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A Study of Non-metric Traits using the William M. Bass Donated Skeletal collection

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Ancestry Determination:

A Study of Non-metric Traits using the William M. Bass Donated Skeletal Collection

Chancellor's Honor's Program: Senior Project

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Abstract

Race is a concept that is still being used today despite the rejection of it by so many academic professionals. Through the years, the word "race" has evolved into more appropriate terms such as ancestry, populations, and ancestral groups. Ancestry determination is a crucial part of the forensic anthropologist's identification of human remains. In this study, the utility of eight non-metric traits as an indicator of ancestry was evaluated. The traits were from the midfacial region and the vault of the cranium. Data was collected from a sample of individuals within the William M. Bass Donated Skeletal Collection at the University of Tennessee. There are expansive collections of skeletal remains in the United States but these collections are limited by the populations included within them. Numerous studies have been conducted upon the potential for estimation of ancestry from skeletal remains. The present examination attempts to recognize whether commonly assessed craniofacial traits can be used to accurately differentiate Hispanic individuals from the population at large.

Chapter I

Introduction

Although anthropologists have rejected race due to its social implications, it still dominates the everyday language of the people. Forensic anthropology is also forced to use the word "race" for the benefit of law enforcement officials when aiding in the identification of an individual. This study focused on the eight non-metric traits from the cranium of three separate population groups. The specific traits were chosen based on their previous success in the determination of ancestry.

Anthropology and Race

The identification of ancestry is an important component of the work of forensic anthropologists in the identification of human remains. In the Western world, human ancestral groups do exist and can be found in government census records, the mass media, and even in chapters of anthropology textbooks (Kennedy 1995). This definition of ancestry is maintained by law enforcement and based on the biological profile. Sauer (1992) suggests that the determination of ancestry is crucial in constructing a profile of missing persons, while Goodman (1995) states ancestry determination is not an essential concept to forensic anthropology. Nonetheless, the ultimate goal is the positive identification of individuals. This identification could be achieved whether the term being used is race or ancestry. By simply replacing that one word, the objective of law enforcement is not compromised. Some of the more current terms used today include ancestry, descendants and populations. These terms are deemed more appropriate for use in an educational setting.

Other anthropologists disagree with these views and uphold that "races" do not exist biologically but rather are socially constructed. These anthropologists recognize that there are population differences and accept that there are phenotypic differences in our species. This does not constitute an establishment of divisions within our species, which is referred to as "race" (Kennedy 1995). The non anthropological view bases population divisions on groupings consisting of several factors such as skin color and facial features. However, anthropologists cannot base categories on only one or two biological factors.

Another problem is that the major ancestral classification have always been expressed as Caucasoid (American White), Negroid (American Black), and Mongoloid. These terms are not used anymore due to their racist nature and failure to reflect actual populations. For example the term Mongoloid encompasses Asians, Native Americans, Hispanics and many others. This is problematic in the fact that these have separate ancestral populations from very different regions. In particular, the Hispanic category is very broad and it is not thoroughly understood whom the population group encompasses. It is also noted that not all Hispanic groups are the same. Individuals with Southwest Hispanic ancestry possess skeletal traits from Native American and European while individuals with Southeast Hispanic ancestry will have a much larger African and European ancestry. Therefore these Hispanics will display different morphological characteristics (Birkby 2008).

Ethnic Categories

In 1977 the United States Office of Management and Budget released the report *Race and Ethnic Standards for Federal Statistics and Administrative Reporting* that established five categories for race. The descriptions for each category are as follows:

1. *American Indian or Alaskan Native:* A person having origins in any of the original peoples of North America, and who maintains cultural identification through tribal affiliations or community recognition.

2. *Asian or Pacific Islander:* A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands, and Samoa.

3. *Black:* A person having origins in any of the black racial groups of Africa.

4. *Hispanic:* A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

5. *White:* A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.

(Wallman 1977).

In 1995, revisions to the *Race and Ethnic Standards for Federal Statistics and Administrative Reporting* reveal that the Hispanic category is classified as ethnicity while the other four are classified as race. When collecting data the racial and ethnic categories are combined. The list includes:

1. *American Indian or Alaskan Native*

2. *Asian or Pacific Islander*

3. *Black, not of Hispanic origin*

4. *Hispanic*

5. *White, not of Hispanic origin*

(Katzen 1995).

