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THE PHYSICAL ANTHROPOLOGY OF CHIGGERVILLE: BIOLOGICAL RELATIONSHIPS AND GROWTH

by

Larry M. Wyckoff

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
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Larry Michael Wyckoff

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CHAPTER I

INTRODUCTION

The Chiggerville mound was located on the west side of the Green River in Ohio County, Kentucky. It was one of a number of shell mounds located along the Green River, with the Indian Knoll site located about three miles downstream on the same side of the river.

The Chiggerville shell midden was approximately 200 feet long east and west and about 100 feet wide north and south. The maximum elevation above the bottom land was 7 feet (Webb and Haag, 1939). Excavations began at the site in April 1938, with a grant from the Works Progress Administration.

A total of 114 human and 12 dog burials were found. Of these human burials, the majority were in a fully flexed position placed in round burial pits. Some partially flexed and one extended burial were also found. Most of the skeletal material was very fragmentary and in a poor state of preservation, with those burials near the surface of the mound being somewhat incomplete and intermixed due to cultivation and the activities of pot hunters.

In addition to the burials, 53 features were uncovered; the majority of those (48) were fire places. Other features included 2 caches of large flint flakes; 1 cache of hickory nuts; 1 cache of mortar and pestles; and 1 concentration of small gastropod shells.

Only 35 of the 114 burials had any associated artifacts. The majority of the artifacts consisted of shell beads, shell pendants, and drilled animal teeth. Other artifacts occurring to a lesser degree were: turtle carapaces, paired mussel shells, columella shell pins, shell "atlatl weights", a bone pendant, bone awls, bone beads, stone "atlatl weights", stone beads, and red ocher. Artifacts occurred more frequently with sub-adult burials than with adult burials (Webb and Haag, 1939).

The purpose of this paper is twofold; the first part will examine the biological relationships that existed between Chiggerville and certain other populations in the Eastern Woodlands area; and the second part will discuss the uses of skeletal populations for the study of human growth.

This paper will serve primarily as a supplement to the preliminary analysis on the Chiggerville population done by Skarland (Webb and Haag, 1939). And in addition, the chapter on growth will discuss the role skeletal populations can play in the study of human growth.

CHAPTER II

BIOLOGICAL RELATIONSHIPS

Introduction

The purpose of this study is to determine what biological relationships exist between the Chiggerville population and certain other Archaic, Early Woodland, and Middle Woodland populations in the Eastern Woodlands area.

Materials and Methods

Comparisons were made using cranio-facial measurements to determine the biological relationships between Chiggerville and the other populations. In two comparisons, non-metric traits were also used.

The metric data for Chiggerville came from Skarland's measurements (Webb and Haag, 1939) and my own measurements on the same individuals. Data for the other populations came from the available literature. A total of 16 measurements were compared when possible. For some of the populations, not all of the 16 measurements were available. Shown below are the cranio-facial measurements used:

1. Maximum Length (L)
2. Maximum Breadth (B)
3. Minimum Frontal Breadth (MF)
4. Basion-Bregma Height (H)
5. Auricular Height (AH)

6. Bizygomatic Breadth (BZ)
7. Upper Facial Height (UFH)
8. Basion-Prosthion Length (BP)
9. Nasal Height (NH)
10. Nasal Breadth (NB)
11. Orbital Height (OH)
12. Maxillo-Alveolar Length (MAL)
13. Maxillo-Alveolar Breadth (MAB)
14. Symphysis Height (SH)
15. Bigonial Breadth (BGB)
16. Minimum Breadth of Ascending Ramus (MBR)

The metric data were analyzed through the use of profile patterns which consider differences and similarities due to shape rather than size (Garn, Lewis and Walenga, 1968). Each variable was transformed into T-scores having a mean of 50 and a standard deviation of 10.

The calculation of the T-scores was made on a desk calculator using the formula:

$$T = \frac{10(X_{i1}-\bar{X}_i)}{\bar{S}_i} + 50$$

where X_{i1} = the mean value of variable i in population 1;

$\bar{X}_i$ = the mean value of variable i in all populations;

and $\bar{S}_i$ = the mean standard deviation of variable i in all populations (Wilkinson, 1971).

A large reference population of over 1200 adult male and female individuals was compiled from data taken from the available literature for numerous sites in the Eastern Woodlands area. This reference population (the data are shown in Appendix A) included the following sites: Indian Knoll (Snow, 1948), Chiggerville (Webb and Haag, 1939), Eva (Lewis and Lewis, 1961), Norton, Knight, Pete Klunk, Frederick, Snyders, Steuben, Bussinger, Juntunen, Young, Backlund (Wilkinson, 1971), Fort Wayne (Wilkinson, 1968), the Fort Ancient populations reported by Robbins and Neumann (1972) and the Red Ocher, Glacial Kame and Old Copper series from Robbins (1963). The 16 cranio-facial variables for the population comparisons were expressed as T-scores in relation to this reference population.

The degree of similarity of patterning of two populations was determined by calculating the product-moment correlation coefficient (r_T) using the formula:

$$r_T = \frac{S(xy)}{\sqrt{(Sx^2)\ (Sy^2)}}$$

where S = sum, and x and y are the deviations from the mean T-score in two populations, x and y (Wilkinson, 1971).

Although this profile pattern method indicates relationships based on shape rather than size, the T-scores are not entirely independent of size. The more a population deviates from the mean measurement, the higher or lower will be the T-score relative to 50. The T-score, then, reflects the extent of pattern similarity regardless of absolute size (Wilkinson, 1971). The product-moment correlation coefficient value is based on the summation of relationships of several measurements and may be considered an estimation of shape, instead of size, to the extent that it evaluates two populations on the basis of the direction of their deviancy from the mean, and not the magnitude of the deviancy. In this way a measurement for which two groups have means which are both greater or lower than the total mean will add a positive increment to the value of r_T. Thus, a positive r_T value indicates similarity while a negative value indicates dissimilarity.

Significance of an observed correlation can be calculated using the following formula for t and then finding the associated probability in a table of t values:

$$T = \frac{r_T}{\sqrt{1-r_T^2}} \quad .n'-2$$

where n' = the number of pairs of observations on which the correlation is based (Fisher, 1970).

The n' value must be converted to n when using the t tables. This is accomplished by subtracting 2 from n' such that $n = n'-2$.

Comparisons

The Chiggerville site was compared to the Eva and Indian Knoll sites and to a series of Old Copper, Glacial Kame, Red Ocher, Kentucky Adena and Ohio Hopewell burials. Griffin (1967) assigns the Eva site to the Middle Archiac period which is arbitrarily placed in the time period between 6000 and 4000 B.C. Indian Knoll and Old Copper were assigned to the Late Archiac period (4000-1000 B.C.) by Griffin, with the Red Ocher and Glacial Kame material assigned to the same period by Fitting (1970). Quimby (1952) felt that the Glacial Kame material may belong to the Early Woodland period. The Kentucky Adena was assigned to the Early Woodland period and the Ohio Hopewell to the Middle Woodland period by Griffin.

The comparative data for the Eva site came from Lewis and Lewis (1961). The data used were those measurements taken on 27 males from the pooled Big Sandy, Three Mile and Eva components. Data for Indian

Knoll came from Snow's report (1948). The Red Ocher, Glacial Kame, and Wisconsin Old Copper series came from Robbins (1963), and the Adena and Ohio Hopewell from Webb and Snow (1945).

Results

Figures 1 through 7 illustrate the T-score profile patterns for the comparison of Chiggerville to the 7 other skeletal populations. These patterns provide a visual indication of the overall similarities between Chiggerville and each of the other series, and are useful in illustrating where the differences or similarities lie in terms of the variables involved.

Shown below are the T-score correlation coefficients for the 7 comparisons along with the associated probability that the calculated correlation should arise, by random sampling, from an uncorrelated population. A probability of .05 or less is considered significant.

Chiggerville-Indian Knoll	.587	.02
Chiggerville-Eva	.304	.40
Chiggerville-Red Ocher	-.478	.10
Chiggerville-Glacial Kame	.111	.80
Chiggerville-Old Copper	-.399	.20
Chiggerville-Adena	.544	.05
Chiggerville-Hopewell	-.329	.30

A positive correlation indicates similarity; but only 2 are significant at the .05 level, these being the comparisons between Chiggerville and Indian Knoll and the Kentucky Adena. Chiggerville does not appear to be similar to the Red Ocher, Old Copper or Ohio Hopewell populations.

The relationships implied by the r_T values shown above are based on the total number of variables recorded, and thus do not reflect differences or similarities within particular regions of the skull, except as these regions influence the final r_T value. Hence, a great difference in one variable can mask similarities in several other variables, or vice versa (Wilkinson, 1971). The use of profile patterns provides a solution to this problem as the relationship between 2 series is illustrated for each variable. When the T-score for both series falls on the same side of the T=50 line, the value of r_T is increased positively; and decreased when the T-score for any variable falls on opposite sides of the T=50 line. A T-score of 50.0 for any variable in either series neither increases nor decreases the value of r_T (Wilkinson, 1971). Figures 1 through 7 illustrate the profile patterns for each of the 7 comparisons.

Figure 1 (p. 9) illustrates the profile pattern for the Chiggerville-Indian Knoll comparison. The majority of the variables for Chiggerville lie on the same side of the T=50 line as do the corresponding variables for Indian Knoll. This accounts for the high r_T value. The differences between the 2 series that lower the value of r_T lie with the following variables: maximum length (L), bizygomatic breadth (BZ), basion-prosthion length (BP), and minimum breadth of ascending ramus (MBR). The differences in nasal breadth between the 2 series do not affect the value of r_T because the T-score for the Chiggerville series is 50.0.

