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# Analysis of The University of Montana Forensic Case 29

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ANALYSIS OF THE UNIVERSITY OF MONTANA FORENSIC CASE 29

By

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Professional Paper

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## TABLE OF CONTENTS

Background.....	1
Skeletal Inventory.....	1
Associated Artifacts.....	4
Age Estimation.....	4
Discussion of Age Estimation Methods.....	10
Sex Estimation.....	11
Discussion of Sex Estimation Methods.....	14
Ancestry Estimation.....	15
Discussion of Ancestry Methods.....	18
Stature Estimation.....	18
Trauma and Pathology.....	19
Forensic Anthropology and Race: A Critical Examination of Non-Metric Approaches.....	22
Final Conclusions.....	30
Literature Cited.....	31
Appendix.....	37

## BACKGROUND

This individual was received from the Great Falls police department in 1985, as Crime Lab # DFS 85-367, agency # MA47-061285. UMFC 29 is maintained in the locked Physical Anthropology Laboratory (Social Science, room 250) on the campus of The University of Montana-Missoula. UMFC 29, like all other specimens in the Laboratory, is used as educational material and only members of the faculty and select students have access to the collection. Analysis took place from January 15-March 26, 2010.

## SKELETAL INVENTORY

UMFC 29 represents one (1) individual consisting of a nearly complete skeleton. All the bones exhibited a yellow to brownish hue suggesting that they have been buried in soil at some time in the past. The articulated cranial bones present include the frontal, left and right parietals, left and right temporal, occipital, left and right maxilla, left and right palatines, left and right lacrimals, left and right nasals, left and right zygomatic, sphenoid, and mandible. Fragmented or absent bones include: vomer, left and right inferior nasal conche, and the left and right auditory ossicles (malleus, incus, and stapes). Cranial bones exhibiting exfoliation due primarily to weathering include frontal, left parietal, temporal and left and right maxilla. The right parietal, temporal, the occipital are in relatively good condition with no evidence of weathering or erosion. The bones of the lacrimal and nasal also indicate some patterning of exfoliation or cortical erosion.

Dentition present include the maxillary left and right medial and lateral incisor, right canine, right 1<sup>st</sup> and 2<sup>nd</sup> premolars, and left and right 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> molars. Dentition on the mandible include: left lateral incisor, right medial and lateral incisor, left and right canine, left and right premolars, and left and right 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> molars. Teeth absent include the maxillary left canine and premolars and the left mandibular medial incisor. All the teeth present exhibit carious lesions throughout and are extremely worn and abraded.

The hyoid bone, between the skull and the postcranial skeleton, is absent. All vertebrae are present, in overall good condition, with the exception of vertebral lipping present, especially on the cervical and lumbar vertebrae. The sacrum is present with a broken lateral edge of the distal sacral foramen. The sternum body, manubrium, and xiphoid process are absent. There are 12 left and 12 right ribs present, exhibiting some cortical flaking, erosion, and discoloring. The left and right clavicles are present. The left and right scapula exhibit cortical bone flaking with thinning resulting in 2 holes on the left subscapular fossa and bone erosion present on the coracoid, acromion, and inferior angle on both the left and right scapula.

The long bones present include left and right humerus, radius, ulna, left femur, right tibia, and right fibula. The right femur, left tibia, and left fibula are absent. The right humerus displays lateral curvature of the humeral shaft; cortical flaking on the lateral epicondyle with the left humerus has cortical thinning on the humeral head. Both the left and right radii have cortical thinning on the neck of the radius and styloid processes, with the addition of thinning on

the oblique line of the left radius. The left femur has erosion on the medial epicondyle. The right patella is present while the left patella is absent. The left and right os coxae are present with both os coxae having thinning of the iliac fossa resulting in lateral cracks.

Tarsals present include the right calcaneus and right cuboid. Absent tarsals are left and right talus, left calcaneus, left cuboid, left and right navicular, left and right medial cuneiform, left and right intermediate cuneiform, and left and right lateral cuneiform. Metatarsals present include the right 3<sup>rd</sup> and 4<sup>th</sup> metatarsals. Absent bones among the metatarsals include: the right 1<sup>st</sup>, 2<sup>nd</sup>, and 5<sup>th</sup> metatarsals, the left 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> metatarsals. Both left and right foot phalanges are absent.

Carpals present include left and right scaphoid, right lunate, right trapezium, right trapezoid, right hamate, and right capitates. Absent carpals include left and right pisiform, left lunate, left trapezium, left trapezoid, left hamate, and left capitates. Metacarpals present include the right 1<sup>st</sup>, right 2<sup>nd</sup>, right 4<sup>th</sup>, left 2<sup>nd</sup>, left 4<sup>th</sup>, and left 5<sup>th</sup>. Absent metacarpals include right 3<sup>rd</sup>, right 5<sup>th</sup>, left 1<sup>st</sup>, and left 3<sup>rd</sup>. Hand phalanges present include the right proximal 1<sup>st</sup>, right proximal 2<sup>nd</sup>, right proximal 3<sup>rd</sup>, right proximal 4<sup>th</sup>, right proximal 5<sup>th</sup>, and the intermediate 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, and distal 1<sup>st</sup> phalanx. Absent hand phalanges include the left 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> metacarpals and all left proximal, intermediate, and distal phalanges.

## ASSOCIATED ARTIFACTS

Present with the remains include an adult-sized leather belt and small pieces of wood.

