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Comprehensive forensic case report: The University of Montana case #UMFC37

Angela J. Regan
The University of Montana

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Comprehensive Forensic Case Report
The University of Montana
Case # UMFC 37

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For the degree of
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May 2003

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Comprehensive Forensic Case Report, case # UMFC 37

Chairperson: Randall R. Skelton

I performed a comprehensive analysis of UMFC 37, which is part of the Department of Anthropology's teaching collection. The techniques and methods I used for this analysis are as follows. Methods for estimating race: from visual assessment from the skull, from palatine shape, from palatine suture shape, from zygomaticomaxillary suture shape, from Giles and Elliot discriminant function analysis, from Gill's interorbital features method, from FORDISC, from dentition, and from measurements of the femur, scapula, and sacrum. Methods for estimating sex: from visual assessment of the skull, from Giles and Elliot discriminant function analysis, from visual assessment of coxal shape in children, from Phenice technique, from visual assessment of the pubis, from measurements of the coxal and sacrum, from the shape of the sacrum, from the sternum, from measurements of the clavicle, from the scapula, from measurements of the tibia, measurements of the femur, and from the shape and measurements of the humerus. Methods for estimating age: from fontanelle closure, from suture closure, from long bone length, from epiphysis closure, from sternal rib ends, from the auricular surface, from the pubic symphysis, from dental development and eruption, from dental attrition, and from the vertebral column. Methods for estimating stature and weight: from the Trotter and Gleser method, from the Genoves method, and the Metropolitan Life Insurance Company chart. Methods for estimating handedness: from asymmetry, and from Stewart's method. I also examined the remains for evidence of pathology and trauma. Based on the application of these methods, the evidence is most consistent with these remains representing a right-handed Caucasian male, 35-44 years, with a height around 5 feet 10 inches and weight around 180 pounds, who exhibited no significant pathology other than possible periodontitis, and who has no apparent peri-mortem trauma.
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CASE BACKGROUND

The case I have chosen to work on is UMFC 37. The Jefferson County Sheriff Department sent the remains to the state crime lab in Missoula, asking for help in identifying the remains. The crime lab sent it to the University of Montana for Dr. Smith to analyze the remains. When the remains arrived at the Physical Anthropology lab at the University of Montana, a letter was attached describing the recovery location of the remains. This letter remains with the case today.

According to the letter, the Jefferson County Sheriff Department recovered the remains on June 24 and 25, 1983. The skull was located along the interstate north of Boulder, Montana. The rest of the remains were discovered the next day in plastic sacks tossed inside the fence of the cemetery in Basin, Montana, 10-12 miles from where the skull was found. The Sheriff Department requested help in determining if the skull belongs to the same individual as the rest of the bones, and any other information that could be determined from the remains.

Today, the remains are housed at the Physical Anthropology Laboratory at the University of Montana-Missoula. They are a part of the collection that is used for educational purposes. The remains are available to students who are currently taking related classes. The Laboratory remains locked, but several graduate students have access to the Lab. Since, this case is part of the collection; other students have conducted analyses of the remains as well. These reports are part of the file on the case. The conclusions drawn by other examiners are as follows.

A report by Bernadine Moore in March, 1999, concluded that “The evidence is most consistent with these remains representing a male, 35-60 years of age, with a height
around 5 feet 8 inches and 6 feet 1 inches, and a weight between 145-171 pounds. Ancestry appears predominantly Caucasian, with some degree of admixture,” (class report). The other report by Connie Hegel in March, 2000, concluded that, “The evidence is most consistent with the remains representing a Caucasoid male, of 40-50 years of age,” (class report).

The analysis of the remains took place January 2003-March 2003. A thorough inventory of the condition of the bones present is presented. A complete set of measurements of the remains is appended to the end of this report. The methods used and the results deduced from each method are presented herein.

For my required literature review of a relevant subject, I have chosen the Phenice method of estimating sex. In this literature review I focus on studies that have attempted to test the reliability of the method and I draw conclusions about its overall accuracy and the accuracy of inexperienced versus experienced investigators making the sex estimation.
LITERATURE REVIEW OF THE PHENICE TECHNIQUE

The Phenice technique is a method for estimating the sex of an individual. This method is presented in Phenice, 1969. Prior to this technique, no reliable methods existed for estimating the sex of an individual. A method was proposed by Washburn 1948, using the ischio-pubic index for sex estimation. Phenice addresses the Washburn (1948) method:

There are two problems connected with this method, however. The major problem is that the method requires that most of the greater part of the bone be intact so that the required measurements may be taken. A minor problem is that the method requires the taking of two measurements and the calculating of the index, and the comparing the index with a chart which gives the male and female values. This procedure takes time. (Phenice, 1969:297)

Phenice wanted to establish an easily applicable method, without the introducing a high level of human error.

The Phenice technique is reported to be easy to apply and relatively accurate. Phenice states, “It must be stressed that this technique has only been tested on adult material. It should not be relied upon for subadult material,” (Phenice, 1969:300). According to Phenice (1969), this technique is easy to apply, even for inexperienced examiner, and it allows for a prompt analysis. It is a non-metric technique which is concerned only with three aspects of the pubis. The three aspects of the pubis needed for this technique are as follows.

The first is the ventral arc, which is only present in females. According to Phenice, the female exhibit an arc that extends from the pubic crest and arcs inferiorly across the ventral surface, which will eventually blend with the medial border of the ischio-pubic ramus. Males may have a similar ridge but it does not take the course as that
of the ventral arc. Therefore, Phenice states, "This should never be confused with the ventral arc if proper observation is carried out," (Phenice, 1969: 300). The next criterion that is used is the subpubic concavity, which is present only in females, "one can see a lateral recurve which occurs in the ischio-pubic ramus of the female a short distance below the lower margin of the pubic symphysis," (Phenice, 1969:300). According to Phenice (1969), this criterion is not as objective as the ventral arc, but only females possess a true subpubic concavity, although males may demonstrate a slight dip in the ischio-pubic ramus that resembles subpubic concavity. The third and final criterion used in this method is width of the medial aspect of the ischio-pubic ramus. This criterion is the most subjective, because there can be intermediate forms of this criterion. According to Phenice (1969), females exhibit a narrow, ridge like medial aspect, and males exhibit a more broad medial aspect. Due to the subjective nature of this criterion, it is not considered as the main criterion on which the estimation is made, and it is only used to support the estimation. These three aspects of the pubis are observed independently, but sex estimation depends on all three.

When estimating the sex of an individual using this technique it is important to keep in mind which criterion is more important. Bass states:

When one or two of these three criteria are ambiguous, there almost always will be one that is definitely male or female. In such cases, sex estimation should be based on the most distinctive criterion in the particular specimen. The presence or absence of the ventral arc probably carries the most weight of the three criteria. (Bass, 1995:210)

Therefore, more emphasis must be placed on the first two criteria and less emphasis on the third and final criteria. If this technique is applied in this manner Phenice (1969) predicts an accuracy of 96% correct sex estimation. This method is the most accurate
method for sex estimation, but misidentifications do occur and should not be over looked. Phenice states, "It must be pointed out that such variability is to be expected, but it presents no really serious problems," (Phenice, 1969:300). Phenice tested his technique on 275 adult individuals from the Terry Collection, which includes both Caucasoid and Negroid individuals. Variation may not pose a serious problem for individuals from these populations, but what about individuals from different populations. Other researchers have tested Phenice's technique; their results are as follows.

Kelley (1978) tested the Phenice technique on a sample of California Indians. He concluded, "Therefore, it is concluded that Phenice's technique offered well-defined defined distinctions and reliable sex evaluations in this study," (Kelley, 1978:122). Lovell (1989) tested the Phenice technique on 50 presumed White individuals. She concluded:

An accuracy in determining sex of 83% was obtained in this study, compared to 95% reported by Phenice. The technique was found to be reliable by replication of results, and its accuracy not affected by the observer's previous experience in osteological analysis. However, accuracy appears to decrease when the method is used on older individuals. (Lovell, 1989:119)

Human variation does play a critical role in the accuracy levels of this technique. This could explain the reason why a considerable loss in accuracy occurred with a different sample. This technique is still considered to be a reliable indicator of sex, but not with the high accuracy levels once thought to be achievable. MacLaughlin and Bruce (1990) tested the Phenice technique on a European sample comprised of English, Dutch, and Scottish individuals. They concluded, "The results of this study show that the experienced observers did indeed show higher level of correct sex identification than the inexperienced observers," (MacLaughlin & Bruce, 1990:1390). This statement suggests
that variability can obscure the expression of the three criterion, and a more experienced
observer would still be able to decipher the criteria.

The three independent tests of the Phenice technique demonstrate that the
expected accuracy is never achievable outside the original sample population. Further
documentation is needed to truly access the reliability of this technique on a global scale.
This method has only been around for 34 years and that is a long enough time for it to be
adequately tested on a global scale. Once the method was introduced it gained instant
approval, but this might have been early. Later researchers have demonstrated that this
technique is neither easy to apply or 96% accurate.

In conclusion, the Phenice technique is a relatively reliable indicator of sex, but
caution should be used when dealing with different populations. This method does
provide a easy, rapid method for the evaluation of sex. The main problem, with this
method, is the disregard for cultural variability in the test. However, a more experienced
researcher will still be able to apply this technique and achieve reliable results. With time
this method will be tested further and more of limits will become clear, but for now it
seems to be a reliable indicator of sex.
INVENTORY

The bones that are not present for analysis include the following.

The cranium: mandible.

The postcranial: right clavicle, manubrium, right and left radius, left femur, right and left patella, right and left tibia, and right and left fibula.

The hand: right and left scaphoid, right and left lunate, right and left triquetral, right and left pisiform, right and left trapezium, right and left trapezoid, right and left capitate, left hamate, right and left first metacarpal, right and left second metacarpal, left fifth metacarpal, four right proximal phalanges, five left proximal phalanges, four right and left middle phalanges, and five right and left distal phalanges.

The foot: right and left talus, right and left calcaneus, right and left cuboid, right and left navicular, right and left medial cuneiform, right and left intermediate cuneiform, right and left lateral cuneiform, five right and left metatarsals, five right and left proximal phalanges, four right and left middle phalanges, and five right and left distal phalanges.

The ribs: first rib, right and left third rib, left fourth rib, left sixth rib, right eighth rib, left ninth rib, left tenth rib, and right twelfth rib.

The vertebral column: atlas, axis, fifth cervical vertebra, sixth cervical vertebra, seventh cervical vertebra, second thoracic vertebra, tenth thoracic vertebra, eleventh cervical vertebra, first lumbar vertebra, third lumbar vertebra, sacrum, and coccyx.

The dentition: all lower dentition, left upper central incisor, left upper lateral incisor, left upper canine, left upper first premolar, left upper second molar, and left upper third molar.
A description of the bones present for analysis includes the following.

Deterioration: I used this to mean environmentally induced deterioration. I will use this meaning of deterioration throughout the analysis.

The left clavicle (maximum length = 169mm) exhibits a slight depression on the inferior sternal end, the clavicle is in relatively good condition, but shows signs of deterioration, probably due to the environment, on both the acromial and sternal end.

The clavicle is in relatively good condition.

The sternum (maximum length of body = 122mm) lacks a sternal foramen, a manubrium, and a xiphoid process. The sternal body is porous and light weight. At the site of the last costal notch the bone is not completely fused together leaving an oval shaped defect in the body.

The right scapula (maximum length = 168mm) exhibits a convex vertebral border, and a medium shape notch formed by the superior border and the coracoid process. The superior angle is broken, postmortem. The right scapula shows signs of deterioration on the acromion, inferior angle, and coracoid process. The body has small cracks and the bone is thinning.

The left scapula (maximum length = 161mm) exhibits a convex vertebral border and a deep shape notch formed by the superior border and the coracoid process. The medial border is broken near the inferior angle. There is deterioration of the acromion, coracoid process, glenoid fossa, scapular spine, and inferior angle. The scapular body exhibits small cracks and tiny holes, as well as thinning of the bone.
The right humerus (maximum length = 357mm) does not exhibit a septal aperture. The right humerus shows signs of deterioration on the capitulum, trochlea, and head. There are several postmortem scrapes on the posterior side of the humeral shaft.

The left humerus (maximum length = 354 mm) does not exhibit a septal aperture. The left humerus shows signs of deterioration on the head, neck, and the capitulum. The posterior side of the greater tubercle exhibits a postmortem defect extending laterally.

The right ulna (maximum length = 277mm) shows signs of deterioration on the edges of the olecranon process, coronoid process, and the semilunar notch. The right ulna exhibits postmortem scrapes on the shaft, head, and styloid process.

The left ulna (maximum length = 275mm) shows signs of deterioration on the edges of the semilunar notch. The left ulna exhibits postmortem scrapes on the head and ulnar shaft.

The right coxal bone exhibits a broken area between the greater and inferior sciatic notch, and a depression on the pubic symphysis. The right coxal shows signs of deterioration on the iliac crest, Ischium, pubis, and sacro-iliac joint. There are cracks and scrapes on the body of the ilium.

The left coxal bone exhibits a broken posterior inferior iliac spine, as well as, a broken away piece between the greater and lesser sciatic notch. The left coxal also has a depression on the pubic symphysis. There are signs of deterioration on the iliac crest, Ischium, pubis, and sacro-iliac joint. There are cracks and scrapes on the body of the ilium, and a crack on the sacro-iliac joint.
The right femur (maximum length = 495mm) shows signs of deterioration on both the lateral and medial epicondyles. The edge of the medial epicondyle is broken off. There are postmortem scrapes on the posterior femoral shaft.

The right hamate is slightly porous, but it does not exhibit obvious lipping. Overall, the hamate is in relatively good condition.

The right third metacarpal is in relatively good condition. There are signs of deterioration on the edges of the proximal end.

The left third metacarpal shows signs of deterioration on both the proximal and distal ends. There is also a postmortem linear defect on the distal end.

The right fourth metacarpal is slightly porous, but is in relatively good condition. There are signs of deterioration on the edges of both the proximal and distal ends.

The left fourth metacarpal is in relatively good condition. There are signs of slight deterioration on both the proximal and distal ends.

The right fifth metacarpal exhibits a porous texture. There are signs of slight deterioration on both the proximal and distal ends. The deterioration seems to be more advanced on the distal end.

The right proximal phalanx (digit 3) exhibits slight lipping on edges of shaft. There are signs of deterioration on both the proximal and distal ends. The deterioration seems more advanced on the proximal end.

The left first rib is in relatively good condition. It exhibits a little porosity near the sternal and vertebral ends.

The right second rib exhibits a significant amount of damage. The bone is fractured near the sternal end. It is also fractured in the middle. The rib is missing a piece.
from the caudal edge. Both fractures show no signs of healing and exhibit a slightly lighter color around the edges of the fracture. Therefore, in conclusion, both fractures are, postmortem.

The left second rib is in relatively good condition. It does exhibit slight deterioration, probably just from handling in the lab.

The right fourth rib exhibits a broken and missing sternal end, as well as, an enlarged vertebral head. It appears to have an extra bony growth attached to the head. There is a fracture on the superior side of the rib, occurring postmortem.

The right fifth rib exhibits a broken sternal end, possibly due to deterioration. The rib shows signs of deterioration on the tubercle. It has a fracture on the distal superior side, as well as, a fracture on the proximal caudal side.

The left fifth rib is missing the sternal end and exhibits a bend, possibly perimortem. The rib is fractured completely through the posterior side. It is also fractured on the superior side.

The right sixth rib shows signs of slight deterioration of the superior sternal end. The rib exhibits a circular defect (different color) on the superior side between the middle and the distal end.

The right seventh rib is in relatively good condition.

The left seventh rib shows signs of slight deterioration on the vertebral head. The rib exhibits a fracture on the superior side, as well as pressure cracks on the posterior side.

The left eighth rib is missing the sternal end. Overall, the rib is in relatively good condition.
The right ninth rib exhibits deterioration on the tubercle and edges of sternal end. The rib is in relatively good condition.

The right tenth rib is in relatively good condition. The rib exhibits deterioration on the superior and inferior sides near the sternal end.

The right eleventh rib is in relatively good condition. The rib does not exhibit a distinct tubercle.

The left eleventh rib shows signs of deterioration on the vertebral end. The rib is fractured twice on the superior side, as well as, fractured on the inferior distal side. These fractures appear to have occurred postmortem.

The left twelfth rib exhibits a slightly broken sternal end. The rib is in relatively good condition.

The hyoid is broken apart at the site of the right lesser horn. Both portions are available for analysis. There is also a fracture between the body and the left greater horn, or possible lack of fusion.

The third cervical vertebra exhibits slight lipping, and a slightly porous body. There are signs of deterioration under the inferior articular facets.

The fourth cervical vertebra exhibits lipping on the body, and is slightly porous around the edges of the body. There are signs of deterioration on the spinous process and under both the superior and inferior articular facets.