Figure 2 (p. 10) illustrates the Chiggerville-Eva profile pattern. No measurements were available for the palate and manidble for the Eva

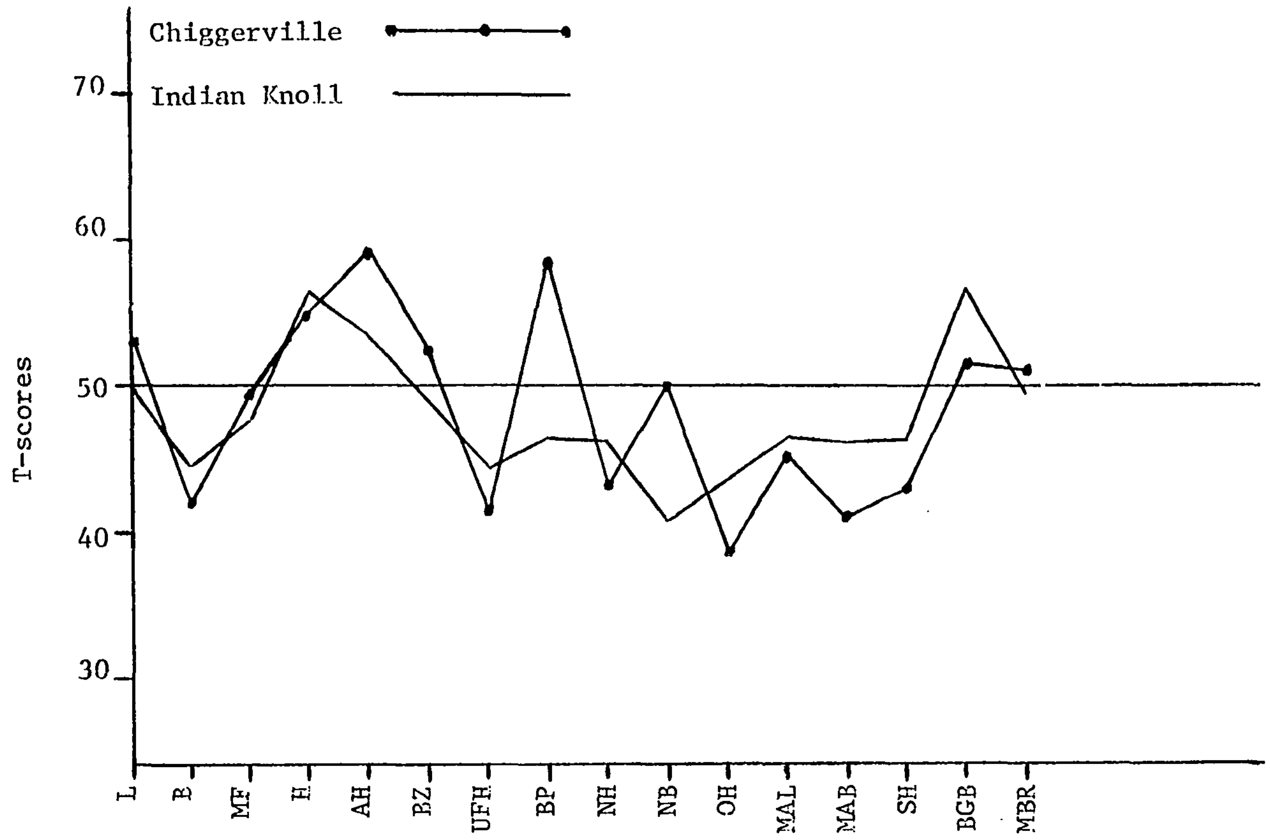

Figure 1. Chiggerville-Indian Knoll Profile Pattern(r_T = .587)

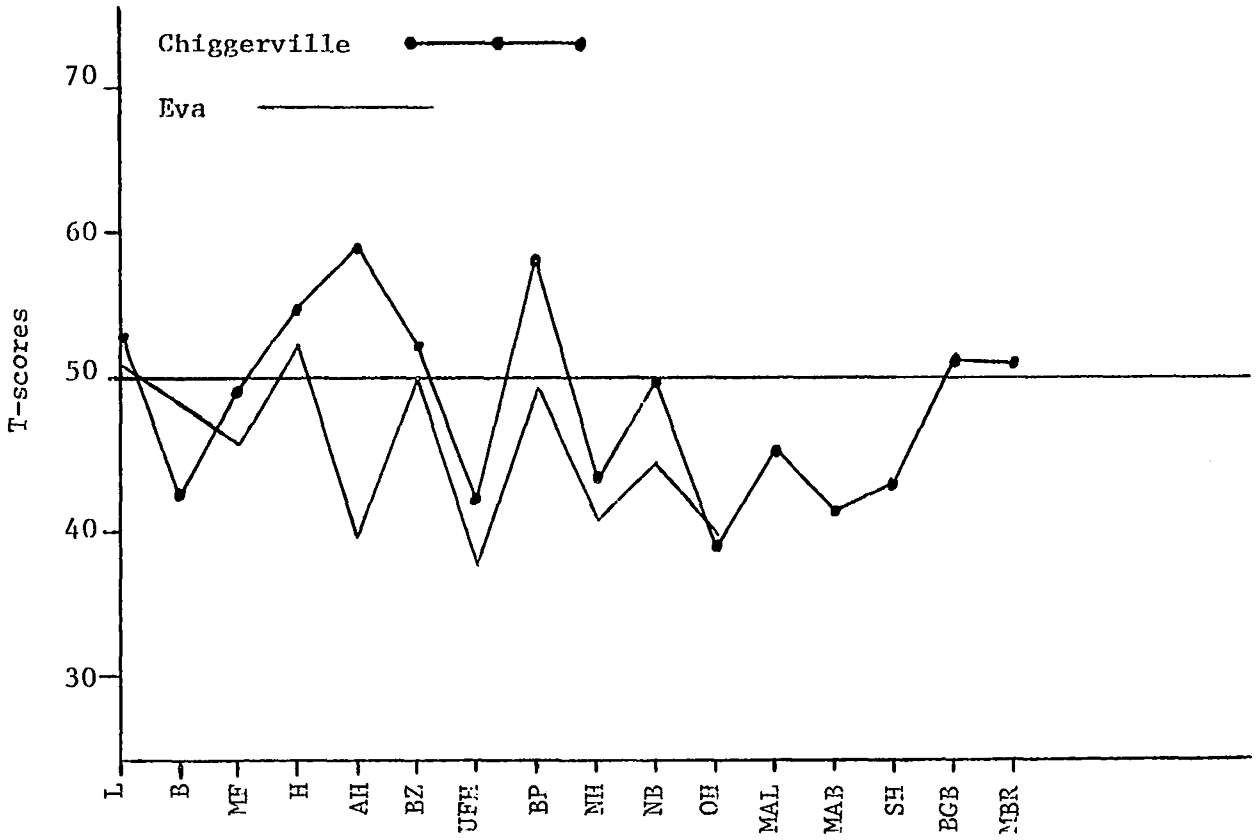

Figure 2. Chiggerville-Eva Profile Pattern (r_T = .304)

population. This leaves only 11 variables to base the comparison on and may not be enough for an accurate comparison. In any case, the r_T value indicates a similarity between the 2 series. As shown in Figure 2, the largest differences occur in auricular height (AH) and basion-prosthion length (BP). The large difference in auricular height between the 2 populations may mask the similarities present in the other variables by lowering the value of r_T.

The Chiggerville-Red Ocher profile pattern is shown in Figure 3 (p. 12). The dissimilarity shown by the negative r_T is clearly presented in Figure 3. Similarities do occur in maximum length (L), bizygomatic breadth (BZ), maxillo-alveolar breadth (MAB), bigonial breadth (BGB), and minimum breadth of ascending ramus (MBR) which tend to increase the value of r_T. It appears that no biological relationship exists between Chiggerville and the Red Ocher series.

The profile pattern for Chiggerville and Glacial Kame is shown in Figure 4 (p. 13). Within this series, 7 variables (B, MF, H, NH, OH, MAB, and MBR) contribute positively to the correlation; 6 variables (L, BZ, UFG, MAL, SH, and BGB) contribute negatively; and 1 (NB) has no effect on the correlation because the T-score for nasal breadth in the Chiggerville population is 50.0. As with the Red Ocher and Old Copper series, 2 variables (AH and BP) had to be omitted because of the lack of data on these measurements. Because of the low positive value and nonsignificance of the correlation, its relationship with Chiggerville cannot be stated.

Figure 5 (p. 14). illustrates the profile pattern for Chiggerville and the Old Copper series. The variables producing a negative