## AGE

UMFC 29 was probably between the ages of 35 and 65 at the time of death. Estimations of chronological age-at-death are based on an assessment of developmental and degenerative skeletal changes. Emphasis is placed on accuracy and precision of each technique with the necessity of reaching final estimates through a composite approach.

### Suture Closure Methods

The use of cranial suture closure for estimating age has a long and controversial history. Todd and Lyon (1924) first suggested that endocranial vault sutures corresponded and related to age. They discovered that cranial sutures were open in young people but had a tendency to closure through time. Despite their initial findings, the research was considered flawed due sampling strategy of discarding specimens that were not “normal”.

In 1985 Richard Meindl and Owen Lovejoy published a study on the validity of determining age from cranial suture closure. Although they encountered considerable variation, the method they developed has been received more favorably because they used acceptable research procedures. Their method focused on 10 locations on the cranial vault useful for determining age. They found that the accuracy of the technique could be enhanced by

dividing the sites into two groups: the cranial vault and the lateral-anterior surface. Each suture is scored by assigning a numeric value based on the amount of suture closure. For each degree of suture closure, these values are 0 for open, 1 for minimal closure, 2 for significant closure, and 3 for complete obliteration. "Minimal" is characterized by the closing of these gaps by bridges of bone that vary from a single connection to bridges that encompass less than 50% of the entire suture. "Significant" closure means that there is more than 50% fusion between the bones. "Obliteration" refers to complete fusion between the bones with no gap. After each site is scored, the resulting numbers are added together to determine the appropriate stage of relationship between closure scores and age.

The controversy over the reliability of ectocranial suture status (open vs. closed) as an age estimation method has been one of forensic anthropology's interests over the years (Krogman and Iscan 1962; Iscan 1988; Dorandeu et al. 2008). The debate continues over whether cranial suture ossification represents an accurate age-predictable process. Historically, it was generally assumed to be a process of natural aging, but a new understanding of the nature of suture closure has produced new insights on the process.

Hershkovitz et al. (1997) describe Buikstra and Ubelaker (1994) as problematic and question Meindl and Lovejoy's three underlying assumptions: that suture closure represents a normal progressive process, that different processes operate in different segments of the same suture, and that some aspects of cranial suture variation are due to population and sex. These



assumptions are suggested to have no factual basis and the application and methods based upon them should be considered very subjective. The division between segments of the same suture is not clear cut in many skulls and the definition of the four degrees of closure is also open to widely different interpretations. What is meant by “marked degree” and “some portion”? How are these things measured?

Using the Meindl and Lovejoy (1985) cranial vault suture scoring technique, the following sutures are scored on UMFC 29: Midlambdoid suture, described as significant, scored 2. Lambda suture, described as significant, scored 2, Obelion suture, described as significant, scored 2, Anterior Sagittal suture, described as obliteration, scored 3, Bregma, described as obliteration, scored 3, Midcoronal, described as obliteration, scored 3, and Pterion, described as significant, scored 2. The composite score based on the cranial vault produces a score of 16-18 that translates to an average age of 48.8 years and is described as “Middle Adult” with an age range of 35-49 years.

#### Pubic Symphysis Methods

A method for estimating adult age from the pubic symphysis surface was first developed by Todd (1920) and further advanced by Brooks and Suchey (1990). Todd initially described the pubic symphysis as a site suitable for age determination. His information was based on observations of 306 male specimens housed at Case Western Reserve University. Todd described regular age-related changes at the pubic symphysis, which he separated into 10 progressive model phases. Each phase corresponds to a related age range

based on the actual ages of the specimens in which he observed these conditions. Brooks and Suchey (1990) refined the method described by Todd (1920) by decreasing the number of stages from 10 to 6, thus expanding the age range estimates for each stage. Both the Todd method and Brooks and the Suchey method focus on the degenerative changes that correlate with age (White and Folkens 2000).

An alternative method for estimating the ages of adults at death from the symphyseal face of the pubis has been presented by McKern and Stewart (1957), based on a three component, five phase method of the pubic symphysis. The technique describes 3 distinct components of the pubic symphysis: Component I. dorsal plateau, Component II. ventral rampart, and Component III. symphyseal rim. Each component of the symphyseal face is then classified on a scale of 0-5. The total score of the three components are added together to relate to an age range.

Using Todd's age phases, UMFC 29, exhibits phase VIII, age 39-44 years. Phase VIII is described by Todd (1920) as follows: "The symphyseal face is described as generally smooth with the ventral surface of pubis inactive. The oval outline is complete or approximately complete. The extremities are clearly defined with no distinct rim to symphyseal face and there is no marked lipping of either dorsal or ventral margin" (Todd 1920).

With the Brooks and Suchey (1990) pubic symphysis scoring system, UMFC 29 is scored as phase 5. In phase 5 the "*symphyseal face is completely rimmed with some slight depression on the face itself, relative to the rim.*" Phase

5 corresponds to a mean age of 45.6, standard deviation of 10.4; with a 95% range of 27-66 years.

Using the Mckern and Stewart (1957) method, UMFC 29's component I is characterized as stage 5: "billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture". Component II is characterized as stage 5: "the rampart is complete" and Component III is characterized as stage 3: "the symphyseal rim is complete. The enclosed symphyseal surface is finely grained in texture and irregular or undulating in appearance." Using this method, the mean age, standard deviation, and age ranges of males obtained from the total scores are calculated using McKern and Stewart symphyseal formulas (after McKern and Stewart 1957) produce a total score of 13, giving an estimated of age of 23-39 years.