The first thoracic vertebra exhibits lipping on the body, and a porous texture. There are signs of deterioration on the transverse processes, body, and on the posterior side of the spinous process. There is also a depression inside the vertebral body between the body and the vertebral arch.
The third thoracic vertebra exhibits slight lipping on the body, and a porous texture on the transverse processes. There is a depression inside the posterior vertebral body between the body and the vertebral arch.

The fourth thoracic vertebra exhibits lipping on the body. There are signs of deterioration on the transverse processes and around the base of the inferior articular facets. There is a small depression inside the posterior vertebral body between the body and the vertebral arch.

The fifth thoracic vertebra exhibits extra articular facets on the posterior side of the spinous process. There are signs of deterioration on the superior articular facets, body, and transverse processes.

The sixth thoracic vertebra exhibits extra articular facets on the anterior side of the spinous process. There is lipping on the distal side of the body. There are signs of deterioration on the transverse processes, and around the base of the inferior articular facets. There is a small hole inside the posterior vertebral body between the body and the vertebral arch.

The seventh thoracic vertebra exhibits slightly broken superior articular facets, and extra articular facets on the posterior side of the spinous process. There are holes on both the proximal and distal side of the body. There are extra bony projections between the superior articular facets, possible due to degenerative joint disease. The seventh thoracic vertebra shows signs of deterioration on the spinous process, transverse processes, and the vertebral body.

The eighth thoracic vertebra exhibits extra bony projections between both the superior and inferior articular facets, possible due to degenerative joint disease. There
are holes on both the proximal and distal sides of the body, as well as, lipping on the vertebral body. There are signs of deterioration on the body and around the base of the inferior articular facets. There is a hole inside the posterior vertebral body between the body and the vertebral arch.

The ninth thoracic vertebra exhibits a broken spinous process, but it is still attached. It also has a broken left transverse process. There are holes and sharp trauma to both the proximal and distal sides of the body. There are signs of deterioration on the body, transverse processes, and around the base of the inferior articular facets. There is a hole inside the posterior vertebral body between the body and the vertebral arch.

The twelfth thoracic vertebra exhibits extra bony projections between both the superior and inferior articular facets. There is lipping on both the proximal and distal sides of the body. There are signs of deterioration on the body and transverse processes. There is a hole inside the posterior vertebral body between the body and the vertebral arch.

The second lumbar vertebra exhibits a broken off left transverse process, a broken back rim of the proximal body, and a broken top edge of left superior articular facet. The second lumbar vertebra exhibits a porous texture. There are signs of deterioration on entire second lumbar vertebra.

The fourth lumbar vertebra exhibits a broken edge of the right transverse process. There are extra bony projections between the superior articular facets. The entire fourth lumbar vertebra is very porous and exhibits lipping on the vertebral body. There are signs of deterioration around the bases of both the superior and inferior articular facets.
and on the spinous process. There is a hole inside the posterior vertebral body between the body and the vertebral arch.

The fifth lumbar vertebra exhibits extra bony projection on the right inferior articular facet, and has a broken right transverse process, possible due to degenerative joint disease. The entire fifth lumbar vertebra is very porous and exhibits lipping on the vertebral body. There are signs of deterioration on the body and under both the superior and inferior articular facets, and on the spinous process.

The right upper central incisor is glued back into the socket. There is an exposure of the tooth root. The enamel is broken around the edges and the dentin is exposed.

The right upper lateral incisor is not in the maxilla, but it is available for analysis. The enamel is broken away in areas and the dentin is exposed.

The right upper canine exhibits a significant amount of attrition, but the enamel rim remains intact.

The left upper canine is not present but there is a small root fragment in the socket. The edges of the socket are sharp.

The right upper first premolar exhibits exposed roots, but the tooth is not loose. There is a significant amount of attrition, and the enamel rim is breached on the lingual side.

The left upper first premolar is not present, but there is root fragments present in the socket. The fragments protrude a little past the occlusal surface.

The right upper second premolar exhibits root exposure. The enamel rim is intact, but there is heavy attrition.
The left upper second premolar exhibits root exposure. This tooth is not worn as much as the right upper second premolar.

The right upper first molar exhibits significant root exposure, and the root is fused on the lingual side. The tooth is slightly loose, but remains in the maxilla.

The left upper first molar exhibits significant root exposure and the tooth is loose. There is a significant dental carie on the distal side of the tooth. The carie has destroyed the majority of the tooth.

The right upper second molar exhibits root exposure. The enamel rim is broken on the lingual side.

The left upper second molar is not present for analysis, but there is a root fragment protruding past the occlusal surface. This fragment looks as if it has a dental carie as well. The other two root sockets exhibit bone resorption.

A possible rib fragment, there is no sternal or vertebral end; therefore I am unsure as to the number or side of this fragment. The coloring seems to be the same as the other ribs.

An unidentified piece of ossified cartilage is present with the remains of this case.

After completely inventorying the remains, there appears to be only one individual present. There were no duplicated bones, and the coloring of the bones seemed to be consistent throughout the skeleton. Therefore I would conclude UMFC 37 represents the remains of one individual.
RACE ESTIMATION

Many physical anthropologists do not agree with the idea that racial types represent a biological reality. However, in the eyes of law enforcement, racial affinity is an important factor in human identification. Therefore, many forensic anthropologists will attempt to estimate race using the broadest category system which is the three race model of Caucasoid, Negroid, and Mongoloid. Caucasoid includes most peoples of European or Middle Eastern origin. Negroid includes most peoples of African origin. Mongoloid includes most of the peoples of Asian, Pacific Island, and American Indian origin. Obviously these groupings are broad and do not reflect the complexities of human variation, but they continue to be used for human identification. Skelton states, "These are very poor categories, poorly named, and not really reflective of the real worldwide pattern of human variation," (Skelton, 2002:21). These are the categories that will be used to describe the unknown individual.

The methods for estimating the race of an individual are relatively accurate; however, this does not necessarily mean that the methods correctly identify the individual's perceived racial affinity. The accuracy of each method, for estimating the race of an individual, varies and will be addressed later.

The skull is the most common area of the skeleton from which the race of an individual is estimated. Bass states, “The skull is the only area of the skeleton from which an accurate estimation of racial origin may be obtained,” (Bass, 1995:86). The skull is presumed to demonstrate the most variation between various groups. This fact, demonstrates how an analysis of the skull could give insight into the racial affinity of the individual. Skelton states:
The skull is the only part of the skeleton from which population affinity may be estimated with any degree of reliability by visual inspection. Even so, estimations of population affinity by this method are not extremely reliable. Probably, somewhere between 50 and 75% accuracy can be expected. (Skelton, 2002:21).

These methods relatively low accuracy levels are due, at least partly, to the migration and mixture of peoples.

Visual Assessment of the Skull

The first method for estimating the race of an individual is based on visual assessment of the skull. This method is frequently used and the criteria, upon which this method is based, are referenced in numerous places: Bass (1995), White (2000), Burns (1999), Skelton (2002), etc. Bass states, "The skull is the only area of the skeleton from which an accurate estimation of racial origin may be obtained," (Bass, 1995:86). The accuracy of this method depends on how well certain racial traits are expressed in the individual.

Certain traits are more common in each race. Bass states, "A careful observation of the following cranial illustrations -- paired frontal and lateral views of a Caucasoid skull, a Negroid skull, and a Mongoloid skull will aid in developing techniques for estimating racial origin," (Bass, 1995:88). Illustrations are in Bass, 1995, on pages 89-91. Caucasoid individuals typically exhibit the following cranial traits: a nasal sill, retreating zygomatics, little or no prognathism, long, narrow face, narrow nasal opening, depressed nasal root (at nasion), and a narrow, high-bridged nose. Negroid individuals typically exhibit the following cranial traits: nasal guttering, prognathism, little or no nasal depression (at nasion), rounded forehead, bregmatic depression, wide nasal opening, and a dense or "ivory texture" to the bone. Mongoloid individuals typically
exhibit the following cranial traits: projecting zygomatics, edge-to-edge bite, shovel-shaped incisors, inferior zygomatic projection, and nasal overgrowth. (Bass, 1995)

I applied this method to UMFC 37. The individual’s expressed cranial traits are as follows: a nasal sill, narrow nasal opening, depressed nasal root, narrow, high-bridged nose, intermediately projecting zygomatics, and a slight nasal overgrowth. I was unable to tell the amount of prognathism because the mandible was not available for analysis. Based on these observations, the remains are most consistent with a Caucasoid individual.

This method could easily give the wrong estimation of race. This method is based on observations of the skull and then the observer must decide if it is a Caucasoid, Negroid, or a Mongoloid expressed trait. This introduces human error and interpretation, “Steele and Bramblett (1988) point out (citing Stewart) that most skulls provide only a vague suggestion of population affinity,” (Skelton, 2002:21).

Gill’s Method

Gill (1985, 1995) has developed a set of criteria for estimating the race of an individual is from the palate shape, palatine suture shape, and zygomaticomaxillary suture shape. This is a relatively new method, which estimates racial affinity based on visual assessments of certain characteristics. It was developed using samples from the Northern Plains of North America and may be more accurate for cases from this region, which includes parts of Montana. This method is straight-forward and easy to use; you simply compare the specimen to pictures and choose the best match. Gill states:

Whites show a very high frequency of parabolic palates. About half of American Indians, on the other hand show elliptic palates. Often the elliptic palate is associated with a very straight palatine suture which greatly facilitates identification of American Indian crania in those cases. The hyperbolic palate is
found in considerable numbers only in samples of Blacks (46%). Whites only show 6% and American Indians 1-2% depending upon sample. (Gill 1995: 785).

The palate shape and palatine suture shape are fairly reliable estimators of racial origin.

The technique for zygomaticofacial suture is similar to that of palate shape and palatine suture. A comparison is made between the specimen and a picture, the closest estimates racial origin. Gill states:

The form of the zygomaticomaxillary suture has proven fairly reliable in distinguishing crania from these two populations. Martindale found that approximately 85% of Plains Indians reveal the widely flaring “angled” suture form while nearly the same percentage of Whites shows the “curved” form. Other Homo sapiens populations show the two forms in more or less equal percentages. (Gill 1995:786-787).

This technique can distinguish Caucasoid from Mongoloid if it can be determined that the person is not Negroid. This technique will give us some information about racial origin but the inability to detect Negroids is a disadvantage. This technique does have high accuracy levels (85%) for distinguishing those of Caucasoid ancestry from those of Mongoloid ancestry.

I applied the palate shape, palatine suture, and zygomaticomaxillary suture techniques to the specimen; the results are as follows. The palate shape seemed to be more parabolic, found frequently in Caucasoid. The palatine suture seemed to be more jagged, also found in Caucasoid with a relatively high frequency. The zygomaticomaxillary suture seemed to be more “curved”, like those of Caucasoid. These results support the previous evidence that the individual is of Caucasoid ancestry. The claimed accuracy of these techniques is relatively high; therefore these results are weighed heavily in the final determination of race.
Metric Methods

The following methods for estimating the race of an individual are metric methods. They are based on measurements of the cranium. These measurements can be difficult to obtain and an examiner should be careful when measuring the cranium. Burns states:

A word of warning is necessary – do not rely on metric analysis unless you have had the opportunity to check your measurement technique with an experienced physical anthropologist. When working alone, it is easy to misinterpret instructions. The results can be misleading and disastrous. (Burns, 1999:153).

These methods have not been found to be highly accurate at the University of Montana; but are applied to UMFC 37 for the sake of completeness.

Giles & Elliot Method

One metric method for estimating the race of an individual is the Giles and Elliot discriminant functions method. This method is presented in Bass (1995). This method is straight-forward. It is a discriminant function of cranial measurements. The measurements needed for this method are as follows: basion-prosthion height, glabelloccipital length, maximum width, basion-bregma height, basion-nasion height, maximum diameter, prosthion-nasion height, and nasal width. The major disadvantage to this method is that you need to have all the measurements; therefore it is not a good method to use if you have only a partial cranium. The accuracy of this method varies, Gill states:

As suggested earlier the problem with the Giles-Elliot approach is not with its sexing capability, which is obviously quite good, but rather with its very poor capacity to correctly predict race. The results obtained by Birkby and also by Fisher and Gill are so bad for American Indian samples from western regions of the United States that some researchers in those areas do not use the race identification formulae at all, at least if Amerindian ancestry is suspected. . If the Giles and Elliot discriminant function method for racial identification has any utility whatsoever, it would seem to be in confirming Caucasoid ancestry in cases where such ancestry is already suspected based upon other evidence.
Since I already suspected that UMFC 37 was Caucasoid, I applied the Giles and Elliot discriminant function method to this individual as suggested in the previous quote from Gill (1995). I arrived at a score of -8.35 on the White/Negroid scale and a score of 8.452 on the White/Indian scale. Both of these scores put the individual well into the Caucasoid range.

**Gill’s Interorbital Features Method**

The next method for estimating the race of an individual is Gill’s (1984) interorbital features method presented in Bass (1995). This method is based on measurements of the skull. Bass states, “Faced with problems in determining racial origins from skeletal remains in the northwestern Great Plains, Gill (1984) and his students at the University of Wyoming have developed an anthropometric method using three indices that results in a ninety-percent-correct classification,” (Bass, 1995:93). A simometer is required to conduct this method. According to Bass, the needed measurements are as follows.

1. Maxillofrontal breadth: breadth between maxillofrontale left and right. Maxillofrontale is defined by Bass (1971:60) as the intersection of the fronto-maxillary suture and “anterior lacrimal crest, or the crest extended (medial edge of the eye orbit)”.
2. Naso-maxillofrontal subtense: subtense from the maxillofrontal point of the deepest point on the nasal bridge.
3. Mid-orbital breadth: the breadth between Zygoorbital left and right. Zygoorbital is defined by Howells as “the intersection of the orbital margin and the zygomaxillary suture” (Howells, 1973:170). Occasionally the suture meanders along the orbital border; then its most mesial location is chosen as zygoorbitale.
4. Naso-zygoorbital subtense: subtense from the zygoorbital points to the deepest point along the nasal bridge.
5. Alpha cord: the point alpha is the deepest point on the maxilla, left and right, on a tangent run between the naso-maxillary suture where it meets the nasal aperture, and zygoorbitale. To determine alpha, a straight line is penciled connecting the above two points, then a straight edge is placed across the two points, and the skull is turned upwards until the profile of the straight edge and penciled line are visible. The deepest point usually coincides with the slight concavity from which the maxilla rises anteriorly to the nasal aperture. When the concavity forms a long shallow depression in profile and the deepest point is difficult to determine, then the mid-point along the penciled line is chosen.
6. Naso-alpha subtense: subtense from the alpha points to the deepest point on the nasal bridge. 
   (Bass, 1995:97)

A diagram of measurement points is presented on page 97 of Bass, 1995. These measurements are hard to obtain and caution should be taken to follow the directions carefully.

I applied this method to UMFC 37. The obtained measurements are as follows: the maxillofrontal breadth is 25mm, the naso-maxillo frontal subtense is 13mm, the zygoorbital breadth is 54mm, the naso-zygoorbital subtense is 20.9mm, the alpha cord is 30mm, and the naso-alpha subtense is 17.1. The three indices are, therefore, as follows: the maxillofrontal (Naso-maxillo frontal subtense/maxillofrontal breadth) is .52, the zygoorbital (naso-zygoorbital subtense/zygoorbital breadth) is .39, and the alpha (naso-alpha subtense/alpha cord) is .57). These indices place the individual in the Caucasoid range; however, the alpha is slightly into the Mongoloid range. Based on these observations, the remains are most consistent with a Caucasoid individual.

This method claims ninety percent accuracy, but since I am not experienced with it I expect that my accuracy maybe considerably lower. The measurements were difficult to obtain and it took me two separate attempts to arrive at the previously mentioned results. This technique is extremely sensitive to the precision of the measurements, and it was the first time I have ever used a simometer and this method. This method does corroborate with the other methods, therefore it will be used to support my finding, but will not be a primary factor in the estimation of the race of the individual.

FORDISC

23
Another metric method for estimating the race of an individual is FORDISC, using cranial measurements. FORDISC is a commercial software package developed by the University of Tennessee, Knoxville. Burns states, “A complete set of measurements from an unidentified person can be compared with a large database of known persons for race and sex assessment,” (Burns, 1999:40). This method is straightforward, but is objective because it is based on measurements from cranial landmarks. This method, unlike Giles and Elliot method, can be used if only a partial cranium is available for analysis. However, the more measurements available, the more accurate and precise the program can be. Burns states, “FORDISC is a set of new statistical methods based on data from more recent populations. If the data are continuously updated by the contribution of information from modern cases, this methodology can continue to be useful in the rapidly changing populations of the United States.” (Burns, 1999:228). The accuracy of this method varies depending on a case by case basis, and the program will tell the accuracy expected for a certain combination of measurements.

I applied the FORDISC method to UMFC 37 during my analysis. FORDISC identified UMFC 37 as a Caucasoid male. The estimated accuracy was given as 66.7 for the measurements I supplied. Which is moderately accurate, but FORDISC estimated the typicality as .000, indicating that none of the Caucasoid males in its database actually look like UMFC 37. These results state that UMFC 37 is closest to the Caucasoid male average but is not a typical Caucasoid male, even though it exhibits measurements common among Caucasoid males. The FORDISC results are appended to the end of this paper.

