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A Preliminary Study to Find Key Craniometric Landmark Measurements Important in Identifying 'Hispanics' in the Forensic Context

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Abstract

Objective: This study attempts to find craniometric landmark measurements that can be standardized and used to identify the ethnicity/race 'Hispanic' when unknown crania are found by the police.

Methods: Craniometric measurements (n=31) were collected from a small sample (n=13) of documented Hispanic crania curated at the Maxwell Museum of Anthropology, Albuquerque, New Mexico. These craniometric measurements, despite documented population affiliation, were analyzed by the FORDISC 3.1 computer program to verify ancestry. The 31 craniometric measurements of the Maxwell Museum sample were converted to means, and then analyzed in FORDISC 3.1 Forensic Data Base (FDB). Subsequently, the craniometric means for the Maxwell Museum Hispanics were compared to the craniometric means calculated by FORDISC 3.1 FDB for Hispanic males (n=148) and females (n=28) and Guatemalan males (n=66) in order to find craniometric measurement landmarks that could be important in identification of 'Hispanic.'

Results: On the first run, FORDISC 3.1 classified Maxwell Museum Hispanics into the American Indian Male (AM) reference group with a posterior probability of 0.284. Regardless, graph of the results depicted in 3D canonical space showed the Maxwell Museum Hispanic sample was closest to the Hispanic male reference group centroid. Furthermore, seven craniometric measurement means computed by SPSS statistical software were nearly identical to each other and could be key in identifying Hispanic crania. These measurements were ZYB; BNL; WFB; NLB; EKB; OCC; and FOB.

Conclusion: Forced migrations spurred by totalitarian regimes in the country of origin or drought and starvation has resulted in migrant fatalities, whether at the US–Mexico border crossing or at sea between Cuba or Haiti and Miami. This research will add a new perspective in using craniometrics to study admixture in general and Hispanic identification in particular, and simultaneously help law enforcement reduce the number of open cases that deal with questionable ancestries.

Keywords: Ancestry • Craniometric landmark measurements • Craniometrlc means • Forensic anthropology • FORDISC 3.1 • Hispanics • Posterior probabilities • Race • SPSS data • Typicality probabilities

Introduction

When human skeletal remains are found, the first question law enforcement asks is: "Who was this person?" Specifically, they want to know the "race," sex, age, stature, and any trauma that would have led to the death of the individual. We forensic anthropologists analyze these skeletal remains to answer this question.

For estimating "race," craniometrics—measurements taken on the skull giving overall size and shape—is employed. This researcher puts the word race in quotes above because when the skull is analyzed, ancestry is what is being estimated, not race. Ancestry is the genetic line of descent, and bones represent the physical expression of this genetic line. Race, on the other hand, is simply a convenient way to create discrete racial categories that are easy for the public in general and law enforcement in particular to recognize. However, we anthropologists know that race is an inaccurate way to explain complex variation in humans. Nevertheless, we provide law enforcement officers with a race designation for an unknown skull recovered from a clandestine grave because they are most familiar with the traditional racial categories; however, we continue to educate them on the complexities of ancestry. Therefore, "Who was this person?" is a social question but the true answer will always be biological based on the person's ancestry.

Since the early 1960s, researchers using sophistical statistical analysis have obtained 76.9% accuracy on average in identifying White, Black, and Native American remains using the skull [1,2]. Toward the end of the 20th century and the beginning of the 21st century, this accuracy (for identifying White and Black male and females) improved, ranging from 85% to 100% when statistical techniques were combined with computer programs [3,4]. These respectable accuracy rates were indicative of single ancestries, meaning that most unknown individuals were not biracial. But the steady increase in biracial or triracial population groups, the constant flow of legal and illegal immigrants to the United States over the past 60 years, and the increasing number of undocumented migrant fatalities across the US–Mexico border have complicated the racial picture to the point where the accuracy rates have decreased drastically for assigning unknown skulls to single ancestries. For example, in my recent research, a computer program

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classified an unknown skull as Hispanic female with respectable probabilities based on its measurements. But there were also probabilities of relationships with White and Native American female sample groups [5,6]. Hispanics are culturally and genetically heterogenous with European, Native American, and African ancestries [7-9]. And, they are usually associated with the countries and geographical regions of Cuba, Puerto Rico, Mexico, Central and South America. Of course, genetic admixture analysis can be used to delineate multiple ancestries by finding DNA markers unique to one population but also present in other populations (i.e., indicating an admixture). However, DNA analysis takes months, bringing more anguish to the victim's family as they hope for a quick resolution. Additionally, DNA analysis is expensive and destructive because the bone is directly analyzed to obtain results. This intentional destruction of bone may come in conflict with the traditional practices of some cultures (if there is preliminary evidence that the victim may belong to, for example, a Native American group). Because Hispanics (including Latinos) are a trihybrid population (of Europe, Native American, and African ancestries), this preliminary study attempts to find key craniometric landmark measurements that can be used to identify 'Hispanics' in the forensic context.