The U.S. Census Bureau report from 2005 indicates that the most common ancestral populations are White, Black and Hispanic. Hispanic individuals represent a growing population within the United States. Many in this population group are farmworkers or illegal immigrants which are not counted in the census. There are up to 2.5 million farmworkers nationwide and about two-thirds are Hispanic (Marentes 1999). With an increasing frequency of a Hispanic population in the United States, there is a greater need to be able to recognize and understand the ancestry of these populations. Furthermore, the possibility for forensic anthropologists to recognize and classify individuals as Hispanics is a potentially problematic situation. The Hispanic population group is one group that has been underrepresented over the years in skeletal collections. A challenge in this is that there are no collections that are very expansive, making the recognition of methods to assess ancestry difficult.

Skeletal markers of ancestry

Traits that indicate skeletal variation are determined by studies on large skeletal collections of specific population groups. There are several of these collections of known individuals. The major sources of research data include the Terry collection, housed at the Smithsonian Institute in Washington, D.C.; the Huntington collection, the Hamann-Todd collection curated in Ohio (St. Hoyme 1989), and the William M. Bass collection in Tennessee. There are limits to these collections, with the majority of these containing individuals with ancestry from European and African populations. In addition, with the exception of the William M. Bass Donated Skeletal collection, these consist primarily of individuals born during the 19th century.

There are two approaches that have been effective in the determination of ancestry: metric approach and non-metric assessments. The metric method uses various measurements to determine ancestry. It is an accurate method because of its quantitative nature. However, these methods are based on samples that include established ancestral groups. The non-metric method is a subjective visual method that identifies variation in the skeleton. Either postcranial elements or the cranium can be used, though the latter has been more extensively studied and is more effective, for determining ancestry. The use of postcrania is limited in the determination of ancestry because studies have yet to identify useful traits (Byers 2005).

Non-metric traits

The assessments of non-metric traits particularly on the cranium are commonly used to determine ancestry. The assumption is that the traits will discriminate among populations making it easier to distinguish between the different groups (Wijsman 1986). A problem with nonmetric traits is that they are qualitative and there can be confusion regarding the definition of the traits. Many of these same concerns have been documented in different studies (Brues 1990; Rhine 1990; Hefner 2007) as a determining factor in identifying ancestry repeatedly.

Rhine (1990), in a study of Southwest Hispanics recognized that several traits were consistent throughout the population. These include: small nasal spine, rounded orbits, complex sutures, wide ascending ramus, and a nasal opening flared at the base (Rhine 1990). In a recent study Birkby (2008), identified non-metric traits that were being used by the Medical Examiner in Arizona which were similar to Rhine's (1990) list. Hefner (2007) used similar typical non-metric traits in a statistical analysis. He proposed using classification statistics in conjunction with non-metric traits to effectively assess ancestry.

Chapter II

Materials and Methods

Eight crania representing three different ancestral groups were examined for a total sample size of 24 specimens. The data was collected from the William M. Bass Donated Skeletal Collection at the University of Tennessee. The ancestries that were examined include, White (or Caucasian), Black (or African American), and Hispanic (from Spanish speaking countries). The number of 24 specimens was selected based on the number of Hispanics in the collection. Since this number was limited to eight specimens, the sample size for each ancestry group was eight to keep all the variables constant.

To maintain consistency all specimens were males with ages between 23 and 46. The average age was 37.38 for Whites, 36.25 for Blacks, and 37.17 for Hispanics. The Hispanic category had two specimens that were left out of the age average, with one having an unknown age and the other an age range in the thirties. There was also a highly fragmented Hispanic cranium, thus several traits were not assessed for one specimen. Based on the small number of Hispanic specimens in the collection, these specimens were included even though there are gaps in the research.