Race from Dentition

24
The next method for estimating the race of an individual, that I applied, is based on features of the dentition. White states:

The problems in using discrete cranial and dental features to determine ancestry are perhaps best appreciated by considering what osteologists agree is a racial marker: the shovel-shaped incisors seen in high frequency in modern Asian populations. Suffice it to say that incisors from Asian populations show a high incidence of shoveling, but also that the presence of shoveled incisors is hardly grounds for confident identification of a dentition as Asian. (White, 2000:375).

This trait does not provide an examiner with a definite estimator, but it does provide a trait that is only found in high frequencies among certain groups. The peoples of Mongoloid ancestry also exhibit, more frequently, crowding of maxillary and mandibular teeth, shovel-shaped incisors, and congenial absences the third molar. If these traits are present there is a high probability that the individual is of Mongoloid descent.

I applied this method to UMFC 37, observations are as follows. The maxillary teeth were not crowded, there was no presence of shovel-shaped incisors, and the third molars were present. This method does not provide any specific information as to the racial affinity of the individual, but is consistent with Caucasoid ancestry.

Race from the Postcranium

The following methods for estimating the race of an individual are based on the postcranial skeleton. These methods are relatively new and should be applied with caution. Burns states, “There is no end to the variation that can be examined, but it is imperative that controls be established on the population to be examined before any method is applied with confidence,” (Burns, 1999:153). These methods are new, but are still important in the analysis of a skeleton. In time, they could provide more accurate techniques for estimating the race of an individual.
Race from Intercondylar Shelf Angle

One postcranial method for estimating the race of an individual is based on femoral measurements. This method is presented in Craig, (1995), and is based on the intercondylar shelf angle of the femur. It is a relatively new technique and a radiograph of the femur is needed to conduct it. This method is used only to distinguish between Caucasoid and Negroid, and does not distinguish Mongoloids. Craig states, "The intercondylar shelf angle shows variation between American Whites and Blacks and is an effective new method for post-cranial metric analysis" (Craig, 1995:781). Like many other methods there is an overlap area that can cause problems if a distinct racial identification is desired. Bass states (citing Craig, 1994) "The mean for the intercondylar shelf angle in Whites is 146.2 degrees and the mean for Blacks is 137.8 degrees. The sectioning point is 141 degrees. Eighteen percent of the sample overlapped across the sectioning point," (Bass, 1995:234). According to Craig (1995), the measurement of the intercondylar shelf angle is relatively easy and once you have the measurement the procedure is basic. She addresses the greatest advantage to this method; this method can be conducted even when a partial or fragmentary femur is available, and pathology and most traumas do not affect the results of this procedure. The accuracy of this method ranges from 82 percent to 89 percent, which is relatively high for racial identification. (Craig, 1995).

I was unable to apply this method to UMFC 37 because a radiograph is needed to make the measurement and that instrument was not available for my analysis. This method would have been interesting to apply just to see what the results would have been. The individual's femur length is quite long, which is consistent with the linear...
body build frequent among Negroids, but all the other evidence point to a Caucasoid individual. This method is not affected by the length or other visual observations; therefore, it would have provided a new dimension to my analysis.

**Race from Femoral Flatness & Torsion**

I was unable to use the intercondylar shelf angle method, so I tried to use another method. This method is from Stewart, 1962 on femoral curvature. Stewart states:

In 1962 I called attention to the possibility of femoral shape helping to distinguish blacks from whites. In this connection I presented evidence that American blacks, at least in so far as some of the less admixed individuals are concerned, have femora which in comparison with those of American whites are less curved anteroposteriorly, more flattened anteroposteriorly in midshaft, and have less anterior twist (torsion) at the upper end. All this amounts to is that a pair of straight, flat femora which have only slight torsion are more likely to be those of an American black than an American white; but, on the other hand, the reverse traits do not necessarily indicate an American white; they could indicate an American Indian. (Stewart, 1979: 232).

This method is considered very subjective, and is not very reliable. The measurements needed to apply this method are not standard anthropometric measurements and not defined in any of the available texts.

Therefore, I did not apply this method to UMFC 37. From just visual assessment the femur seems to have a pronounced curvature to it, which is considered more Caucasoid than Negroid, but without the proper measurements this method is inapplicable.

**Race from the Scapula**

The next method I used for estimating the race of an individual is based on measurements and indices of the scapula. The procedure is presented in Hrdlicka (1942), and is based on simple measurements of the adult scapula. This procedure is straight-
forward, but it is not particularly accurate. The data upon which this method is based were compiled from a variety of heterogeneous sources. Hrdlicka states, “They have not all been taken by the exact Broca’s procedure, and often extend to wholly inadequate series, hence the data have only a limited value,” (Hrdlicka, 1942:380). This fact, along with the considerable amount of overlap between the groups, for scapular index, makes this method inadequate, and it should be used only in support of other evidence, Hrdlicka (1942) also points out his opinion that there is a strong environmental component to scapula shape:

Near all observers have pointed out ‘racial differences’ in the scapular dimensions and indices; but the term ‘racial’ was used loosely. Differences were shown to exist in both the absolute and the relative dimensions of the bone, but they evidently were those of environmental groups rather than true races. (Hrdlicka, 1942:383).

This method can enforce and strengthen conclusions drawn from other methods but should not be considered a prominent factor in an analysis.

I applied this method to the individual’s scapula and the results are as follows. The right scapula has a length of 168mm, a breadth of 106.5mm, and a scapular index of 63.39. The left scapula has a length of 161mm, a breadth of 110.4mm, and a scapular index of 68.57. These measurements place the individual, using the charts presented in Bass, 1995:127, into two separate groups based on both the right and left scapula. These groups are New Caledonia and Melanesian. I then used the chart on page 128 of Bass, 1995, and the scapular index and length measurements were such that UMFC could have belonged to any of the groups listed. Therefore, this method did not yield useful results with UMFC 37.

Race from the Sacrum
The next method for estimating the race of an individual is based on measurements of the sacrum. This method is presented by Bass (1995). This method is based on the individual’s sacral index. The measurements needed to obtain a sacral index are as follows: maximum anterior height and maximum anterior breadth. Once the index is obtained, a comparison is made to the average sacral indexes of various groups. This method is not accurate, but it can enhance an estimate. There is considerable overlap between each racial group demonstrating little if any variance between them. Also, the sex of the individual is needed in order to place the individual into the racial categories. This method should not be used as a primary factor in the analysis.

I was unable to apply this method to the individual because the sacrum was not available for analysis. It would have been interesting to see where the sacral index of this individual would fall. Without a sacrum this method is not applicable to this analysis.

Summary

The above methods have yielded the following results. Both the metric and non-metric methods place UMFC 37 into the Caucasoid range. Therefore, the remains are most consistent with a Caucasoid individual.
SEX ESTIMATION

Estimating the sex of an individual is important for proper identification. The techniques involved in estimating the sex of an individual are highly accurate. This is due to the fact that there are limited choices. An examiner has a 50% chance of correct estimation by chance alone. This high accuracy is only achievable for adult skeletal material; preadolescent children do not exhibit as many clearly diagnostic characters.

The race of an individual must also be kept in mind while sexing the individual. White states, “Because of such interpopulational differences in seize and robusticity, males from one population are sometimes mistaken for females in other populations,” (White, 2000:363).

The accuracy level for sex estimation depends on what techniques and how many are applied to the unknown individual. Krogman states:

Percentage of accuracy, for adult material is as follows: entire skeleton = 100%; skull alone = 90%; pelvis alone = 95%; skull plus pelvis = 98%, long bones alone = 80%; long bones plus skull = 90-95%; long bones plus pelvis = 95%+. (Krogman, 1962:149).

The more techniques applied to the individual directly correlates to the level of accuracy. Therefore, if a technique is available then it should be used.

The following methods for estimating the sex of an individual are based on both metric and non-metric cranial analysis techniques. Every individual is born with a skull that looks female, in that it is small and not strongly muscle marked. Therefore, sexing of an immature skull is not very accurate. According to Skelton, male skulls change at puberty and start exhibiting the common male characters:

Since most developmental errors are failures to develop full expressions of a sex specific traits, there are some males who retain female skull characteristics but
few females who exhibit male characteristics. Therefore, we need to give
greater weight to male characteristics in sexing the skull. (Skelton, 2002:13).

Visual Assessment of the Skull

The first method for estimating the sex of an individual is based on visual
assessment of the skull. This technique is used frequently and the criteria, upon which
the method is based, are described in numerous places: Bass (1995), White (2000), Burns
(1999), Skelton (2002), etc; therefore it is not necessary to state them all here. This
technique looks at specific characteristics of the skull and the observer must decide
whether it is from a female or a male based on its expressed characteristics. Bass states,
"Estimation of sex is based on the generalization that the male is more robust, rugged,
and muscle marked than the female. Absolute differences seldom exist, and many
intermediate forms are found," (Bass, 1995:85). This statement alone suggests that the
accuracy of this method is not very high.

According to Bass (1995), the common expressions of skull characteristics are as
follows. On the face: the supraorbital ridges are more prominent in males than in females;
the upper edges of the eye orbits are blunt in males, sharp in females; males typically
exhibit a larger palate; and males exhibit relatively larger teeth. On the mandible: Males
exhibit a more square chin, while females exhibit a rounded with a point in the midline.
On the vault: The female skull is smaller, smoother, and more gracile; males exhibit more
prominent muscle ridges, especially on the occipital bone; the posterior end of the
zygomatic process extends as a crest farther in males, often much past the external
auditory meatus; males exhibit relatively larger mastoid processes; and males exhibit
larger frontal sinuses. (Bass, 1995)
On any skull, a combination of male and female traits may occur, making sex estimation difficult. Since every one is born with a more female-like skull, an examiner should weigh male traits more than female traits. Keen states, “In every lot of skulls we find occasional male crania which are less masculine than the average and tend towards the female type. Similarly there are women’s skulls which approach the masculine type is some or in all respects,” (Keen, 1950:76). This fact should be kept in mind while the analysis is being conducted. Male and female expressions of traits are more easily identified if there are comparison skulls available, but if the examiner is dealing with only one skull the expressions might not be so obvious. Keen states:

Nevertheless than anatomical criteria listed under 21, 22 and 23 (table 1: supraorbital ridges, occipital crest and nuchal lines, and ridges at upper rim of the auditory meatus) will always be valuable, and presumably this applies to the skulls of all racial groups,” (Keen, 1950:77).

I applied this method to UMFC 37. The observed expressions of the criteria are as follows. On the face: the individual exhibited very prominent brow ridges, blunt upper edges of the eye orbits, and a relatively broad palate. On the vault: the skull was large, rough, and robust, with prominent muscle attachments; the zygomatic process extends farther than the external auditory meatus; the mastoid processes are relatively large with prominent muscle markings; and the frontal sinuses are intermediate to large. I was unable to make observations on the mandible because it was not present for analysis. Based on these observations, the remains are most consistent with a male individual.

**Sex from Cranial Measurements**

The next method for estimating the sex of an individual is based on measurements of the skull, presented by Giles and Elliot (1963). This technique is based on four
measurements of the skull. These measurements are as follows: maximum cranial length (g-op), maximum cranial breadth (eu-eu), facial width (zy-zy), and mastoid length (po-ms). Once these measurements are obtained, they are placed in this formula, 2.184(g-op) +1.000(eu-eu) +6.224(zy-zy) +6.122(po-ms) = [1495.40] 70%. If the sum is greater than 1495.40, the skull is male, if less than 1495.40, the skull is female. This method claims an accuracy of 70%. This is fairly accurate, but should be used in conjunction with other techniques. (Skelton, 2002:26).

I applied this technique to UMFC 37. I obtained a maximum cranial length of 191mm, a maximum cranial breadth of 145mm, a facial width of 132mm, and a mastoid length of 27.9mm. The overall sum of the equation was 1554.516. This score is greater than 1495.40; therefore, this method suggests that the individual is male. This method can give the wrong estimation because in some populations cranial measurements are smaller than others and vice versa due to body size differences. Therefore caution should be taken while interpreting the results from this method. Giles and Elliot state, “It was found that the discriminatory power held up, but the male-female dividing point in some cases may need to be adjusted to the population at hand,” (Giles & Elliot, 1963:67). Even a method that seems definitive can be ambiguous. Racial origin is a factor in this method and should be considered prior to the application of this technique.

Postcranial Methods for Estimating Sex

The following methods for estimating the sex of an individual are based on postcranial analysis techniques. Every individual is born with characteristically male pelves, in that the pubis bones are short. Skelton states, “At puberty, male pelves change only slightly, whereas female pelves change significantly to prepare them for
childbearing,” (Skelton, 2002:71). According to Skelton, as for the cranium, a failure to develop normally can cause misestimation. Therefore, more emphasis must be placed on female characteristics. **Visual Assessment of Coxal Shape**

The next method for estimating the sex of an individual is a visual assessment of the coxal shape in children. This method is presented in Skelton (2002). This method is applicable to the coxal bones of children prior to puberty. Skelton states:

> Even in pre-adolescents, the coxal bones will show some indication of sex. The shape of the sciatic notch may be the most reliable criterion for young children, and elevation of the auricular surface seems about 80% accurate for estimating sex in children. The shape of the pubis is not reliable for this age group – they will all tend to look male. If, however, a young individual has a pubis shape that looks female, you can be reasonably certain that it is female. (Skelton, 2002:72).

This method is basically a matter of weighing female traits more highly than male traits. If there is any hint of a female character, then the individual is unlikely to be male. This is due to the fact that everyone starts out with a male-looking pelvis and the traits of the female pelvis changes during and after puberty.

I was unable to apply this method to UMFC 37 because this individual was an adult. Therefore, this method is inappropriate for this analysis. This method can give the wrong estimation of sex, due to the fact, that it could be a female individual that has not yet gone through puberty. Knowing this in advance, makes this technique only useful when there is evidence of a female-looking pelvis; you can say with high accuracy that the individual is a female. However, the reverse is not always true.

**The Phenice Technique**

The next method for estimating the sex of an individual is the Phenice technique for estimating sex from the coxal bones. This method is presented by Phenice (1969).
Phenice states, "This paper deals with a newly developed technique of sexing the hip bone which is accurate, rapid, highly objective, and which does not require years of experience for accurate application," (Phenice, 1969:298). This method is concerned with three individual aspects of the pubis: the ventral arc, the subpubic concavity, and the medial aspect of the ischio-pubic ramus.

I applied the Phenice technique to UMFC 37. The individual did not exhibit a ventral arc. The individual displayed a slight subpubic concavity, and a flat, broad, and blunt medial aspect of the ischio-pubic ramus. Based on these observations, the remains are most consistent with a male individual. This method does have an accuracy range of 96-100%, but since I am not an expert on this technique, my accuracy is probably not that high.

**Visual Assessment of the Pubis**

The next method for estimating the sex of an individual is based on visual assessment of the pelvis. This technique is frequently used and the determining criteria are described in numerous places: Bass (1995), White (2000), Burns (1999), Skelton (2002), etc. This technique is based on simple observations of the pelvis. This technique looks at more criteria than the Phenice technique.

The common criteria, according to Bass (1995), are as follows. On the articulated pelvis, males exhibit a V-shaped narrower subpubic angle, whereas; females exhibit a U-shaped wider one. Females exhibit both an ischio-pubic ramus ridge and a ventral arc; however, males do not exhibit either one. Males exhibit a short pubic bone, whereas; females exhibit a long, rectangular pubic bone. On the ilium, females exhibit a wide shallow sciatic notch, whereas; males exhibit a narrow, deep sciatic notch. Females
exhibit a raised auricular surface, but the male auricular surface is not raised. Females exhibit a laterally divergent ilium, whereas males exhibit a high vertical ilium. On the overall pelvis, females exhibit an elliptical pelvic inlet; males on the other hand, exhibit a heart-shaped pelvic inlet. Females exhibit a shallow, spacious pelvis also known as birth canal, whereas males exhibit a constricted pelvis. Females exhibit a relatively small, triangular obturator foramen; males exhibit a large, ovoid obturator foramen. Females exhibit a relatively small acetabulum, whereas males exhibit a relatively large acetabulum. Male pelves are typically more rugged and muscle marked; female pelves are generally smooth, and lack a strong definition of muscle attachments. (Bass, 1995).

The accuracy of this technique depends on several factors, but overall, it is relatively accurate. Rogers and Saunders state:

The overall degree of intraobserver error for all pelvic traits was 11.3%, a value slightly higher than the acceptable level of 10%, suggesting that some features are difficult to observe. Intraobserver error by trait identified four problematic criteria: acetabulum size and shape (11.2%), auricular surface height (11.3%), preauricular sulcus (11.3%), and ischiopubic ramus shape (11.3). The remaining traits ranged from no error to 9.7%. (Rogers & Saunders, 1994:1050).