As periods of colonization and the transatlantic slave trade in the 17th century brought geographically distinct populations from Europe and Africa into contact with the Indigenous peoples of the Americas, the subsequent history of settlement coupled with periods of admixture among these population groups has resulted in the current complex and diverse US population. Mexico is the largest single source of legal immigrants, accounting for 12–14% of immigration flow during each of the past four decades. When illegal immigration is included, Latin America surpasses Asia as the greatest source of immigration and Mexico becomes the predominant single source of immigrants into the United States [10]. In addition, in terms of admixture proportions (which are important in forensic analysis), it is among these Hispanics—as opposed to other populations—where one finds the greater proportion of Native American (or Indigenous) ancestry. In essence, statistical standards need to be created to identify admixture in a skull. Therefore, craniometrics can serve as a reasonable proxy for genetic markers.

While the immigration data are supported by admixture genetic analyses [7,8], this proposal does not suggest that genetic analysis could potentially be phased out of identity reconstruction in the forensic context. Genetic analysis is invaluable and is still the primary method for positive identification. Generally, what is implied is that using craniometrics to find key measurements in order to create baseline probabilities and membership coefficients to identify Hispanics (or other admixed groups) adds to the methods involved in identifying unknown human remains and helps calibrate other lines of evidence. Additionally, there are several other advantages to my proposed study. First, law enforcement would obtain the analysis based on craniometrics within days compared to DNA analysis, which takes 3–12 weeks on average for various reasons, including delays due to heavy workload [11]. Second, craniometrics involves taking measurements of the skull and entering the data into a computer program for analysis; no high-tech machines are needed, so this method is therefore less expensive than DNA analysis which requires a sophisticated laboratory with high-tech machines for analyzing samples accompanied by strict policies against contamination. Although the cost to run DNA samples is falling, lab machine use and maintenance fees (added to the total cost) will keep the DNA analysis costs high [12]. Third, the colonial era and abuses during this period have sensitized descendants of marginalized people to how their cultural remains are treated after death. In the Muslim and Jewish cultures and religions, for example, autopsy is forbidden because it violates the body [13]. This belief in not modifying the body extends to most Native American tribes for both their contemporary and historical human remains. DNA analysis is destructive because one must analyze the bone directly, resulting in destruction of the bone. If preliminary evidence from a US–Mexico border fatality—prior to any skeletal analysis—suggests "Hispanic" and there is a small amount of skeletal remains, then law enforcement must balance the importance of making the identification using DNA or using a nondestructive method of identification so that the remains can be returned to the family for burial. Craniometrics can make this identification without violating most cultural mortuary traditions. This preliminary study attempts to find craniometric landmark measurements that can be standardized and used to identify 'Hispanic' when unknown crania are found by the police.

Materials and Methods

In June 2024, thirty-one craniometric measurements were taken from a small sample (n=13) of Hispanic crania curated at the Maxwell Museum of Anthropology, Albuquerque, New Mexico (Table 1). The majority of these skeletal materials came from contemporary individuals who, in the past, completed paperwork for their bodies to be used in scientific research after death. But, there was one victim of violent crime whose remains were never claimed. The point here is that sex, date of birth, age, cause of death, and population affiliation were all known—hence the use of the label "Hispanic" because these individuals identified themselves in their personal documents as Hispanic during their lifetime (Table 2). This self-identification is probably based on their family ancestry in Cuba, Puerto Rico, Mexico, Central, and South America. Yet, others identify themselves as 'Spanish' claiming ancestry in Spain. Moreover, human populations have been migrating and admixing for generations making the relationship between genotype and phenotype very complex. First, the biological anthropologist compared the Hispanic population affiliation documented by Maxwell Museum collection manager(s) with results based on craniometric measurements (obtained from this sample group) generated by the FORDISC 3.1 computer program. Each of the 31

Table 1. Craniometric measurement data of Hispanic sample (n=13) from the Maxwell of Anthropology, Albuquerque, New Mexico.