All crania were assessed in the same manner. The approach was based on an examination of the morphological traits of the cranium using a scoring method modified after Hefner (2007). The morphological traits chosen for assessment were selected as they 1) are features of craniofacial skeleton, and 2) are successful in differentiating between other population groups. Eight traits were chosen for this study with four being from the midfacial

region, three from the upper portion of the brain case, and one trait from the mandible. The midfacial region has proven to be the most beneficial in ancestry determination (Rhine 1990).

Trait Descriptions

Anterior Nasal Spine (ANS)

This feature is the point where the left and right maxillas connect and the right and left nasal apertures are intersected by the midsagittal plane. It is the most posterior point of the nasal aperture. It is scored as 1) slight 2) medium 3) marked. The projection of the ANS is indicated by the small arrow on Figure 1.

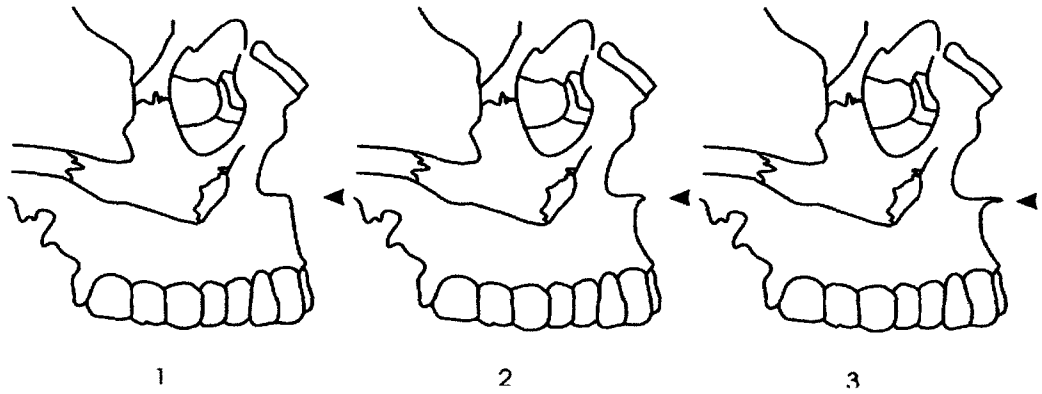


Figure 1. Anterior Nasal Spine (ANS) (Hefner 2007).

Nasal Aperture Width (NAW)

This is located on the midfacial skeleton and measures the width of the nasal aperture. It is scored as 1) narrow 2) medium 3) broad. The variation of widths can be found on Figure 2.

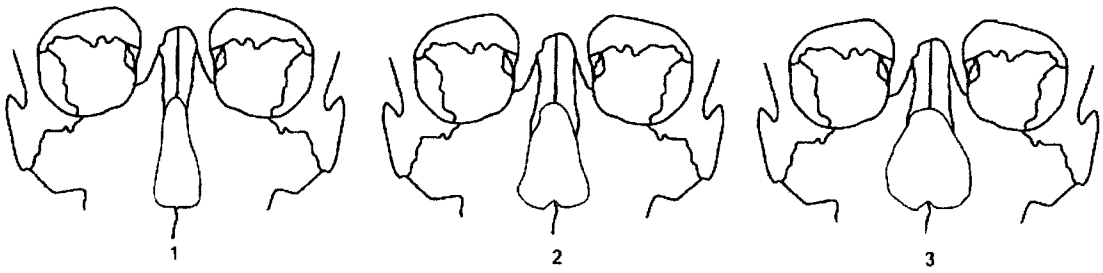


Figure 2. Nasal Aperture Width (Hefner 2007).

Interorbital Breadth (IOB)

This is the maximum distance from dacryon to dacryon on the right and left orbits. Dacryon is defined as the point on the medial wall of the orbit at the junction of the lacrimoaxillary suture and the frontal bone (Bass 2005). It is scored as 1) narrow 2) medium 3) broad. It is indicated by the dashed lines on Figure 3.

