

Estimation of Stature from the Maximum Metacarpal Lengths of the Ancient Maya

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ABSTRACT

Estimation of stature is an important part of an archaeological analysis of skeletal remains. Stature provides insight into various factors of a population, including nutrition, health, and genetics. Due to poor preservation in the Maya Lowlands, it is rare to find intact measurable long bones for which stature estimation equations exist. In an effort to increase the recovery of quantifiable data, non-Maya metacarpal equations were tested with Maya data to determine their accuracy and applicability to the Maya. Preliminary results show the metacarpal stature estimation equations of American blacks have approximately 86% in common with the long bone stature estimation of the Maya. However, a small sample size was used and the results are inconclusive.

INTRODUCTION

The stature of a living human reflects nutritional, genetic, and disease patterns an individual experiences. In archaeology, this information can be applied to a better understanding of a specific population's ecology, stress, and activity patterns (Larsen 1997:2). Therefore, it is crucial to have a means of estimating stature from human skeletal remains.

For instance, stature was studied at the Maya site of Tikal for its implications on demography and social organization (Haviland 1967:316). Male stature increased in the last century B.C.E. as tomb burials appeared, while non-tomb burial stature did not (Haviland 1967:320). This indicated a distinct ruling class emergence, with the elite males in Tikal receiving better nutrition than the general population (Haviland 1967:321). Unlike the males, female stature remained stable through all time periods, and is a possible reflection of a relatively lower status for women in Maya society (Haviland 1967:323).

Stature estimates from Tikal also contributed to the understanding of chronic malnutrition in the ancient Maya. Since maize is deficient in several essential amino acids, hinders iron absorption, and lacks some important minerals, it can cause physiological disturbance and reduced height (Larsen 1997:16). The drastic 10 cm reduction of stature in both elite males and non-elite males during the Late Classic highlighted dwindling dietary resources and a greater reliance on maize (Haviland 1967:322).

The most common stature estimates are derived from long bones, specifically the femur. These are based upon the principle that the various long bones correlate positively with stature (Simmons et al. 1990:628). Pioneers in estimating stature from long bones have been Pearson (1898), Dupertuis and Hadden (1951), Trotter and Gleser (1952), and Genoves (1967) (see Table 1).

Table 1. Calculation of stature from maximum metacarpal lengths (Genoves 1967:76)

Male	
Femur	$2.26(\text{FEM}^1) + 66.379 \pm 3.417 \text{ cm}$
Tibia	$1.96(\text{TIB}^1) + 93.752 \pm 2.812 \text{ cm}$
Female	
Femur	$2.59(\text{FEM}^1) + 49.742 \pm 3.816 \text{ cm}$
Tibia	$2.72(\text{TIB}1) + 63.781 \pm 3.513 \text{ cm}$

¹Subtract 2.5 cm to obtain the stature while alive.

For instances when measurable long bones do not exist, other alternatives are available. Jason and Taylor (1995) derived formulae from the vertebrae, while Steele (1970) estimated stature from fragments long bones. This last method is highly desirable, as remnants of long bones are usually present archaeologically. However, it is problematic in application because of the difficulty in identifying the exact location of necessary anatomical landmarks (Simmons et al. 1990:629).

Another viable method is from metacarpals. The standard error estimate is higher than that from long bones, but is close to those produced by Steele (1970) (Wilbur 1998:182). Himes et al. (1977), Musgrave and Harneja (1978) (see Table 2), and Meadows and Jantz (1992) (see Table 2) have all created metacarpal equations from samples of known height. While not estimating stature directly from metacarpals, Wilbur (1998) (see Table 2) has estimated femur length from metacarpals and subsequently used that estimate in stature estimation.

Stature estimation equations are most accurate when derived from one population and then applied to the same population (Trotter and Gleser 1952:467). This is because the proportions from one population are not necessarily the same as those from another (Genoves 1967:67). Therefore, the metacarpal equations created by Meadows and Jantz (1992) for American whites and blacks will not have the same accuracy if applied to the Maya. Currently, the only equation applicable to the Maya is Genoves's (1967) long bone stature estimation equation (see Table 2).

Genoves's (1967) long bone equations have been used on modern and ancient indigenous Mesoamerican populations. His data was collected from modern cadavers who were characterized as Indigenous or Indigenous with some Mestizo, both morphoscopically and serologically (Genoves 1967: 70-71). These formulae are presently the most reliable known for the ancient Maya as the racial affiliation is similar.

The useful application of the Genoves 1967) correlation is unfortunately hindered by poor preservation (Danforth 1994:207) (see Figure 1). The alternating rainy and dry seasons, aggressive vegetation with thirsty roots, and burials within or under shifting cobble fill creates a great deal of postmortem breakage, crushing, and erosion (Saul and Saul 1997). As a result, few long bones remain intact for archaeologists to measure. For instance, Cuello has one of the largest known skeletal series from a Maya Preclassic site (Saul and Saul 1991:134), yet "only one male femur and one female tibia could be measured directly" (Saul and Saul 1991:153).