		#66	#338	#317	#339	#316	#329	#302	#238	#242	#234	#171	#168	#218
GOL (max. lg.)	187	187	160	179	190	175	185	185	183	184	190	180	-	150
XCB (max. br.)	0	132	131	137	136	135	143	141	140	133	138	133	-	120
ZYB (zy-zy lg.)	131	128	120	117	130	128	131	124	135	134	133	125	-	170
BBH (ba-b ht.)	0	140	124	130	140	135	134	140	130	132	0	130	-	12
BNL (ba-n lg.)	103	102	93	96	110	105	100	104	98	101	108	100	-	89
BPL (ba-pr lg)	93.3	94.8	87.8	97.8	105	102	102.4	95.1	90.2	93	98.5	87.9	-	87.7
MAB (ecm-ecm)	0	61	57	61	0	0	0	0	0	0	68.6	0	-	0
MAL (pr-alv)	0	57.4	49.5	58	63.6	57	60.4	52.8	50.8	50	57.2	44.5	-	50.1
AUB (alb)	-	117	120	114	115.2	126.4	126.6	126.1	127.8	128.6	120.6	123.1	122	113.3
UFHT (n-pr)	75.9	71.9	69.6	73.5	58.7	75.7	68.8	66.4	68.6	65.1	74.4	63.2	-	68.6
WFB (ft-ft)	98	95.61	84.9	91	95.9	90	92.2	91.9	103.6	93.1	95.44	92.1	-	90.3
UFBR (fmt-fmt)	108.1	108	96.6	103	100.5	103.7	104.6	103	114.4	109.3	102.7	106	-	96
NLH (n-ns)	56.6	56	50.8	52	57.4	62.3	55.2	57.6	56.2	53.2	54.3	48.7	-	47.9

NLB (al-al)	21.9	23.1	20.2	24.6	20.2	25	27.7	24.5	24.6	21.5	26.1	22.5	-	20
OBB (d-ec)	46.9	43.9	40.5	41.5	42.9	41	46.2	43.2	47.3	50	44.6	45.2	-	43.1
OBH (obh)	38.5	35.3	44.3	37.3	36	36	36.1	34.5	37.4	57.9	38	34.7	-	36.7
EKB (ec-ec)	99.3	96.6	90.9	95.5	92.8	95.7	97.1	94	106.3	103.9	95.5	98.4	-	88.6
DKB (d-d)	-	13.1	15.93	14.4	15.1	14.8	16.2	13.1	15.3	16.5	15.5	15.1	14.3	7.9
FRC (n-b)	-	0	110.9	105.5	112.4	113.1	103	112.1	119.6	107.7	114.6	0	109.6	100
PAC (b-l)	-	0	120.8	103.9	126.2	122.4	116.5	113.9	118.7	112.6	114.1	0	114	101.7
OCC (l-o)	-	0	101.1	89.1	93.6	91.8	93.8	99.4	97.3	93.3	96.3	0	98.7	78.6
FOL (ba-o)	37.7	46.3	29.9	34	38	32.8	39.5	34	43.2	39	36.7	34.9	-	31.6
FOB (fob)	-	31	34.3	28.9	31.5	31.4	27.1	30.1	33.1	31	31.3	29.1	30.1	26
MDH (mdh)	26.5	31.6	32.3	30	27.6	39.4	39.6	38.5	33.7	34.3	28.9	36.9	-	27.4
GNI (gn-id)	29.3	31.4	29.4	34.2	37.6	35	28.4	0	30.2	32.1	38.9	0	-	31.8
HMF (hmf)	28.4	31	29.3	30.5	32	31.9	27.4	0	32.4	34	34.9	26.8	-	29
TMF (tmf)	11	11.8	9.2	14.1	9.09	13	11.4	0	11.4	11.2	12.2	13.5	-	9.5
GOG (go-go)	105	91.6	85.1	89.7	103	92.7	92.4	86.6	100.5	104.6	99.3	96.4	-	82.8
CDL (cdl-cdl)	118	124.7	114.1	104.8	124.2	113.6	119.6	113.5	0	116.6	118.9	113.9	-	110.4
WRB (wrb)	29.7	32.8	28.8	31	28.6	34.8	33.8	26.9	32	30.1	30.4	29.6	-	25
XRB (xrb)		41	42.5	40.8	39.4	41.2	44.2	46.5	37.2	41.7	41.4	38.5	39	39.7

*Cranial osteometric landmark definitions: GOL-Gaximum Length; XCB-Maximum Breadth; ZYB-Bizygomatic Breadth; BBH-Basion-BregmaHheight; BNL-Cranial Base Length [basion-nasion]; BPL-Basion-Prosthion Length; MAB-Maximum Alveolar Breadth [ectomalare-ectomalare]; MAL-Maximum Alveolar Length [prosthion-alveolar]; AUB-Biauricular Breadth; UFHT-Upper Facial Height [nasion-prosthion]; WFB-Minimum Frontal Breadth [frontotemporale-frontotemporale]; UFBR-Upper Facial Breadth [frontomalare temporale-frontomalare temporale]; NLH-Nasal Height [nasion-nasospinale]; NLB-Nasal Breadth [alare-alare]; OBB-Orbital Breadth [dacryon-ectoconchion]; OBH-Orbital Height; EKB-Biorbital Breadth [ectoconchion- ectoconchion]; DKB-Interorbital Breadth [dacryon-dacryon]; FRC-Frontal Chord [nasion to bregma]; PAC-Parietal Chord [bregma-lambda]; OCC-Occipital Chord [lambda-opisthocranion]; FOL-Foramen Magnum Length [basion- opisthocranion]; FOB-Foramen Magnum Breadth; MDH-Mastoid Length; GNI-Chin Height [gnathion-infradentale]; HMF-Body Height at Mental Foramen; TMF- Body Thickness at Mental Foramen; GOG-Bigonial Breadth [gonion-gonion]; CDL-Bicondylar Breath [condylion laterale-condylion laterale]; WRB-Minimum Ramus Breadth; XRB-Maximum Ramus Breadth