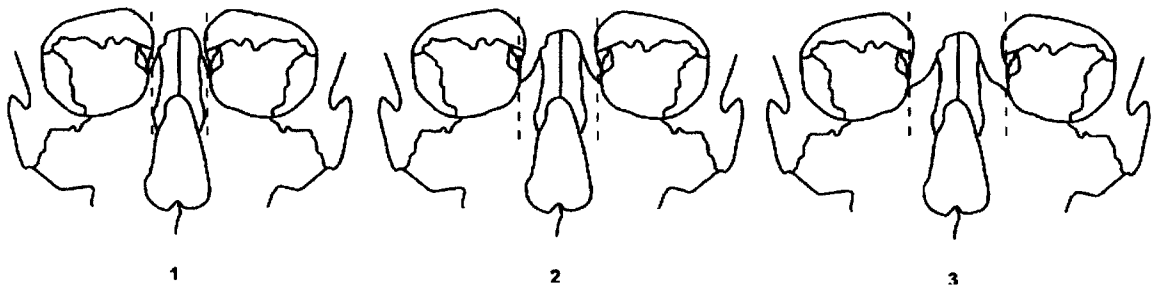


Figure 3. Interorbital Breadth (IOB) (Hefner 2007).

Eye Orbit Shape (EOS)

This is a trait that identifies the shape of the eye orbit. It is scored as 1) square 2) angle 3) round. Figure 4 shows the eye orbit shape.

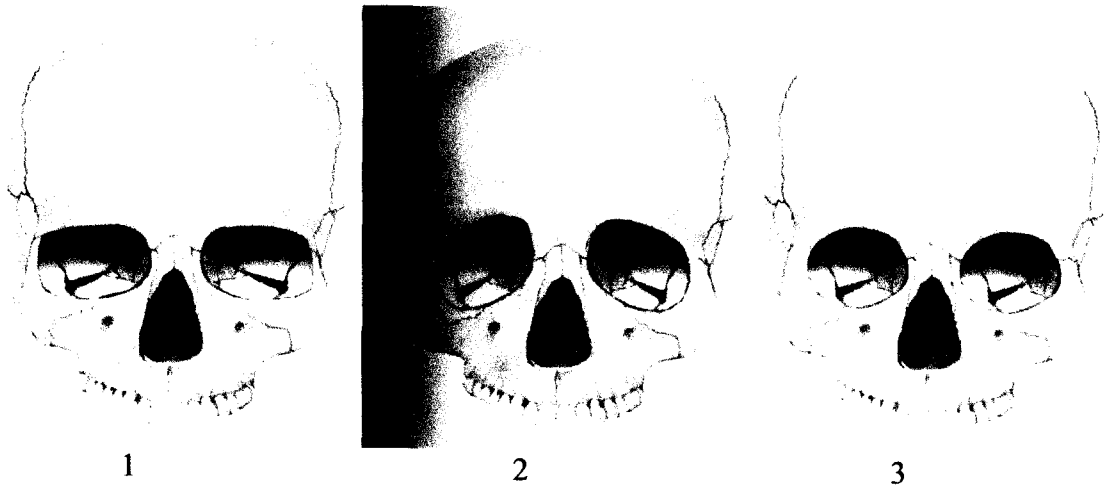


Figure 4. Eye Orbit Shape (EOS) (Byers 2005).

Post-bregmatic Depression (PBD)

This is a slight depression immediately posterior to bregma, which is the intersection of the coronal and sagittal sutures in the midline. It is scored as 0) absent or 1) present. It is indicated by the small arrows on Figure 5.

