Title

A Model Growth Curve for Juvenile Age Estimation using Diaphyseal Long Bone Lengths among Ancient Maya Populations

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JUVENILE AGE ESTIMATION USING DIAPHYSEAL LONG BONE LENGTHS AMONG ANCIENT MAYA POPULATIONS

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Standards for diaphyseal lengths of the femur, humerus, and tibia that can be used in juvenile age estimation for the ancient Maya are presented. It is argued that these new standards are necessary given differences in stature and limb proportion in Mesoamerican groups compared to the prehistoric North American groups upon whom the current available standards have been developed. Using data from 96 juveniles in the protohistoric Maya series from Tipu, Belize, regression equations were developed to predict age of dental development using diaphyseal lengths; all had excellent fit and statistical significance. When the equations were tested with diaphyseal lengths from other Mesoamerican populations, the results were supportive of such application.

Se presentan los estándares de las longitudes de los diáfises del húmero, fémur, y tibia, las cuales serán usadas en la estimación de las edades juveniles en poblaciones mayas prehistóricas. Se propone que estos estándares nuevos son necesarios ya que los estándares empleados actualmente fueron desarollados en poblaciones norteamericanas y existen diferencias en estatura y las proporciones de los miembros entre estas poblaciones prehístoricas y las poblaciones prehistóricas Mayas. Usando datos de 75 jóvenes en la serie Maya protohistórica de Tipu, Belice, se produjeron ecuaciones de regresión para predecir la edad de desarrollo dental basada en las longitudes de los diáfises; todas tenían la bondad excelente de ajuste y la significación estadística. Cuando estas ecuaciones fueron comparadas con datos tomados de otras poblaciones mesoamericanas, las curvas parecen ser bastante coherentes.

Accurate aging of juveniles is important for interpretation of findings in a number of areas of research in archaeology and bioarchaeology. Its most obvious value is in reconstruction of paleodemographic profiles, such as might be used in the determination of life expectancies, but it also plays an essential role in analysis of health patterns. For example, high mortality rates of neonates may indicate high levels of maternal stress (Storey 1992), or increased mortality at certain ages may be tied to practices such as weaning, which in turn is often reflective of subsistence (Larsen 1995). In a more recent study, Reyes Gutierrez and colleagues (2006) compared long bone age to dental age in juveniles from the Classic Maya site of Xcambó, Yucatán, arguing that the shorter-than-expected long bone lengths seen were suggestive of nutritional and disease stress. More purely cultural questions can be addressed as well. The presence of particular burial goods, such as food-procurement tools, with specific age cohorts potentially suggests when youngsters started assuming adult activities. In turn, the absence of juveniles younger than a certain age within a cemetery may reveal when rites of passage, such as baptism, took place within a society (e.g., Cohen et al. 1997).

Determination of age becomes problematic, however, when the skeletal material is badly preserved or fragmentary, and juvenile remains are

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especially prone to such conditions given their lesser bone mass compared to that of adults (Walker 1997). The generally poor preservation of Maya skeletal remains due to the acidic soils of the Yucatán is well known, and the limitations it places on the work of bioarchaeologists are numerous, especially in the area of sample size. Therefore, it is necessary for researchers to have available as many aging techniques for juveniles as possible.

Among the bioarchaeological methods commonly used in estimation of chronological age, evaluation of dental development and eruption is considered the most reliable (Johnston and Zimmer 1989; Ubelaker 1989) since teeth are less affected by nutritional inadequacies or other health disruptions compared to other skeletal elements (Demirjian 1986; Garn et al. 1965). However, they are not always present or able to be utilized. Sometimes crania may be missing, having been removed at time of death for ritualistic purposes or later during secondary reburial or pothunting. Fragile deciduous teeth are especially vulnerable to destruction by taphonomic processes. Ossuaries also present analysis challenges since each bone element must be evaluated separately. In these situations, long bone epiphyseal union can be employed in evaluating age at death in adolescent skeletons.