Table 2. The Maxwell museum of anthropology, Albuquerque, New Mexico cranial sample with known demographic information.

No.	Sex	DOB	Year of Death	Age	Cause of Death	Population
#66	M	1936	1978	42	Subdural hematoma	Hispanic?
#338	M	1952	2022	70	Metastatic disease	Hispanic/White
#317	F	1922	2018	96	Stroke	Hispanic/White
#339	F	1939	2022	83	Cardiac death	Hispanic
#316	M	1949	2018	68	Cardiovascular disease	Hispanic/White
#329	M	1955	2021	65	Cardiopulmonary failure	Hispanic
#302	M	1936	2016	80	Chronic pulmonary disease	Hispanic
#238	M	1943	2002	59	Undetermined	Hispanic
#242	M	1951	2004	52	Enthanolism	Hispanic/Mexican
#234	M	1912	2002	91	Cardiopulmonary disease	Hispanic
#171	M	1957	1988	30	Gunshot wound to head	Hispanic
#168	F	1906	1987	81	Cardiovascular disease	Hispanic
#218	F	1935	2001	66	Cardiovascular disease	Hispanic

craniometric measurements were converted to means, and then analyzed in FORDISC 3.1 (Table 3). Male and female Maxwell Museum individuals were combined in the analysis because of the overall small sample size (n=13, with only four females). Second, to find craniometric measurement landmarks (Figure 1) that could be important in the identification of 'Hispanic,' the SPSS statistical software was used to compute craniometric means for the Maxwell Museum Hispanics and then compared to the craniometric means for Hispanic males (n=148), females (n=28), and Guatemalan males (n=66) calculated by the FORDISC 3.1 computer program (Table 4).

FORDISC 3.1 computer program

FORDISC 3.1 generates the unknown's posterior and typicality probability of membership in each reference group in the database. Posterior probabilities sum to 1 (100 percent) and is based on the unknown's relative similarities (all Mahalanobis distances [D2]) to all groups) [14]. A high posterior probability, which in turn creates a small distance, indicates a greater similarity than to other groups. Typicality probabilities, in contrast, are the unknown's probability of membership in each group, based on the unknown's absolute similarity. The percentage of correct group allocations—or groups with the typical profile of the unknown case—is an indication of how well groups can be separated using the available variables. The word "typical" used above is important because distance probabilities or "typicality probabilities" can be calculated to ascertain whether an individual is typical for a specific group (and not assumed to belong to a respective group, as in posterior probabilities). When the typicality probabilities are uniformly low (i.e., less than 0.01 for each group), the posterior probabilities and classification should be disregarded because

Table 3. Craniometric means for Maxwell Museum Hispanics (mm).

Measurement ID.	Means	N
GOL	179.615	13
XCB	**134.916**	13
ZYB	131.231	13
BBH	132.272	13
BNL	100.692	13
BPL	95.068	13
MAB	**61.9**	13
MAL	50.101	13
AUB	121.596	13
UFHT	69.266	13
WFB	93.378	13
UFBR	104.307	13
NLH	54.478	13
NLB	24.977	13
OBB	44.33	13
OBH	37.135	13
EKB	96.512	13
DKB	14.395	13
FRC	**109.863**	13
PAC	**114.981**	13
OCC	**93.909**	13
FOL	36.735	13
FOB	30.392	13
MDH	32.818	13
GNI	**32.59**	13
HMF	**30.616**	13
TMF	**11.441**	13
GOG	94.587	13
CDL	**107.725**	13
WRB	30.288	13
XRB	40.998	13

*Cranial osteometric landmark definitions: (See Table 1)
BOLD: Means (divided by 13) recalculated for some individuals due to missing measurements. (See Table 1).