The criteria used for estimating the sex of an individual are relatively accurate when used alone but when considered together a higher level of accuracy can be achieved. The level of accuracy is also a direct reflection of experience. The intraobserver error was due to certain criteria being difficult to identify, and experience will lower this error. Rogers and Saunders state, “Thus, it would appear that the best results, and likely the most widely applicable results, could be obtained by employing some subset of all criteria” (Rogers & Saunders, 1994:1054).
I applied this technique to UMFC 37. The observed expressions of the criteria are as follows. The individual exhibited a V-shaped subpubic angle, a short pubic bone, a small-deep sciatic notch, a high vertical ilium, a relatively large, ovoid obturator foramen, a relatively large acetabulum, and there was evidence of prominent muscle attachments. Ventral arc and ischio-pubic ramus ridge were absent, and the auricular surface was not raised. These observations are most consistent with the individual being a male. Those observations that involve an articulated pelvis may be insecure because the sacrum is not present for examination. These observations of the pelvis are consistent with the findings from the skull, that UMFC 37 is a male.

**Measurements of the Coxa and Sacrum**

The next method for estimating the sex of an individual is based on measurements of the coxal bones and sacrum. This method is presented in Camacho et. al. (1993). Nine measurements and one index are needed to apply this method. The nine measurements and index are as follows.

1. Iliac width or distance from the anterior superior spine to the posterior superior spine (distance ASS-PSS).
2. Curved length of the iliac crest, taken from the anterior superior spine to the posterior superior spine (iliac crest arch).
4. Maximum thickness of the iliac crest in its middle third (middle thickness).
5. Maximum thickness of iliac crest in its posterior third (posterior thickness).
6. Maximum rise of the superior border or maximum line perpendicular to the plane of the iliac width from the iliac crest (iliac crest rise).
7. Distance from the upper point of the iliac crest to the anterior superior spine (distance apex-ASS). The upper point of the iliac crest is the point of the iliac crest to which a plane parallel to that of the iliac width is tangent.
8. Minimum distance from the tubercle of the iliac crest to the anterior superior spine (distance tubercle-ASS).
9. Distance from the upper point of the iliac crest to the posterior superior spine (distance apex-PSS).

Iliac crest Index = (iliac crest rise/distance ASS-PSS) x 100.

(Camacho et. al. 1993:779-787).
According to their study (Camacho et. al., 1993), not all of these measurements are useful in estimating the sex of an individual. Only three of the measurements and the index proved to show differences between the sexes. The three measurements are: iliac crest arch, iliac crest rise, and distance apex-ASS. The authors state:

They can be used for sexing human remains when the iliac crest is undamaged. And here we must point out the maximum rise and the iliac crest index, whose probability of error in affirming these differences of means is .0000 (Table 3), thereby we think these two parameters are the most useful for sexing human skeletal remains. (Camacho et. al. 1993:779-787).

This method is fairly accurate, but if they had provided a picture of the exact measurements I would have been more confident that I had done them correctly.

I applied this method to UMFC 37. I used a spreading caliper to take the measurements. The iliac crest arch was 254.1mm. This measurement falls into the male range. According to the authors, the male mean is 238.74. The iliac crest rise is 100mm. This measurement falls into the male range. According to the authors, the male mean is 67.04. The distance apex-ASS is 96mm, which falls into the male range. According to the authors, the male mean is 96.59. The iliac crest index is 57.14, which fall into the male range. According to the authors, the male mean is 44.50. (Camacho et. al., 1993) Based on these observations the remains are most consistent with a male individual.

This method could possibly give the wrong results because the measurements are not easy to obtain and this introduced a high potential for human error. The measurements of the individual were quite a bit higher than the averages presented in the study. However, the female range was quite a bit lower than the male range. Therefore, the individual was placed into the male range.

**Sex from the Sacrum**
The next method for estimating the sex of an individual is based on measurements of the sacrum. This method is presented in Bass (1995). The measurements are as follows: maximum anterior height, maximum anterior breadth, and the sacral index. The method is primarily based on the sacral index of the individual. A comparison is made of the observed index and the average index for males and females. This method is not very accurate because there is considerable overlap between the male and female ranges. It does, however, give a general estimate of the sex of the individual. This method should be used in conjunction with more accurate methods.

I was unable to apply this method to UMFC 37 because the sacrum was not available for analysis. Based on examination of the coxal bones, the auricular surface seemed short and narrow, which would be more consistent with a male sacrum. This is just an observation, since the sacrum is not available for analysis. The coxal bones are more consistent with a male individual; therefore the sacrum would probably be consistent with a male individual as well. This method can give an incorrect estimation for sex, but when used in conjunction with the visual assessment technique, of the sacrum, the estimation is fairly reliable.

The next method for estimating the sex of an individual is based on the visual assessment of the sacrum. This method is relatively accurate and is a good indicator of the sex of the individual. The basis of this technique, according to Bass (1995) is that male sacra are typically more curved than female sacra. In comparison, female sacra tend to be more flat. Female sacra are relatively smaller and wider than those of males. Bass states, “In some cases the width of the body of the sacrum to the ala is greater in males,” (Bass, 1995:113). Female sacra are optimized to provide a broader pelvis for childbirth;
therefore, a distinction between male and female sacra is typically obvious. I was unable to apply this technique to UMFC 37 because the sacrum was not available for analysis.

**Sex from the Sternum**

The next method for estimating the sex of an individual is based on measurements of the sternum presented in Jit et. al. (1980). This method is a metric technique in which measurements of the sternum are taken and compared to a mean for both males and females. The authors state:

> If the combined length of the manubrium and mesosternum was more than 140mm the sternum was male, and if less than 131mm it was female. No opinion could be given if the length was between 131 and 140mm. By this measurement 72.12% male and 62.50% female sterna could be sexed with 100% accuracy. The length of the mesosternum alone could also determine the sex correctly in 50.32% male and 29.55% female specimens. The length of the manubrium, manubrium-corpus index, width of the first sternebra or their index, was not found to be useful in sexing a given sternum. (Jit et. al., 1980:217).

This method is relatively accurate if you have a complete sternum, but there is also overlap between the male and female range.

I attempted to apply this method to UMFC 37, but was unable to complete it because the manubrium was not available for analysis. I did take the measurements of the mesosternum (body), which is 122mm long, the width of the first sternebra is 25.9mm, and the width of the third sternebra is 33.9mm. The length of the individual's mesosternum does place the individual into the male range. The width of the first and third sternebra ranges for both male and female are almost exactly the same, which makes them of no use in this analysis. Based on these observations, the remains are most consistent with a male individual. This method is relatively accurate when there is an intact sternum, but since only a partial sternum was available this method is only about
50% accurate. Therefore, this method should only be used in conjunction with more reliable methods.

The next method for estimating the sex of an individual is based on the visual assessment of the sternum. This method is not very reliable and should not be the primary factor in estimating the sex of an individual unless no other parts of the skeleton are available. There is plenty of room for error with this technique. The basic premise of this technique is, according to Bass (1995), the male sternal body is more than twice the length of the manubrium, and the female sternal body is less than twice the length of the manubrium. Male sterna are characterized as being long and narrow, whereas female sterna are short and broad. (Bass, 1995)

I was unable to apply this technique to UMFC 37 because the manubrium was not available for examination. From an examination of the sternal body, it is relatively long and narrow, which is more commonly true of male sterna. This is just an observation, without the manubrium this technique gives inconclusive results.

Sex from Measurements of the Clavicle

The next method for estimating the sex of an individual is based on measurements of the clavicle. This method is presented in Bass (1995). This method is based on measurements of the clavicle, the measurements are as follows: maximum length, circumference at the middle of the bone, and the claviculohumeral index. These measurements must be considered together when estimating the sex of an individual. Bass states, "The accuracy of estimating an individual's sex based on measurements of the clavicle has met with varying degrees of success," (Bass, 1995:133). The accuracy also depends on which clavicle, right or left, is available for analysis.
This method is used when the sex of an individual is already presumed and verification is needed. Jit and Singh state:

There is no such single character which can determine the sex of all clavicles. The weight of the clavicle, which can distinguish 24 percent male bones if the right clavicle is available and 35 percent if the left is available, is a better guide than the length for the male case. Thus, for positively declaring the bone to be a definitely female one, the length alone is more useful than any other single character because by this method 12 to 14 percent female clavicles can be easily sorted out, whereas by other individual characters the value varies from zero to 10 percent only. (Jit and Singh 1966:570/ Bass, 1995:136).

I applied this method to UMFC 37. Only the left clavicle was available for analysis. The measurements obtained are as follows: the maximum length is 169mm; the circumference at the middle of the clavicle is 45mm, and the robustness index is 26.63. Based on the length of this individual’s clavicle, falls within the male range of, 158.24 ± 10.06. This method could give an incorrect estimation because the chart used is from a sample of Negroid individuals, and the individual is most consistent with a Caucasoid individual. Therefore, these results could be different if a Caucasoid sample was used. I was unable to find a Caucasoid sample.

**Sex from the Scapula**

The next method for estimating the sex of an individual is based on measurements of the scapula. This method is presented in Hrdlicka (1942). Hrdlicka states, “Sex differences in the scapula begin to manifest themselves from the fetal life. They do not progress evenly in all the characters or in all the individuals. In general, however, the female bones remain throughout life the more infantile,” (Hrdlicka, 1942:413). This method implements Hrdlicka’s assertion through measurements of the scapula. The measurements are as follows: height total, infraspinous height, Broca’s breadth, scapular
index total, infraspinous height, glenoid point height and breadth, and glenoid index total. Not all of these measurements are useful in determining the sex of an individual. According to Hrdlicka (1942), the most useful is the infraspinous height, and the infraspinous index, and the least useful is the lower glenoid index. Once the needed measurements are obtained, a comparison of them to the available charts is done. This method is not very accurate, because there is considerable overlap between the male and female ranges. This method can support the results of other methods, but should not be a primary source in determining the sex of an individual.

I applied this method to UMFC 37. The measurements obtained are as follows: the maximum length of the right scapula is 168mm, left scapula is 161mm, the length of the glenoid cavity of the right scapula is 47.3mm, left scapula id 47.3mm, the maximum breadth of the right scapula is 106.5mm, left scapula is 110.4mm, and the scapular index for the right scapula is 63.39, left scapula is 68.57. These observations place the individual into both the male and female ranges, due to overlap of the ranges. This method can obviously give an incorrect estimate, due to the considerable overlap of the ranges, but in combination with the visual assessment of the scapula, a more accurate estimation can be made.

The next method for estimating the sex of an individual is based on the visual assessment of the scapula. The method for a visual assessment of the scapula is presented in Skelton (2002) and draws upon some of his unpublished research. This method is based on simple observations of the scapula. According to Skelton (2002), females exhibit a relatively broad scapula, with a deeper glenoid fossa which is set at almost a right angle to the axis of the scapular body. Males exhibit a narrower scapula,
with a relatively shallow, broad glenoid fossa which typically point more superiorly. (Skelton, 2002) This technique is not very reliable and should not be a primary criterion in the sex estimation of an individual. When this technique is used, in conjunction with others, the accuracy levels are higher.

I applied this technique for estimating the sex of UMFC 37. The observations recorded are more consistent with those of a male individual. The individual exhibits a relatively narrow scapula, with a shallow, broad glenoid fossa. The glenoid fossa of the individual was not set at a right angle to the axis of the scapular body. Based on these observations, the remains are most consistent with a male individual.

**Sex from Limb Bones**

The following methods for estimating the sex of an individual are based on the limb bones of the postcranial skeleton. Sexual dimorphism in body size is present between males and females, allowing for the estimation of sex from the postcranial skeleton. As with any other part of the skeleton, sexually diagnostic characteristics of the postcranial skeleton may not emerge until adulthood, and all of these methods assume an adult individual. Most techniques used to estimate the sex of an individual from the postcranial skeleton are metric techniques. White states:

> The results on the most dimorphic limb bones can be summarized by noting that single measurements, or combinations of measurements, have usually been found to correctly identify the sex is between 80 and 90% of all individuals. Incorrect identification within any population is a consequence of size overlap between males and females in the center of overall ranges. (White, 2000:365-366).

**Sex from Measurements of the Tibia**

The next method for estimating the sex of an individual is based on measurements of the Tibia of Negroids and Caucasoid. This method is presented in Iscan and Miller-
Shaivitz (1984a, 1984b). This method is a straightforward technique, in which measurements indicate the individual’s sex. This technique demonstrates that measurements of the tibia can accurately predict the sex of an individual. The authors state:

Thus the proximal epiphyseal breadth was the most significant sexually dimorphic characteristic in the sexing of both races. This was followed by the distal epiphyseal breadth and the circumference at the nutrient foramen level. Length of the tibia was the least contributing variable in both races. (Iscan & Miller-Shaivitz, 1984b: 1089).

According to the authors, females of both races have a higher accuracy level than the males did, and Caucasoids are not as dimorphic as Negroids. (Iscan & Miller-Shaivitz, 1984b)

The study by Iscan and Miller-Shaivitz on sexing the tibia achieved high accuracy and demonstrated that the long bones can predict sex. The authors state:

The present study achieved a maximum accuracy of 87.3% for whites using only one variable and 90.0% for blacks using two variables. The corresponding figures from the femur were 89.0% using only the femoral length for Indians, 85.0% using four femoral variables for whites, and 78.4% using the femoral circumference and length for blacks. In this respect, the data indicated that sexual dimorphism was better predicted by the tibia than the femur. (Iscan & Miller-Shaivitz, 1984b:1090-1091).

These results suggest that race must be estimated first in order to achieve this level of accuracy. If the individual is of mixed ancestry or the race is ambiguous then the accuracy of this method would significantly decline.

I was unable to apply this method to individual because neither the right nor left tibia were present for analysis. This method seems to be straightforward and it would have been interesting to apply it and see if it correlated with the other data collected. The
femur is quite robust, and long. It would have been especially interesting to test their claim that tibial measurements were better for estimating sex than femoral measurements.

Sex from Measurements of the Femur

The next method for estimating the sex of an individual is based on measurements of the femur. This method is presented in Krogman (1962), and Bass (1995). The measurements are as follows: vertical diameter of the head, popliteal length, bicondylar width, trochanteric oblique length, maximum length, maximum diameter of the femoral head, anterior-posterior diameter of midshaft, and the circumference at midshaft. The accuracy of this method varies depending on the measurements obtained.

The accuracy varies between populations, because some measurement is more accurate for certain populations. According to Bass [Di Bennardo and Taylor (1979)], “They found that the midshaft femoral circumference measurements proved as accurate as any other femoral measurement in sexing the femur and that this measurement can be used on other than archaeological populations,” (Bass, 1995:231). The accuracy of this method increase when more than one measurement is used.

I applied this method to UMFC 37. Only the right femur was available for analysis. The measurements obtained are as follows: the vertical diameter is 51.4mm, the popliteal length is 146.1mm, the bicondylar width is 88.5mm, the trochanteric oblique length is 473mm, the maximum length is 490mm, the anterior-posterior diameter at midshaft is 51.5mm, and the circumference of the midshaft is 100mm. All of the obtained measurements, place UMFC 37 in the male range. The measurements are above the sectioning point for males, therefore the remains are most consistent with being a male individual. This method could give an incorrect estimate if the individual fell into
or close to the indeterminate range, but since the measurements obtained from this individual were well into the male range, it is probably a reliable estimator of the sex for this individual.

**Sex from the Humerus**

The next method for estimating the sex of an individual is based on measurements of the humerus. This method is presented in Bass (1995). The measurements are as follows: maximum length, vertical diameter of the humeral head, transverse diameter of the humeral head, and the epicondylar width of the humerus. These measurements have varying accuracy rates and are better used in conjunction with one another.

Studies show that the more accurate estimation of sex from measurements of the humerus is based on the humeral head. Krogman states (citing Dwight, 1905), “it is very evident that the differences between the bones of the arm and thigh in the matter of length are much less important sexually than those of the diameters of the heads,” (Krogman, 1962:144). According to Bass (1995), the humerus is not a reliable estimator of the sex of an individual.

I applied this method to UMFC 37. The measurements obtained are as follows: the maximum length of the right humerus is 357mm, left is 354mm, the vertical diameter of the right humeral head is 51.2mm, left is 50.5mm, the transverse diameter of the right humeral head is 47.1mm, left is 45mm, and the epicondylar width of the right humerus is 65.7mm, left is 66.5mm. All the obtained measurements place the individual well into the male range. These observations correspond with the previous finding of the remains being most consistent with a male individual.
This method can, an often does, give an incorrect estimate of sex because there is
overlap between the male and female range. This individual’s measurements are,
however, clearly above the male mean and outside the female range. This method should
never be used as the single source of sex estimation unless no other bones are available.
Both the metric and visual techniques available for the humerus are poor indicators of the
sex of an individual. They should always be used in conjunction with other sexing
techniques that are more reliable, if possible.