#### Auricular Surface Methods

Lovejoy et al. (1985) examined the auricular surface of the os coxae as a possible source of regular change corresponding to age. Lovejoy et al. describe age-related changes in surface granulation, microporosity, macroporosity, transverse organization, billowing, and striations that are somewhat similar to those described for the surface of the pubic symphysis. Beginning in adulthood, these features of the sacroiliac joint become progressively and regularly modified as age increases.

Using the Lovejoy et al. (1985) technique the auricular surface of UMFC 29 as representing is scored as phase 7, which suggests an age range of 50-59

and is described as “dense irregular surface of rugged topography and moderate to marked activity in preauricular areas”.

#### Miscellaneous Methods

Other degenerative changes in the skeleton also serve as an indicator of age at death. M. Yasar Iscan (1985) showed that the ends of the ribs that join with the sternum (via the costal cartilage) undergo changes through life. UMFC 29 has rib ends that are characterized as “light and porous U-shaped and deeper, a sharp rim edge, and a rim contour as irregular with projections”. This description corresponds to an age range from 50-59 years of age.

Stewart (1958) noted the utility of the development of vertebral osteoarthritis (lipping) as a general indicator of age. Vertebral lipping generally is absent until the age range of 28-30, happening in only approximately 5% of the cases, but elevates to 10% of the total population from 35-40 years, 20% in 41-50 years, then plateaus to 25% in 51+ years of age and is much more prevalent in cases where the person is generally older in life (Albert 1998). Using Stewart’s technique, UMFC 29’s lumbar vertebrae are classified as 3 out of 4, 0 indicating no lipping and 4 indicating maximum lipping suggesting an age range from 35-84 years of age.

Dental attrition (wear) is also age related and can be used for estimating age at death for individuals. The dental attrition method from Tromly (1996) suggests an age potentially as high as 60 years of age. Using standards for the molars, Tromly’s scoring technique describes the molars of UMFC 29 as having “the enamel rim completely worn away”. The standards developed by Scott

(1979) use the molar occlusal surface and score the surface 0 to 10. Using these standards, UMFC 29 is scored as a 10, with the molars described as, “no enamel on any part of the quadrant-dentine exposure complete. Wear is extended below the cervicoenamel junction into the root” (Scott 1979). The dentition present in this individual is extremely abraded and worn without any evidence of any modern dental care.

#### Discussion of Age Estimation Methods

With any non-metric method, the descriptive techniques can produce high levels of inter and intra-observer error. Buckberry and Chamberlain (2002) recognized that “the problem arises from the fact that rates of skeletal remodeling and degeneration, from which most methods of adult age estimation are derived, can be highly variable between different individuals and populations”. Descriptive surface aging techniques of age estimation need to be subject validity and replicability testing. It is believed that with non-metric techniques, there is a tendency to overestimate ages of younger adults and to underestimate ages in categories above 60 years old (Bedford et al. 1993; Falys et al. 2006).

The life history of a person is an important factor in determining the rate of skeletal aging. Factors such as diet, health, disease, physical activity, and cultural differences will certainly have an impact on the range of variation between individual of a population. The methods of surface aging techniques need to be tested and redefined, using large, multiracial, and known-age modern and, if possible, archaeological populations (Buckberry and Chamberlain 2002). This will probably lead to the redefinition of age ranges and standard deviations.

Combining the dental attrition, cranial suture closure, methods of pubic symphyseal aging, auricular surface aging techniques, sternal rib ends, and vertebral lipping, the conservative age range for UMFC 29 would be between the ages of 35-65. With all the aging techniques developed for adults, changes to the skeleton are dominated by degenerative factors throughout the person's life. Factors that can affect the general appearance of the skeleton could include diet, lifestyle, occupation, and/or socioeconomic status in life. Consequently, many of the aging techniques tend to underestimate the old and overestimate the young. Other problems with degenerative scoring techniques are that the samples do not account for the human diversity found throughout the world, the techniques are based on small samples that only reflect a portion of a population, or the samples have a small age range of individuals represented. While some authors have focused on the utility of combining age indicators as opposed to using a single method (Schmitt et al. 2002), there are problems associated with accuracy, precision, and error rates of different methods tested on different populations.

## SEX

### Sex Estimation from the Skull

A visual assessment of the skull's features is consistent with the male sex. A scoring system developed from sexually dimorphic cranial features by Walker (cited in Buikstra and Ubelaker 1994), examines 5 dependent cranial features: the nuchal crest, mastoid process, supra-orbital margin, supra-orbital ridge/glabella, and the mental eminence of the mandible. The assessments are

scored on robusticity from 1 to 5 and defined as follows: 1 as definite female, 2 as probable female, 3 as ambiguous, 4 as probable male, and 5 as definite male.

In another method in evaluating the morphological features of the skull for sex estimation, Williams and Rogers (2006) analyzed the precision and accuracy of morphological characteristics of the skull was tested on a modern sample of 50 adult crania. The following general craniofacial features are identified as of high-quality: mastoid size, supraorbital ridge size, general size and architecture, rugosity of the zygomatic extension, size and shape of the nasal aperture, and gonial angle.

Using the method from Walker (cited in Buikstra and Ubelaker 1994) UMFC 29 is scored as a male based on the following sexually dimorphic structures: nuchal crest = 4, mastoid process = 3, subra-orbital margin = 4, subra-orbital ridge/glabella = 4, and mental eminence = 3.