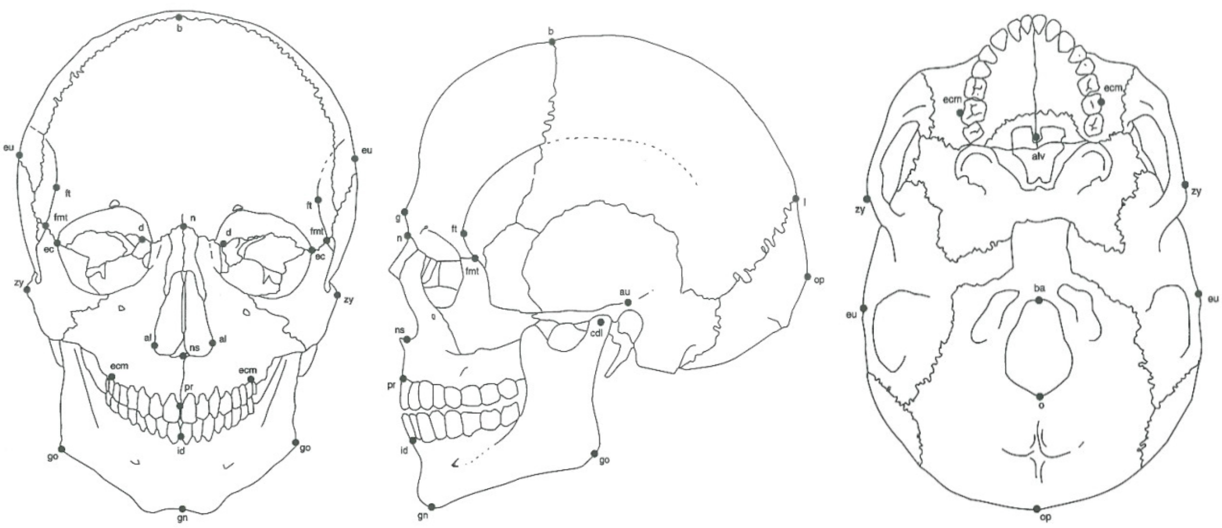

Figure 1. Cranial measuring points in **a)** Frontal, **b)** Profile and **c)** Posterior views. (Adapted from Buikstra and Ubelaker 1994).

Table 4. Comparison of craniometric means of Maxwell Museum Hispanics (MMH), FORDISC 3.1 Hispanics (FDBH), and Guatemalan (FDBG) sample groups (mm).

Measurement IDΩ	MMH Means*	FDBH Means (m, n=148)	FDBH (f, n=28)	FDBG (m, n=66)∞
GOL	179.6	177.8	170.1	173.1
XCB	134.1	138.4	133.3	136.5
ZYBβ	131.2	131	122.8	131.8
BBH	132.3	136.3	129.9	133.3
BNLβ	100.7	100.7	95	98.5
BPL	95	98.3	92.3	97.9
MAB	62	65.2	62.3	64.5
MAL	50.1	55.3	51.8	55.2
AUB	121.5	124.1	118.4	123.9
UFHT	69.2	73.4	67	71.7
WFBβ	93.4	94	90.4	93
NLH	54.5	52.1	48.5	51.9
NLBβ	25	24.9	24.4	25.5
OBB	44.3	39.8	38.8	39
OBH	37.1	35.3	35.4	36.2
EKBβ	96.5	96.5	93.6	96.3
FRC	110	111	104.6	106.4
PAC	114.9	111.7	108.4	112.2
OCCβ	94	96.8	94.6	95.7
FOL	37	36.5	35.7	35.5
FOBβ	30.4	30.9	30	30.2
MDH	33	28.4	25.3	31.2
BRA	48	46.6	46.2	46.8
BBA	55	53.4	52.8	52.1
NBA	78	80	81	81.1

*Males (m) and females (f) combined due to small sample size ∞Only males in FORDISC FDB Guatemalan sample ΩCraniometrics not used in mean comparison (removed by FORDISC 3.1): UFBR, GNI, HMF, TMF, GOG, CDL, WRB, NAA (Nasion Angle), PRA (Prosthion Angle), BAA (Basion Angle) BOLD: BRA: Bregma Angle; BBA: Basion Angle; NBA: Nasion-Basion Angle βPotential key craniometric landmark measurements in hispanics

classification accuracy is critical in biological evidence for affiliation [15]. An important result is that the D2 values will follow a chi-square distribution with p degree of freedom.

Additionally, FORDISC 3.1 uses canonical variates to display data in graphic form. Canonical variate analysis is most effective in problems where many variables are used to compare differences among and within many reference groups. It is a technique that uses raw data to produce coefficients (or eigenvectors), and these coefficients are used to obtain new variables called canonical variates which maximize the among-groups variation (eigenvalues) relative to the standardized within-groups variation [16]. The variables (or measurements) are combined into a reduced number of functions to maximize the separation between groups. Such plots provide visual information as to which sample means (or centroids) are close or distant to one another in multivariate space. Moreover, multidimensional data space transforms confidence "intervals" into confidence "spheroids" (or ellipses), which are equidistant with regard to the within-group dispersion. Finally, there are usually several canonical variates, independently, holding biological information. However, it is the earlier variates that will contain information such as differences in overall shape and size.