The next method for estimating the sex of an individual is based on visual
assessment of the humerus. This method is presented in Trotter (1934). This method is
based on observations obtained from the distal humerus. The basis of this method is that
females exhibit septal apertures more frequently than males do. Trotter states:

The distribution of the apertures between the sexes is higher in the females than
in males of both races. In the white group the sex difference, 3.9 percent for the
males and 6.7 percent for the females, is a statistically significant one, but the
number of apertures in males is smaller than the expected chance value and in the
females, the actual number is larger. Thus the apertures occur more frequently
among females than the males, and significantly so in the American Negro group.
(Trotter, 1934:217).

If an individual has a septal aperture there is a good probability that the individual is a
female. If the individual lacks a septal aperture it does not indicate that the individual is a
male. This method is not very reliable, but can be used in conjunction with other
techniques, and documentation may prove useful in the future.

I applied this technique to UMFC 37. Both humeri are available for examination.
Neither humeri exhibit a septal aperture. This does not either confirm or refute my
previous findings of sex, because a significant number of both males and females lack a
septal aperture.

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Summary

The methods that were applied to UMFC 37 yielded the following conclusions. Both the metric and non-metric visual methods place the individual well into the male range. Therefore, the remains, present for analysis, are most consistent with a Caucasoid male.
AGE ESTIMATION

Age estimation is concerned with age at death not time since death. Estimating an individual’s age at death is a complicated and imprecise process, and that is why it is preferred that age ranges are used instead of single number estimates. White states, “Sex identification in skeletal remains is dichotomous, but determination of an individual’s age at death is more complex because it involves dividing the continuum of growth. Individuals of the same chronological age can show different degrees of development,” (White, 2000:341). Human variation must be kept in mind at all times when conducting a skeletal analysis. Age estimation is based on different factors depending on the perceived age stage of an individual. There are different methods for subadults and adults.

Age estimation is an important part of identification, and therefore must be conducted. The more methods used the more accurate the estimate will be. Bass states, “When estimating the age of a complete or partial skeleton it has long been known that more than one area, bone, or criteria should be used. This has been called the multifactorial aging method,” (Bass, 1995:19). A multifactorial approach has been taken for the age estimation of UMFC 37. The methods utilized for this approach are as follows.

Fontanelle Closure

The first method for estimating the age of an individual is based on the fontanelle closure of the cranium. This method is presented in Skelton (2002). This method is based on the fontanelle closure of neonates. This method is a reliable method for
estimating the age of really young individuals. According to Skelton (2002), the ages of
fontanelle closure, culled from Gray’s Anatomy, are as follows.

- The posterior fontanel and the anterior side fontanelles close by 3 months.
- The greater wing of the sphenoid fuses to the body of the sphenoid by 9 months.
- The posterior side fontanelles close by 1 year.
- The anterior fontanel and the frontal suture (Metopic) close by 2 years. Note that in some
  people the metopic suture never closes. This condition is called metopism.
- The lateral and basilar parts of the occipital grow together by 3 years.
- The two halves of the mandible fuse at 6-9 months.
(Skelton, 2002:15).

I was unable to apply this method to UMFC 37. Other than the trivial result that
this individual is older than 3 years based on fusion of the parts of the occipital; this does
not give any useful information as to the identity of the individual.

**Suture Closure**

The next set of methods for estimating the age of an individual are based on
cranial suture closure. There are several of these methods, one of which were developed
by Baker (1984) and is presented in Skelton (2002). The sagittal, coronal, and
lambdoidal sutures are utilized in this method, and both endocranial and ectocranial
sutures are scored. A score of open, commenced, or terminated is given to each suture.
According to Skelton (2002), the three stages of suture closure are defined as follows:
open is defined as the suture is visible as a crack over its entire length; commenced is
defined as the suture has been filled in with bone in at least one spot along it length, but
the suture is still visible as a crack in at least one spot; and terminated is defined as the
suture has been completely filled in with bone and is no longer visible at any spot along
its length. (Skelton, 2002) Each score has a corresponding age estimate based on
Baker’s (1984) analysis. This method yields very broad age estimates which reflects the
wide range of variation in timing of suture closure within populations. This method is relatively unreliable, but is easy to apply.

I applied this method to UMFC 37. The endocranial sutures could not be seen therefore, only the ectocranial sutures were scored for this technique. All three sutures were scored as commenced; the suture has been filled in with bone in at least one spot along its length, but the suture is still visible as a crack in at least one spot, giving an age range of 19-89. This method is relatively unreliable; therefore this estimate will only provide support to more reliable methods.

The next method for estimating the age of an individual is also based on cranial suture closure. This method is presented in White (2000), and is called the suture site method for cranial suture closure. This method focuses on specific sites along the ectocranial sutures. White states (citing Buikstra and Ubelaker, 1994), “sites are one-centimeter ectocranial segments of the sutures,” (White, 2000:347). A score is giving to each site, the scores are totaled, and an age range is then assigned. The suture sites are scored as follows: 0, or open, given when there is no evidence of any ectocranial closure; 1, is given to suture sites with minimal closure; 2, is given to sites with significant closure; and 3, is given to a completely obliterated suture. (White, 2000:347) The site name and description of the site are as follows:

1. Midlambdoid
2. Lambda
3. Obelion
4. Anterior sagittal
5. Bregma
6. Midcoronal
7. Pterion
8. Sphenofrontal

midpoint of left lambdoid suture.
intersection of sagittal and lambdoidal.
at Obelion.
1/3 the distance from bregma to lambda.
at bregma.
midpoint of left coronal suture.
usually where the parietosphenoid suture meets the frontal.
midpoint of left Sphenofrontal suture.
9. Inferior Sphenotemporal intersection between left Sphenotemporal suture and line between articular tubercles of the temporomandibular joint.

10. Superior Sphenotemporal on the left Sphenotemporal suture 2 cm below junction with parietal.

11. Incisive suture incisive suture separating maxilla and premaxilla.

12. Anterior Median Palatine score entire length of paired maxillae between incisive foramen and palatine bone.

13. Posterior Median Palatine score entire length.

14. Transverse Palatine score entire length.

15. Sagittal (endocr) entire sagittal suture endocranially.

16. Left Lambdoidal (endocr) score indicated portion.

17. Left Coronal (endocr) score indicated portion.


This method is relatively unreliable, but it does provide narrower age ranges than Baker’s method at the expense of additional complexity. It can aid in the identification of an individual, when used with other age indicators.

I applied this method to UMFC 37. In order to attain an age range, the scores obtained for sites 1-7 are added and the sites of 6-10 are added. The combined score for 1-7 is 10 and for 6-10 is 6, this gives the following age ranges of 39.4 ±9.1 and 43.4 ±10.7 respectively. I was unable to score the endocranial sites because the inside of the skull was not visible. This method could give an incorrect estimate because the observer has to make subtle distinctions between degrees of suture closure at each site. The observer must decide if the suture shows minimal closure or significant closure, but where is the line between them? An incorrect scope could result in a higher or lower estimate of the age range. Therefore, the age estimate, obtained by this method, is tentative and should only be used to support more accurate methods.

Age from Long Bone Length
The next methods I will consider for estimating the age of an individual is based on the length of the long bones. This technique is presented in Bass, 1995, White, 2000, and Skelton, 2002. These are techniques for age estimation in subadults. These methods are straightforward and easy to apply. A measurement of the long bones is taken and then compared to a chart to determine an approximate age range. According to Skelton (2002), the charts compiled for age from long bones measurements assume that the epiphyses are not attached for young individuals and that they are attached for older individuals. Therefore, it is not important if an epiphysis is not attached or even missing. (Skelton, 2002). This makes the method easy to apply to individuals under the age of about 14 years. This method provides rough estimates of age because growth rates vary.

This method is fairly reliable, but if more precise criteria are available they should be consulted. Long bone length provides a basis for an individual's age but should not be a primary factor in age estimation. White (2000) states, "This method is not very exact, because growth rates vary widely among populations and even among individuals of the same racial groups. In spite of these limitations, long-bone length can provide useful information on age in the absence of more exact criteria," (White, 2000:349).

I applied this method to UMFC 37, using the charts in Bass, 1995, White, 2000, and Skelton, 2002. The obtained measurements are as follows: humerus is 357mm, ulna is 277mm, and the femur is 490mm. I was unable to measure the radius, tibia, and fibula because they were not available for analysis. I used the measurements of the longest humerus and ulna, but there was only one femur. The corresponding age ranges for these measurements are as follows. From Bass (1995), the individual is older than 5.5 years. From White (2000), the individual is older than 18.5 years. From Skelton (2002), the
individual is older than 14 years. These results do not contribute significantly to this analysis because they just reveal that the individual is an adult.

**Epiphysis Closure**

The next methods for estimating the age of an individual are based on epiphyseal closure. These methods are presented in Bass (1995) and White (2000). There are several different methods for epiphysis closure, but only two will be described and used. The first is just general epiphysis closure of long bones present by Bass, 1995. The second is the McKern and Stewart method present by White, 2000.

For the method presented in Bass (1995), an examination of the humerus, radius, ulna, femur, tibia, and fibula is needed. A score is given to each bone and thus an estimated age. A complete examination of the bones is needed for this method. A score is given to each bone. The scores are as follows:

- 0- open suture (no union)
- 1- one quarter united or fused
- 2- one half united or fused
- 3- three quarters united or fused
- 4- completely fused

(Bass, 1995:17).

For the method presented by White (2000), a more precise examination occurs. The bones needed are as follows: medial clavicle, scapular acromion, scapular medial border, humeral proximal end, humeral medial epicondyle, proximal radius, proximal ulna, distal radius, distal ulna, iliac crest, ischium, femur head, distal femur, proximal tibia, proximal fibula, distal tibia, and the distal fibula. A score is given to each site and an estimated age. The age estimates vary greatly, but the youngest and oldest known age of fusion is presented, therefore allowing a researcher to give an approximate age range. White
states, "Fusion of a postcranial epiphysis is orderly, and an epiphysis fuses at a known age, but these ages vary by individual, sex, and population," (White, 2000:349).

I applied both of these methods to UMFC 37. For the method presented by Bass (1995), I scored the humerus, ulna, and femur as a complete union, giving a corresponding age range of older than 24 years. The radius, tibia and fibula were not available for analysis. For the method present by White (2000), I scored everything as a complete union, with the exception of the proximal and distal radius, proximal and distal tibia, and the proximal and distal fibula. These observations give a corresponding age of older than 30 years. Based on these observations, the remains are most consistent with the individual being older than 30 years of age.

These methods might give an incorrect estimate because the charts I used were for male skeletal remains. In this case I found the remains were most consistent with a male individual, therefore I used a male based chart. These methods are relatively accurate and the fusion of epiphysis is generally easy to score.

The next method for estimating the age of an individual is based on the epiphyseal fusion of the medial clavicle. This method is presented by both Bass (1995) and Burns (1999). This method is based on the fusion of the medial clavicular epiphysis. Burns states, "In the human body, the medial clavicular epiphysis is the last to fuse. Fusion usually takes place in the mid twenties; however, the widest age range reported is fifteen to thirty-two," (Burns, 1999:51). This refers to the time complete fusions occur, but the time fusion begins is also of importance. Bass states, "According to McKern and Stewart (1957), the medial clavicular epiphysis begins to unite in the 17th or 18th year. They found unattached epiphysis as late as the 22nd years, but no cases of complete union were
found before age 23,” (Bass, 1995:132). The union of the clavicular epiphysis is quite variable but can give some estimation of how old an individual might be.

A complete examination of the clavicle is needed to determine if the epiphysis is fused. There are three stages of union for the medial clavicle: open diaphyseal surface, early epiphyseal fusion, and complete epiphyseal fusion. A medial clavicular epiphysis in early fusion will have lines of fusion and a relatively rough surface. A completely fused medial clavicular epiphysis will be smooth. If the medial clavicle is not smooth then complete union has not occurred. This method is relatively accurate, but human variation must be taken into account. Fusion times do vary from individual to individual, therefore this method cannot be considered as highly accurate.

I applied this method to UMFC 37. The medial clavicular epiphysis was smooth and showed no signs of fusion lines. Therefore the epiphysis was scored as completely fused. Based on the method presented by Bass (1995), the individual falls within the age range of older than 23 years. Based on the method presented by Burns (1999), the individual falls within the age range of older than the mid twenties. Based on these observations, the remains are most consistent with an individual older than 25 years old. This method provides useful information; it states that the individual is an adult and older than 25 years. This method might provide an incorrect estimate, but since the epiphysis was fused, this estimate seems to be appropriate. The results of this method correspond with other results.

Sternal Rib Ends

The next method for estimating the age of an individual is based on visual assessment of the sternal end of the 4th right rib. This method is presented by Iscan, Loth, and Wright
(1984a, 1984b). This method is based on the analysis of the right 4th sternal rib end. Iscan et al. states:

The right fourth rib was collected at autopsy from 93 white males. The sternal extremity of each rib was analyzed in relation to the pit depth (component I), pit shape (component II), and rim and wall configurations (component III), each of which was divided into six stages. Pit shape and rim and wall configurations yielded better results than absolute pit depth alone. (Iscan et. al., 1984b:147).

Based on these components, a nine phase scoring system with corresponding ages was created. These phases are not absolute and variation does occur but the phase most consistent with the observations of the remains is the phase that should be chosen. The nine phases for white males are as follows.

0. The articular surface is flat or billowy with a regular rim and rounded edges. The bone itself is smooth, firm, and very solid.

1. (ages 16.5-18.0) Amorphous indentation is beginning to show in the articular surface, but billowing still may be present. The rim is rounded and regular. In some cases scallops may start to appear at the edges. The bone is still firm and solid.

2. (ages 20.8-23.1) The pit is now deeper and has an assumed V-shaped appearance formed by the anterior and posterior walls. The walls are thick and smooth with a scalloped or slightly wavy rim with rounded edges. The bone is still firm and solid.

3. (ages 24.1-27.7) The deepening pit has taken on a narrow-to-moderate U-shape. Walls still are fairly thick with rounded edges. Some scalloping still may be present, but the rim is becoming more irregular. The bone is still quite firm and solid.

4. (ages 25.7-30.6) Pit depth is increasing, but the shape is a narrow to moderate wide U. The walls are thinner, but the edges remain rounded. The rim is more irregular, with no uniform scalloped pattern remaining. There is some decrease in weight and firmness of the bone. The overall quality of the bone, however, still is good.

5. (ages 34.4-42.3) There is little change in pit depth, but the shape in this phase is predominantly a moderate wide U. Walls show further thinning, and the edges are becoming sharp. Irregularity is increasing in the rim. The scalloped pattern is gone completely and has been replaced with irregular bony projections. The condition of the bone is fairly good. There are, however, some signs of deterioration, with evidence of porosity and loss of density.

6. (ages 44.3-55.7) The pit is noticeably deep with a wide U-shape. The walls are thin with sharp edges. The rim is irregular and exhibits some rather long bony projections that frequently are more pronounced at the superior and inferior borders. The bone is noticeably lighter in weight, thinner, and more porous, especially inside the pit.

7. (ages 54.3-64.1) The pit is deep, with a wide to very wide U-shape. The walls are thin and fragile with sharp, irregular edges and bony projections. The bone is light in weight and brittle, with significant deterioration in quality and obvious porosity.

8. (ages 65.0-78.0) In this final stage the pit is very deep and widely U-shaped. In some cases the floor of the pit is absent or filled with bony projections. The walls are extremely thin, fragile, and brittle, with sharp, highly irregular edges and bony
projections. The bone is very lightweight, thin, brittle, friable, and porous. “Window” formation is sometimes is seen in the walls. (Bass, 1995:141-143).

There are phases for white females as well, but since the remains of this individual are most consistent with a Caucasoid male individual, the white male phases are presented. The female phases are on pages 143-146 in Bass, 1995.

This method is relatively accurate but several factors could affect its accuracy. Iscan et. al. states, “It should be noted that many conditions are known to affect bone remodeling, and thus, may alter the expressed pattern of aging in the ribs. These include endocrine disorders, chronic lung disease, medication, sex and racial differences, diet, degree of physical activity, and intercostals variations,” (Iscan et. al., 1984a:1103). It is important to take these factors into consideration prior to analysis. It is difficult to determine these factors from skeletal remains, but nevertheless, they can affect the results obtained from this method.

I applied this method to UMFC 37. The fourth right rib was not available for analysis; therefore I used the right seventh rib. The observations of the rib are as follows: the pit is relatively deep, and the pit shape is a narrow to moderate U-shape; the walls are thin, and the wall edges are rounded in places and sharp in others; the rim is irregular, and the scalloped pattern is not present, yet there are no bony projections present; and the rib is relatively lightweight, but there are no obvious signs of deterioration. Based on these observations, the remains are most consistent with phase 4-5, probably more consistent with phase 4. These phases give a corresponding age of 25.7-42.3.
This method is relatively accurate, but these phases were provided from the right fourth rib; therefore, the above age estimation could be incorrect because I used the right seventh rib. Iscan et. al. states:

Intercostal variation may come into play because this study was based on the fourth rib. Semine and Damon addressed this issue and stressed that the first rib changes much faster than the lower ones. It was also shown that while intercostals variation does exist between the lower ribs, it is more gradual. (Iscan et. al., 1984a:1103).