Using the method by Williams and Rogers (2006), male expression is present from the following features present in UMFC 29: fairly rugged size and architecture, low sloping frontal shape, small frontal bossing, medium to large supraorbital ridges, square, low orbits, small parietal eminences, large occipital condyles, large, U-shaped palate, and a mandible with the following characteristics: broad ascending ramus, gonial angle less than 125 degrees with angle averted and a square chin.

#### Sex Estimation from the Pelvis

Postcranially, the pelvis provides the most abundant and accurate data for sex estimation (Ubelaker 1989; Iscan 2005). The most predictably dimorphic

bones in the human body are those of the bony pelvis, which become distinctive during the adolescent growth spurt (Coleman 1969). Traditional methods from Stewart (1958), Krogman and Iscan (1962), White and Folkens (2000), and Walker (2005) use the following tendencies in the determination of sex from the pelvis: the sacrum and os coxae are more robust than females, the pelvic inlets are relatively narrower in males than females, the greater sciatic notch is relatively narrower than the notch in females, females tend to have relatively longer pubic portions of the os coxae than males, the subpubic angle is larger in females than in males, a smaller, flatter auricular area on the medial portion of the ilium that articulates with the sacrum, an absent preauricular sulcus, and a larger acetabulum.

The Phenice (1969) technique is described as the most accurate and commonly used method for the determination of the sex of an individual. This method provides criteria that describe three aspects of the pubis (Ubelaker and Volk 2002): the ventral arc, subpubic concavity, and the medial aspect of the ischiopubic ramus. The ventral arc is a slightly elevated ridge of bone that sweeps inferiorly and laterally across the ventral surface of the pubis. Female os coxae display a subpubic concavity, while males don't show pronounced concavity. The medial aspect of the ischiopubic ramus displays a sharp edge in females; while in males the surface is flat, broad and blunt.

The UMFC 29 Phenice characteristics are as follows: the ventral arc displays elevated ridges, but do not take on the wide, evenly arching path of the female's ventral arc or set off the lower medial quadrant of the pubis. The



subpubic concavity has a straight, slightly curved ramus and the medial aspect of the ischiopubic ramus is fairly flat, broad, and blunt. Using the Phenice method, UMFC 29 is suggested as male.

Rogers and Saunders (1994) assess the reliability and precision of 17 individual morphological features of the pelvis frequently used to determine sex. Their sample consists of a documented 19<sup>th</sup> century skeletal sample from St. Thomas Anglican Church. Combining both the reliability and precision of the traits, the following traits are ranked according to precision and accuracy. UMFC 29 displayed the following features indicative of the male sex: ventral arc absent, large/ovoid obturator foramen shape, small pelvis size and shape, long and narrow sacral shape, v-shaped subpubic concavity and angle, narrow pubic bone, the development of muscle markings, absent dorsal pubic pitting, large acetabulum size, absent preauricular sulcus, high, vertical iliac shape, small sciatic notch, six (6) or more sacral segments, heart shaped pelvic inlet, absent ischiopubic ramus ridge, and a flat auricular surface height.

#### Discussion of Sex Estimation Methods

Many of the non-metric characteristics used to describe sex rely on robusticity and overall size. However, the variation found in these features found throughout the world creates ambiguities within the sexes. The three aspects of the pubic surface suggested by Phenice (1969) focused on the ventral arc, ischiopubic ramus, and the subpubic concavity are suggested to have up to 96% accuracy. In comparison, Rogers and Saunders (1994) recognize that the Phenice characteristics are not equally accurate. In their research, they rank the

ventral arc as the most accurate trait, the subpubic concavity as the fifth most accurate, and the ischiopubic ramus only as the sixteenth most accurate. This independent evaluation of the morphological features only further underscores the need for continuing research and cross population comparisons. Like the other aspects of the biological profile, multiple methods and techniques provide researchers higher degrees of accuracy than a single technique alone.

## ANCESTRY

A metric and a non-metric evaluation based on cranial features suggest that UMFC 29 was of African descent. Cranial measurements when entered in FORDISC 3.0 (Jantz and Ousley 2006) suggest a Black male.

The non-metric traits from Krogman and Iscan (1962), El-Najjar and McWilliams (1975), Morse et al. (1983), Brues (1990), Rhine (1990), and point to the midfacial area as the most productive region for race attribution. In Rhine's (1990) evaluation, many of the traits selected in his study have been used in other non-metric evaluations of race. Based on a sample of 87 adult crania, Rhine scored the traits as definitive when occurring in 30% or in 50% or more in the traits described. Of those traits, the following traits that were observed in 50% or more of the Black cases include: simple sutures, wide nasal opening, straight nasal depression, "tented" nasal form, small nasal spine, moderate prognathism, elliptic dental arcade shape, blunt chin, vertical profile of the chin, and a round external auditory meatus.

With any non-metric analysis, the intra and inter-observer error is an important factor. Ancestry analysis is usually accomplished through a visual inspection of the morphological variants of the cranium, mandible, and the postcranial skeleton (Konigsberg et al. 2008; Hefner 2009). With the traditionally used 3 “racial” classifications, “Mongoloid”, “Caucasoid”, and “Negroid” (Bass 2005; Klepinger 2006; Burns 2007; Byers 2008; Pickering and Bachman 2009), the first procedure in any analysis is to assume that there are three populations in which all people can be separated. Predicting ancestry using non-metric traits is not straightforward, often relying on years of experience and a remarkable understanding of human variation (Hefner 2009). Also, the degree of overlap between the racial characteristics and the use of descriptive traits creates ambiguities within the characteristics used to describe each “race” (Caspari 2003).