Results and Discussion

Analysis of Maxwell Museum hispanic craniometric Means in FORDISC 3.1

The mean calculated craniometrics were inputted into the FORDISC 3.1 Forensic Data Base (FDB). Simultaneously, FORDISC 3.1 calculated angles based on these measurements: Nasion Angle (NAA), Prosthion Angle (PRA), Basion Angle (BAA), Nasion-Basion Angle (NBA), Basion Angle (BBA), Bregma Angle (BRA). All of these measurements were used in the analysis. Since there was clear information on ancestry and sex for Maxwell Museum sample group, only White females, Black females, Hispanic females, American Indian females, White males, Black males, Hispanic males, Guatemalan males, and American Indian males in the FORDISC 3.1 FDB were selected as reference groups. These groups represent the trihybrid ancestry of Hispanics. The name "American Indian" (as opposed to Native American) is the language used in the FORDISC 3.1 FDB.

On the first run (or initial processing), FORDISC 3.1 classified Maxwell Museum Hispanics into the American Indian Male (AM) reference group with a posterior probability of 0.284 (Table 5). The typicality probabilities were 0.524 (Typ F, which is dependent on sample size), 0.453 (Typ Chi—which is not dependent on sample size), and 0.560 (Typ R—where the Maxwell Museum sample was ranked 22th out of 50 individuals within the group). In essence, the Maxwell Museum Hispanics were as typical as 44% of the American Indian male reference group. However, other typicality probabilities show that the Maxwell Museum Hispanic sample is within the range of variation of the following reference groups in FORDISC 3.1 FDB: Hispanic males, Guatemalan males, Black males, White males, American Indian females, Hispanic females, Black females, and White females. All of these reference groups have typicality probabilities above .05. The graph of the results depicted in 3D canonical space showed this variation (Figure 2). The

Table 5. FORDISC 3.1 classification of Maxwell Museum Hispanic sample group in FDB.

Multigroup Classification of Current Case						
Groupα	Classified Into	Distance from	Probabilities			
			Posterior	Typ F	Typ Chi	Typ R
AM (22/50)	**AM**	25.2	0.284	0.524	0.453	0.560 (22/50)
HM (69/149)	-	26.2	0.17	0.449	0.397	0.537 (69/149)
GTM (43/67)	-	26.2	0.166	0.459	0.395	0.358 (43/67)
BM (34/80)	-	26.3	0.159	0.451	0.391	0.575 (34/80)
WM (153/263)	-	27	0.112	0.402	0.355	0.418 (153/263)
AF (22/26)	-	27.9	0.072	0.408	0.312	0.154 (22/26)
HF (23/29)	-	29.9	0.027	0.312	0.229	0.207 (23/29)
BF (46/52)	-	33	0.006	0.182	0.132	0.115 (46/52)
WF (124/142)	-	33	0.006	0.168	0.131	0.127 (124/142)

Current case is closest to AMs
αReference groups: AM= American Indian Males; HM= Hispanic Males; GTM= Guatemalan males; BM= Black Males; WM= White Males; AF= American Indian Females; HF= Hispanic Females; BF= Black Females; WF= White Females

Maxwell Museum Hispanic sample (indicated by the bold 'X' in the graph) is closest to the Hispanic male reference group centroid but also within the American Indian male, American Indian female, Guatemalan male, and Black male reference group ellipses. The FORDISC 3.1 results are not surprising. Human populations have been migrating and admixing (i.e., through warfare and exogamy) for thousands of years so that ancestry is complex despite bureaucratic or state phenotypical assortment or self-identification.

A second run was completed using only the FDB's males: Hispanic, Black, White, Guatemalan males, and American Indian. FORDISC classified the Maxwell Museum Hispanic sample in the Hispanic male reference group with a posterior probability of 0.356 (Table 6). The typicality probabilities were were 0.180 (Typ F), 0.115 (Typ Chi), and 0.181 (Typ R—where the Maxwell Museum sample was ranked 118th out of 144 individuals within the group). The Maxwell Museum Hispanics were as typical as 82% of the Hispanic male reference group. The Maxwell Museum Hispanic sample (indicated by the bold 'X' in the graph) is closest to the Hispanic and Black male reference group centroids but also within the American Indian male and White male reference group ellipses (Figure 3).