If epiphyseal union has not occurred, however, lengths of long bone diaphyses can provide age estimates (Scheuer and Black 2004; Ubelaker 1989). Although growth data from modern populations in which children's chronological ages are known could be used to establish standards for this purpose (e.g., Falhauber 1976), such samples are typically not appropriate to apply to ancient groups with highly different genetic, nutritional, and disease experiences. Consequently, standards are generally created based on analysis of juveniles from prehistoric skeletal samples for whom dental age was able to be determined and diaphyseal length could be measured. Several of these model curves produced from graphing mean diaphyseal lengths by age have been developed for ancient North American populations, including the protohistoric Arikara (Merchant and Ubelaker 1977), Late Woodland Illinois Valley (Walker 1969), and the Archaic Indian Knoll (Johnston 1962; Sundick 1972). Researchers have also long noted that growth patterns are population specific (Demirjian et al. 1985), and no model curves have thus far been established for Mesoamerican groups. Such a curve would have potentially been useful in the study of juvenile growth patterns at Xcambó (Reyes Gutierrez et al. 2006), where model curves from Indian Knoll were employed instead.

The need for juvenile aging standards specifically for use with ancient Mesoamericans is supported in a number of ways. Buikstra and Mielke (1985:387) state that for a growth curve to be appropriate for use in determining age at death, the two populations involved (the reference population and the population being analyzed) should have experienced similar environmental stresses. Arguably, dietary patterns have the biggest effect in this area, influencing innumerable cultural and health variables from birth spacing to nutritional deficiencies to disease repertoires (Larsen 1995). Subsistence strategies are quite different between Mesoamerican populations and the North American populations for whom curves have been developed. Mesoamericans have been agricultural for thousands of years (Pohl et al. 1996), whereas the Indian Knoll, Illinois Valley, and Arikara groups were foraging, transitional to domestication, and horticultural, respectively (Blakeslee 1994; Buikstra 1984; Webb 1946).

Buikstra and Mielke (1985:386) have also suggested that when seeking an appropriate reference sample for comparison to an archaeological population, the selection of one that is closely related reduces the potential sources of error based on factors such as differences in the genetic potential of growth by age. The probability of genetic differences between North and Central American populations seems great considering the geographical distance involved. Furthermore, the Maya were in the past, and still are, a very short people (Bogin and Keep 1999; Danforth 1994, 1999a; Márquez and del Ángel 1997; Tiesler Blos 2001) compared to most other ancient New World populations (Table 1). Such differences have led Ubelaker (1989:62) to recommend that bioarchaeologists analyzing Mesoamerican populations should employ stature estimation formulae developed by Genovés (1967; see also del Angel and Cisneros 2004), whereas those analyzing prehistoric populations from northern North America usually will have more accurate results using the formulae developed by Trotter and Gleser (1958). In their attempt to reconstruct long bone length in mod-

Table 1. Mean Adult Statures by Sex for Selected Maya Populations and Others Referenced in the Text.

	Males		Females	
Population	*N*	Stature (cm)	*N*	Stature (cm)
Colonial Tipu Maya[a]	149	160.3	106	148.3
Preclassic Cuello Maya[b]	11	161.5	9	153.7
Classic Xcambó[c]	–	162.0	–	150.3
Late Classic Barton Ramie Maya[d]	10	156.6	6	145.7
Late Classic Seibal Maya[d]	18	159.1	4	145.7
Late Classic Tikal Maya[e]	21	155.3	11	148.7
Late Classic Jaina[f]	24	160.1	17	150.2
Postclassic Yucatac Maya[g]	29	160.9	11	148.4
Postclassic Zaculeu[h]	20	160.4	4	148.5
Modern Maya[i]	77	155.1	56	142.7
Protohistoric Arikara[j]	236	168.7	192	156.5
Late Woodland Illinois Valley[k]	112	167.1	106	159.3
Archaic Indian Knoll[l]	–	165.6	–	156.9

Note: All estimations for Maya populations were made using Genovés 1967 unless otherwise noted.

[a] Cohen et al. 1997.

[b] Saul and Saul 1991.