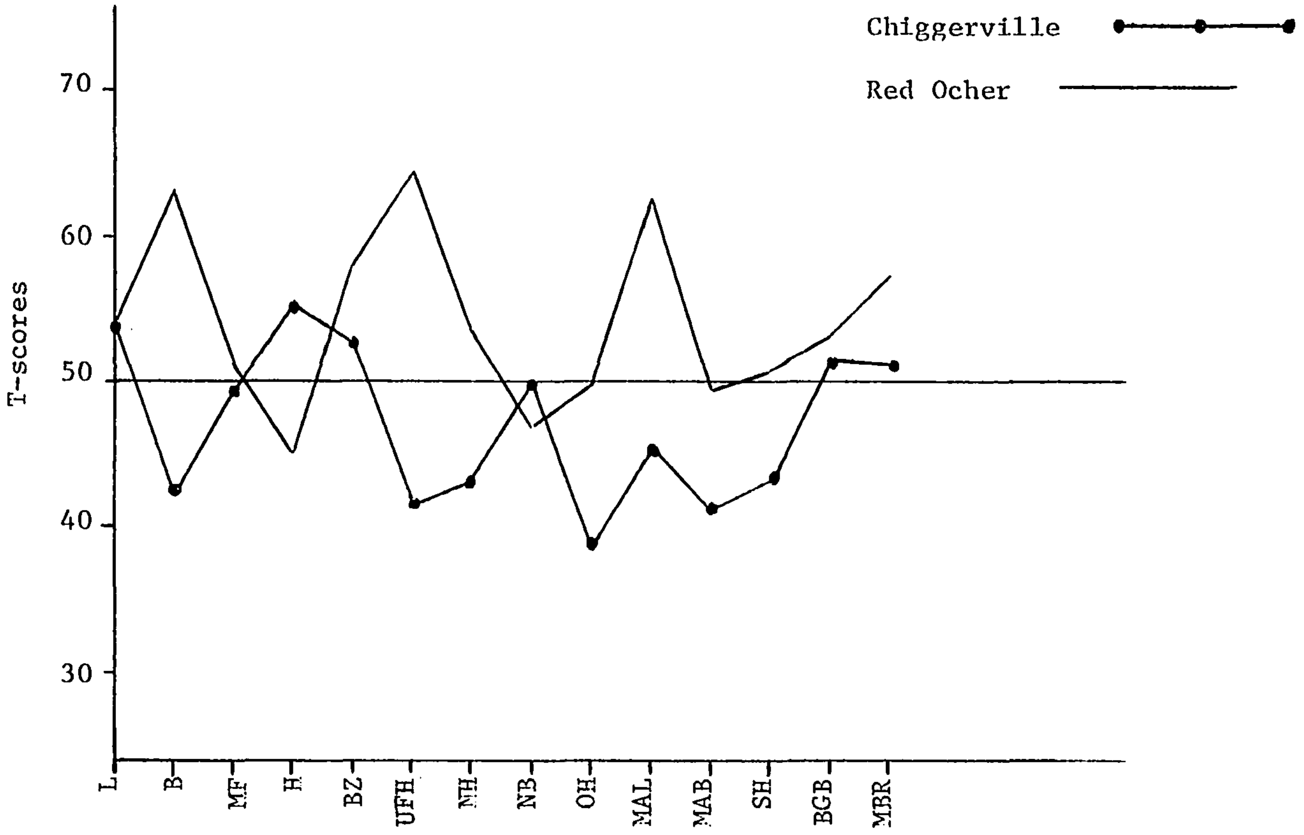

Figure 3. Chiggerville-Red Ocher Profile Pattern ($r_T = -.478$).

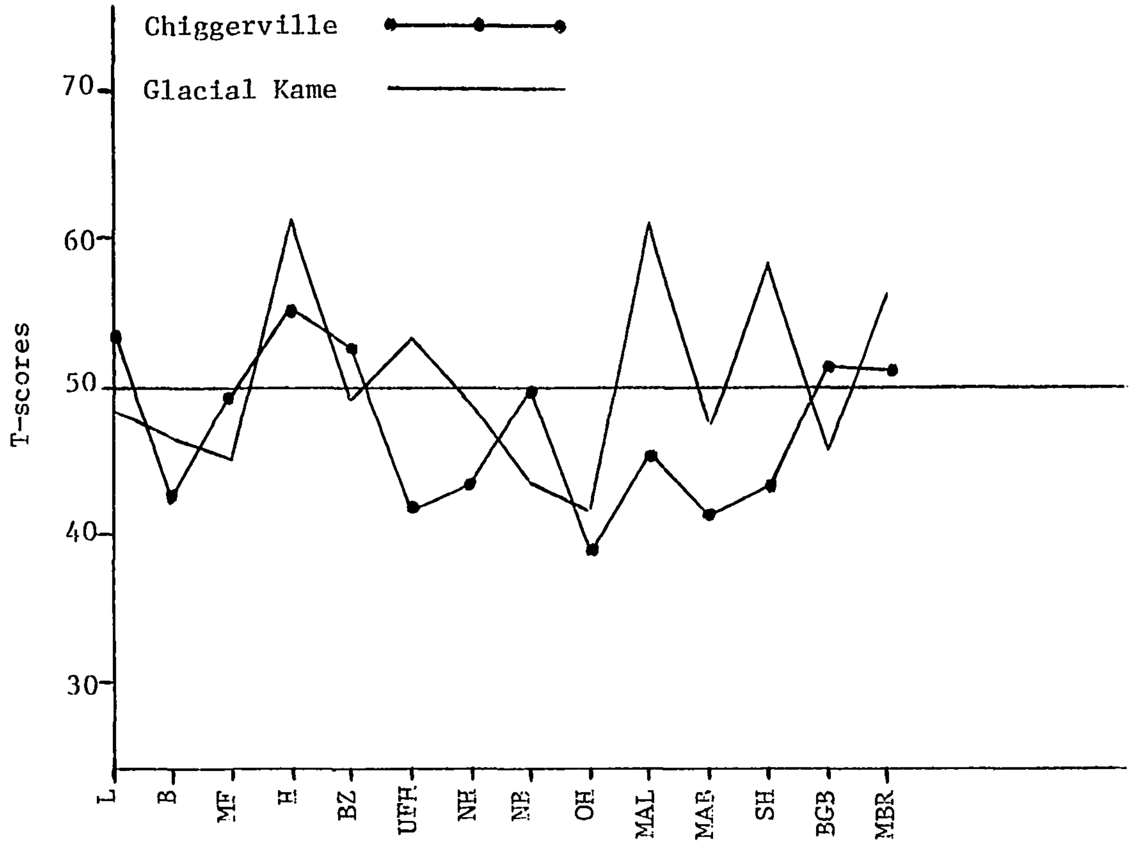

Figure 4. Chiggerville-Glacial Kame Profile Pattern (r_T = .111)

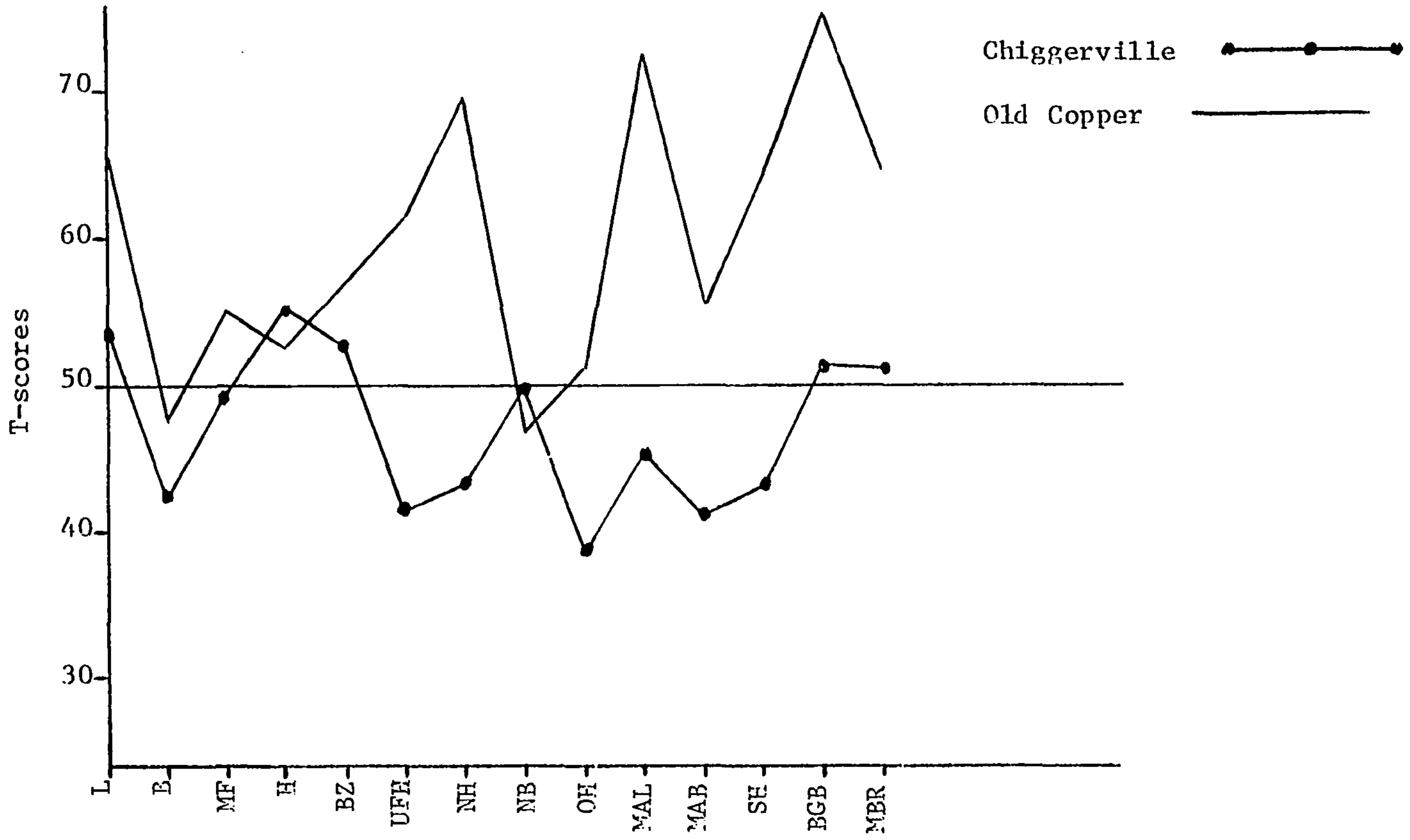

Figure 5. Chiggerville-Old Copper Profile Pattern (r_T = -.399)

correlation occur mostly in the facial region and palate while the similarities are in the vault area. The negative r_T value indicates a dissimilarity between the 2 populations.

The Chiggerville-Adena profile pattern illustrated in Figure 6 (p. 16) shows a significant ($p=.05$) similarity between the 2 populations. The differences between the 2 series occur in maximum length (L), maximum breadth (B), bizygomatic breadth (BZ) and maxillo-alveolar length (MAL).

Illustrated in Figure 7 (p. 17) is the profile pattern for the Chiggerville-Ohio Hopewell populations. The negative correlation, although the differences are not significant at the .05 level, does suggest a marked dissimilarity between the 2 populations. These dissimilarities occur throughout the skull regions, but are more numerous in the facial area. Similarities do occur in 7 out of the 16 variables (L, H, AH, BZ, BP, BGB, and MBR), but it is not only that differences occur in variable value that causes the negative value of r_T; but that the differences are large when present.

Data on non-metrical variants of the skeleton are available for only 2 of the above 7 populations. The study of biological relationships based on non-metric variants is discussed below.

The Use of Non-metric Variants in Skeletal Studies

The use of non-metric variants in the skeleton for the study of biological relationships between populations has increased in frequency and importance since the earlier studies by Laughlin and Jørgensen (1956) and Brothwell (1959).