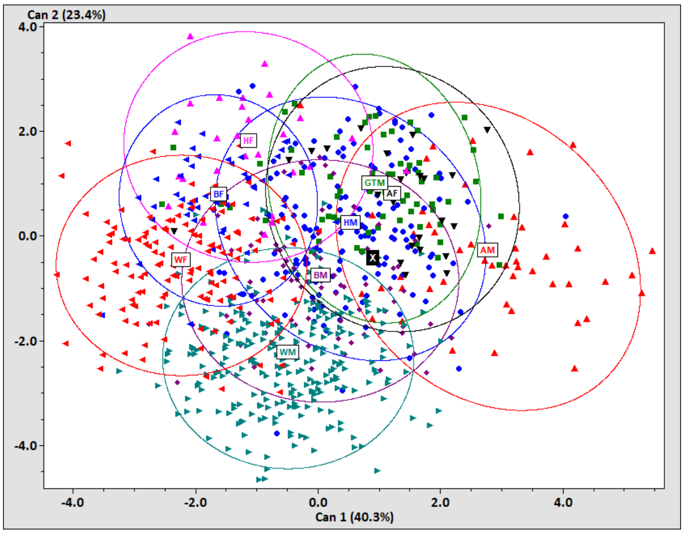

Figure 2. Graph of Maxwell Museum sample group FORDISC 3.1 (FDB) classification results in canonical space (male and female reference groups).

Comparison of craniometric landmark measurement means

To find craniometric measurement landmarks that could be important in the identification of 'Hispanic,' the SPSS statistical software was used to compute craniometric means for the Maxwell Museum Hispanics and then compared to craniometric means for Hispanic males (n=148), Hispanic females (n=28), and Guatemalan males (n=66) from the FORDISC 3.1 FDB (Table 4). The anthropologist found seven craniometric measurements with nearly identical or similar means that could be key in the identification of 'Hispanic' when an unknown cranium is recovered by police. These measurements are Bizygomatic Breadth (ZYB); Cranial Base Length (BNL); Minimal Frontal Breadth (WFB); Nasal Breadth (NLB); Biorbital Breadth (EKB); Occipital Chord (OCC); and Foramen Magnum Breadth (FOB) Figure 4 and Figure 5. Figures 4 and 5 generated by SPSS, gives two different views of the same data, and there may be other craniometric measurements which are important in this respective identification. What is critical is the fact that a larger sample of Hispanic cranial data must be obtained from academic departments and museums located on the east coast of the United States (U.S.) where one is likely to find curated skeletal materials documented as having Cuban and/or Puerto Rican population affiliations and similar institutions located in the southwest and western regions of the U.S. where one is likely to find curated skeletal materials documented as having Mexican, Central American, and South American population affiliations. Only then can we extricate the cultural, environmental and genetic factors governing these largely craniofacial landmark measurements [17-23].

Table 6. FORDISC 3.1 classification of Maxwell Museum Hispanic sample group in FDB (males).

Multigroup Classification of Current Case						
Groupα	Classified Into		Probabilities			
			Posterior	Typ F	Typ Chi	Typ R
HM (118/144)	**HM**	37.2	0.356	0.18	0.115	0.181 (118/144)
BM (49/62)	-	37.4	0.316	0.183	0.11	0.210 (49/62)
WM (200/234)	-	37.9	0.255	0.159	0.101	0.145 (200/234)
GTM (59/67)	-	40.8	0.059	0.106	0.056	0.119 (59/67)
AM (10/16)	-	43.7	0.014	0.095	0.03	0.375 (10/16)

Current case is closest to HMs
αReference groups: HM= Hispanic Males; BM= Black Male; WM= White Male; GTM= Guatemalan Males; AM= American Indian Males

Conclusion

While admixture studies using the human skull are not new, the traditional focus has been on more research-oriented and philosophical questions such as race, ancestry, and craniofacial variation without providing any answers to practical applications in the forensic context, This research has the

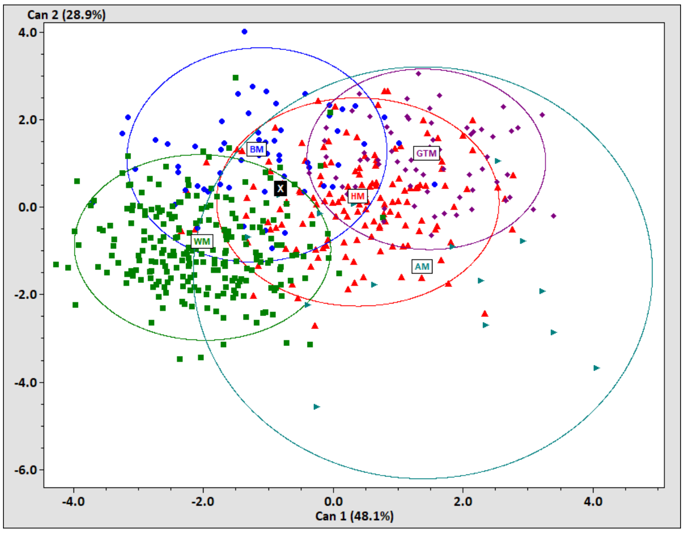

Figure 3. Graph of Maxwell Museum sample group FORDISC 3.1 (FDB) classification results in canonical space (male reference groups).