This could explain why the seventh rib analysis estimated a lower age range than was expected. If the fourth rib was available for analysis it would have been interesting to see the amount of difference between the sternal end of seventh and fourth ribs.

Auricular Surface

The next method for estimating the age of an individual is based on visual assessment of the auricular surface of the ilium. This method is presented in White (2000). This method is based on an examination of the auricular surface of the ilium. White states, “The use of this surface to age individual specimens has some advantages, namely, that this part of the os coxae is more likely to be preserved in forensic and archaeological cases, and that the changes on the auricular surface, unlike those on the pubic symphysis, extend well beyond the age of 50 years,” (White, 2000:355). This method is based on the premise that the auricular surface changes continually with age and these changes are visible. An eight phase scoring system is utilized in this technique. The phase that is the most consistent with the remains should be chosen. The eight phases of the auricular surface are as follows.

1. Age 20-24; billowing and very fine granularity.
2. Age 25-29; reduction of billowing but retention of youthful appearance.
3. Age 30-34; general loss of billowing, replacement by striae, coarsening of granularity
4. Age 35-39; uniform coarse granularity.
5. Age 40-44; transition from coarse granularity to dense surface; this may take place over islands on the surface of one or both faces.
6. Age 45-49; completion of densification with complete loss of granularity.
7. Age 50-59; dense irregular surface of rugged topography and moderate to marked activity in preauricular areas.
8. Age 60+; breakdown with marginal lipping, microporosity, increased irregularity, and marked activity in preauricular areas.
Pictures along with phases (White, 2000:358-359).

This method is somewhat unreliable and should not be used only as a primary factor in the age estimation of an individual unless no other indicators are present. Murray and Murray state, “The results of this study indicate that the amount of degenerative change in the auricular surface is not dependent upon race or sex in any given category. However, degenerative change in the auricular surface is much too variable across individuals to be used as a single criterion for age estimation,” (Murray & Murray, 1991:1168). Due to human variation this method is not recommended for use alone in forensic cases because it has considerable estimation errors.

I applied this method to UMFC 37; the observations of the auricular surface are as follows. The surface texture is mostly coarse but there is dense bone starting to appear. A reduction of striae with almost no billowing is present. There is slight deterioration near the apex. The auricular surface is becoming broad and slightly triangular, but there is no obvious lipping present. Based on these observations, the remains are most consistent with a combination of phases 4 and 5; these phases have a corresponding age range of 35-44 years.

This method could give an incorrect estimate because there is considerable variation from individual to individual. White states, “both the original research and subsequent tests on the method suggest that the method, like the pubic symphysis methods, has large estimation errors associated with it and should not be used alone in the
assessment of an unknown’s age at death,” (White, 2000:355). This estimate will provide information as to the individual age, but not as a primary factor in the overall age estimation.

**Pubic Symphysis**

The following methods for estimating the age of an individual are based on the visual assessment of the pubic symphysis. Meindl et. al. states:

> The anatomical feature most frequently used for determination of age at death in both demographic and forensic Osteology is the pubic symphyseal face. In fact, it is frequently the only source of information used for age estimation, and even when used in conjunction with other criteria it is universally considered to be the most reliable. (Meindl et. al., 1985:29).

There are two different approaches to aging the pubic symphysis. The first, Todd’s approach, involves matching the appearance of a pubic symphysis of unknown age with the description of a stage corresponding to a known age range. The second, the Mckern and Stewart approach, involves the scoring of changes in three separate components of the pubic symphysis. Ubelaker states, “Both methods should be employed with the realization that the estimates may be incorrect by 10 or more years. The error may be even greater if the investigator has little experience with the technique,” (Ubelaker, 1987:59).

Todd’s method is based on the visual assessment of the pubic symphysis. Bass states, “Todd (1920) observed that the symphyseal face of the pubic bone undergoes a regular metamorphosis from puberty onward,” (Bass, 1995:200). Todd created a ten phase symphyseal aging technique. The ten phases, with definitions and corresponding ages are as follows.
1. First postadolescent: 18-19 years. Symphyseal surface rugged, traversed by horizontal ridges separated by well-marking grooves; no ossific nodules fusing with the surface; no definite delimiting margin; no definition of extremities.

2. Second postadolescent: 20-21 years. Symphyseal surface still rugged, traversed by horizontal ridges, the grooves between which are, however, becoming filled near the dorsal limit with a new formation of finely textured bone. This formation begins to obscure the hinder extremities of the horizontal ridges. Ossific nodules fusing with the upper symphyseal face may occur; dorsal limiting margin begins to develop, no delimiting of extremities; foreshadowing of ventral beveling.

3. Third postadolescent: 22-24 years. Symphyseal face shows progressive formation of the dorsal plateau; presence of fusing ossific nodules; dorsal margin gradually becoming more defined; beveling as a result of ventral rarefaction becoming rapidly more pronounced; no delimiting of extremities.

4. 25-26 years. Great increase of ventral beveled area; corresponding delimiting of lower extremities.

5. 27-30 years. Little or no change in symphyseal face and dorsal plateau, except sporadic and premature attempts at the formation of a ventral rampart occur; lower extremity, like dorsal margin, is increasing in clearness of definition; commencing formation of upper extremity with or without the intervention of a bony (ossific) nodule.

6. 30-35 years. More difficult to appraise correctly; essential feature is completion of oval outline of symphyseal face. More individual variation than at younger ages; terminal phases affect relatively minor details. Also, tendency for terminal phase to be cut short. Increasing definition of extremities; development and practical completion of ventral rampart; retention of granular appearance of symphyseal face and ventral aspect of the pubis; absence of lipping of symphyseal margin.

7. 35-39 years. Paramount feature; face and ventral aspect change from granular texture to fine grained or dense bone. Changes in symphyseal face and ventral aspect of pubis consequent upon diminishing activity; commencing bony outgrowth into attachment of tendons and ligaments, especially the gracilis tendon and sacrotuberous ligament.

8. 39-44 years. Symphyseal face generally smooth and inactive; ventral surface of pubis also inactive; oval outline complete or approximately complete; extremities clearly defined; no distinct "rim" to symphyseal face; no marked lipping of either dorsal or ventral margin.

9. 45-50 years. Characterized by well-marked "rim". Symphyseal face presents a more or less marked rim; dorsal margin uniformly lipped; ventral margin irregularly lipped.

10. 50+. Rarefaction of face and irregular ossification. Symphyseal face eroded and showing erratic ossification; ventral border more or less broken down; disfigurement increases with age.


This method is a relatively reliable technique for age estimation. White states, "Todd recognized ten phases of pubic symphysis age, ranging from 18-19 years to 50+ years, and noted that these phases were more reliable age indicators between 20 and 40 years than after 40 years," (White, 2000:351). This method is widely used for aging unknown individuals and is one of the most reliable techniques available.
I applied this method to UMFC 37. The pubic symphyseal observations are as follows. The overall texture of the pubic symphysis is becoming fine grained and dense. There is some bony projection, but no obvious lipping. A complete oval outline exists, with slightly defined extremities. Based on these observations, the remains are most consistent with phase 7; which has a corresponding age of 35-39 years. This phase is most consistent with the remains, but there are some similarities with phase 8, 39-44 years. Since not all the criteria of phase 8 are met, I reduced the maximum age range of this phase. Therefore, the remains of the individual are most consistent with a 35-42 year old individual.

This method might give an incorrect estimation because the differences between the phases are pretty subtle and distinctions are difficult to make. An experienced osteologist achieves the greatest accuracy, therefore the accuracy of this method is decreased. White states, “Few tests of this method were made, although the method gained wide acceptance. Brooks (1955) found a tendency of the Todd system to overage, especially in the third and fourth decades,” (White, 2000:352). Keeping this in mind, the estimation obtained could possibly be higher than the true age of the individual.

The next method for estimating the age of an individual is a revision of the Todd pubic symphysis phase system by Meindl et. al. (1985). This method is presented in Skelton (2002). The Meindl et. al. method is a revision of the Todd method. This method recognizes only 5 phases as opposed to the ten phases of the Todd method. The five phases are defined as follows.

1. Preepiphyseal stage: (Todd stages 1-5) younger than 29 years. There seem to be two subphases here, which overlap to some extent.
a. <25. Pronounced billowing. Little or no rampart formation on the ventral side. Little or no definition of lower extremity. No significant difference between appearance of the dorsal and ventral halves of the symphysis (demifaces).

b. 24-29. Beveling of ventral margin. At least some definition of lower extremity. Substantially reduced billowing (but billowing may persist into the 40’s). Differences in the appearance of the dorsal and ventral demifaces usually present.

2. Active epiphyseal stage: (Todd stage 6) 30-35 years. Formation and completion of the ventral rampart. Frequently, the rampart never forms completely and gaps are left along it length. [Also note that Todd defined this stage by completion of the dorsal margin and upper extremity, giving an oval outline to the symphyseal face. Many people have found this to be a reliable characteristic.]

3. Immediate postepiphyseal stage: (Todd stage 7) 36-40 years. The texture of the surface changes from grainy to fine grained (or smooth) and dense. Ventral rampart formation is usually complete before this stage, but traces of beveling in the form of a sulcus (groove) beneath the rampart can occasionally be found.

4. Maturing stage: (Todd stage 8) 40-44 years. The surface is smooth (dense) with no degenerative changes. All ramparts should be completed (ignore gaps).

5. Degenerative stage: (Todd stages 9 and 10) older than 45 years. Degenerative changes are present. These may include bone loss, formation of bony spurs or spikes, and the formation of an elevated “rim” around the margins of the symphysis. The timing of the onset of degenerative changes is variable, and depends partly on body size. Smaller individuals (therefore females) tend to show degenerative changes sooner.

(Skelton, 2002:66).

This method is relatively accurate and should be used in conjunction with the Todd method as well as other pubic symphysis aging techniques to ensure a rounded estimation.

I applied this method to UMFC 37. The observations of the pubic symphysis have already been stated, therefore, the corresponding phase and age are as follows. The remains are most consistent with a combination of phases 3 and 4; which has a corresponding age of 36-44 years of age. This estimation is consistent with the Todd method age estimation. This method might give an incorrect estimation as well, but since both results correspond, the method’s estimation will be perceived as being appropriate for this individual.

The next method for estimating the age of an individual is, another revision of Todd’s method, based on visual assessment of the pubic symphysis. This method
developed by Katz and Suchey (1986) is presented in Bass (1995). This method combines Todd’s stages and correlates different ages with the stages. This method is only applicable to male specimens. The six stages are as follows.

1. (15-23: 18.9 years) Todd’s phases 1, 2, 3.
2. (19-35: 24.7 years) Todd’s phases 4, 5.
4. (23-59: 36.8 years) Todd’s phases 7, 8.
5. (28-78: 51.0 years) Todd’s phase 9.
6. (36-87: 62.7 years) Todd’s phase 10.

(Katz & Suchey, 1986:434).

The definitions of each stage correspond with those of Todd’s method. This method has considerable overlap between stages, but the mean age is of some use. Katz and Suchey state, “The traditional Todd system and its modified form are found to be the best systems. When implementation is considered, a modified Todd six phase system is recommended,” (Katz & Suchey, 1986: 427). This method is more accurate than the Todd system because broad age ranges are utilized. This could be either advantageous or disadvantageous, depending on the situation.

I applied this method to UMFC 37. The results are as follows. The observations of the pubic symphysis have already been presented, and the results of the Todd method have already been presented therefore, only the corresponding phase will be presented. The remains are most consistent with phase 4, with a corresponding age of 23-59 years (mean 36.8 years). This method actually provides a better estimation where this individual is concerned because I thought the individual was between Todd’s phases 7 and 8. This method groups Todd’s phases 7 and 8. Based on these observations, the remains are most consistent with a 23-59 year old individual.
The McKern and Stewart (1957) method for pubic symphysis aging has a different approach than the previous three methods, this method is presented in Bass (1995), and is appropriate for aging male individuals. Bass states, “McKern and Stewart (1957) developed a more objective system for studying the symphyseal surface, but it is complicated and difficult for the unskilled to implement,” (Bass, 1995:202). This method is harder to apply, but the rewards are a more accurate estimation of an unknown individual’s age. This method is not based on the overall stages of the pubic symphysis, but instead it deals with three separate components. Ubelaker states:

Their system focuses on three aspects of the symphyseal face: the dorsal demifaces, the ventral rampart, and the symphyseal rim. They showed that these components change independently at different rates, and that Todd’s method over-simplifies the changes at the expense of accuracy. The McKern and Stewart system involves ranking each component on a scale of 0 to 5 and adding the three numerical values to provide a total score that can be converted to an age estimate. (Ubelaker, 1987:55).

The stages of each component are as follows.

Component 1; Dorsal Plateau.
0. Dorsal margin absent.
1. A slight margin formation first appears in the middle third of the dorsal border.
2. The dorsal margin extends along entire dorsal border.
3. Filling in of grooves and resorption of ridges to form a beginning plateau in the middle third of the dorsal demifaces.
4. The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demifaces.
5. Billowing disappears completely and the surface of the entire demifaces becomes flat and slightly granulated in texture.

Component 2; Ventral Rampart.
0. Ventral beveling is absent.
1. Ventral beveling is present only at superior extremity of ventral border.
2. Bevel extends inferiorly along ventral border.
3. The ventral rampart begins by means of bony extensions from either or both extremities.
4. The rampart is extensive, but gaps are still evident in the upper two-thirds.
5. The rampart is complete.

Component 3; Symphyseal Rim.
0. The symphyseal rim is absent.
1. A partial rim is present, usually at the superior end of the dorsal margin, it is round and smooth in texture and elevated above the symphyseal face.
2. The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.
3. The symphyseal rim is complete. The enclosed symphyseal surface is finely grained in texture and irregular or undulating appearance.

4. The rim begins to break down. The face becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.

5. Further break down of the rim (especially along the superior ventral edge) and rarefaction of the symphyseal face. There is also disintegration and erratic ossification along the ventral rim.


This method is relatively accurate, but is difficult to implement. This method is only applicable to male individuals and if by chance the estimation of sex is incorrect then the age estimation may also be incorrect.

I applied this method to UMFC 37. The observations are as follows. The overall observations of the pubic symphysis have already been present, therefore only the observations of the three components will be addressed. The dorsal plateau exhibited a granular texture, and was slightly flattened. There were no billows present. The ventral rampart was complete. The symphyseal rim is starting to breakdown, and is becoming sharply defined. There are no obvious signs of lipping. Based on these observations, the total score for the remains is a 14, with a corresponding age of 29+, and a mean age of 35.84.

This method might give an incorrect estimation because this was the first time I have used this technique. Also age estimation could be affected if the individual was not a male, but the remains of the individual are most consistent with a male, therefore this method was implemented for this analysis and the results will be used in the final estimation of the individual’s age.

This method is presented in Bass (1995). The Gilbert and McKern method for aging the pubic symphysis is basically the same method as the McKern and Stewart method, but for females. This method is presented in Bass (1995). Different definitions
of stages are used compared to the McKern and Stewart method and different correlating ages are used as well, but the overall technique is the same. A total score is obtained with a corresponding age. The stages of each component are as follows.

Component 1; Dorsal Demiface.
0. Ridges and furrows very distinct, ridges are billowed, dorsal margin undefined.
1. Ridges begin to flatten, furrows to fill in, and a flat dorsal margin begins in mid-third of demiface.
2. Dorsal demiface spreads ventrally, becomes wider as flattening continues, dorsal margin extends superiorly and inferiorly.
3. Dorsal demiface is quite smooth; margin may be narrow or indistinct from face.
4. Demiface becomes complete and unbroken, is broad and very fine grained, and may exhibit vestigial billowing.
5. Demiface becomes pitted and irregular through rarefaction.

Component 2; Ventral Rampart.
0. Ridges and furrows very distinct. The entire demiface is beveled up toward the dorsal demiface.
1. Beginning inferiorly, the furrows of the ventral demiface begin to fill in, forming an expanding beveled rampart, the lateral edge of which is a distinct, curved line extending the length of the symphysis.
2. Fill in of furrows and expansion of demiface continues from both superior and inferior ends, rampart spreads laterally along its ventral edge.
3. All but about 1/3 of the ventral demiface is filled in with fine grained bone.
4. The ventral rampart presents a broad, complete fine grained surface from the pubic crest to the inferior ramus.
5. Ventral rampart may begin to break down, assuming a very pitted and perhaps cancellous appearance through rarefaction.

Component 3; Symphyseal Rim.
0. The rim is absent.
1. The rim begins in the mid-third of the dorsal surface.
2. The dorsal part of the symphyseal rim is complete.
3. The rim extends from the superior and inferior ends of the symphysis until all but one-third of the ventral aspect is complete.
4. The symphyseal rim is complete.
5. Ventral margin of dorsal demiface may break down so that gaps appear in the rim, or it may round off so that there is no longer a clear dividing line between the dorsal demiface and the ventral rampart.