This study examined an additional means of estimating stature for the Maya. An original stature estimation equation from the metacarpals could not be created due to small sample size. Instead, non-Maya metacarpal equations were tested with Maya data to determine their accuracy and applicability to the Maya.

Table 2. Calculation of stature from maximum metacarpal length (in centimeters unless noted).

Wilbur (1998:188)

Femur Estimation

Female

Metacarpal 2	$3.639(\text{MC2mm}) + 19.544 \pm 1.161 \text{ cm}$
Metacarpal 3	$3.808(\text{MC3mm}) + 19.105 \pm 1.243 \text{ cm}$

Stature Error Estimate

“Adjustment is made by multiplying the standard error of the estimated femur length by the first constant in the stature regression formula, and then adding the product to the standard error of the estimated stature” (Steele 1970:90).

Female

Metacarpal 2	$1.161(2.59) + 3.816 = 6.82 \text{ cm}$
Metacarpal 3	$1.243(2.59) + 3.816 = 7.03 \text{ cm}$

Stature Estimation

Metacarpal 2	$2.59(\text{FEM}) = 49.742 \pm 6.82 \text{ cm}$
Metacarpal 2	$2.59(\text{FEM}) = 49.742 \pm 7.03 \text{ cm}$

Meadows and Jantz (1992:151)

Male, left

Metacarpal 3	$1.298(\text{MC3}) + 84.90$	$80.28 \pm 5.19 \text{ cm}$
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Male, right

Metacarpal 3	$1.278(\text{MC3}) + 85.98$	$81.61 \pm 5.36 \text{ cm}$
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Female, left

Metacarpal 3	$1.298(\text{MC3}) + 82.81$	$75.79 \pm 5.19 \text{ cm}$
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Female, left

Metacarpal 2	$1.261(\text{MC2}) + 82.52$	$76.11 \pm 5.15 \text{ cm}$
Metacarpal 3	$1.279(\text{MC3}) + 83.44$	$76.80 \pm 5.36 \text{ cm}$
Metacarpal 4	$1.375(\text{MC4}) + 86.44$	$81.07 \pm 5.33 \text{ cm}$

Musgrave and Harnja (1978:115)

Male, left

Metacarpal 3	$1.12(\text{MC3}) + 98.21 \pm 5.82 \text{ cm}$
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Male, right

Metacarpal 3	$1.26(\text{MC3}) + 88.80 \pm 6.016 \text{ cm}$
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Female, left

Metacarpal 3	$1.25(\text{MC3}) + 22.71 \pm 6.59 \text{ cm}$
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Female, right

Metacarpal 2	$1.35(\text{MC3}) + 80.26 \pm 4.73 \text{ cm}$
Metacarpal 3	$1.29(\text{MC3}) + 80.26 \pm 4.73 \text{ cm}$
Metacarpal 4	$1.35(\text{MC4}) + 85.94 \pm 4.98 \text{ cm}$



Figure 1. An example of preservation at the site of Dos Barbaras

METHODS

The sample used in this study is small due to poor preservation and lack of metacarpal measurements from previous Maya studies. The sample was collected and measured by Julie or Frank Saul with the author measuring the individual from Dos Barbaras (Figure 1).

In total, this study uses data from four adult males and two adult females. Sex was determined by Julie or Frank Saul using pelvic and cranial characteristics of each skeleton. The measurements for the samples according to site in centimeters are as follows:

	Dos Barbaras male	RB-11 male	Maya Hak Cab Pek male	La Milpa male	Saki Tzul female	Mohibol Kanchi female
Left MC3		6.40		6.70		5.95
Left Femur	39.80				38.00	
Left Tibia			38.10	34.20	31.50	
Right MC2					5.95	6.28
Right MC3	5.58		6.70			6.25
Right MC4						5.35
Right Femur		47.00			38.30	
Right Tibia			38.00			33.50

All measurements were recorded to the nearest millimeter. Metacarpals were measured along the midline length which was defined as “the length from the midline of the proximal articular surface to the midline of the distal articular surface” using a sliding caliper (Meadows and Jantz 1992:148).

The data from each individual was applied to an equation from the population sources of American whites and blacks (Meadows and Jantz 1992:151), British (Musgrave and Harneja 1978:115), and Native Illinoisan (Wilbur 1998:188). In addition, the Genoves (1967) equations were used and represented the standard from which all comparisons were made.

Once the stature estimation was calculated, stature range was recorded. The deviation from the Mesoamerican standard error of estimate was also determined, along with the number of centimeters per estimation that were in common with the Mesoamerican stature range.