[c] Cetina Bastida and Sierra Sosa report that "maximum stature could be evaluated in only 15.52% of the adult population analyzed" (2005:672; translated from Spanish by M. E. Danforth).

[d] Cohen et al. 1989.

[e] Danforth 1999a, recalculated from Haviland 1967.

[f] Pijoan Aguadé and Salas Cuesta 1984; statures based on Pearson as outlined in Comas 1966:413.

[g] Márquez and del Ángel 1997.

[h] Danforth 1994, recalculated from Stewart 1953.

[i] Steggerda 1938; measurements taken on living subjects.

[j] Adapted from Cole 1994.

[k] Adapted from Cook 1984.

[l] Snow 1948; no sample sizes given.

ern Guatemalans using formulae drawn from incomplete bones in the prehistoric United States, Wright and Vásquez (2003) found the results to be unreliable. They concluded that the very short stature typical of the Maya may have caused statistical problems by being so far out of range of the mean statures of the samples from which the equations were derived. Thus, given the inability for prehistoric North American populations to meet the criteria put forth by Buikstra and Mielke (1985), the need for a set of aging standards using diaphyseal length based upon Mesoamerican data appears evident.

Such a set of standards is presented here using regression equations developed from an analysis of the human remains recovered at the colonial Maya cemetery of Tipu, Belize. Dating to the late sixteenth–early seventeenth centuries, the human remains of more than 550 individuals were recovered at the site, making it one of the largest known skeletal collections in Mesoamerica. In addition, the level of preservation seen is much better than that of most Maya series (Cohen et al. 1997; Jacobi 2000). The Tipu population therefore provides one of the best available samples with which to establish juvenile aging standards using diaphyseal length for the Maya, which then potentially may be extrapolated to Mesoamerican populations in general.

Materials and Methods

The site of Tipu is situated on the Mopán River in the Cayo District of west-central Belize. Although the cemetery is postcontact, Tipu was located on the frontier where the Spanish had little effective presence beyond the establishment of a *visita* mission. An analysis of nonmetric dental traits by Jacobi (2000) finds no indication of European admixture in the collection; this conclusion is additionally supported by the cranial morphology and short stature characteristic of the population (Cohen et al. 1997). As a result of their early historic date and relative isolation, the inhabitants of the Tipu appear to have continued to practice many Postclassic Maya cultural traits, especially maize-based subsistence (Graham 1991), although ancient Maya dietary practices did vary extensively over space and time (Dunning et al. 1998). It is assumed that this may be extrapolated to their health patterns as well, as evidenced by the fact that the average heights for males and females at Tipu are quite similar to mean statures reported for a number of other more ancient Maya populations (Table 1). The period of use of the cemetery does allow that individuals buried there may have died of introduced infectious disease, but no suggestions of hurried or multiple burials have been found (Cohen et al. 1997).

In order to obtain the sample used for this study, those juveniles age 12 years and under who had long bones that required no or minimal estimation for measurement were identified in the Tipu collection (*n* = 96), although Hoppa and Gruspier (1998) have developed regression equations to estimate length in fragmentary bones. The length of the better-preserved humerus, tibia, or femur for each individual was used, regardless of side. As the most reliable age indicator available among the various skeletal elements (Johnston and Zimmer 1989; Ubelaker 1989), dental development was used to estimate chronological age. The standards employed for this purpose are those presented in Ubelaker (1989:64). Using data from a large number of Native American and "nonwhite" groups, he (1989:65) suggests that his compilation likely represents the best dental age estimation standards available for New World juveniles.

Nevertheless, it should be kept in mind that considerable intra- and interpopulation variation exists for timing of tooth development, gingival eruption, and alveolar eruption among populations (Halcrow et al. 2007; Konigsberg and Holman 1997; Liversidge 2003). In addition, Lampl and Johnston (1996) have shown that dental age often does not always correlate perfectly with chronological age, especially when modern reference samples are used.