Brues (1990) also addressed the problem of identifying race. It is important to acknowledge the difference between “race”, a socially constructed mechanism for self identification, and “ancestry”, a scientifically derived descriptor of the biological component of population variation. Of these two concepts, only ancestry can be estimated in anthropological practice. Nonetheless, the study of the physical differences in people has considerable time depth in American anthropology (Komar and Buikstra 2008). The assessment of ancestry through the use of non-metric features lacks the statistical rigor common to metric approaches (Konigsberg et al. 2009). “The lack of a methodological approach and the fact that there are no estimates of

expected error rates associated with ancestry prediction using the morphoscopic method, suggests that they have not been investigated with appropriate scientific and legal considerations in mind. Minimizing subjectivity is certainly one of the goals of the scientific method” (Walker 2008).

Using the traits suggested by Rhine (1990) UMFC 29 displayed the following: simple cranial sutures, wide nasal opening, straight nasal depression, “tented” nasal form, small nasal spine, moderate prognathism, elliptic dental arcade shape, blunt chin, vertical profile of the chin, and a round external auditory meatus.

Krogman and Iscan (1962) and Brues (1990) indicated other features of the cranium that are used as potential indicators of African ancestry. These are indicated on UMFC 29: low, rounded nasal root, low nasal bridge, a “guttered” lower border of the nose, and a wide width. The face has a forward projecting profile, narrow shape, rectangular eye orbits, and a receding lower eye border. The cranial vault has small brow ridges and smooth muscle marks. The jaws and teeth are described as large, an elliptic palatal shape, with possible spatulated upper incisors.

A visual assessment from El-Najjar and McWilliams (1975) and Morse et al. (1983) also corroborates African descent. Overall, UMFC 29’s skull had a long skull length with a narrow breadth, a long coronal contour, a flat sagittal contour, narrow face breadth, low to medium face height, forward projecting jaws, wide interorbital distance, wide nasal orifice width, sharp nasal sill, and a wide palate shape.

Research does suggest that the cranium is the most reliable indicator of ancestry in the skeleton, but the femur has also been studied as an indicator of ancestry (Stewart 1979). Stewart suggests that people of African descent have straight femoral shafts, while European and Asian femoral shafts tend to be curved. The left femur of UMFC 29 is characterized as curved, however the mild torsion in the femoral neck is consistent with the torsion typical of Europeans and Africans.

#### Discussion of Ancestry Estimation Methods

Ancestry is not decided by a reference to a single index or an isolated non-metric trait. One must always use a large number of traits to gain a sense of direction of the variables expressed in an individual. Rhine's (1990) method provided the greatest number of trait observed in the crania with the frequencies of each trait found within each case. Using the Black traits that were found on at least 50% of the cases in their study, the analogous racial characteristics of UMFC 29 strongly indicates African descent.

#### STATURE

Methods of calculating living stature are based on the correlation between body height and limb length. The considerable variation found among different populations makes necessary the development of population-specific formulas. Trotter's (1970) regression formulas are used to estimate living stature from long bones of males and females.

The long bones present in UMFC 29 consists of left femur, right tibia, left and right humerus, left and right radius, and left and right ulna, the measurements are 42.3, 35.2, 29.0, 30.4, 22.7, 22.9, 24.5, and 24.7, (cm), respectively. Using formula suggested for Black Males (Trotter 1970), stature estimates from the long bones are: left femur  $159.60 \pm 3.94$  cm (5'2"-5'5"), right tibia  $163.11 \pm 3.78$  (5'3"-5'6") cm, left humerus  $156.64 \pm 4.43$  (<5'-5'3"), right humerus  $161.20 \pm 4.43$  (5'2"-5'5"), left radius  $159.19 \pm 4.30$  (<5'-5'4"), right radius  $159.88 \pm 4.30$  (<5'-5'4") cm, left ulna  $159.16 \pm 4.42$  (<5'-5'5") cm, and right ulna  $159.81 \pm 4.42$  cm (<5'-5'4"). Using the regression formulas, UMFC 29 has a height range from under 5 feet tall using estimates from left and right radius and ulna to as tall as 5 foot 6 inches using estimates from the right tibia.

#### TRAUMA/PATHOLOGY

An assessment of the trauma and condition of the remains is consistent with heavy weathering that led to environmental degradation. There is no conclusive evidence of any pathology present.

The skull with the mandible is complete and shows some postmortem degradation on the frontal bone, left zygomatic, left temporal, and left parietal along the sagittal suture. The wear patterns can be described as cortical bone flaking due to possible chemical erosion and sun exposure. The left and right zygomatic display an unusual pattern on the posterior aspect of the zygomatic bone. The frontal exhibits 90% cortical flaking while the left parietal is approximated at 55%, left zygomatic is 80%, and the left temporal is

approximately 25% eroded. The occipital bone superior to the nuchal crest displays some slight pitting. The mandible has only the slightest presence of cortical flaking on the left ascending ramus.

All of the teeth are present, except for the left maxillary canine, 1<sup>st</sup> and 2<sup>nd</sup> maxillary premolars, and left lateral mandibular incisor. All of the absent teeth are considered of postmortem occurrences due to the lack of alveolar absorption. The teeth, although nearly complete, are extremely worn down to or near the pulp cavity.