This method is only applicable to females. This method is as reliable as the McKern and Stewart method is for aging males. The sex of the individual is necessary prior to the estimation of age using these techniques.
I did not apply this technique to UMFC 37, because the remains are most consistent with a male individual, therefore I used the McKern and Stewart method instead.

**Dental Development and Eruption**

The next method for estimating the age of an individual is based on dental development and eruption. This method is presented in Bass (1995). This technique is based on the premise that teeth erupt and develop at known times. This method is easy to apply and provides accurate information as to the age of an individual. Bass states, “One of the more accurate indicators of chronological age through approximately age 12 is dental calcification and eruption. One of the best documented and current charts was compiled by Ubelaker (1978),” (Bass, 1995:303). A reproduction of Ubelaker (1978) chart is available on pages 303-304 in Bass, 1995. This chart documents tooth development from age 5 months in utero to 35 years. This chart details the eruption times of the various deciduous and adult teeth. A comparison is made between the unknown individual’s dentition and the chart, finding the best match. This method is relatively accurate and is considered to be an important age indicator. Bass states (citing Ubelaker, 1978), “These changes are the most accurate method of establishing the age of adult individuals at death,” (Bass, 1995:304). The accuracy of this method decreases if the individual is older than 35 years old.

I applied this method to UMFC 37, and the results are as follows. This individual had a completely erupted dentition. The third molars had erupted but were unavailable for analysis. This individual was most consistent with the last stage of dental development. Based on these observations, the remains are most consistent with an
individual older than 35 years. This method might give an incorrect estimate because the complete roots of the teeth were not visible. The individual did display bone resorption; and parts of the roots were exposed. My age estimate used this evidence when it was available.

The next method for estimating the age of an individual is based on dental calcification. This method is presented in Skelton (2002) and was developed from his research into literature of dentistry. This method is based on the premise that, teeth begin forming with the tips of the cusps of the crown and the formation is completed when the tips of the roots are formed. Skelton states, "To estimate age by tooth calcification simply note any teeth that are not completely formed yet and match their state of development to the dental calcification standards," (Skelton, 2002:41). This method is similar to the dental eruption technique, but eruption does not necessarily mean a tooth is completely formed. This technique is relatively accurate, but there is one factor that can greatly affect the accuracy of this technique. In order to correctly apply this technique an X-ray of the jaw is needed, to show the stage of tooth formation. This method is also a method for estimating the age of subadults, therefore it is inappropriate for adult individuals.

I was unable to apply this method to UMFC 37 because X-rays were not available for this analysis. However, even if X-rays were available, this method would have been inappropriate because this individual is an adult.

Dental Attrition

The following methods for estimating the age of an individual are based on tooth wear. Bass states, "In modern populations, tooth wear will not offer much help in aging,
and even in prehistoric populations it is of limited value. Much research needs to be conducted on dental attrition and its correlation with different foods and food preparation techniques," (Bass, 1995:19). Tooth wear is extremely variable from individual to individual. According to Bass (1995), dentitions of individuals within a population wear at different rates based on the differences in diet and tooth structure. This fact can have a negative affect on the accuracy of this technique. According to White (2000), certain pathologies and uses of teeth can accelerate dental wear. These should be kept in mind while using dental wear for estimating the age of an individual.

The first method for estimating the age of an individual based on tooth wear, was developed by Brothwell and is presented in Bass (1995). The Brothwell method of age estimation by dental attrition is based on the wear of the three molars. This method is straightforward and easy to apply. The unknown individual’s teeth are compared to a chart of dental wear stages. The chart used is on page 301 in Bass, 1995. Each stage has a correlating age range for it. This method is fairly unreliable and should not be used as a primary factor in age estimation. This method is based on the premise that the first molars wear faster than the second and third molars. Once wear starts, a gradual increase in wear continues throughout life.

Brothwell’s method is based on the wear patterns of premedieval British teeth. Since tooth wear varies from individual to individual, this method will not be as reliable when used with a modern individual. This method does not take into account dental work, which could affect the results of this method.

I applied this method to UMFC 37, and the results are as follows. I scored both the right and left maxillary molars together, the mandible was not available for analysis.
The first molars exhibited exposed dentin, but a rim remained around the edges. The second molars exhibited the most wear, with dentin exposed and a rim that was not intact, at the sight of most wear. The third molars were not present for analysis, therefore the results are based on the scores of the first and second molar. Based on these observations, the individual scored in the range of stage 2, with a corresponding age of 25-35 years.

This method might give an incorrect estimation, because this is a modern individual. This method could underestimate an individual age because tooth wear was accelerated in prehistoric populations, thus predicting a younger age at this stage of wear.

The next method for estimating the age of an individual based on tooth wear, was developed by Lovejoy and is presented in White (2000). The Lovejoy method of dental attrition is based on the wear patterns of both the maxilla and mandible. This method utilized all the teeth for estimating age. This technique is similar to the Brothwell method, in that a comparison is made between the unknown’s teeth and a chart of wear patterns. This method focuses on the wear of the right maxillary and left mandibular dentition. Pictures of the stages are available on page 346 of White, 2000. The black in the pictures demonstrates the amount of dentin that is exposed due to wear.

This method, like the previous method, is not based on tooth wear patterns of modern populations. This method is based on the wear patterns of a prehistoric Native American population from Libben, Ohio. The accuracy of this method is variable, but the authors of this method feel differently. White states (citing Lovejoy, 1985):

That dental wear assessed by seriation procedures is an important and reliable indicator of adult age at death. In fact, Lovejoy and colleagues concluded that dental wear is the best single indicator for determining age at death in skeletal populations. (White, 2000:344).
The accuracy will be lower for an inexperienced examiner or when applied to an individual who was not a prehistoric Native American, but will produce an approximation of an age.

I applied this to UMFC 37, the results are as follows. The mandible was not available for analysis; therefore, the observations are those of the right maxilla. The incisors exhibit the most wear, but a slight rim is remaining around the exposed dentin, except in the area of most wear. The canine exhibits exposed dentin, but a rim remains around the dentin, except in the area of greatest wear. The premolars exhibit exposed dentin but a rim is still intact around the dentin. The first molar exhibit exposed dentin, with an intact rim around the edges. The second molar showed extensive wear; the rim around the dentin was broken down on the side of the most wear, but an almost complete rim remained. The third molar was not available for analysis; therefore scores were attributed without the use of the third molar.

Based on these observations, the remains were most consistent with stage G, corresponding to an age range of 35-40 years. This age range is consistent with other age estimations from the pubic symphysis. Therefore this method will be considered as a corroborating factor in the final age estimation. This method might give an incorrect estimation, if the individual had a great deal of dental intervention, such as fillings. This does not seem to be the case with this unknown individual; dental wear is evident and dental work is lacking.

The next method for estimating the age of an individual is based on tooth wear patterns. This method was developed by Skelton for use with California Native
Americans based on studies by several students at the University of California, Davis, and is presented in Skelton (2002). Skelton’s method for dental attrition aging is based on the wear patterns of the incisors, canines, premolars, and molars separately. An age range is correlated from the individual scores. This method is similar to both of the previous methods. This method is about as reliable as any dental attrition aging technique. This method was established for wear patterns of prehistoric Native American living in the Central Valley of California. This method is only valid for those individuals, and probably not all of them. Nevertheless, an approximate age range can be estimated from this method, but it should not be used as a primary factor in the age estimation, unless the individual is from the Central Valley of California.

I applied this method to UMFC 37. Since the dental attrition observations have already been presented, only the corresponding stages will be addressed. The incisors were scored as a 7, the rim of enamel around the tooth is wearing away on the sides adjacent to the side of the heaviest wear, and less than 50% of the enamel remains intact; this stage has a corresponding age range of 30-45 years. The canines were scored as a 6, the rim of enamel around the tooth has been breached on the side of heaviest wear; this stage has a corresponding age range of 30-45 years. The premolars were scored as a 6, the shape of dentine exposure becomes oval, but the rim of enamel around the tooth is still complete; this stage has a corresponding age range of greater than 40 years. The first molar was scored as a 10, all four dentine patches are connected, but have not coalesced to forma squarish area of dentine exposure; this stage has a corresponding age range of greater than 35 years. The second molar was scored as a 12, the enamel rim has been breached on one side. I scored this tooth as stage 12, even though the dentine patches are
not fully coalesced. Between 50% and 99% of the enamel rim remains; this stage has a corresponding age range of greater than 45 years.

Based on these observations, the remains are most consistent with a 30-45 years old individual. These results are based on the wear patterns of a prehistoric Native American population; therefore, this method could, obviously, give an incorrect estimation. These results will be used in conjunction with the other age estimations, but will not be a primary factor in the estimation.

The next method for estimating the age of an individual is based on tooth wear patterns was developed by Tromly (1996) and modified by Skelton (2002). The Tromly method for dental attrition is based on the same wear stages as the Skelton method, but this method has established different correlating age ranges. Also, all three molars are scored together. This method is based on wear patterns of modern people of Western Montana. This method might be relatively reliable, based on the fact it deals with modern individuals.

I applied this method to UMFC 37. The wear pattern observations and the corresponding stages have already been presented, therefore only the adjusted age ranges will be presented. Incisors were scored as a 7; with a corresponding age range of greater than 35 years. The canines were scored as a 6; with a corresponding age range of greater than 38 years. The premolars were scored as a 6; with a corresponding age range of greater than 40 years. The molars were scored as a 10 and 12; with a corresponding age range of greater than 35 years. Based on these observations, the remains are most consistent with an individual who is older than 35 years. This method could give an incorrect estimation if the individual being aged is not from a modern population of
Western Montana. UMFC 37 is thought to be a modern individual from an area in Western Montana, therefore, these results will be considered as a primary factor in the age estimation.

The next method for estimating the age of an individual is based on degenerative changes of teeth. This method is presented in Burns (1999), and is based on the degenerative changes of teeth. This method focuses on six dental changes: attrition, periodontosis, secondary dentin, cementum deposition, root resorption, and root transparency. According to Burns and Maples (1976), the six dental changes are defined as follows.

- **Attrition**: is the degree to which the enamel, and subsequently the dentin, is worn away on the occlusal surfaces of teeth.
- **Periodontosis**: the level of attachment of the gingival tissues tends to recede with advancing years. Periodontal disease or abrasions of gingival tissue, may of course, distort the measurement of this variable.
- **Secondary dentin**: the calcified nontubular substance deposited by the pulp on the walls of the pulp chamber and root canal. Deposition of secondary dentin causes a decrease in size of the pulp chamber. Worn and unworn teeth from the same mouth tend to show the same amount of secondary dentin.
- **Cementum deposition**: the mineralized tissue which covers the tooth root. It secures the periodontal fibers to the root surface. Layers of cementum are laid down throughout life in the process of continually reanchoring the teeth.
- **Root resorption**: resorption usually begins at the root tip and progresses through the cementum and into the dentin.
- **Root transparency**: is caused by the increased mineralization of dentinal tubules with advancing age. Mineralization associated with age begins at the root tip and proceeds toward the crown.


This method is based on these six dental changes. Only two are visible externally, attrition and periodontosis. The remaining four are internal tooth changes; therefore, the tooth must be cut into serial sections to observe them. A score of 0-3 is given to each tooth for each factor. Once these scores have been obtained they are placed into a formula and a corresponding age is provided. Formulas for this method are presented on
This method is relatively accurate but in order to achieve high accuracy the teeth must be destroyed. The formulas cannot be applied with only the external factors; therefore this method is of limited use in forensic cases.

I was unable to apply this method to the individual because I was not allowed to destroy the individual’s teeth. This individual is a part of the Osteology lab and therefore other students need to be able to examine it as well. It would have been interesting to see the internal changes of the teeth, but that was not an option for this analysis, therefore this method is not applicable to the individual.

**Age from the Vertebral Column**

The next method for estimating the age of an individual is based on scoring degenerative changes of the vertebral column. This method is presented in Bass (1995). The main focuses of this aging technique is the formation of osteophytes (lipping) on the vertebral centrum. According to Bass (1995, citing Stewart, 1958), osteophytes develop with advancing age; thus, age can be predicted based on the amount of osteophytes present. A scoring scale of 0 (no lipping) to 4+ (Maximum lipping) is used to describe the vertebra. Bass states:

Stewart concluded that (a) between the ages of 20 and 30 lipping develops rather slowly; (b) between 30 and 40 lipping intensifies; (c) between 40 and 50 lipping intensifies, especially in the lumbar region; and (d) beyond the age of 50, lipping becomes quite pronounced. (Bass, 1995:19).

This method is fairly reliable, but other factors can influence the formation of osteophytes, therefore this method can only be considered relevant when used in conjunction with other methods.
I applied this technique to UMFC 37 and the observations of the vertebral column are as follow. Most of the vertebra exhibit slight lipping and porosity. The lipping does slightly increase further down the vertebral column. The observed lipping is not in an advanced stage. Based on these observations, the remains are most consistent with a 20-40 year old individual. Stage (a) and (b) were combined in estimating an age range because the individual did show signs of lipping and it was more intensified on some vertebra. Therefore a combination of those stages is most consistent with the condition of the remains. This method could give an older estimation if the individual was suffering from degenerative joint disease, which accelerates the formation of osteophytes. The individual does not show signs of degenerative joint disease, therefore this estimation is probably reliable.

The next method for estimating the age of an individual is based on the progression of osteoarthritis in the lower back, and is presented in Burns (1999). This method is slightly different from the vertebral osteophytosis method. It focuses on the advancement of epiphyseal ring fusion in the vertebral column. Burns states, “Further analysis can be accomplished by assessing the development of osteoarthritic lipping at the edges of the vertebral disks,” (Burns, 1999:64). The stages of age changes in the vertebral column are as follows.

1. Child (under 16 years); the epiphyseal ring is completely absent.
2. Late teenager (16-20 years); the epiphyseal ring is in the process of fusing.
3. Young adult (20-29 years); the epiphyseal ring is fused, but no osteoarthritis is visible. The bone is smooth and solid.
4. Older adult (over 30 years); osteoarthritis is obvious and the vertebral body is beginning to degenerate.

(Burns, 1999:65).
An examination of the entire vertebral column is needed for this method. The focus of this method is on the lumbar vertebrae and the amount degeneration visible. This method is relatively reliable but should not be a primary factor in the final age estimation.

I applied this method to UMFC 37. The observations of the vertebral column have already been presented, therefore only the corresponding stages will be addressed. A combination of stages 3 and 4 are most consistent with the remains. The epiphyseal ring is fused. Osteoarthritis is visible but is not advanced. Therefore a combination of the stages is most consistent with the individual. The corresponding age for these stages is about 20-35 years. This method could give an incorrect estimate if the individual had suffered a back injury or suffered from a disease. Neither of these factors seems to be affecting the individual; therefore the results of this method should be relatively reliable.

Summary

The methods utilized for estimating the age of an individual yielded the following results. The age of UMFC 37 probably fell within a broad range of 35-55 years. A narrow range of 35-44 years can be suggested based on most common age results obtained by a variety of methods. These age ranges were constructed based on the more reliable methods. A chart of the methods, age range estimates and weight given to each method are as follows.
<table>
<thead>
<tr>
<th>Method</th>
<th>Age</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Suture Closure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baker's Method</td>
<td>19-89 years</td>
<td>low</td>
</tr>
<tr>
<td>Suture Site Method</td>
<td>39.4-43.4±9.1 years</td>
<td>medium</td>
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<tr>
<td>Epiphysis Closure</td>
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<tr>
<td>Bass</td>
<td>&gt;24 years</td>
<td>medium</td>
</tr>
<tr>
<td>McKern &amp; Stewart</td>
<td>&gt;30 years</td>
<td>medium</td>
</tr>
<tr>
<td>Medial Clavicle</td>
<td>&gt;25 years</td>
<td>medium</td>
</tr>
<tr>
<td>Sternal Rib Ends</td>
<td>25.7-42.3 years</td>
<td>low</td>
</tr>
<tr>
<td>Auricular Surface</td>
<td>35-44 years</td>
<td>medium</td>
</tr>
<tr>
<td>Pubic Symphysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Todd's Method</td>
<td>35-42 years</td>
<td>high</td>
</tr>
<tr>
<td>Meindl's Method</td>
<td>36-44 years</td>
<td>high</td>
</tr>
<tr>
<td>Katz &amp; Suchey's Method</td>
<td>23-59 years</td>
<td>high</td>
</tr>
<tr>
<td>McKern &amp; Stewart's Method</td>
<td>29+ (35.84) years</td>
<td>high</td>
</tr>
<tr>
<td>Dental Development &amp; Eruption</td>
<td>&gt;35 years</td>
<td>high</td>
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<tr>
<td>Dental Attrition</td>
<td></td>
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<tr>
<td>Brothwell's Method</td>
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<tr>
<td>Lovejoy's Method</td>
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<tr>
<td>Skelton's Method</td>
<td>30-45 years</td>
<td>medium</td>
</tr>
<tr>
<td>Tromly's Method</td>
<td>&gt;35 years</td>
<td>medium</td>
</tr>
</tbody>
</table>
STATURE AND WEIGHT ESTIMATION

Estimating Stature

The first method for estimating the stature of an individual is based on the measurements of the long bones without the epiphysis attached. This method was developed by Stewart (1979) and is presented in Skelton (2002). Stewart (1979) method is used to estimate fetal stature. Measurements of the humerus, radius, ulna, fibula, and tibia can be used for this method. Not all the bones need to be present for this method. The tibias or fibulas are probably more accurate indicators of stature. Once the measurements have been obtained they are plugged into a formula for stature. The formulas used for this method are reproduced on page 92 in Skelton, 2002. This method is relatively accurate, and should be applied to fetal individuals.