Once dental ages were determined, individuals were placed into age categories, starting with birth to six months followed by intervals of a year after that (i.e., 0–.5 years, .5–1.5 years, etc.), and the mean diaphyseal length by bone was determined for each group. These results were then plotted against the age category in order to develop regression equations for the femur, humerus, and tibia. Although males and females display potentially different growth rates, especially in later childhood, they could not be analyzed separately since juveniles do not exhibit skeletal sex indicators until the later teens (Bass 2005:19). The data were entered into an SPSS (version 15.0) spreadsheet, and a linear regression analysis was run to determine rates of growth as well as the predictive power of long bone length for use in age estimation.

Results and Discussion

The sample sizes, mean lengths, standard deviations, and ranges by age group for each bone are listed in Table 2. The resultant growth curves with the smoothed values plotted may be found in Figure 1. All three curves show some similarities in pattern, with faster growth in the first few years of life and then again in later childhood when the mid-childhood growth spurt would be expected to take place (Bogin and Smith 1997). The slight lull in growth velocity between ages three and seven or so is particularly observable in the femur. It is also possible that the lull could be an artifact of the relatively small sample size involved.

Regression analysis was run separately for each bone, and significant positive correlations between dental age and long bone length were found for the femur, humerus, and tibia (Figures 2, 3, and 4, respectively). All three regression equations have good characteristics, with excellent fit and statistical significance (Table 3). The model using the tibia has a residual plot that indicates a violation of homoscedasticity to some degree, though with its statistically significant slope coefficient and an r^2 value of .93, this is not something that precludes its use. When possible, however, the age estimate gained using the femur should be given greatest weight. The data set for measurements from this bone is relatively large ($N = 77$) compared to those for the humerus ($N = 40$) and tibia ($N = 31$), and there are no missing age groups. In addition, several researchers have found the femur to be the most correlated with estimating dental age (Hoffman 1979:467–468; Ubelaker 1974).

A two-step process in applying the model is recommended. The first step is to apply the appropriate regression equation for the bone under consideration to estimate an "exact" age; the second is to round the estimated age to the nearest whole number (which in cases in which a negative age is estimated is zero). Using the data from Burial 276, the length of the femur is 315 cm. Substituting this value into the model, the result of the first step is: age = 11.334 = –3.92 + (.05 * 315); age is then rounded to 11 years in the second step. In this case, it can also be seen that the estimated age of 11 years matches the age determined through dental analysis. Of the 77 individuals with femora, the regression accurately predicted dental age for 42 cases (Table 4). Of the remaining 35, 29 showed an error of ±1 year, and only six (7.8 percent) showed an error of ±2 years.

The equations all have solid goodness of fit, but it is worthwhile to remember that as long bone length increases, there is a tendency for the equations to have a larger average error in estimating age. Ubelaker's (1989) standards for dental age also show this pattern, with an error ranging from ±2 months for neonates to ±30 months for 12-year-olds. Variability in individual growth increases with age among children, especially as sexual dimorphism starts to take greater effect and growth spurts begin to differentially occur. Since the method presented here uses long bone length to estimate dental age rather than chronological age, the potential errors, and thus level of accuracy, of both methodologies must be considered in evaluation of final age estimations.

When the femur results here are compared to growth curves from other populations, the predicted pattern is of the Maya curve being shorter at all ages compared to all of the groups with the exception of the Late Woodland Lower Illinois Valley population; this group appears to fall behind the Maya in mean juvenile height after age six (Figure 5). The Late Woodland group, however, still ended up much taller as adults compared to the Maya (Table 1), suggesting that "catch-up" growth occurred in adolescence. The possible explanations for this pattern are numerous and complicated, ranging from potential interobserver differences in age determination to stresses associated with changes in subsistence strategies in the Late Woodland group (Cook 1984).

The curves were then tested for applicability to other Mesoamerican populations using data from Classic Maya at Tikal and Dos Pilas, Guatemala (L. Wright, personal communication 2002), and Late Postclassic Aztec from Xaltocan, Mexico

Table 2. Mean Humeral, Femoral, and Tibial Diaphyseal Lengths (cm) for Tipu Juveniles.