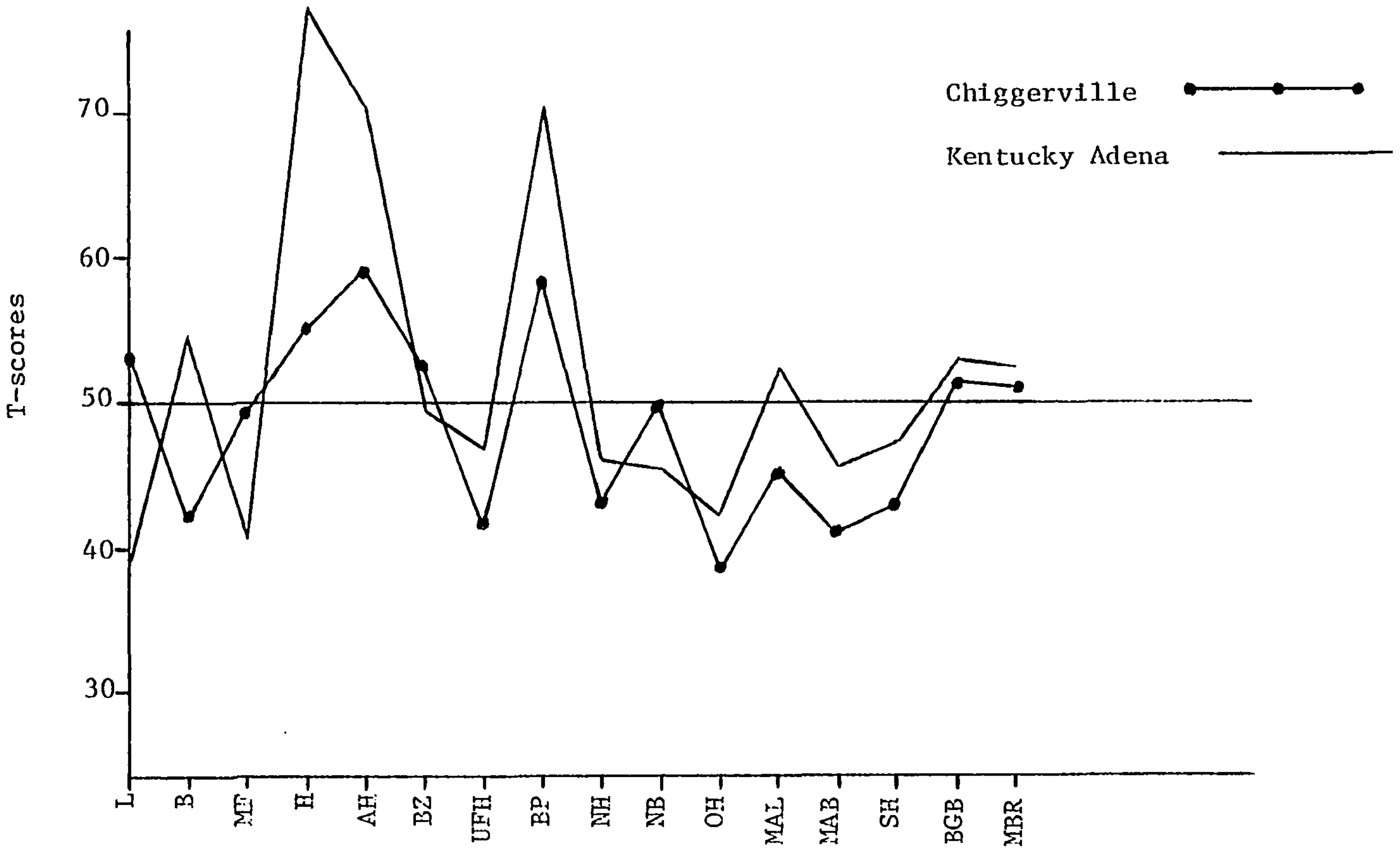

Figure 6. Chiggerville-Adena Profile Pattern (r_T = .544)

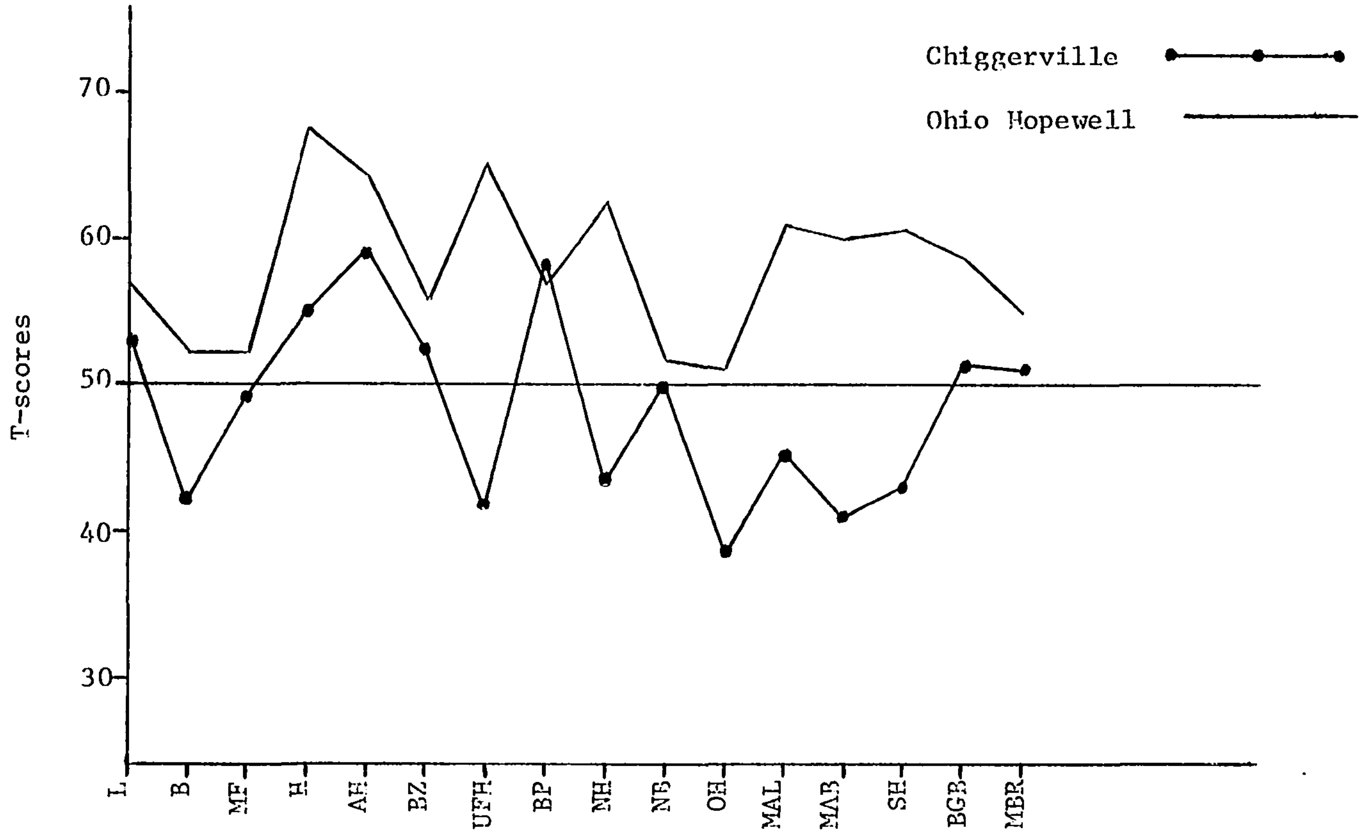

Figure 7. Chiggerville-Ohio Hopewell Profile Pattern (r_T = -.329)

The justification for discrete trait analysis lies with the major assumption that these traits are highly genetic in nature. Although much more precise evaluation of non-genetical factors is needed, Berry's study (1975) suggests that genetical factors, although far removed from the final anatomical detail, are the major determinants of variant expression and therefore provide a valuable genetical tool for physical anthropologists.

Corruccini (1974; 1976) questions the increased use of population comparisons based on non-metric traits to the exclusion of other methods and questions the assumptions underlying the use of non-metric variants. Corruccini found sex differences in trait frequencies for a number of traits as did Berry (1975) in a different study. Corruccini (1974) found an age dependency for a number of traits while Berry (1975) found only the trait "foramen of Huschke" to have a significant age dependency and states that

> It seems that age correlations need not be considered when dealing with adult material, with the possible exception of the foramen of Huschke; but caution is essential when prepubertal material is studied (1975:530).

Corruccini (1974) also found an intercorrelation between some traits and a small general influence exerted upon non-metric morphology by metrical variation of the human skull (Corruccini, 1976). Artificial cranial deformation has also been shown to affect the probabilities of occurrence of some minor non-metric variants, particularly wormian bones, by Ossenberg (1970). She recommends the exclusion of deformed skulls from population studies in which genetic divergence between groups is based on cranial trait frequencies.

Chiggerville Non-metric Variants

All adult, combined male and female, crania from Chiggerville were scored for 29 non-metric variants following the descriptions by Berry and Berry (1967), Brothwell (1959), Anderson (1969), Suchey (1975), and DeVilliers (1968). Also scored were 11 post-cranial variants. The incidence of these traits are shown in Appendices B and C.

Bilateral traits were scored for each side, but due to the fragmentary nature and incompleteness of this collection, a total number of individuals who possessed the trait, either on one side or both sides, is also included so that fragmentary individuals having only one side of a paired bone would not be excluded from the analysis.

To minimize the effect of age related variation in trait frequencies shown to exist by Corruccini (1974), only adult skulls exhibiting closure of the spheno-occipital synchondrosis were used. Both male and female individuals were pooled for the analysis because of the difficulty in sexing fragmentary remains; few significant sex related differences have been found, and it appears that the traits that show sex differences vary with different populations. For the purpose of this study, bilateral variants were considered not to be correlated with respect to sides of the body, and scoring was done on an individual basis in such a way that if a trait was present on one side or the other or both sides, it was scored as present. This procedure prevents the doubling of the sample size for bilateral traits when scoring each side separately.

Comparisons

Data on non-metric variants were available for Indian Knoll (Snow, 1948) and Kentucky Adena (Webb and Snow, 1945) only. It is also these 2 populations which have been shown by the previous metrical comparisons to be significantly related to Chiggerville. It will be interesting to see if the comparisons based on non-metric data substantiate the results shown by the metrical data.