The 24 vertebrae and sacrum are present. Vertebral lipping is present on the lower margin of C4, both margins of C5 and C6, and the upper margin of C7. The left upper facet of T1 was enlarged, antemortem or perimortem. The spinous processes of T4 and T5 are broken off postmortem. There is a large amount of lipping and pitting of the upper margins on all lumbar vertebrae. With each subsequent lumbar vertebra the degree of lipping becomes more and more pronounced in the progressive development of bony outgrowths (osteophytes) on the margins of the rounded center of the vertebra (Ubelaker 1989). The sacrum is complete with the exception of the right fifth posterior sacral foramina, which is broken perhaps postmortem. The sternum and manubrium are complete with slight postmortem deterioration on the costal grooves. All of the ribs are present with left right rib 5, 7, and 8 fractured postmortem. Left 4<sup>th</sup> rib shows a possible healed puncture wound 52 mm past the angle on the posterior side.

Both os coxae are complete with iliac tuberosities showing slight lipping and pitting. There are also bony outgrowths lateral to the iliac tuberosities on the

left and right os coxae. The pubic symphyses are fairly smooth with a ridge along the posterior border. Both iliac fossae are cracked postmortem. The scapulae are present, complete, and in fairly good condition. The right scapula shows slight lipping on the clavicular surface of the coracoid process. The left scapula shows slight lipping on the anterior side of the acromion process. There are two holes in the center of the left scapular body, which suggests antemortem trauma. Both clavicles are complete. The sternal portion of the right clavicle shows possible antemortem deformation. The left clavicle is more elongated and gracile than the right.

The left and right humerus, ulna, and radius are complete. There is mild lateral torsion on the left and right humerus; with similar erosion or weathering consistent with those on the skull on the lateral aspect of the humeral shaft and on the lateral epicondyle of the right humerus. There is some lipping along the trochlear notch, radial notch, and the head of the right ulna. The right tibia displays some cortical thinning along the medial aspect of the tibial plateau with some remnants of the cortical thinning present across much of the skeleton. The left femur is essentially complete, with the distal portion weathered, and part of the medial epicondyle destroyed due to weathering.



## FORENSIC ANTHROPOLOGY AND RACE: A CRITICAL EXAMINATION OF NON-METRIC APPROACHES

An integral part of the biological profile constructed by forensic anthropologists for unknown human skeletal remains is the estimation of the socially-perceived ancestry or race of an individual. Defining the term “race” has proven difficult in the history of physical and forensic anthropology because concepts of race have been based on composites of biological, social, and ethnic criteria (White and Folkens 2000; Cattaneo 2007).

Part of the reason for the disagreement has been in their approaches and goals. Forensic anthropologists answer practical questions of age, sex, and race to construct the biological profile and narrow down missing person identifications, while the research oriented biological anthropologists explore within-group variation from a scientific perspective (Ousley et al. 2009). Race has also been used to refer to aspects of both biological and cultural variation, ancestry to language, and racial derived continental groupings (Relethford 2009). While external characteristics such as skin color and hair texture make the identification of race less difficult using external body characteristics, Brace (1995) explains that skeletal analysis provides no direct evidence for skin color, but it does allow for an accurate estimate of original geographic origins.

The diagnosis of race has had a long and checkered past (Shapiro 1959 and Spencer 1981). The first volume of the *American Journal of Physical Anthropology*, published in 1918, reflects the many dimensions of the race concept that we continue to see today (Caspari 2009). Perhaps the most

influential physical anthropologist of the time, Ales Hrdlicka (1918), used race to refer to geographic divisions of the human species, but also to smaller categories that could correspond to nationality and even smaller social groups. The recognition of the characteristics of different populations was seen as an important means of reconstructing prehistory and thus explaining cultural change (Brues 1990). At the time, the analysis of skeletal traits and the methods available suffered weaknesses, deficiencies, and biases in the samples and collections. In Krogman and Iscan's pioneering working in forensic anthropology, *The Human Skeleton in Forensic Medicine* they noted that the discussion of racial differences in the skeleton is a controversial area. "That the data represents an arch-type to the point of stereotype. There really are no "pure" races." It is not difficult for me to evaluate just *how* a single skull is classified as White, Negroid, or Mongoloid, nor can the mandible, pelvis, long bones, or scapula be correctly classified with reference to racial differences."

To conduct an analysis of ancestral background, forensic anthropologists use osteological traits that are known to vary among different human populations. This prediction is usually accomplished through a visual inspection of the morphological traits of the cranium, mandible, and/or through a metric analysis of the cranial and postcranial skeleton. The relationship between racial traits and classification accuracy is something often discussed in terms of physical anthropology, where race, along with sex, are common elements in skeletal analysis.

Within the biological profile established for a case, ancestry estimations are usually more difficult, less precise, and less reliable than indicators of age, sex, or stature. The estimation of ancestry using non-metric traits is not straightforward and often relies on years of experience and an understanding that human variation is continuous and not discrete. Stated by Ubelaker (2002) that some population differences are apparent in the skeleton, but variation within groups and the overlap among groups reduce the accuracy for individual skeletons. This creates problems in the process of identifying of unknown remains using the categories of age, race, sex, and stature in the biological profile. Race is an important factor in identifying skeletal remains which then can lead to a positive identification. But unlike sex, age, or stature, the subject may not perceive his or her racial identity in the same way that the forensic anthropologist might see it (Klimentidis et al. 2009).

