.¹⁾

Functions from Terry ²⁾	Hamann-Todd Whites						Hamann-Todd Blacks					
	N		Males		Females		N		Males		Females	
	M	F	%	N	%	N	M	F	%	N	%	N
S1 = 0.14461 × circum. – 13.20915												
56	55		91.1	51	81.8	45	51	61	92.2	47	68.9	42
(40)	(39)		(75.0)	(30)	(79.5)	(30)						
S2 = 0.00108 × length + 0.14698 × circum. – 13.03439												
55	54		92.7	51	83.3	45	51	61	92.2	47	68.9	42
(40)	(39)		(77.5)	(31)	(79.5)	(31)						
S3 = –0.00122 × length + 0.15623 × a-p. + 0.09284 × circum. – 13.13618												
54	54		92.6	52	83.3	45	51	60	88.2	45	68.3	41
(40)	(39)		(75.5)	(31)	(79.5)	(31)						

¹⁾ Functions on the tibia are from İşcan and Miller-Shaivitz (1984). Discriminant score values greater than the sectioning point of 0 classify as male.

²⁾ Values in parentheses refer to the original study on the TC (İşcan and Miller-Shaivitz 1984).

Table 3. Sex prediction accuracy of Terry derived discriminant function formulae for Blacks from the femur and tibia on Hamann-Todd specimens.¹⁾

Functions from Terry ²⁾	Hamann-Todd Whites						Hamann-Todd Blacks					
	N		Males		Females		N		Males		Females	
	M	F	%	N	%	N	M	F	%	N	%	N
FEMUR												
S1 = 0.184 × circum. – 15.823												
56	55		87.5	49	74.5	41	51	61	86.3	44	72.1	44
							(65)	(65)	(75.4)		(70.8)	
S2 = 0.107 × circum. + 0.021 × length – 18.744												
56	54		75.0	42	85.2	46	51	61	86.3	44	80.3	49
							(65)	(65)	(81.5)		(75.4)	
S3 = 0.024 × length + 0.3 × trans. – 18.744												
56	54		82.1	46	74.1	40	51	61	86.3	44	80.3	49
							(65)	(65)	(78.5)		(76.9)	
TIBIA												
S4 = 0.157 × circum. – 14.95396												
56	55		62.5	35	90.9	50	51	61	84.3	43	83.6	51
							(40)	(40)	(77.5)	(31)	(82.5)	(33)
S5 = 0.01521 × length + 0.11266 × circum. – 16.58839												
55	54		47.3	26	96.3	52	51	61	84.3	43	88.5	54
							(40)	(40)	(82.5)	(33)	(82.5)	(33)
S6 = 0.01527 × length – 0.12294 × a-p. + 0.152 × circum. – 16.18537												
54	54		44.4	24	94.4	51	51	60	78.4	40	85.0	51
							(40)	(40)	(80.0)	(32)	(87.5)	(35)

¹⁾ Functions on the femur are from DiBennardo and Taylor (1982) and on the tibia from İşcan and Miller-Shaivitz (1984). Discriminant score values greater than the sectioning point of 0 classify as male.

²⁾ Values in parentheses refer to the original studies on the TC femora (DiBennardo and Taylor 1982) and tibiae (İşcan and Miller-Shaivitz 1984).

Comparative prediction accuracy for race assessment from the pelvis using TC derived formulae predicted race in 2.4% (R1_m) to 11% (R3_m) better when tested on White HTC males (Table 4). Only function R1_m (iliac breadth), predicted HTC Blacks better. The

remaining functions did not predict race as well; accuracy dropped a maximum of 5% (R4_m).

As indicated in the right side of Table 4, when both races of HTC females were evaluated with the TC formulae, there was an overall decrease in predictive

Table 4. Race prediction accuracy of Terry derived discriminant function formulae from the pelvis on Hamann-Todd specimens.¹⁾

Hamann-Todd Males					Hamann-Todd Females				
N		Whites		Blacks	N		Whites		Blacks
W	B	%	N	%	W	B	%	N	%
R1 _m = 0.0637219 × Biil. - 16.84043					R1 _f = 0.0604552 × Biil. - 16.0448				
51	50	78.4	40	78.0	50	50	54.0	27	82.0
(75)	(75)	(76.0)		(74.7)	(75)	(75)	(76.0)		(78.7)
R2 _m = 0.1303004 × trans. - 15.34591					R2 _f = 0.1336859 × trans. - 17.01109				
52	50	84.6	44	74.0	51	52	70.6	36	76.9
(75)	(75)	(74.7)		(77.3)	(75)	(75)	(78.7)		(88.0)
R3 _m = 0.0179339 × Biil. + 0.1035484 × trans. - 16.93482					R3 _f = 0.0175062 × Biil. + 0.1036824 × trans. - 7.83939				
51	50	84.3	43	80.0	50	50	70.0	35	80.0
(75)	(75)	(73.3)		(84.0)	(75)	(75)	(80.0)		(85.3)
R4 _m = 0.01687589 × Biil. + 0.092774 × trans. + 0.03013967 × a-p. - 18.5722					R4 _f = 0.02424984 × Biil. + 0.08991074 × trans. + 0.00875715 × a-p. - 1882642				
51	50	86.3	44	76.0	49	50	69.4	34	78.0
(100)	(100)	(78.0)	(78)	(81.0)	(100)	(100)	(83.0)	(83)	(84.0)

¹⁾ Functions R1 through R3 for both sexes are from İşcan (1981) and Function R4 from İşcan and Cotton (1985). Discriminant score values greater than the sectioning point of 0 classify as male. Values in parentheses refer to original studies based on the Terry collection (İşcan 1981, İşcan and Cotton 1985).