Statistical Methods

A measure of divergence between the 2 populations was determined using Berry and Berry's (1967) statistical approach modified with suggestions from Sjøvold (1973). The measure of divergence 'X' between 2 populations is taken as:

$$X=(\theta_1-\theta_2)^2-(1/n_1+1/n_2)$$

for any character where θ is the angular transformation of the percentage incidence (p) of the same variant in 2 samples measured in radians, such that

$$\theta=\sin^{-1}(1-2p)$$

and n is the population size for the character in population 1 or 2. When extreme proportions are observed, i.e. $p=0$ or $p=1$, Sjøvold (1973) suggests using Bartlett's Adjustment to obtain further variance stabilization, $p=0$ being replaced by $p=1/4N$ and $p=1$ by $p=1-1/4N$, where N is the actual number of observations.

The variance of X is calculated by the formula

$$\text{var}X=2(1/n_1+1/n_2)^2$$

as suggested by Sjøvold. All measures of divergence are summed and the sum is divided by the number of variants to obtain a mean measure of divergence. To obtain the variance of the mean measure of divergence, the sum of single variances must be divided by the square of the number of variants. The standard deviation is obtained by taking the positive square root of the variance of the mean measure of divergence, or by dividing the positive square root of the sum of single variances by the number of variants.

The mean measure of divergence obtained this way may be regarded as significant at the .05 probability level when it is greater than twice its standard deviation.

When variances of single variants are considered to be too high or if the proportions of some variants are based on too few observations compared with the other variants, they should be left out of consideration when the mean measure of divergence is calculated (Sjovold, 1973).

Results

Chiggerville was compared to Indian Knoll using 7 cranial traits and 7 post-cranial traits. The data for Indian Knoll were the pooled data for adult males and females. Data on Chiggerville femurs came from Webb and Haag's report (1939). The variants along with their X value and variance of X are shown in Table 1 (p. 22).

The variant "suprascapular foramen" was not used in the calculation of the mean measure of divergence because of the high variance associated with this trait. Its variance, if included, would have been equal to more than one half of the total variance of all 14 traits. Using 13 variants gave a mean measure of divergence of 0.0986 and a

Table 1

Chiggerville-Indian Knoll Variants

Variant	X	varX
Metopism--complete	-0.0248	0.0012
Auditory exostosis	-0.0131	0.0008
Parietal foramen	-0.0085	0.0020
Lambdoid ossicle	0.0496	0.0034
Foramen of Huschke	0.1212	0.0010
Ossicle at lambda	0.1036	0.0020
Mandibular torus	0.9191	0.0008
Septal aperture	0.0216	0.0008
Suprascapular foramen	-0.1160	0.0288
Squatting facets	-0.0295	0.0028
Calcaneus: anterior-middle facets discrete	0.0117	0.0010
Femur: third trochanter	0.2079	0.0030
Femur: crista hypotrochanterica	-0.0524	0.0056
Femur: fossa hypotrochanterica	-0.0242	0.0030

standard deviation of 0.0254. Since the mean measure of divergence is greater than twice its standard deviation, Indian Knoll can be considered significantly similar to Chiggerville at the .05 probability level.

Chiggerville was compared to Adena using 4 cranial variants and 6 post-cranial variants. The data for the Kentucky Adena population was the pooled male and female data from Webb and Snow's (1945) report. Only 10 variants could be extracted from the report that were comparable to the variants scored for Chiggerville; and it is likely that it was too small a sample to rely on for an accurate statistical assessment of the biological relationship between these 2 populations. The variants used and their associated X values and variances are shown in Table 2.

Table 2

Chiggerville-Adena Variants

Variant	X	varX
Metopism--complete	-0.0771	0.0148
Auditory exostosis	-0.0700	0.0110
Parietal foramen	0.4028	0.0146
Mandibular torus	0.1368	0.0122
Septal aperture	-0.0427	0.0036
Suprascapular foramen	-0.1610	0.0518
Squatting facets	0.0152	0.0076
Femur: third trochanter	0.0391	0.0066
Femur: crista hypotrochanterica	-0.0520	0.0090
Femur: fossa hypotrochanterica	-0.0220	0.0062

All variances were higher than those in the Chiggerville and Indian Knoll comparison; this was more than likely due to the small number of observations. Again, the trait "suprascapular foramen" was dropped because of its very high variance. Using only 9 traits, the mean measure of divergence was 0.0366 and its standard deviation was 0.0325. This meant that these 2 populations were not significantly similar at the .05 level. Although Adena was shown to be significantly similar to Chiggerville through the use of cranial measurements, it should be noted that too much weight should not be placed on the results using non-metric traits because of the small number of traits used, and the large variances encountered with a number of the traits. In this instance, I would consider the T-score data, which showed Adena to be significantly similar to Chiggerville, to be more correct.

Conclusions

The biological similarity shown to exist between Chiggerville and Indian Knoll, the Kentucky Adena and possibly Eva, because of Eva's high positive T-score, was further supported by the similarity in burial practices.

Although no radio-carbon dates exist for Chiggerville, it was assigned to the Late Archaic period (4000 to 1000 B.C.) based on its cultural similarity to Indian Knoll. The significant similarity between Chiggerville and Indian Knoll shown by cranial measurements and skeletal morphology was also reflected in the archaeological data. Both populations were buried in artificial mounds composed largely of shell refuse. The predominant interment mode was in the fully flexed position in round burial pits, although some partially flexed and extended burials also occurred. Caches of flint blades; associated dog burials; and some use of red ocher were found at both sites (Webb and Haag, 1939; Webb, 1946).

The Eva site is a 3 component site located in Benton County, Tennessee, and is believed to have been a single habitation area used over a period of several thousand years by the same people (Lewis and Lewis, 1961). The earliest component, the Eva Phase, is assigned to the Middle Archiac period by Griffin (1967) and Lewis and Lewis (1961), with the second component, the Three Mile component, assigned to the Late Middle Archaic and the third component Big Sandy, assigned to the Late Archaic period (Lewis and Lewis, 1961). Archaeologically, the Eva site was very similar to Chiggerville. Burial was in an artificial mound composed partially of shell refuse with all adult burials, with 2 exceptions, interred in a flexed position in circular burial pits. The heaviest concentration of shell content occurred in the Three Mile component. Some use of red ocher and some dog burials occurred in the Three Mile and Big Sandy components with dog bones found in the Eva component midden (Lewis and Lewis, 1961). An archaeological similarity between Chiggerville and Eva has also been shown to exist by Lewis and Kneberg (1959) through the use of trait list comparisons.

The significant similarity between Chiggerville and the Kentucky Adena populations shown to exist by cranial measurements was also reflected to some degree by the archaeological data, although some differences did exist. Temporally, the Adena was assigned to the Early Woodland period by Griffin (1967), a time period between 1000 to 2000 B.C. The use of artificial mounds for burial occurred; many of the individuals were buried in an extended position in burial pits that were occasionally lined with bark or logs. Secondary burials in the form of cremations and bundle burials were also present and there was some use of red ocher (Dragoo, 1963).

The populations showing the greatest dissimilarity to Chiggerville, shown by the negative T-scores, were the Red Ocher, Old Copper, and Ohio Hopewell series although none were significantly different at the .05 level.

The Red Ocher burial complex was centered in the Illinois region, with sites also occurring in Indiana, Michigan, Minnesota, Ohio, and Wisconsin (Dragoo, 1963). Red Ocher was assigned to the Late Archaic period by Fitting (1970) although the late Red Ocher may have extended into the Early Woodland period (Ritzenthaler and Quimby, 1962). The time period from 1500 B.C. to 100 B.C. is suggested by Ritzenthaler and Quimby (1962) for Red Ocher. The nuclear traits used to define the Red Ocher complex differ in many respects from the traits at Chiggerville. Red Ocher burials were usually flexed burials in pits dug into ridges of sand, gravel, or loess; powdered red ocher was found in the graves; and "turkey-tail" blades of blue-gray flint, large lanceolate ceremonial knives of whitish flint, caches of ovate-triangular points, presence of worked copper, and tubular marine shell beads were found associated with the burials. "Turkey-tail" blades, the large ceremonial blades, and the caches of ovate-triangular knives are regarded as diagnostic traits for the Red Ocher burial complex (Ritzenthaler and Quimby, 1962). Some Red Ocher burials were interred in artificial mounds and the use of cremation and bundle reburial have been found.

Some Red Ocher traits have appeared occasionally in some early Adena sites; but this is believed to represent a diffusion from Red Ocher to Adena (Ritzenthaler and Quimby, 1962).

The Old Copper burial complex appears to have had its center in the Wisconsin area. Three sites from Wisconsin provide most of the information used in defining the Old Copper complex; these are the Osceola site (Ritzenthaler, 1946), the Oconto site (Ritzenthaler and Wittry, 1952) and the Reigh site (Baerreis, et. al., 1954). Although Griffin (1967) assigns the Old Copper complex to the Late Archaic period, 2 radio-carbon dates of 5600 ± 400 B.P. and 7510 ± 340 B.P. from the Oconto site suggest that it may have extended into the Middle Archaic period.

The most distinctive trait of the Old Copper complex was the inclusion of copper artifacts with the burials. Burials were interred in sand or sand and gravel ridges bordering rivers or lakes. A variety of burial positions were used - bundle, partially flexed, fully flexed, and extended. The predominant method was bundle-reburial in single or multiple interments. Partial cremations occurred at all 3 sites. Other associated material included chipped and ground stone artifacts, bone whistles and 1 dog burial reported from the Reigh site.

Archaeologically, the Middle Woodland Ohio Hopewell burial pattern shared more traits with Adena than with Chiggerville. Burial is in large artificial mounds with cremation being the predominant method used in early Hopewell shifting to inhumation in late Hopewell. Associated with the burials were elaborate ceremonial objects of copper, mica, and stone along with the distinctive Hopewell ceramics. Some log tombs also occurred (Prufer, 1964).