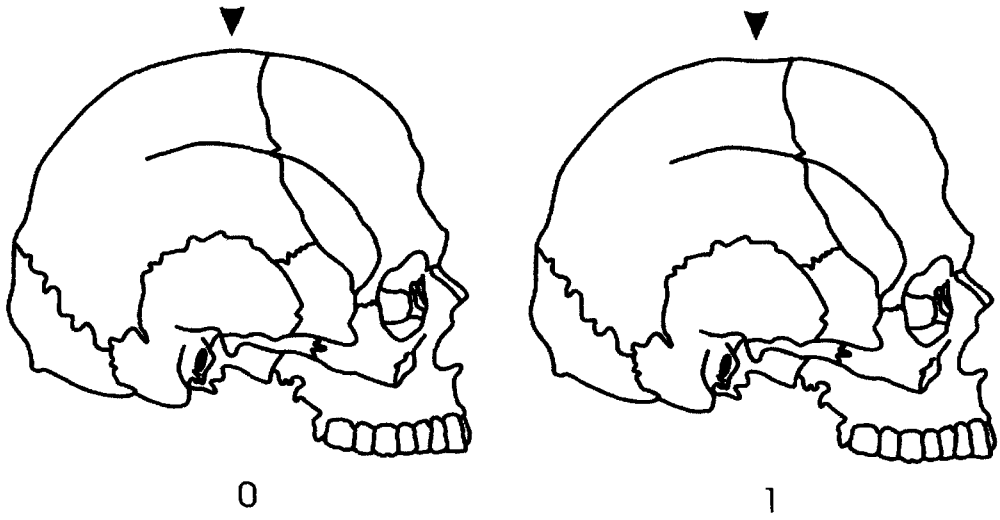


Figure 5. Post-bregmetic Depression (PBD) (Hefner 2007).

Vault Sutures (VS)

This assessment considers the sagittal suture and whether it is 1) simple or 2) complex. Figure 6 shows the sagittal suture.

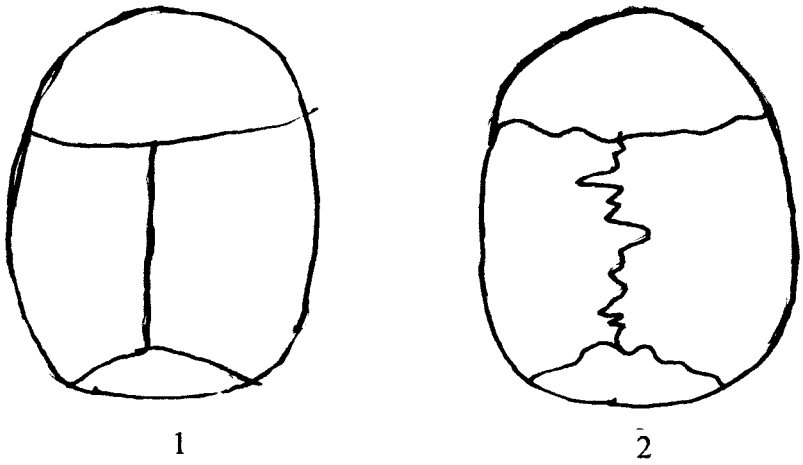
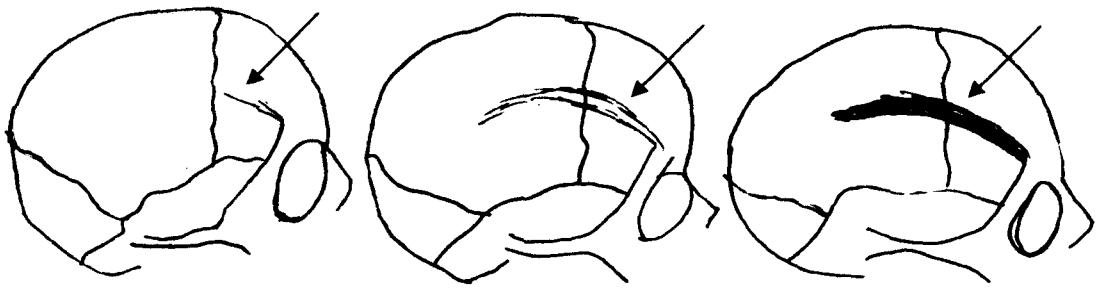


Figure 6. Vault Sutures (VS)

Muscle Marks- Temporal Lines (MM)

The temporal lines are the muscle attachment sites of the temporalis muscle. This defined region begins anteriorly at the frontosphenoid process of the zygomatic bone, continuing laterally on the frontal bone onto the parietal bone. It is scored as 1) smooth 2) slightly raised 3) marked. The arrow in Figure 7 indicates the different degree of muscle markings.