The continued use of race in physical or forensic anthropology has been criticized because of the emphasis on disproving the biological race concept, while textbooks in forensic anthropology have structured human variation into three main races: "Caucasoid," "Mongoloid", and "Negroid" (Ousley et al. 2009). The use of geographically defined races is common within many disciplines, but this doesn't suggest that this is the best way to describe or analyze human variation. The consensus is that variation does exist and the important question concerns in the best way of describing and analyzing variation. Marks (1996) notes that the tendency for Americans to classify people in three races is a

product of history; with the American notion of black is actually based West African norms and the notion of Asian is based on East Asian norms.

Since the recognizable soft tissue characteristics such as skin color, hair form, and facial features often allow for a description of the attribution of geographic ancestry among living people, the hard tissues display less reliable signatures of affinity. There are no human skeletal markers that correspond perfectly to geographic origin (Shipman, Walker, and Bichel 1985; White and Folkens 2000). The problem is that most physical anthropologists today view human variability in genetic terms rather than the classification of skull morphologies (Relethford 2010). Studies have revealed that much of human craniometric variation follows both a neutral and a natural selection model in shaping the global diversity in cranial morphology. As suggested by Long and Healy (2009) “pattern of DNA diversity implies that some populations belong to more than one race. The boundaries in global variation are not abrupt and do not fit a strict view of the race concept and the number of races and the cutoffs used to define them are arbitrary. The race concept is at best a crude first-order approximation to the geographically structured phenotypic variation in the human species.”

Most American forensic anthropologists have accepted the biological race concept from classic physical anthropology and have applied it to methods of human identification. The reason, hypothesized by Sauer (1992), is because American forensic anthropologists focus on the concepts of social race and skeletal morphology in only American Whites and Blacks. While there are a

relatively small number of discrete physical differences among human beings (Ousley et al. 2009), craniometric and molecular data does show strong geographic patterning of human variation despite the overlap in their distributions suggesting that craniometrics can be used to classified geographic origin.

Analysis of craniometric variation in Black and White Americans supports the idea that morphological differences exist between American Whites and Blacks (Konigsberg and Jantz 2002; Ousley et al. 2009). Ousley and Jantz (2002) suggest that the majority of biological differences of American blacks and whites focus on the historical, social, genetic, and geographical influences between them. Within the confines of forensic anthropology, the commonly used three race model has been more of a comparison or a dichotomy of opposites. The Black and White comparison between the skeletal characteristics has characterized the Asian population in the middle or “grey” area of comparisons. Non-metric techniques suggested by Krogman and Iscan (1962) or Rhine (1990), typically place one of the three characteristics or descriptions as in the middle and the other two as the peripheries. For example, the nasal orifice widths characterized as Mongoloid are typically called “medium”, Caucasoid as “narrow”, and Negroid as “wide”. As suggested, the subjectiveness and observer error is problematic in the proper designation of racial grouping. For the inexperienced observer, it would be imperative that a comparative skull would be implemented to properly characterize a trait as either “medium”, “narrow”, or “wide” to correctly classify an individual as Asian, European, or African, respectively. To further the

analysis, the extent of human variation needs to be taken into account with the full spectrum of characteristics within human populations.

The interpretation of non-metric traits has traditionally involved qualifying a bone's shape, a suture's appearance, a feature's presence or absence, or a feature's degree of expression. The reliance on observer experience has produced methods that are as much an art as a science (Hefner 2009). With race estimation, Stewart (1979) suggests "that the challenge of being correct in a racial identification largely depends upon the observer's experience." Rhine (1990) suggests that a non-metric evaluation of the skull is often preferred to metric analysis as it requires no expensive or delicate equipment, it can be accomplished rapidly, and there are many features that can be assessed. In many regards, non-metric analyses may be seen as less satisfactory method than metric approaches because the definition of a trait is always difficult to explain. At what point along the continuum of variation does nasal shape becomes narrow, rather than medium or large? Will observer A evaluate those shapes in precisely the same way as observer B? The ambiguities in descriptive traits with the methods are problematic in any non-metric approach.

Given the limitations of such subjective criteria for recognizing geographic ancestry, some have turned to cranial metric methods for racial assessment, but the limitations are also true for metric approaches. Inter-observer error is also prevalent in metric methods such as FORDISC (Jantz and Ousley 2006). In Gill's (1990) conclusion to the continued use of non-metric traits, he suggests the strengths of non-metric approaches in that they may be carried out with no, or

with only minimal instruments, the observations may be made rapidly, and a non-metric assessment may be collected on specimens too damaged or incomplete for metric analysis.

In a non-metric analysis, if the observer is experienced and is able to maintain a consistent standard for the morphological estimation, then the morphoscopic traits are capable of classification according to a description of presence or absence. Until recently, the issue of subjectivity and standardization was not fully addressed in the forensic anthropological community. Walker (2008) suggests that the use of illustrations helps reduce inter-observer error in the estimation of ancestral affinity of a skull. Like many non-metric estimation techniques, a combination of traits tends to be more reliable rather than single trait alone.

Minimizing subjectivity is certainly one of the goals of the scientific method, further defining the need for forensic anthropologists to standardize and test the methods applicable to all aspects of skeletal analysis. Experienced observers are often able to predict ancestry correctly for the populations that they regularly work with, citing one trait or another in support of their assessment. As stated by Hefner, "when ambiguous or discordant trait values are encountered, admixture, or individual idiosyncrasy is invoked without any consideration of the actual distribution of traits in the reference population, bias conclusions are inevitable when using lists of traits supposedly representative of each ancestry as presented in textbooks and research articles." Geographic, regional, and population biases are also prevalent within a forensic context in which a certain

population concentration is higher in parts of the United States. Also forensic anthropologists with considerable experience with another race may find proper identification more difficult.