The relationship of the Glacial Kame series to Chiggerville was not clarified by the comparison of cranial measurements. Archaeologically, the Glacial Kame burial complex was somewhat unlike Chiggerville and was most similar to the Red Ocher complex, although Rolingson (1967) observed that artifacts included as grave goods in Glacial Kame burials were more similar to the Kentucky Archaic than they were to the Old Copper artifacts.

Glacial Kame shared the same nuclear traits with Red Ocher, with the addition of the presence of the sandal sole gorget of Gulf Coast marine shell in Glacial Kame sites (Ritzenthaler and Quimby, 1962). Glacial Kame burials seem to have had a more southerly distribution than the main Red Ocher concentration (Fitting, 1970).

Glacial Kame was considered to be contemporaneous with Red Ocher in the Late Archaic period (Fitting, 1970; Dragoo, 1963; Cunningham, 1948), but Quimby (1952) felt that Glacial Kame may belong to the Early Woodland period.

Glacial Kame burials generally occurred in pits dug into glacial outwash deposits. The majority of the burials were in a flexed position, but extended, partially cremated and bundle burials have been found. Associated artifacts were mainly ornamental rather than tools, consisting of copper awls, beads, gorgets, and bone and antler tools (Cunningham, 1948).

The biological and archaeological data have led me to believe that Chiggerville probably belongs to the same population found at the Indian Knoll site, and may also belong to the populations found at the other Green River shell mounds, although skeletal data on these populations were not available.

The similarity of the Eva components to Chiggerville may suggest population affinities between the Kentucky and Tennessee Archaic people, but the evidence is not conclusive. The significant similarity between the Chiggerville and the Kentucky Adena populations supports Dragoo's (1963: 1976) theory that the origin and development of the Adena burial complex can be traced back to Archaic groups indigenous to the area, as opposed to looking to Mesoamerica for the origins of the Adena people.

Although a few traits are shared between Chiggerville and the Ohio Hopewell and Glacial Kame, Old Copper and Red Ocher burial complexes, it seems that no close biological relationship exists between Chiggerville and these populations, although archaeologically, Glacial Kame and Red Ocher are somewhat similar to Chiggerville and Indian Knoll in burial artifacts (Rolingson, 1967).

CHAPTER III

GROWTH

Introduction

The study of human growth through the use of skeletal populations can yield significant information on secular trends in growth by adding a time dimension greater than what is presently available for studies on living people. Although typical growth studies on living peoples focus on height, weight, and time of adolescence, measurements of long bones from skeletal populations can provide information on linear growth which is analogous to stature in living populations. In addition to linear growth, growth rate and changes in proportion can also be studied from skeletal populations.

Problems Associated with Growth Studies Utilizing Skeletal Populations

Johnston (1968) describes some of the problems associated with the study of growth in skeletal populations:

1. Skeletal populations are generally numerically restricted and frequently temporally diffuse; and there is the problem of the unequal distribution of immature skeletons typically found among skeletal populations. The unbalanced mortality curve affects the distribution of immature skeletons available for study with a large portion of the immature skeletons being less than 1 year of age.

2. The assessment of age must be based on the observation of anatomical indicators in the skeleton; and at the present time, no accurate method exists for the determination of sex in prepubertal children.

3. Sub-adult skeletons available for study represent the individuals that failed to reach maturity. Infectious and genetic diseases, congenital anomalies, and various kinds of accidents are the major causes of death, with some more important to the study of growth than others.

Any illness that persists for long periods of time will affect the growth process by slowing it down (Tanner, 1962). This results in individuals with shorter bone lengths than healthy children of the same age. Diseases are classified as either acute or chronic depending on the duration of the illness. Those diseases that are acute would have less effect on growth than chronic diseases because of their short duration. The same holds true for causes of death other than disease. Any cause of death that occurs in a short period of time, such as accidents, would not result in abnormal bone growth. Most diseases are acute although some, such as leukemia, bronchitis, pneumonia, and tuberculosis, may be either acute or chronic. Those diseases that are usually chronic include diabetes mellitus and cirrhosis of the liver (Thomas, 1973).

The World Health Organization publishes statistics on causes of death in different age groups for many present day populations. These data can be used as a guide to examining the causes of death in earlier populations. Although some diseases present today, such as tuberculosis, were not present in aboriginal American Indian populations, the statistics can serve as a guide to the general classes of causes in different age groups.

Using Chile as a representative population, the greatest causes of death between birth and 1 year were the various forms of pneumonia, influenza, diahhroeal diseases, measles, avitaminoses and other nutritional deficiencies, genetic defects, congenital anomalies, birth injuries and difficult labor, conditions of the placenta and cord, haemolytic disease, various forms of accidents, and anoxic and hypoxic conditions (WHO, 1972). The majority of these causes would not have affected the growth rate because of their acute nature, although some genetic defects and congenital anomalies may have affected prenatal growth and thus the size of the infant at birth.

In the age group from 1 to 14 years, many of the above mentioned diseases were still taking their toll, but not as frequently. Infectious hepatitis, leukemia, meningitis, and rheumatic fever were more prevalent in this period than others, with accidents, particularly those caused by fire, also very common.

Between 15 and 34, tuberculosis of the respiratory system, various cancers, rheumatic heart disease, and cirrhosis of the liver were becoming prevalent, although they were more so in the later periods. This period includes the highest rate of suicides and self inflicted injuries and a high number of deaths caused by accidents. Many of the deaths caused by disease in these later periods were of a chronic nature, but since many of these individuals were fully grown at the time of death they would not have been used in growth studies; thus these diseases would not be significant.

In general, it would seem that most causes of death occurring throughout the growth period were of an acute nature, and thus would have had a minimal effect on the growth process.

Age Determination

To obtain the most accurate estimation of chronological age, an anatomical indicator should display the least amount of non-age related variability. The dentition meets this requirement better than any other indicator. Traditional dental age assessments were determined from the stage of eruption of the teeth for which Schour and Massler's (1941) "Development of the Human Dentition" chart was relied upon despite the availability of numerous other tooth eruption studies (Merchant, 1973). The reliability of Schour and Massler's chart has been questioned by Sundick (1972). The chart is based on a small sample and it is unlikely that the true range of variation can be determined from this small a sample. It is also unlikely that they were able to observe each stage of development of every tooth in the chart, making interpolation of some stages necessary.

The tooth formation standards of Moorrees, Fanning and Hunt (1963a, 1963b) were selected by Merchant (1973) for her growth study because their sample was one of the largest studied and the developmental standards were established for more teeth (13) than any other work. The formation standards show the mean age, the variation for each tooth, and are relatively easy to use. For these reasons, this method was also used to age the sub-adults at Chiggerville.

It must be kept in mind, however, that Moorrees, Fanning and Hunt's developmental standards were based on a white population which raises the question of their applicability for an aboriginal Indian population. Studies by Garn and Moorrees (1951) and Moorrees (1957) reported that Indian and Aleut posterior teeth tended to erupt earlier than those of whites. Merchant (1973) felt it was not feasible to compensate for the differences in applying the white standards to Indian populations, citing the following reasons:

> 1. instead of calcifying earlier, the Indian teeth may erupt at an earlier stage;
>
> 2. if the teeth do calcify earlier, the calcification of the crown and root may be consistently earlier; or
>
> 3. the earlier stages of calcification may be essentially the same between the Indian and white populations, with only the development of the later stages occurring more rapidly in the Indians (1973:21-22).

Merchant felt that the last possibility is the most likely, but goes on to say that studies that compare tooth eruption between Indians and whites found that the permanent second molar erupts consistently earlier among Indians. The use of the M_2 eruption based on whites would overage Indian skeletal material. For this reason, Merchant suggests not using M_2 whenever possible.

As Johnston (1969) pointed out, it is impossible to determine the chronological age of any individual with any precision at all. For any aging criterion used, the range of variation in the age at attainment is quite striking.

Individuals in the age group between birth and 1 year can usually be determined, and the presence of a fetus can also be determined. But after 1 year of age, I found the variation to be so great that individuals were assigned to 3-year age groups. Even then, some individuals overlapped 2 age groups and had to be subjectively assigned to 1 group or the other. Table 3 (p. 35) shows the age breakdown of the Chiggerville sub-adults.

Table 3

Age of Sub-adult Individuals at Chiggerville

Burial Number	Catalog Number	Age	Burial Number	Catalog Number	Age	Burial Number	Catalog Number	Age
2	15-2	15-20 yr	56	15-54	B-1 yr	85a	15-81	B-1 yr
3	15-3	1-3 yr	57	15-55	B-1 yr	85b	15-81	B-1 yr
7	15-7	1-3 yr	60	15-58	B-1 yr	88	15-83	F-B
8a	15-8	6-9 yr	63	15-60	1-3 yr	90	15-85	B-1 yr
8b	15-91	1-3 yr	64	15-61	3-6 yr	91	15-86	B-1 yr
8c	15-91	B-1 yr	67	15-64	B-1 yr	94	15-89	15-20 yr
17	15-17	F-B	68	15-65	9-12 yr	95	15-90	1-3 yr
19	15-18	B-1 yr	69	15-66	1-3 yr	96	15-91	B-1 yr
22	15-21	1-3 yr	70	15-67	1-3 yr	102	15-95	B-1 yr
23	15-22	3-6 yr	71	15-68	B-1 yr	105	15-98	B-1 yr
26	15-25	12-15 yr	72	15-69	B-1 yr	106	15-99	F-B
31	15-30	9-12 yr	74	15-71	B-1 yr	110	15-103	6-9 yr
33	15-32	3-6 yr	75	15-72	B-1 yr	111	15-104	6-9 yr
36	15-35	B-1 yr	80	15-76	B-1 yr	113	15-106	12-15 yr
37	15-36	B-1 yr	84	15-80	6-9 yr	124	15-113	6-9 yr
46	15-45	1-3 yr						

Growth Comparisons

The Kentucky Archaic populations represented by Chiggerville and Indian Knoll were compared to the protohistoric Arikara Indians and a population of modern white children.

The Chiggerville population contained 46 sub-adult individuals in varying stages of preservation and completeness. Of these 46 individuals, only 23 were complete enough to provide any bones for measurement. These measurements are shown in Appendix D. Because of the biological relatedness of Indian Knoll to Chiggerville shown in the previous chapter, these measurements were combined with measurements of 128 individuals from Indian Knoll taken by Sundick (unpublished data in the possession of the author) to increase the sample size. The Indian Knoll sub-adults were aged using Schour and Massler's (1941) standards. The means, ranges, and standard deviations for each group of the combined data are given in Table 4 (p. 37).