Table 5. Results of applying regression formulae from the Terry Collection to estimate cadaveral stature in the Hamann-Todd Collection.¹⁾

Cadaveral and estimated stature	Hamann-Todd Whites					Hamann-Todd Blacks				
	N	Mean	S.D.	r	t	N	Mean	S.D.	r	t
MALES										
WM1 = 2.38 × femur + 61.41						BM1 = 2.11 × femur + 70.35				
Cadaver st.	56	170.50	6.60	0.87	1.61	51	175.69	8.04	0.86	4.78 ²⁾
Estimated st.		169.80	5.57				172.77	5.39		
WM2 = 2.52 × tibia + 78.63						BM2 = 2.19 × tibia + 86.02				
Cadaver st.	55	170.69	6.51	0.74	0.99	50	175.80	8.08	0.88	1.18
Estimated st.		171.28	5.00				175.11	5.68		
WM3 = 1.30 × (femur + tibia) + 63.29						BM3 = 1.15 × (femur + tibia) + 71.04				
Cadaver st.	55	170.69	6.51	0.85	0.70	50	175.80	8.08	0.89	4.01 ²⁾
Estimated st.		170.36	4.97				173.57	5.76		
FEMALES										
WF4 = 2.47 × femur + 54.10						BF4 = 2.28 × femur + 59.76				
Cadaver st.	54	159.20	7.22	0.87	1.64	61	163.39	6.92	0.85	4.94 ²⁾
Estimated st.		160.00	6.02				161.09	5.44		
WF5 = 2.90 × tibia + 61.53						BF5 = 2.45 × tibia + 72.65				
Cadaver st.	54	159.20	7.22	0.86	4.54 ²⁾	61	163.40	6.93	0.79	1.26
Estimated st.		161.50	6.34				162.70	5.17		
WF6 = 1.39 × (femur + tibia) + 53.20						BF6 = 1.26 × (femur + tibia) + 59.72				
Cadaver st.	54	159.20	7.22	0.88	3.22 ²⁾	61	163.39	6.93	0.85	3.16 ²⁾
Estimated st.		160.68	6.26				161.92	5.45		

¹⁾ Formulae for stature are from Trotter (1970). A correction factor of 2.5 cm was added to the calculation of the cadaveral length (Trotter 1970).

²⁾ Indicates a significant difference between the cadaveral and estimated statures at p < 0.01 level.

accuracy, particularly for Whites. Functions R2_f–R4_f averaged about 10% lower. Only R1_f showed a major drop, falling from 76% to 54%. In Black females, the predictive value was considerably better, especially for R1_f.

Regression formulae for stature (Table 5), also derived from the TC (Trotter and Gleser 1952, Trotter 1970), were applied to HTC specimens. A constant of 2.5 cm was added to each formula to compensate for the difference between cadaveral and living stature (Trotter 1970). These results were then compared to the actual cadaveral heights. Table 5 lists the descriptive statistics for both the estimated and cadaveral statures, and the correlation coefficients between the bone lengths and actual cadaveral stature. The Student's t-test indicated that the differences between the estimated and cadaveral statures were significant for formulae ST5 (tibia-based) and ST6 (femur plus tibia) in White females, ST1 (femur-based) and ST3 (femur plus tibia) in Black males and ST4 (femur-based) and ST6 (femur plus tibia) in Black females. The best predictor of stature was the femur-based formulae in Whites and tibia-based in Blacks.

HISTORICAL BACKGROUND

To better evaluate the results, it is necessary to provide some background on these two collections. The TC started by Robert J. Terry at Missouri Medical College in 1898 (Trotter 1981). In 1967, its more than 2,000 specimens were transported to its present location at the Smithsonian Institution.

The HTC, housed at the Cleveland Museum of Natural History, was begun by Carl August Hamann in 1893 at Western Reserve University (Cobb 1959). T. Wingate Todd started his collection in 1912 (Cobb 1959, 1981) and amassed over 3,300 skeletons in his 26 year tenure (Cobb 1959). These assemblages were later combined to form the Hamann-Todd Collection which served as the data base for most of the studies completed before 1967 (Krogman 1939, Cobb 1959).

The TC and HTC differed in a number of ways. Cobb (1935) stated that the number of Black cadavera in the HTC increased as a result of the migration of southern Blacks to Cleveland after 1915. Of Whites with known birth-places, 60% were European born. Most American born Whites came from the north-east. Most persons in the TC were thought to have spent their lives in Missouri.