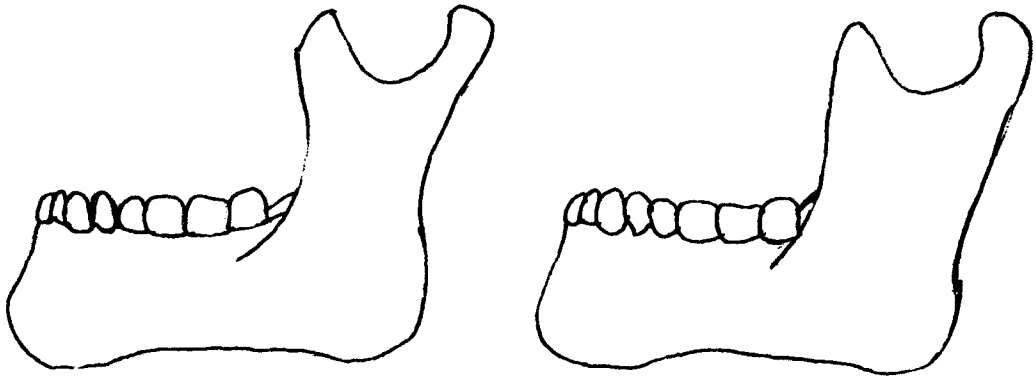


1 2 3

Figure 7. Muscle Marks (MM)

Ascending Ramus (AR)

The ascending ramus is located on the mandible and is a broad vertical projection that terminates with the anteriorly coronoid processes and the posteriorly condyles. The feature focuses on the lateral midpoint of the ascending ramus and is scored as 1) pinched or 2) wide. Figure 8 shows the variation of the ascending ramus.



1 2

Figure 8. Ascending Ramus (AR)

Chapter III

Results

A total of 188 traits were assessed for this study. The traits chosen for this project have been used in many non-metric ancestry studies (Rhine 1990, Byers, 2005, Hefner 2007). Table 1 shows the similarities and/or differences between what was expected and what was observed. Table 2 shows the skulls from the William M. Bass Donated Skeletal Collection and the observations for each of the eight non-metric traits. Table 3 shows the accuracy of the tests by displaying the number that was correctly identified and the percentages.

Table 1. Expected versus Observed Results

	White		Black		Hispanic	
	Expected	Observed	Expected	Observed	Expected	Observed
ANS	marked	marked	slight	slight	slight	marked
NAW	narrow	narrow	broad	broad	medium	medium
IOB	narrow	narrow	broad	broad	medium	broad
PBD	absent	absent	present	some present	absent	absent
EOS	angle	angle	square	mixed	round	square/angle
VS	complex	complex	simple	simple	simple	complex
MM	marked	marked	smooth	slight/marked	slight	slight
AR	pinched	varied	pinched	pinched	wide	varied

Table 2. Assessment of the Eight Non-Metric Traits

	ANS	NAW	IOB	EOS	PBD	VS	MM	AR	Estimated Ancestry	Actual Ancestry
22-99D	marked	medium	narrow	angle	absent	simple	n/a	pinched	W	H
28-99D	medium	broad	n/a	n/a	n/a	simple	slightly raised	wide	Cannot be determined	H
34-99D	marked	medium	narrow	square	absent	complex	slightly raised	pinched	B	H
37-04D	marked	medium	medium	square	absent	complex	slightly raised	pinched	B	H
20-94D	marked	medium	broad	angle	absent	complex	smooth	pinched	W	H
42-04D	marked	medium	broad	angle	absent	complex	marked	wide	W	H
46-04D	marked	medium	broad	square	absent	simple	slightly raised	pinched	B	H
35-05D	slight	medium	broad	angle	absent	complex	slightly raised	wide	H	H
48-04D	slight	broad	broad	round	absent	simple	marked	pinched	H	B
8-99D	medium	broad	broad	square	present	simple	marked	pinched	B	B
4-95D	marked	broad	broad	angle	absent	simple	slightly marked	pinched	W	B
25-04D	marked	broad	broad	angle	absent	simple	marked	wide	W	B
21-92D	medium	broad	broad	square	present	complex	slightly marked	wide	B	B
18-90D	slight	medium	broad	angle	absent	simple	marked	pinched	H	B
46-03D	slight	medium	medium	round	absent	complex	slightly marked	pinched	H	B
53-05D	slight	medium	broad	round	present	simple	slightly marked	wide	B	B
8-87D	marked	medium	medium	angle	absent	complex	marked	wide	W	W
14-93D	marked	narrow	broad	angle	absent	complex	smooth	wide	W	W
27-93D	slight	narrow	narrow	angle	absent	complex	marked	pinched	W	W
34-05D	medium	narrow	narrow	angle	absent	complex	smooth	pinched	W	W
02-02D	medium	narrow	narrow	angle	absent	simple	marked	pinched	W	W
13-91D	marked	narrow	narrow	angle	absent	complex	slightly marked	wide	W	W
74-05D	marked	narrow	broad	angle	absent	simple	marked	wide	W	W
36-05D	marked	medium	broad	angle	absent	complex	slightly marked	pinched	W	W