The Arikara skeletal material came from the Mobridge site (39WW1) in north-central South Dakota. The site was assigned to the protohistoric period - that period just after initial European contact (Merchant, 1973). Over 380 sub-adult individuals were recovered, but only 193 of the skeletons were found to be suitable for study by Merchant. Merchant broke her age groups into 1-year intervals - an interval I considered too narrow in light of the above discussion on dental aging standards and the wide range of variation present. The sub-adults were aged using 2 techniques, the dental standards of Moorrees, Fanning and Hunt, and Schour and Massler. Her age estimates using Moorrees, Fanning

Table 4

Chiggerville and Indian Knoll Bone Lengths in Millimeters

Age	Humerus	Radius	Ulna	Ilium	Femur	Tibia	Fibula
F-B							
n	10	9	8	9	9	7	6
Mean	65.4	53.5	61.4	34.1	77.2	68.0	65.8
Range	55.0-70.5	53.0-57.0	53.0-65.5	28.0-37.0	72.0-80.0	66.0-70.5	64.0-68.0
s.d.	4.31	3.41	3.98	2.59	2.18	1.61	1.57
B-1							
n	14	13	12	10	13	12	9
Mean	97.9	77.8	86.4	50.0	121.2	102.3	99.3
Range	79.0-116.0	64.0-91.0	72.0-102.0	42.5-61.0	94.5-154.0	81.5-128.5	76.5-124.0
s.d.	11.72	8.63	10.04	6.41	18.58	15.22	15.90
1-3							
n	24	16	20	22	25	22	14
Mean	124.4	98.5	109.0	64.3	161.4	134.5	129.5
Range	114.5-138.5	91.0-110.0	95.5-125.0	51.5-75.0	140.0-183.0	111.0-157.5	104.5-156.0
s.d.	8.40	5.87	6.99	5.38	12.80	12.36	12.59

Table 4 (Continued)

Age	Humerus	Radius	Ulna	Ilium	Femur	Tibia	Fibula
3-6							
n	15	13	11	7	16	14	12
Mean	149.9	115.2	126.5	75.8	200.0	166.1	162.5
Range	135.0-161.0	96.0-125.0	115.0-138.0	70.0-81.0	165.0-225.0	136.0-184.0	130.5-177.5
s.d.	8.73	8.55	8.32	4.29	18.09	15.63	15.30
6-9							
n	11	10	8	9	12	11	10
Mean	185.8	143.8	159.7	88.9	261.0	217.3	207.1
Range	164.0-205.0	128.0-154.0	143.5-170.0	84.5-96.5	229.0-287.0	192.0-244.0	183.0-221.0
s.d.	13.10	9.37	9.51	4.18	16.46	15.86	13.44
9-12							
n	14	11	14	11	13	14	11
Mean	211.3	166.4	182.6	100.6	303.6	247.5	243.6
Range	197.0-250.0	147.0-202.0	164.0-223.0	89.0-112.0	281.0-355.0	227.0-273.0	216.0-293.0
s.d.	12.48	15.75	15.27	7.56	23.19	22.87	25.69
12-15							
n	24	26	25	20	27	27	23
Mean	257.9	196.6	217.7	123.4	361.2	299.6	283.2
Range	209.0-299.0	157.0-226.0	172.0-242.0	101.0-139.0	291.0-407.0	234.0-351.0	233.0-326.0
s.d.	24.07	17.82	19.70	11.12	31.97	28.17	27.37

and Hunt's standards were used for the comparisons shown in Figures 8 through 13 (pp. 40-45).

The white population sample, taken from Maresh (1955), consists of measurements of long bones taken from roentgenograms of the left arm and leg of average healthy children. The values shown in the figures are the fiftieth percentile uncorrected radiogram lengths of long bones without epiphyses.

Discussion

The study of skeletal growth through time must, because of the nature of the data, be treated with caution. In addition to the many complex variables affecting growth, we are handicapped by the type of data available. We are dealing with a few unrelated populations; the data from the modern white population are based on healthy living individuals while the data from the aboriginal populations are from individuals who died; the inherent error in aging skeletal populations and the lack of a sexing technique all combine to exaggerate the differences between growth rates in the populations studied.

In spite of these difficulties, Figures 8 through 13 do show a trend in growth that may be meaningful. All graphs show that the rate of growth in the first 2 years of life is very similar for all populations. It is after this 2-year period that the growth rates vary. The growth rates after 2 years reflect the temporal position of the 3 populations with the oldest population, Kentucky Archaic, below that of the protohistoric Arikara, and the Arikara below the modern white population.

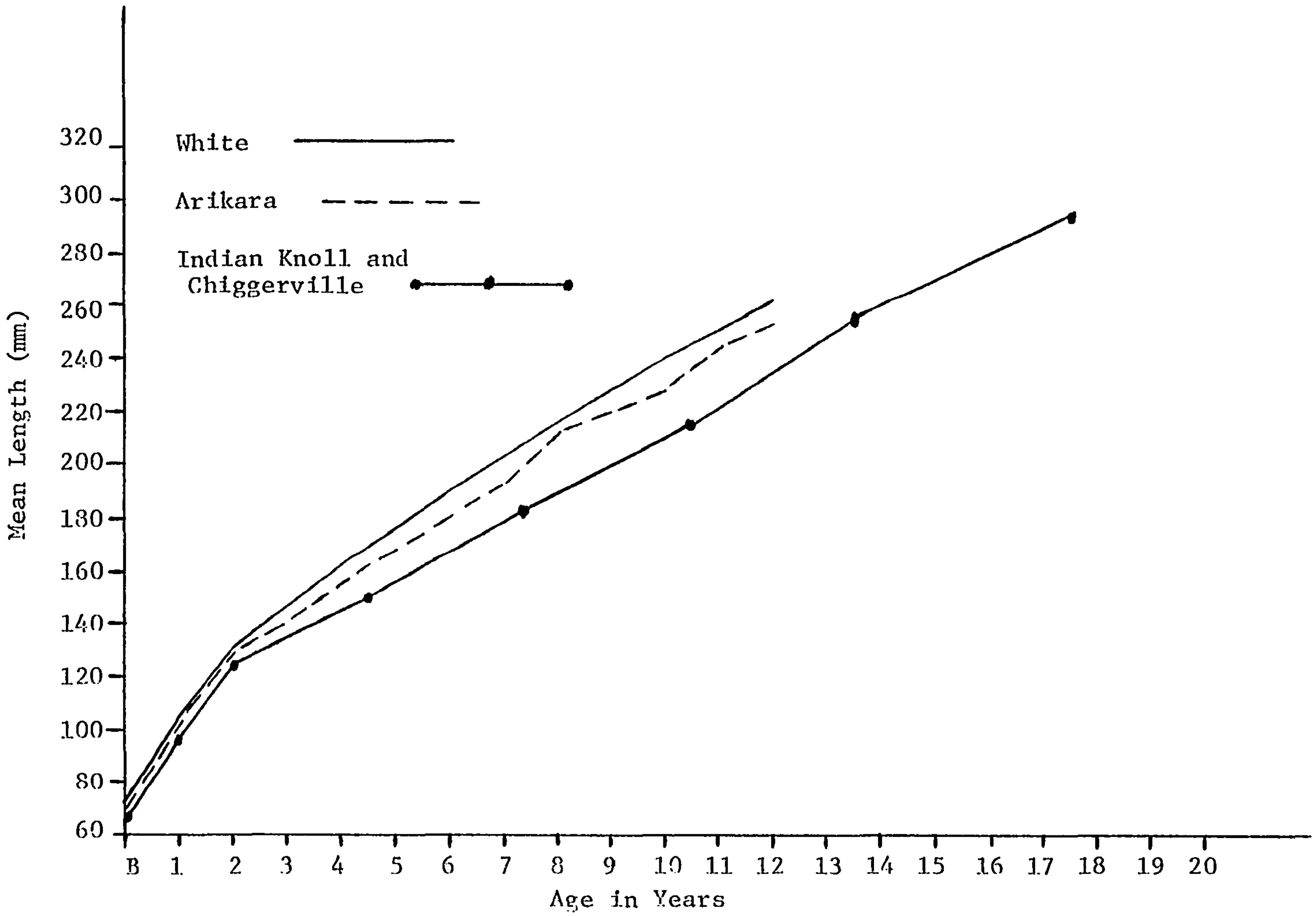

Figure 8. Growth of the Humerus.