I was unable to apply this method to UMFC 37 because it is for fetal stature, and this individual is an adult.

The next method for estimating the stature of subadults based on the length of the femur, with or without attached epiphysis. This method was developed by El-Najjar and McWilliams (1978), and is presented in Skelton (2002). The maximum length of the femur is needed for this method. There is a correlating stature estimate for each femur length. This chart is used for estimating subadult stature; therefore, it is not applicable to adult specimens. However, the stature of shorter individuals could be estimated using this chart. The maximum femur length of 400mm is the last to be addressed on this chart. So, if an adult individual has a 400mm or shorter femur then this chart could be used. This method is relatively reliable because the femur is the most accurate indicator of stature.
I was unable to use this method for estimating UMFC 37 stature. The maximum femur length of UMFC 37 is 490mm, well over the 400mm maximum for this method.

The Trotter and Gleser (1952) method for estimating the stature of adults is based on measurements of the long bones. This method is presented in Bass (1995). This method uses the maximum length of the humerus, radius, ulna, femur, tibia, and fibula. Not all of these bones need to be present to estimate stature; however, if the bones are present it is best to utilize them. This method, like other stature methods, uses a chart of long bones lengths with corresponding height estimations, although regression formulas are also available. For this method, the race and sex of the individual must be estimated prior to stature estimation. There are separate charts for American White males, American White females, American Negro males, and American Negro females.

This method is relatively reliable and should be consulted for the stature estimation of unknown individuals. Trotter and Gleser state, “These data are from American White and Negro military personnel and comprise measurements of stature during life and measurements of long bones of the free limbs after death,” (Trotter & Gleser, 1952:511). The high accuracy of this method is a direct result of being able to compare living stature to post-mortem stature. This allowed for a comprehensive study on how to convert long bone length to living stature. This study provided the most accurate formula for estimating the stature of individuals.

I applied this method to UMFC 37 and the results are as follows. These stature estimates are from the American White male chart. The humerus is 357mm in length; this has a corresponding stature of 180-181cm (5’10” - 5’11”). The ulna is 277mm in length; this has a corresponding stature of 176-177cm (5’9”). The femur is 490mm in length.
length; this has a corresponding stature of 178cm (5’10”). The longest measurements were used for the humerus and ulna. There was only one femur available for analysis. The radius, tibia, and fibula were not present for analysis. Based on these observations, the remains are most consistent with a 5’9” – 5’11” individual. This estimate is relatively reliable.

Another method for estimating the stature of adults based on the length of the long bones was developed by and is presented in Bass (1995). The Genoves method for estimating stature is different from the Trotter and Gleser method, in that its base is not a chart of measurements with corresponding stature estimations, but a regression formula which produces the estimated stature from measurements. There is one formula that utilizes all the long bones. For this formula, all the bones are needed. However, there are separate formulas for the femur and tibia. These formulas are presented on page 35 of Bass, 1995.

I applied this method to UMFC 37 and the results are as follows. I used the formula for the femur because the tibia was not present for analysis. This formula estimated the stature to be 177.119cm (5’10”). This estimation corresponds to the previous estimations of stature. This estimation is relatively precise; it has a standard deviation of 3.417 cm. This creates an estimated stature range of 173.536-180.53 cm (5’8”-5’11”).

**Estimating Weight**

The method for estimating the weight of an individual is presented in Skelton (2002). This method utilizes a chart from the Metropolitan Life Insurance Company. The chart contains stature estimations with corresponding weight estimations. This
method is not very accurate, because it predicts what people should weigh at a given height, not what they actually weigh. It is also based on early 20th century Americans and may not be reliable for other populations.

I applied this method to UMFC 37 and the results are as follows. The corresponding weight for a stature of 5'8"-5'11" is 145-157 pounds. This estimate is for a medium build male individual. This weight has to be corrected for individuals older than 35 years. Assuming that UMFC was 45 years old, the corrected weight estimation is 160-197 pounds.

Summary

Based on the method for estimating the stature and weight of an individual, the remains are most consistent with an individual with a height between 5 feet 8 inches and 5 feet 11 inches; with the greatest possibility of being 5 feet 10 inches, and weight between 160-197 pounds; with the greatest possibility of being around 180 pounds.
HANDEDNESS ESTIMATION

Handedness from Asymmetry

The first method for estimating the handedness of an individual is based on examination of the humeri. This method is presented in Burns (1999). This method has two parts. The first part is based on the length of the humeri, for which it is believed that the dominant arm tends to be longer. The second is based on the morphology of the humeri. Burns states:

The two humeri can be compared for differences in the muscle attachment areas, particularly the deltoid tuberosity. The dominant side is expected to show slightly larger attachment areas. The humeri can also be compared at the elbow area where differences in osteoarthritic changes may indicate increased use on one side over the other. (Burns, 1999:157).

This method can give some indication of what hand the individual used more often. It however can not predict this with a great deal of accuracy. Burns states, “The methods of recognizing handedness in skeletal remains are imprecise,” (Burns, 1999:157). Therefore, this method can tell an examiner that there is a greater possibility that one hand was the dominant one.

I applied this method to UMFC 37, the observations are as follows. The right arm is longer than the left arm. There is a slightly more pronounced muscle attachment on the right arm at the deltoid tuberosity. The bone in this area is a little thicker than the left one. There is no obvious difference at the elbow end of the humeri. Therefore, the individual has a higher probability of being right handed.

Stewart’s Method

Another method for estimating the handedness of an individual is based on the glenoid fossa, of the scapula. This method is presented in Burns (1999), and is based on
the premise that a beveling of the fossa occurs with more use. Burns states (citing Stewart, 1979), “If one rim is beveled and the other is not, the person did probably more reaching with the arm on the beveled side,” (Burns, 1999:158). This method is not very reliable but it does give a slight indication of what the dominant hand was.

I applied this method to UMFC 37; the observations are as follows. The right scapula shows a slight beveled rim, whereas the left does not. Based on this observation, the individual has a higher probability of being right handed.

Based on the two methods for estimating handedness, the remains are most consistent with a right handed individual. However, this estimate is not very reliable and should be only considered as a probability.
PATHOLOGY AND TRAUMA

The vertebrae of UMFC 37 exhibit lipping, porosity, bony projections, and are deteriorating due to advancing age. These criteria are more pronounced on the lower thoracic and lumbar vertebrae. The right and left coxal bone exhibits slight lipping around the edges of the acetabulum, and bony projections inside the obturator foramen. The femoral head also has slight lipping and deterioration. Based on these observations, I would conclude that this individual’s condition is consistent with the description of osteoarthritis (degenerative joint disease) by White (2000). White states:

Osteoarthritis, the most common form of arthritis, is characterized by the destruction of the articular cartilage in a joint and the formation of adjacent bone, in the form of bony lipping and spur formation (osteophytes), around the edges of the joint. A better term for this phenomenon is degenerative joint disease.


This individual exhibits early stages of the disease and died prior to the full progression of it. Therefore, it is hard to say whether it was really degenerative joint disease, or just age related. Ubelaker states:

Osteoarthritis is a gradual alteration of the articular cartilage and articular surfaces of the bone as a consequence of long-term mechanical stress, repeated minor irritation of the cartilage, or disruption of circulation of the blood to the area. Its most common expression, a build-up of osteophytes (lipping) along the margins of the vertebral centra. Although usually considered as pathology, osteophytic development is normal unless it occurs prematurely. (Ubelaker, 1978:78).

The characteristics did not seem to be advanced, therefore I would conclude that the individual was not suffering from a premature form, but age related degeneration seems to be occurring.

The dentition exhibits significant root exposure, attrition, and alveolar bone resorption. The bone around the tooth sockets is extremely porous. There is a dental
carie present on the upper left first molar. The teeth on the left side seem to be deteriorating from the inside out. The teeth exhibit a black coloring inside the enamel. The attrition is more pronounced on the right side, but the left side seems to exhibit more pronounced bone resorption. Based on these observations I conclude that the individual’s condition is consistent with the description of periodontal disease by White (2000).

White states:

Periodontitis is the inflammation of tissues around a tooth. It can involve both soft tissues and the bone itself. Periodontal disease in skeletal remains is recognized as a result of infection of the alveolar bone and adjacent tissues. It causes recession of the alveolar bone, as either a horizontal lowering of the crest of the alveolar process or an irregular lowering of the process, with pockets or wells expanding into the cancellous bone of the jaws. (White, 2000:402).

The individual exhibited advanced forms of this condition and could possibly be the reason for the loss of several teeth. There is also evidence, i.e. no signs of healing, of postmortem tooth loss.

There seems to be no obvious signs of perimortem trauma suffered by the individual, however, postmortem trauma is present and widespread throughout the skeleton. The postmortem trauma was presented in the inventory and description of each bone present for analysis; therefore, it is not necessary to restate them here.
CONCLUSIONS

Summary of Analysis

Based on the application of the methods previously presented, the evidence is most consistent with these remains representing a right-handed Caucasian male, 35-44 years, with a height around 5 feet 10 inches, and weight around 180 pounds, who exhibited no significant pathology other than possible periodontitis, and who has no apparent peri-mortem trauma.

Race

Visual assessment suggests that the remains are those of a Caucasoid. The skull is relatively high, with squared angular orbit shapes, narrow face, narrow nasal aperture, a prominent nasal sill, and projecting zygomatics. These are all characteristics most common in Caucasians. Metric methods, (FORDISC 2.0, Gill's interorbital features, and Giles and Elliot discriminant function) calculated from cranial measurements place the individual well into the Caucasoid range.

Sex

Visual assessment of the skull, pelvis, and several postcranial bones, provide considerable evidence that the individual was male. Common male characters exhibited include the following. On the skull: prominent brow ridges, sunken nasal root, large, rugged mastoid processes, square, rounded orbits, and prominent muscle attachments. On the pelvis: a narrow pubis, a narrow deep sciatic notch, a flat auricular surface, a v-shaped subpubic concavity angle, a relatively large acetabulum, a large oval obturator

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foramen, prominent muscle attachments, and no ventral arc. Postcranial bones: the scapula is narrow; the glenoid fossa is broad and shallow, and the glenoid fossa is not set at a right angle to the axis of the body. Metric methods, (measurements of the sternum, clavicle, femur, humerus, coxal bones, and Giles and Elliot discriminant function) place the individual well into the male range.

Age

The individual was probably between 35-44 years of age at the time of death. All ectocranial sutures are commenced, suggesting an age of 19-89 years Baker (1984) method. This range was narrowed by the suture site method (White, 2000), suggesting an age range of 39.4 ±9.1-43.4±10.7. This range is narrowed by the auricular surface technique, with this individual being scored as phase 5; corresponding age range of 40-44 years. The dental attrition scores place the individual over 35 years. This range is further narrowed by the pubic symphysis techniques (Todd, Meindl, McKern & Stewart, and Katz & Suchey) suggesting an age range of 35-40 years.

Stature and Weight

The individual was probably about 5’10” tall and weighed around 180 pounds. Stature was calculated from measurements of the long bones present, using the chart for White males, giving a range of 5’8”-5’11”. The weight corresponding to this stature (Metropolitan Life Insurance Company standards) is 160-197 pounds. These estimates are adjusted for both age and stature.
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**CRANIAL MEASUREMENTS**

**UMFC 37**

*ALL MEASUREMENTS ARE IN MILLIMETERS*

1. Maximum cranial length (g-op) 191
2. Maximum cranial breadth (eu-eu) 145
3. Basion-bregma height (ba-b) 145
4. Porion-bregma height (po-b) 139
5. Basion-porion height (ba-po) 64
6. Basion-prosthion height (ba-pr) 96
7. Bregma-nasion length (ba-n) 112
8. Prosthion-nasion height (pr-n) 65
9. Auricular height (po-ap) 140
10. Minimum frontal breadth (ft-ft) 106
11. Total facial height (n-gn) No Mandible
12. Upper facial height (n-ids) 75.8
13. Facial width (zy-zy) 132
14. Nasal height (n-ns) 50.8
15. Nasal breadth (al-al) 25.2
16. Orbit height 32.8
17. Orbit breadth (mf-ec) 35.9
18. Maxilloalveolar length (pr-alv) 46
19. Maxilloalveolar breadth (ecm-ecm) 63.1
20. Palatal length (ol-sta) 43.1
21. Palatal breadth (enm-enm) 35.4
22. Bicondylar breadth (cdl-cdl) No Mandible
23. Bigonial breadth (go-go) No Mandible
24. Height of ascending ramus (go-cdl) No Mandible
25. Minimum breath of ascending ramus No Mandible

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<table>
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<tr>
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<td>Height of mandibular symphysis (gn-idi)</td>
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<tr>
<td>27.</td>
<td>Mastoid size (po-ms)</td>
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<tr>
<td>28.</td>
<td>Foramen magnum length</td>
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<tr>
<td>29.</td>
<td>Foramen magnum breadth</td>
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<td>Cranial Index</td>
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<td>Cranial Length-Height Index</td>
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<td>Cranial Breadth-Height index</td>
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<td>Mean Basion-Height Index</td>
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<td>Flatness of the Cranial Base Index</td>
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<td>Frontoparietal Index</td>
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<td>39.</td>
<td>Total Facial Index</td>
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Reference pages 68-84 (Bass)
# BONE MEASUREMENTS

**UMFC 37**

*All measurements are in millimeters*

*NP = Not present for analysis*

## CLAVICLE

1. Maximum length NP 169
2. Circumference at middle of bone NP 45
3. Claviculohumeral Index NP 12.71
4. Robustness Index NP 26.63

Diagram on page 133 (Bass)

## STERNUM

1. Length of manubrium NP
2. Length of mesosternum 122
3. Width of first sternebra 25.9
4. Width of third sternebra 33.9

Diagram on page 118 (Bass)

## SCAPULA

1. Maximum length 168 161
2. Maximum breadth 110 111.5
3. Length of spine 143.6 147.6
4. Length of supraspinous line 58.4 (broken) 60.5
5. Length of infraspinous line 127.1 120.2
6. Scapular Index 63.39 68.57

Diagram on page 123 (Bass)
HUMERUS
1. Maximum length 357 350
2. Maximum diameter midshaft 75 73
3. Minimum diameter midshaft 65 60
4. Maximum diameter of the head 51.2 50.5
5. Least circumference of the shaft 73 68
6. Robusticity Index 20.45 19.21
7. Radiohumeral Index No Radius No Radius
Diagram on page 153 (Bass)

RADIUS
1. Maximum length NP NP
2. Humeroradial Index NP NP
Diagram on page 167 (Bass)

ULNA
1. Maximum length 276 274
2. Physiological length 244.3 243.8
3. Least circumference of the shaft 48 46
4. Caliber Index 19.65 18.87
Diagram on page 175 (Bass)

SACRUM
1. Maximum anterior height NP
2. Maximum anterior breadth NP
3. Sacral Index NP
Diagram on page 114 (Bass)

COXAL BONES
1. Maximum length 230 230

99
<table>
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<tr>
<th>Measurement</th>
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<th>Value 2</th>
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<tbody>
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<td>85.17</td>
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<tr>
<td>Ischium length</td>
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Diagram on page 199-201 (Bass)

**FEMUR**

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<td>Mediolateral diameter of the midshaft</td>
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<td>Maximum diameter of the head</td>
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<tr>
<td>Circumference of the midshaft</td>
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<tr>
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<td>Subtrochanteric Mediolateral diameter</td>
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<td>Platymeric Index</td>
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<td>Robusticity Index</td>
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Diagram on page 224 (Bass)

**TIBIA**

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<td>A-P diameter at the nutrient foramen</td>
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<tr>
<td>Mediolateral diameter nutrient foramen</td>
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<td>Circumference nutrient foramen</td>
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Diagram on page 246 (Bass)

**FIBULA**

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Diagram on page 246 (Bass)
FORDISC 2.0 Analysis of

Discriminant function results using 13 variables:

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<th>ZYB</th>
<th>BSH</th>
<th>BPL</th>
<th>MAB</th>
<th>AUB</th>
<th>UFHT</th>
<th>WFB</th>
<th>NLH</th>
<th>NLB</th>
<th>OBB</th>
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<th>HM</th>
<th>CHM</th>
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Total: 606 Correct: 404 66.7%

Multigroup Classification of

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is closest to WMs
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