	Humerus					Femur					Tibia				
Age	N	Mean	SD	Low	High	N	Mean	SD	Low	High	N	Mean	SD	Low	High
0	6	61.3	7.5	53	73	6	76.3	4.2	70	82	2	69.0	2.8	67	71
1	2	78.0	21.2	63	93	6	103.0	13.9	81	122	1	70.0	–	70	70
2	1	115.0	–	115	115	4	118.8	6.2	112	125	1	112.0	–	112	112
3	7	115.7	6.1	107	122	14	149.0	15.3	120	178	4	128.0	4.7	122	133
4	2	137.5	5.0	134	141	3	179.3	7.5	175	188	2	147.0	.0	147	147
5	1	146.0	–	146	146	5	186.4	11.3	175	202	0	–	–	–	–
6	5	158.6	15.5	138	174	9	209.0	25.5	180	255	3	170.7	15.2	157	187
7	5	166.0	10.9	150	180	8	225.8	20.6	192	260	6	196.3	19.2	177	231
8	1	178.0	–	178	178	1	257.0	–	257	257	1	227.0	–	227	227
9	2	191.0	1.4	190	192	6	256.8	12.3	241	270	4	224.5	24.4	210	261
10	4	202.3	6.1	196	208	6	290.7	8.4	284	305	4	238.5	17.1	222	261
11	2	214.0	7.1	209	219	4	301.5	19.5	273	315	0	–	–	–	–
12	2	214.5	10.6	207	222	5	309.6	10.0	293	320	3	257.7	4.0	254	262

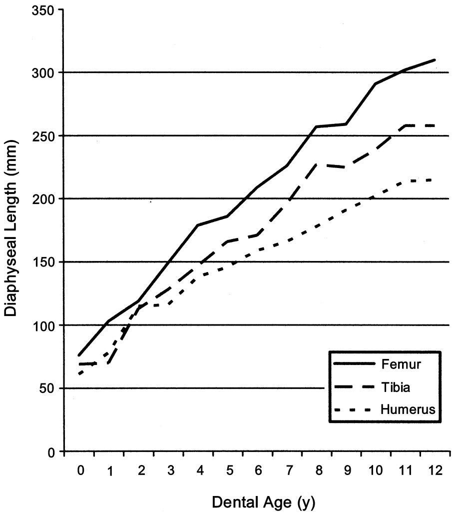

Figure 1. Tipu Maya smoothed model growth curves based on mean diaphyseal lengths for the humerus, femur and tibia.

(Danforth 2000). The results are seen in Table 5. As would be expected, the Maya curve appears to provide good estimation for younger children, but the estimated ages deviate more among older individuals. Although there was a slight tendency to overestimate age at death using the diaphyseal length data, the differences are all about two years or less. It is likely, however, that a variety of cultural factors also play a role in variation in adult stature in Mesoamerican populations. For example, differential access to resources affecting health according to status may be in operation, especially considering that all of the individuals tested came from state-level cultures (Danforth 1999a; Falhauber 1994). Others have also noted temporal trends, in that average height among the Maya decreased from the Preclassic to the Postclassic (e.g., Bogin and Keep 1999; Márquez and del Ángel 1997; Tiesler Blos 2001; cf. Danforth 1999b). Nevertheless, the equations appear to be fairly successful in their application to populations beyond the one on which they are based.

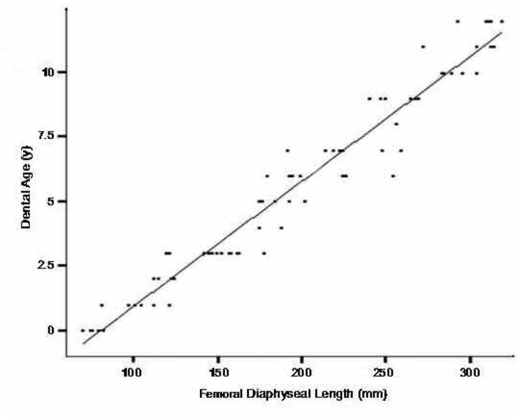

Figure 2. Regression analysis for age by femur diaphyseal length.