Table 3. Number of Estimated Ancestries that were Accurate

	Number Correct**	Accuracy Percentage
White	8	100%
Black	3	37.5%
Hispanic	1*	12.50%

*(1 of the crania was fragmented and missing pieces of the midfacial area)

** n=8 for each ancestral group

Chapter IV

Discussion

The majority of the cranial assessments using the eight traits varied from the expected results. One possibility is that these traits could be disappearing within population groups due to the mixing of these groups. This variation is not helpful in determining ancestry because a consensus needs to be established for these traits. All eight (100%) White crania examined, were accurately identified (see Table 3). This is indicative of the White population group having thorough studies of their corresponding non-metric traits. Only three of eight Black crania (37.5%) were accurately identified (see Table 3). For the Hispanic sample of crania the collection of traits was not accurate in determining ancestry. From the estimations, there was only one Hispanic cranium (12.5%) that displayed the established traits consistent with the Hispanic population group (see Table 3). There is not a comprehensive collection of Hispanic ancestry within the William M. Bass Donated Skeletal Collection and further studies need to be completed to determine the appropriate list of non-metric traits.

From the midfacial region the traits that were assessed were the anterior nasal spine (ANS), the nasal aperture width (NAW), the interorbital breadth (IOB), and the eye orbit shape (EOS). Both the ANS and the NAW were both good indicators of White ancestry. The ANS was not a good indicator of Black ancestry having only half of the individuals possessing the expected result (see Table 1). The Hispanic ancestry had only one individual who possessed the ANS expected result (see Table 1). The NAW did have a high success rate of being accurate within the Black and Hispanic ancestries (see Table 1). The IOB was found in the Black population group more frequently than the Hispanic and White population groups. The EOS was

very accurate in the White population group with all eight crania possessing angled orbits. The Black population group only had two individuals who displayed square orbits. The Hispanic population group displayed a wide variety of the EOS.

The traits from the vault that were assessed were the post-bregmetic depression (PBD), the vault sutures- sagittal suture (VS), the muscle markings-temporal line (MM), and the ascending ramus (AR) on the mandible. The PBD was useful in determining Black ancestry because if the individual possessed this trait then the classification was Black. However, it was not very helpful in determining between White or Hispanic ancestry. The VS assessment aided in determining White ancestry, but it was difficult to determine between Black or Hispanic ancestry. The MM was a difficult trait to assess because it was very ambiguous. The assessment scored the trait on 1) smooth 2) slightly raised) and 3) marked. It was not a useful trait in determining Black ancestry because not a single individual portrayed smooth muscle markings. This trait showed a greater potential in the Hispanic populations. The AR trait showed considerable variation within the three population groups making it very difficult to assess in all three population groups.

There was a nasal overgrowth observed on every Hispanic skull that was intact. This was not an observation on the crania from other ancestral groups. From this observation the nasal overgrowth would be an effective trait in determining Hispanic ancestry. Rhine (1990) noted this feature in his non-metric trait list. The projection is often at least a millimeter into the nasal aperture. The apparent overgrowth makes it an effective trait in determining Hispanic ancestry.