These two cities also had different demographic structures which changed over time. St. Louis was more populous than Cleveland (Bureau of Census 1913). In 1910, for example, Cleveland had a population of 642,000 compared with 881,000 for St. Louis. As a highly industrialized city, Cleveland attracted masses of people in search of steady work. Therefore, it is likely that changes in the gene pool were rapid in those years. St. Louis was a crossroad of commerce and migration and probably had a slower influx of people from all directions. Thus, it is probable that specimens in the TC represented an urban and rural mixture. It might also be expected that the flow of genes was more gradual through this area.

DISCUSSION AND CONCLUSIONS

The present study marks the first attempt to cross-validate techniques based on one major collection by testing them on the other. This comparison is extremely valuable because the results indicate whether the TC and HTC can be used interchangeably as data bases for the development of new techniques to assess physical characteristics from the skeleton.

Several conclusions have been drawn from this study:

1. Males in both collections had nearly the same mean age, but females averaged about a decade older in the TC.
2. Though not significant, long bone lengths of TC specimens were longer than those of the HTC.
3. Based on Angel's (1976) interpretation of pelvic brim height, individuals in the TC may have been healthier than their HTC counterparts.
4. Sex should be assessed using the tibia in Whites and the femur in Blacks. Sexing formulae were found to be race specific, and therefore, cannot be used interchangeably.
5. Techniques used for race determination from the pelvis were fairly successful in males, but not in females.
6. In estimating stature, it must be assumed that original cadaveral length in both collections was measured by methods yielding a comparable degree of accuracy. TC-based regression formulae worked best for Whites when derived from the femur, and in Blacks when derived from the tibia. A single bone length may be superior to using combined lengths of the femur and tibia.

Although certain differences and similarities existed between the two collections, it was extremely difficult to make a clearcut judgment as to which was more representative of the White and Black inhabitants of North Africa. It is the author's opinion that Hamann-Todd specimens were likely to represent a more static, urbanized, and occupationally similar group of people. On the other hand, since the Terry Collection appeared to have been drawn from a more heterogeneous group of individuals, its physical characteristics were probably more diverse and, thus, better reflect the population at large. However, the question of which collection can provide greater accuracy on a modern population cannot be answered from these data. There are indications that temporal changes may have rendered techniques from both collections relatively ineffective. However, it is impossible to test on an appropriate scale because of the lack of a contemporary skeletal assemblage. This study also underscores the pressing need for the establishment of a large scale, well documented, modern skeletal collection.

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REFERENCES

- ANGEL J. L., 1976: Colonial to modern skeletal change in U. S. A. *Am. J. Phys. Anthropol.* 45, 723 - 735.
- BUREAU OF THE CENSUS, 1913: *Thirteenth Census of the United States in the Year 1910*. Volumes I - IV. Washington, D. C. : Government Printing Office.
- COBB W. M., 1935: Municipal history from anatomical records. *Scientific Monthly* 40, 157 - 162.
- COBB W. M., 1959: Thomas Wingate Todd, M. B., Ch. B., F. R. C. S. (Eng.), 1885-1938. *J. Nat. Med. Assn.* 51, 233 - 246.
- COBB W. M., 1981: Thomas Wingate Todd, 1885-1938. *Am. J. Phys. Anthropol.* 56, 517 - 520.
- DIBENNARDO R., TAYLOR J. V., 1982: Classification and misclassification in sexing the Black femur by discriminant function analysis. *Am. J. Phys. Anthropol.* 58, 145 - 151.
- IŞCAN M. Y., 1981: Race determination from the pelvis. *Ossa* 8, 95 - 100.
- IŞCAN M. Y., 1983: Assessment of race from the pelvis. *Am. J. Phys. Anthropol.* 62, 205 - 208.
- IŞCAN M. Y., COTTON T. S., 1985: The effect of age on the determination of race from the pelvis. *J. Hum. Evol.* 14, 275 - 282.
- IŞCAN M. Y., MILLER-SHAIVITZ P., 1984: Determination of sex from the tibia. *Am. J. Phys. Anthropol.* 64, 53 - 58.
- KROGMAN W. M., 1939: Contributions of T. Wingate Todd to anatomy and physical anthropology. *Am. J. Phys. Anthropol.* 25, 145-186.
- KROGMAN W. M., IŞCAN M. Y., 1986: *The Human Skeleton in Forensic Medicine*. Springfield: Charles C. Thomas.
- TROTTER M., 1970: Estimation of stature from intact long limb bones. In: T. D. Stewart (Ed.): *Personal Identification in Mass Disasters*. Washington, D. C.: National Museum of Natural History, pp. 71-84.
- TROTTER M., 1981: Robert J. Terry, 1871-1966. *Am. J. Phys. Anthropol.* 56, 503 - 508.
- TROTTER M., GLEESER G. C., 1952: Estimation of stature from long bones of American Whites and Negroes. *Am. J. Phys. Anthropol.* 10, 463 - 514.

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