Conclusions

The primary goal of this study was to establish standards using diaphyseal lengths that could be used for age determination in children specifically for the ancient Maya. This is especially important given the poor preservation of skeletal remains in

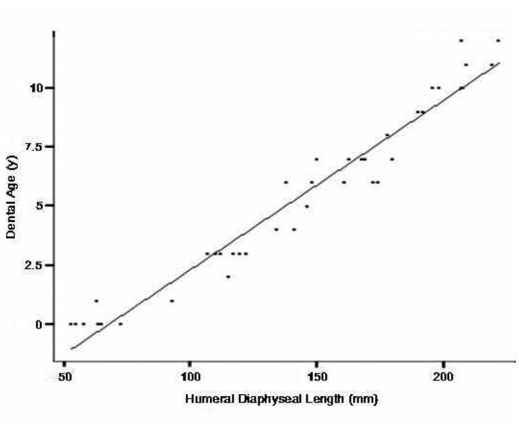

Figure 3. Regression analysis for age by humerus diaphyseal length.

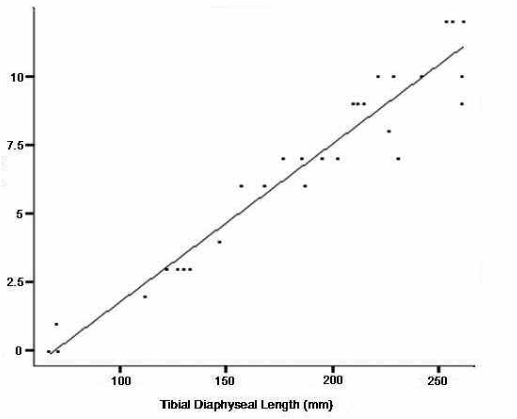

Figure 4. Regression analysis for age by tibia diaphyseal length.

Table 3. Regression Equation by Bone for Age Estimation.

Bone	*N*	Equation	r^2
Femur	77	Age = –3.92 + .05 (diaphyseal length) ± .793	.95
Humerus	40	Age = –4.91 + .07 (diaphyseal length) ± .768	.95
Tibia	31	Age = –3.97 + .06 (diaphyseal length) ± .930	.93

the region, which may at times leave bone length as the only employable age indicator for certain individuals. Age estimation using this method, however, must be undertaken with recognition of the fact that growth is greatly subject to diet and disease dynamics; furthermore, even under the best health circumstances, notable variability in long bone length among individuals of the same age will exist.

The regression equations presented here have limitations in that they are based on data from only one population, and thus the subsistence pattern, cultural practices, and environmental setting that shaped the growth of its members cannot be said to be representative of those affecting all Mesoamerican populations; researchers need to be aware of how populations under study may vary from Tipu in these aspects and how such variation might affect growth. However, it is argued that the equations in general will provide more reliable age estimates than use of the other growth models currently available, all of which are based on data from prehistoric populations from North America. The individuals from Tipu reflect not only the comparably shorter stature of Central Americans in general but also differences in long bone proportions. Differences in genetic backgrounds and subsistence practices also likely would have reduced the reliability of existing standards. Thus, not only do these age estimation regression equations constitute a valuable tool for bioarchaeologists studying the ancient Maya, but they arguably may be applied to other prehistoric Mesoamerican populations as well.

Acknowledgments. We would like to thank Mark N. Cohen (State University of New York–Plattsburgh) for use of the Tipu collection. We are also grateful to Lori Wright (Texas A&M) for sharing her data from Tikal and Elizabeth Brumfiel (Northwestern) for access to the Xaltocan collection. Thanks as well are given to Vera Tiesler Blos and our anonymous reviewers for their valuable comments and suggestions.