RESULTS

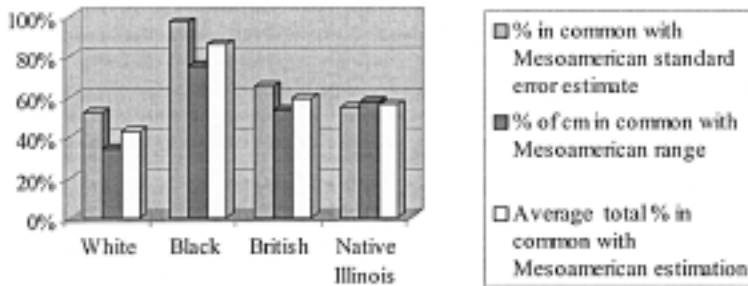
The Maya average metacarpal standard error of estimate for each formula in centimeters is:

	Mesoamerican	White	Black	British	Native Illinois
Male MC3	± 3.25	± 5.125	± 5.125	±5.625	N/A
Female MC2	± 3.75	±8.00	± 1.75	±5.50	±6.25
Female MC3	± 3.50	±8.50	± 5.50	± 7.00	± 6.50
Female MC4	± 3.50	±5.50	± 2.00	± 3.50	N/A
Average MC standard error	±3.50	± 6.781	± 3.593	± 5.406	± 6.375

The average number of centimeters per estimation that were in common with the Mesoamerican stature range in centimeters are recorded as follows:

	Mesoamerican	White	Black	British	Native Illinois
Male MC3	6.5	4.5	4	.75	N/A
Female MC2	7.5	1	7	3	4
Female MC3	7	1	3	2	4
Female MC4	7	3	7	5	N/A
Average cm in common	7	2.38	5.25	3.69	4

A comparison of the previous results is highlighted below as average percentages in common with the Mesoamerican stature estimation:



With the limited sample, the results overwhelmingly show that the Meadows and Jantz (1992) equations for American blacks have more in common (86%) with the Genoves (1967) estimates than that of the British (59%), the Native Illinois population (56%), or American whites (43%). The American black average metacarpal standard error from Maya data is ± 3.593 cm, only a 3% difference from the sample’s Mesoamerican standard error estimate of ± 3.50 cm. In addition, the sample American black stature range included an average of 75% of the sample Mesoamerican stature range. In comparison, the American white sample standard error estimate was almost twice as large, and only included 2.38 cm of a possible 7.00 cm (34%).

DISCUSSION

The sample size utilized in this study is inadequate for statistical analysis. Although the average percent in common with the Mesoamerican stature estimate from other population stature estimates were completed, these results should not be applied in the field. A sample of at least 30 individuals per sex and bone is needed before any results will be reliable.

Ideally, modern Maya should be analyzed to develop a stature estimation equation from metacarpal length. The data set should consist of measurements of stature and hand-wrist radiographs of adults. This was the method used by Meadows and Jantz (1992), Musgrave and Harneja (1978), and Himes et al. (1977). This method has the added benefit of creating a permanent record through the radiograph. It can be reviewed in the future and used in alternative studies such as sex identification from the metacarpal length.

If living subjects are not available, the method used by Wilbur (1998) can be followed to achieve an estimate, although not recommended. This entails estimating femur length from metacarpals and applying the estimated femur length to an established stature estimation equation with an adjusted standard error. This method unfortunately produces high standard error estimates (over ± 6.00 cm) and would have little application value in archaeology.

For instance, if the Saki Tzul data is entered into Wilbur’s (1998) equation (regression would be different for the Maya, but similar results were predicted by Wilbur for other populations), the estimated femur range does not include the actual femur length (41.20 ± 1.161 cm versus 38.15 cm). It is not surprising then that the estimated stature range does not include the accepted Genoves (1967) stature estimation (151.27 ± 6.82 cm versus 143.371 ± 3.816 cm).

The Himes et al. (1977) metacarpal stature estimation equations for indigenous Guatemalan children could not be tested in this study due to lack of juvenile samples, but should be explored in future studies.

CONCLUSIONS

This study examined the reliability of applying metacarpal stature estimation equations derived from different populations to the Maya. The sample size was too small to determine with moderate confidence, which, if any, of the equations used have merit in Maya archaeology. Further studies utilizing maximum metacarpal length (with a minimum data set of 30 individuals per sex and bone) can be conducted. A few examples include re-calculating the results from this study, using modern Maya data, or determining sex. The real issue that needs to be addressed is the recording of data. Poor preservation leaves few bones intact and few researchers will measure a bone that does not have an established equation. Therefore, further attempts will be greatly hindered until physical anthropologists record all the measurements of individual skeletons.

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