In regards to the scientific method and subjective to peer review, using non-metric traits is an art, an art that is intuitive, untestable, unempirical, and consequently unscientific. For the further advancement of non-metric traits in the estimation of ancestry from skeletal remains, standardization is imperative. The standardization of trait definitions and the further refinement of the method will undoubtedly help reduce the inter-observer error in future analysis. Walker (2008) explains that the optimal weighing of the traits seen in an individual to produce the best prediction of ancestry can be accomplished through statistical methods and reference group distributions. This will help create reliable and replicable indicators of ancestry for the further refinement of the science of forensic anthropology.



## FINAL CONCLUSIONS

This individual is most likely a Black male with an age around 35-65 years of age, but potentially from 18-89 years of age. Using measurement from the left femur, a height ranges from 5'3"-5'6" is most likely. Possible skeletal trauma is found on the vertebral bodies, left 4<sup>th</sup> rib, and on the left scapula. No obvious pathology is present on the entire skeleton. The teeth are heavily worn and abraded suggesting of limited or no dental care. Using the commonly used non-metric methods used by physical anthropology, an African ancestry is strongly and consistently suggested by characteristics throughout the skull. Age estimates, although fairly broad, do provide a range that is consistent with the degenerative findings throughout the skeleton. Sex estimations are the most accurate estimations of the biological profile. With the methods based on sexual dimorphic cranial characteristics, in conjunction to the pelvic indicators of sex, a suggestion of the male sex is very convincing.

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## APPENDIX

### Appendix A: Cranial Measurements

<b>Cranial Measurement</b>	<b>mm</b>
Maximum Cranial Length (GOL)	188
Maximum Cranial Breadth (XCB)	136
Bizygomatic Breadth (ZYB)	137
Basion-Bregma Height (BBH)	126
Cranial Base Length (BNL)	102
Basion-Prosthion Length (BPL)	100
Maxillo-Alveolar Breadth (MAB)	66
Maxillo-Alveolar Length (MAL)	50
Biauricular Breadth (AUB)	127
Upper Facial Height	69
Minimum Frontal Breadth (WFB)	94
Upper Facial Breadth	98
Nasal Height (NLH)	53
Nasal Breadth (NLB)	28
Orbital Breadth (OBB)	39
Orbital Height (OBH)	38
Biorbital breadth (EKB)	101
Interorbital Breadth (DKB)	27
Frontal Chord (FRC)	102
Parietal Chord (PAC)	168
Occipital Chord (OCC)	94
Foramen Magnum Length (FOL)	34
Foramen Magnum Breadth (FOB)	26
Mastoid Length (MDL)	27



Appendix B: Postcranial Measurements

<b>Postcranial Measurement</b>	<b>mm</b>
Chin Height	31
Height of Mandibular Body	39
Breadth of Mandibular Body	15
Bigonial Width	82
Bicondylar Breadth	127
Minimum Ramus Breadth	41
Maximum Ramus Breadth	51
Maximum Ramus Height	66
Mandibular Length	106
Maximum Length of the Clavicle (Left)	150
Sagittal Diameter of the Clavicle at Midshaft	33
Vertical Diameter of the Clavicle at Midshaft	34
Height of the Scapula (Left)	165
Breadth of the Scapula	106
Maximum length of the Humerus (Left)	301
Epicondylar Breadth of the Humerus	61
Maximum Vertical Diameter of the Head of the Humerus	48
Maximum Diameter of the Humerus at Midshaft	21
Minimum Diameter of the Humerus at Midshaft	20
Maximum Length of the Radius (Left)	227
Sagittal Diameter of the Radius at Midshaft	17
Transverse Diameter of the Radius at Midshaft	11
Maximum Length of the Ulna (Left)	245
Dorso-Volar Diameter of the Ulna	15
Transverse Diameter of the Ulna	14
Physiological Length of the Ulna	226
Minimum Circumference of the Ulna	38
Anterior Height of the Sacrum	131
Anterior Breadth of the Sacrum	100
Transverse Diameter of Sacral Segment 1	57
Height of the Innominate	212
Iliac Breadth	160
Pubis Length	74
Ischium Length	91
Maximum Length of the Femur (Left)	423
Bicondylar Length of the Femur	415
Epicondylar Breadth of the Femur	83

Maximum Diameter of the Femur Head	47
Anterio-posterior Subtrochanteric Diameter of the Femur	29
Transverse Subtrochanteric Diameter of the Femur	34
Anterio-posterior Diameter of the Femur at Midshaft	29
Transverse Diameter of the Femur at Midshaft	30
Circumference of the Femur at Midshaft	89
Length of the Tibia (Right)	350
Maximum Epiphyseal Breadth of the Proximal Tibia	69
Maximum Epiphyseal Breadth of the Distal Tibia	41
Maximum Diameter of the Tibia at the Nutrient Foramen	21
Transverse Diameter of the Tibia at the Nutrient Foramen	30
Circumference of the Tibia at the Nutrient Foramen	83
Maximum Length of the Fibula	342
Maximum Diameter of the Fibula at Midshaft	17
Maximum Length of the Calcaneus (Right)	82
Middle Breadth of the Calcaneus	45