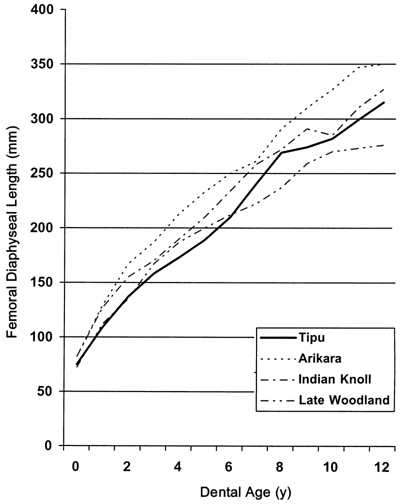

Figure 5. Comparison of Tipu unsmoothed model growth curve for femur with femoral unsmoothed growth curves for other ancient North American populations.

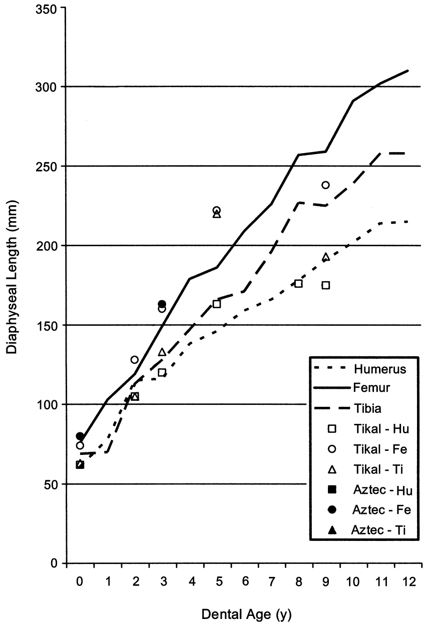

Figure 6. Caption needed.

Table 4. Results of Regression for Each Individual in the Tipu Collection.

Burial Number	Age (yr)	Femur Length (cm)	Predicted Age from Femur Length (yr)	Error in Predicting Age Using Femur Length	Rounded Predicted Age from Femur Length (yr)	Rounded Error in Predicting Age Using Femur Length
459	0	70	–.52706	.52706	0	0
443	0	75	–.28501	.28501	0	0
546	0	75	–.28501	.28501	0	0
155B	0	76	–.2366	.2366	0	0
470	0	80	–.04295	.04295	0	0
103	0	82	.05387	–.05387	0	0
449	1	81	.00546	.99454	0	–1
435	1	97	.78003	.21997	1	0
160	1	101	.97367	.02633	1	0
209a	1	105	1.16731	–.16731	1	0
433	1	112	1.50619	–.50619	2	1
432	1	122	1.9903	–.9903	2	1
251	2	112	1.50619	.49381	2	0
538	2	115	1.65142	.34858	2	0
14a	2	123	2.03871	–.03871	2	0
291	2	125	2.13553	–.13553	2	0
266	3	120	1.89347	1.10653	2	–1
388	3	122	1.9903	1.0097	2	–1
386	3	142	2.95851	.04149	3	0
346	3	142	2.95851	.04149	3	0
458	3	145	3.10374	–.10374	3	0
170	3	147	3.20056	–.20056	3	0
521	3	147	3.20056	–.20056	3	0
505	3	150	3.34579	–.34579	3	0
485	3	153	3.49103	–.49103	3	0
431	3	157	3.68467	–.68467	4	1
69b	3	158	3.73308	–.73308	4	1
457	3	162	3.92672	–.92672	4	1
430	3	163	3.97513	–.97513	4	1
445	3	178	4.70129	–1.70129	5	2
506	4	175	4.55606	–.55606	5	1
195	4	175	4.55606	–.55606	5	1
451	4	188	5.1854	–1.1854	5	1
329	5	175	4.55606	.44394	5	0
501	5	177	4.65288	.34712	5	0
25	5	185	5.04017	–.04017	5	0
411	5	193	5.42745	–.42745	5	0
162	5	202	5.86315	–.86315	6	1
478	6	180	4.79812	1.20188	5	–1

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Table 4 (continued). Results of Regression for Each Individual in the Tipu Collection.