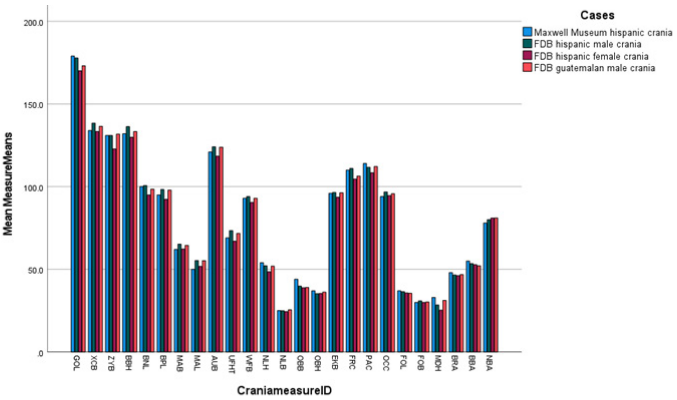

Figure 4. Bar graph showing comparison of craniometric landmark measurement means of Maxwell Museum Hispanics to means for Hispanic males (n=148), Hispanic females (n=28), and Guatemalan males (n=66) from the FORDISC 3.1 FDB. The following means are near identical or similar: ZYB; BNL; WFB; NLB; EKB; OCC; FOB.

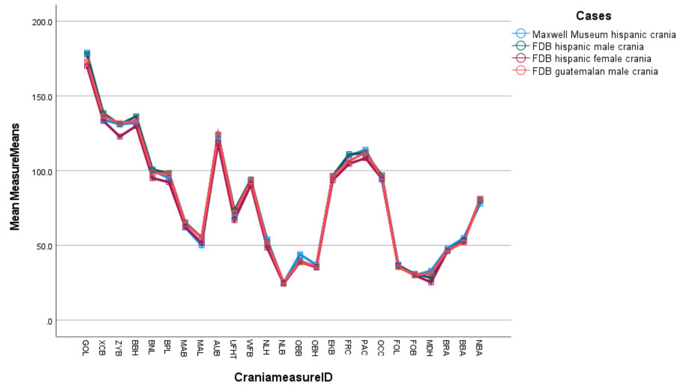

Figure 5. Line graph showing comparison of craniometric landmark measurement means of Maxwell Museum Hispanics to means for Hispanic males (n=148), Hispanic females (n=28), and Guatemalan males (n=66) from the FORDISC 3.1 FDB. The following means are near identical or similar: ZYB; BNL; WFB; NLB; EKB; OCC; FOB.

potential to generate standard probability parameters based on respective craniometric measurements for identifying "Hispanic" crania, particularly when a cranium is discovered and assessed showing primarily European and Native American ancestry estimates. On a larger scale, this research has the potential to identify admixture in other population groups. Forced migrations spurred by totalitarian regimes in the country of origin or drought and starvation has resulted in migrant fatalities, whether at the US–Mexico border crossing or at sea between Cuba or Haiti and Miami. This research will add a new perspective in using craniometrics (i.e., practical applications) to study admixture in general and Hispanic identification in particular, and simultaneously help law enforcement reduce the number of open cases that deal with questionable ancestries.

Future Directions

1. Submit an application for a larger grant in order to obtain craniometric data from a larger sample of Hispanic skeletal materials curated at academic departments and museums located on the east coast of the United States (U.S.) where one is likely to find curated skeletal materials documented as having Cuban and/or Puerto Rican population affiliations and similar institutions located in the southwest and western regions of the U.S. where one is likely to find curated skeletal materials documented as having Mexican, Central American, and South American population affiliations. This is critical in understanding if 'Hispanic' can be identified within the complex mix of environment, admixture, and genetics.

2. Further explore whether or not the few craniofacial landmark measurements noted in this research is governed solely by genetics and, therefore, could be used to identify an unknown skull as 'Hispanic.' (Or are we simply capturing the variation due to admixture based on their trihybrid ancestry.)

3. A MicroScribe 3D digitizer will be used to better capture cranial size and shape. Three-dimensional (3D) osteometric landmark coordinates show greater discrimination among modern cranial sample groups than traditional one-dimensional (linear) measurements and more nontraditional measurements (i.e. arcs and angles), which may be key in finding population affinity, can be calculated. The goal is to get a better representation of cranial morphology and reduce error rates.

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Conflict of Interest

None.

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