From this study, the non-metric traits that proved the most potential to differentiate Hispanic population groups were the nasal aperture width and muscle markings. The presence of nasal overgrowth, as observed in this study and which has shown success in past studies (Rhine

1990, Hefner 2007), is a trait that was found with frequency among Hispanic crania. The non-metric traits which have shown the most potential for the assessment of ancestry for the black population group include nasal aperture width, interorbital breadth, vault sutures, and post-bregmetic depression (if present). Most of the non-metric traits for the White population group had at least 50 percent accuracy, therefore suggesting that these non-metric traits are effective in differentiating that population group. This could be influenced by the focus of previous studies, researcher error and limits of the selected attributes.

Chapter V

Conclusion

This study explored the implications of "race" on forensic anthropologists and how the area has evolved over the years. The evolution has deemed more appropriate and accurate words such as ancestry and population groups. Through this examination eight non-metric traits from the midfacial region, vault, and mandible were studied with three ancestral populations (White, Black, and Hispanic). This analysis of population groups indicates that many of the traditional non-metric traits are not as effective in differentiating between population groups. It appears that the ability to identify observable indicators of ancestry is becoming more difficult as populations become less distinct, likely due to the mixing of populations. Nonetheless, the need to make a statement with regards to ancestry is crucial to the generation of the forensic case report. There is a great need for more expansive collections involving the groups that are not represented. Future studies can be greatly improved with larger collections on different population groups. Further research must be done to increase the validity of ancestry determination and therefore aid the forensic anthropologist in their future work.

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References

Bass WM (2005) *Human Osteology: A Laboratory and Field Manual*, Fifth Edition. Columbia, MO: Missouri Archaeological Society.

Birkby WH, Fenton TW, Anderson BE (2008) *Identifying Southwest Hispanics Using Nonmetric Traits and the Cultural Profile*. J Forensic Sci 53:29-33.

Brues A (1990) The Once and Future Diagnosis of Race. *Skeletal Attribution of Race: Methods for Forensic Anthropology* edited by G. Gill, S. Rhine . Maxwell Museum of Anthropology Anthropological Papers No. 4. Albuquerque, NM: University of New Mexico.

Byers, SM (2005) *Introduction to Forensic Anthropology: A Textbook*, Second Edition. Boston, MA: Pearson Education, Inc.

Hefner JT (2007) The Statistical Determination of Ancestry Using Cranial Non-metric Traits. A dissertation presented to The Graduate School of the University of Florida.

Goodman AH (2007) *The Problematics of "Race" in Contemporary Biological Anthropology*. In Boaz N, Wolfe L, editors. Biological Anthropology: The State of Science. International Institute for Human Evolutionary Research. Bend, OR: Central Oregon University Center.

Katzen, S (1995). *Race and Ethnic Standards for Federal Statistics and Administrative Reporting.* Office of Management and Budget. http://www.whitehouse.gov/omb/fedreg/race-ethnicity.html

Kennedy KAR (1995) *"But Professor, Why Teach Race Identification if Races Don't Exist?"* J Forensic Sci 40:797-800.

Marentes C and CP Marentes (1999) Fact Sheet on Farmworkers. http://www.farmworkers.org /fwssheet.html

Rhine S (1990) Non-metric Skull Racing. *Skeletal Attribution of Race: Methods for Forensic Anthropology* edited by G. Gill, S. Rhine . Maxwell Museum of Anthropology Anthropological Papers No. 4. Albuquerque, NM: University of New Mexico.

Sauer N (1992) *Forensic anthropology and the concept of race: If races don't exist, why are forensic anthropologists so good at identifying them?* Social Science and Medicine 34: 107-111.

St. Hoyme, LE. and Iscan, MY (1989) Determination of Sex and Race: Accuracy and Assumptions. In Reconstruction of Life From the Skeleton edited by M.Y. Iscan and K.A.R. Kennedy. Alan R. Liss: New York, NY. 53-93.

Wallman KK and Hodgdon J (1977) *Race and Ethnic Standards for Federal Statistics and Administrative Reporting*. Statistical Reporter 77-10:450-454.

Wijsman, EM. and Neves, WA (1986) *The Use of Non-metric Variation in Estimating Human Population Admixture: A Test Case with Brazilian Blacks, Whites and Mulattos.* American Journal of Physical Anthropology 70(3):395-405.