Burial Number	Age (yr)	Femur Length (cm)	Predicted Age from Femur Length (yr)	Error in Predicting Age Using Femur Length	Rounded Predicted Age from Femur Length (yr)	Rounded Error in Predicting Age Using Femur Length
139	6	180	4.79812	1.20188	5	–1
41	6	193	5.42745	.57255	5	–1
434	6	195	5.52428	.47572	6	0
475	6	200	5.76633	.23367	6	0
181	6	225	6.9766	–.9766	7	1
322a	6	226	7.02501	–1.02501	7	1
487	6	227	7.07342	–1.07342	7	1
517	6	255	8.42892	–2.42892	8	2
382	7	192	5.37904	1.62096	5	–2
397	7	215	6.49249	.50751	6	–1
132D	7	219	6.68613	.31387	7	0
398	7	223	6.87977	.12023	7	0
392	7	224	6.92819	.07181	7	0
125	7	225	6.9766	.0234	7	0
548	7	248	8.09004	–1.09004	8	1
127	7	260	8.67097	–1.67097	9	2
416	8	257	8.52574	–.52574	9	1
530	9	241	7.75117	1.24883	8	–1
30	9	247	8.04163	.95837	8	–1
339	9	250	8.18686	.81314	8	–1
212	9	265	8.91302	.08698	9	0
359	9	268	9.05825	–.05825	9	0
68	9	270	9.15508	–.15508	9	0
143	10	284	9.83283	.16717	10	0
401	10	284	9.83283	.16717	10	0
509	10	285	9.88124	.11876	10	0
281	10	290	10.12329	–.12329	10	0
396	10	296	10.41375	–.41375	10	0
464	10	305	10.84945	–.84945	11	1
408	11	273	9.30031	1.69969	9	–2
482	11	305	10.84945	.15055	11	0
494	11	313	11.23674	–.23674	11	0
276	11	315	11.33356	–.33356	11	0
477	12	293	10.26852	1.73148	10	–2
63b	12	310	11.0915	.9085	11	–1
381	12	312	11.18832	.81168	11	–1
265	12	313	11.23674	.76326	11	–1
79	12	320	11.57561	.42439	12	0

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Table 5. Comparison of Dental Age and Long Bone Diaphyseal Age Predicted Using Model Curves in Figure 1 for Juveniles from Selected Prehistoric Mesoamerican Sites.

Individual	Bone	Diaphyseal Length (mm)	Dental Age (yr)	Predicted Age (yr)	Difference
Maya					
Tikal PNT-174B	Humerus	61	0	0	0
Tikal PNT-153	Humerus	112	2	2	0
Tikal PNT-117	Humerus	106	2	2	0
	Femur	128	2	2	0
	Tibia	105	2	2	0
Tikal PTP-PD152	Humerus	161	4	6	2
	Femur	211	4	6	2
	Tibia	196	4	7	3
Tikal PNT-180	Humerus	164	5	7	2
	Femur	222	5	7	2
Tikal PTP-160B	Humerus	176	7	7–8	<1
Tikal PTP-201	Humerus	257	9–10	>12	>2
Chican Tikal Rescate	Humerus	120	3–4	3	< –1
	Femur	160	3–4	3–4	0
	Tibia	133	3–4	2–3	–1
Dos Pilas Bu 14	Femur	219	5	7	2
Aztec					
Xaltocán G 19-20	Humerus	62	0	0	0
	Femur	79	0	0	0
	Tibia	62	0	0	0
Xaltocán Op G-4	Humerus	72	.5–.75	.5	< –.25
	Femur	84	.5–.75	0	< –.75
	Tibia	70	.5–.75	0	< –.75
Xaltocán Op C-5	Humerus	126	2–3	2	<1
	Femur	164	2–3	3–4	1
	Tibia	139	2–3	3–4	1
Xaltocán Town D	Humerus	135	4	4	0
Xaltocán Bu Str 37	Humerus	172	5	8	3
	Femur	239	5	7	2
	Tibia	188	5	6–7	1–2
Xaltocán Town C	Humerus	147	5–6	5–6	0

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