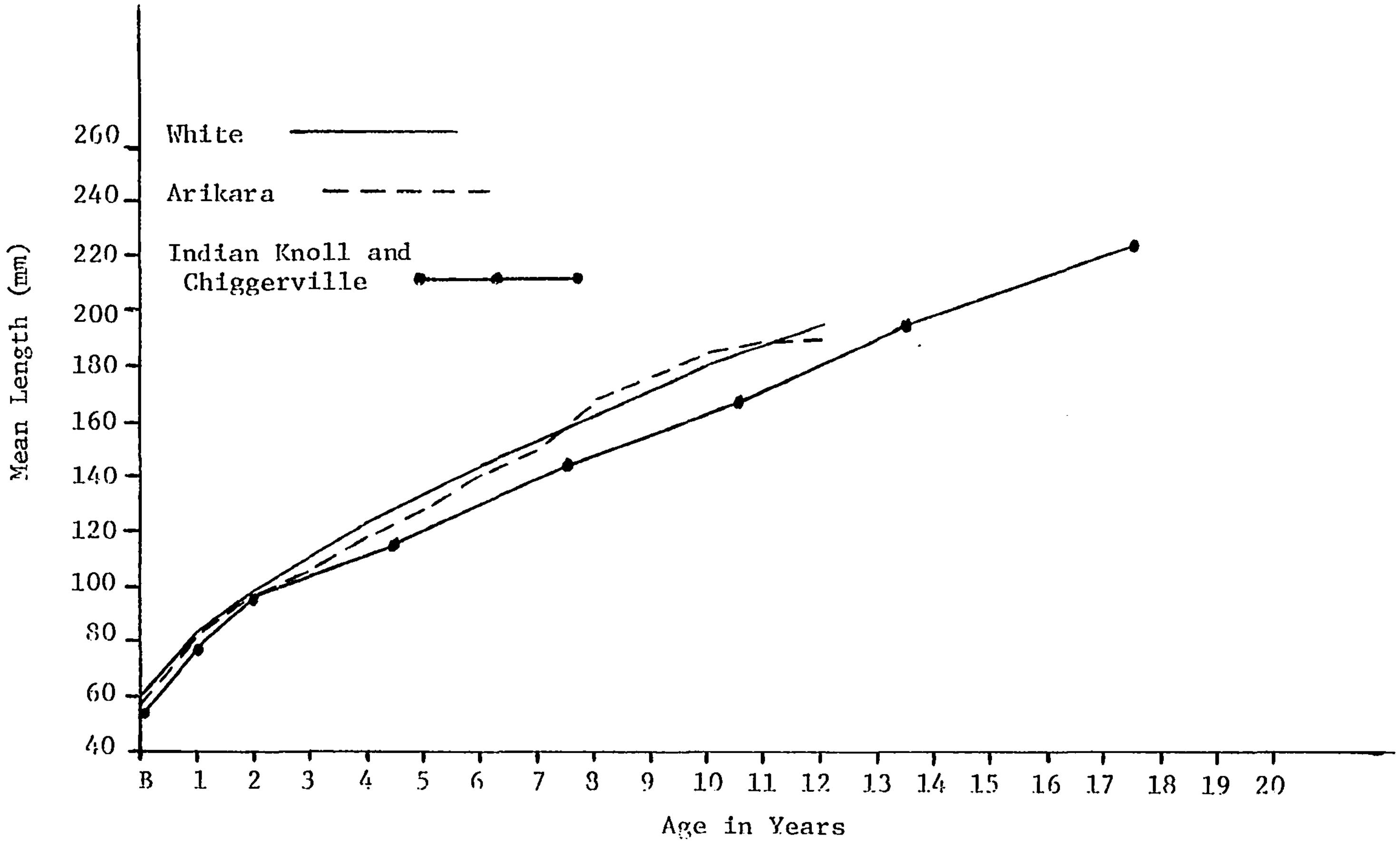

Figure 9. Growth of the Radius.

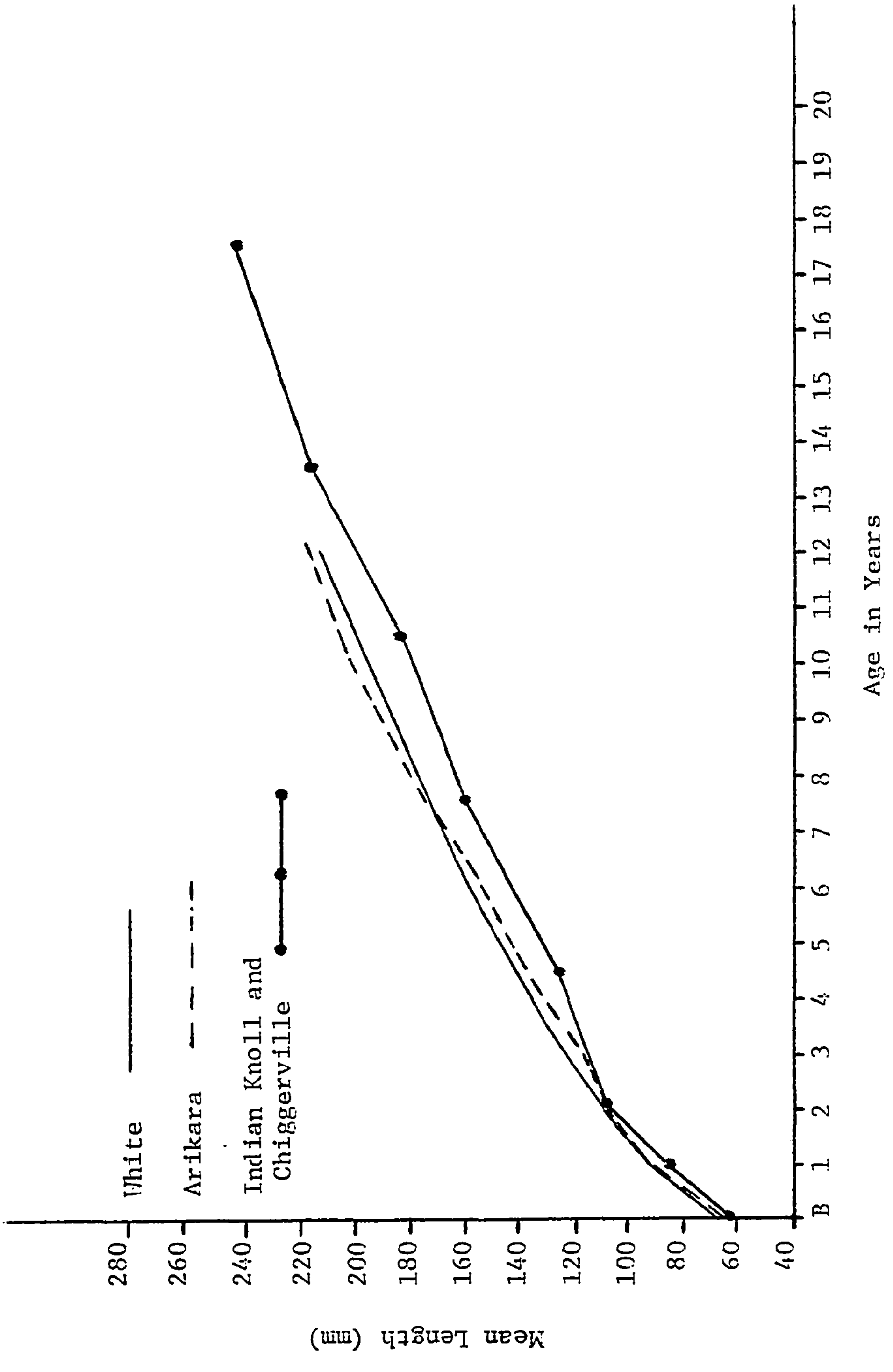

Figure 10. Growth of the Ulna.

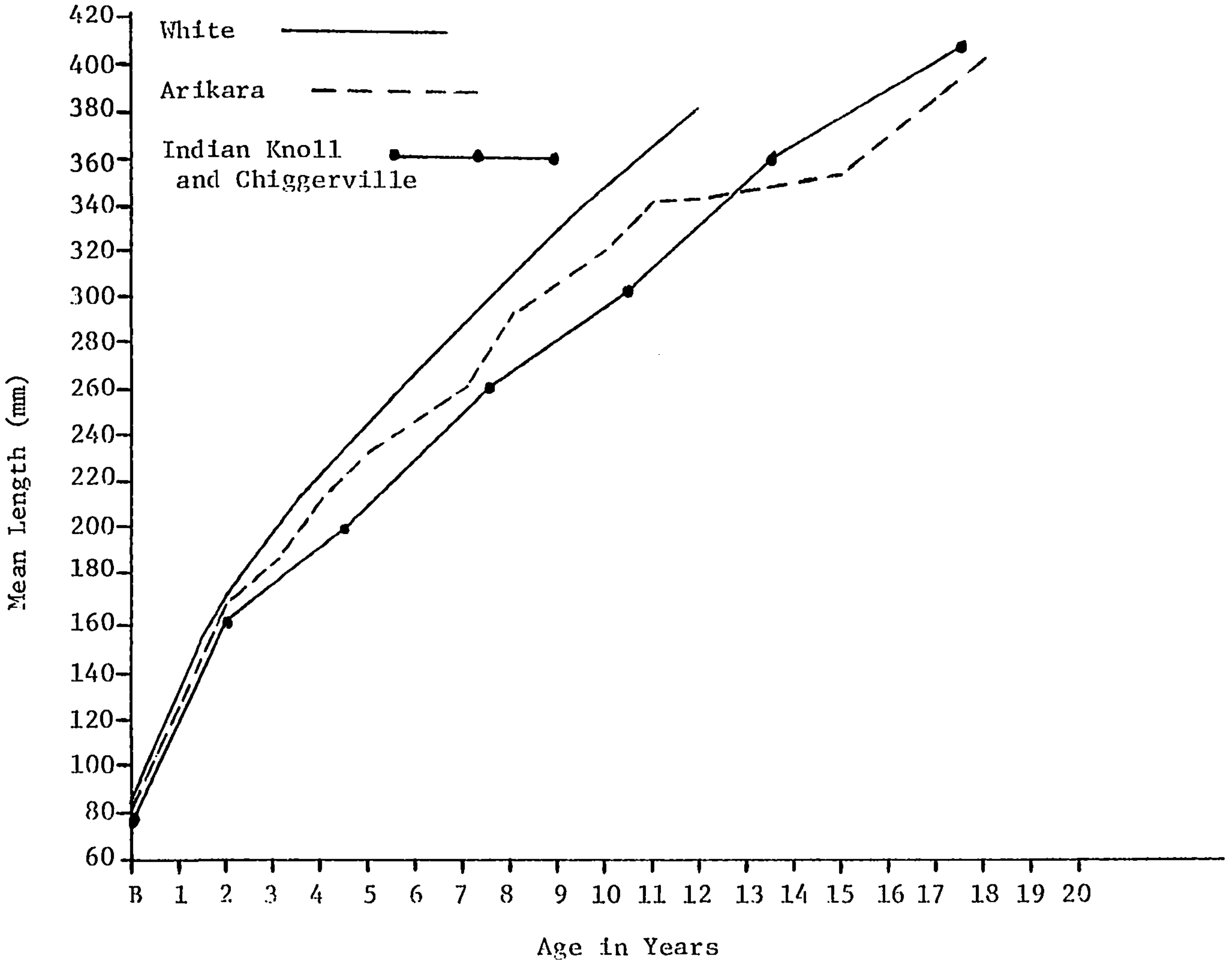

Figure 11. Growth of the Femur.

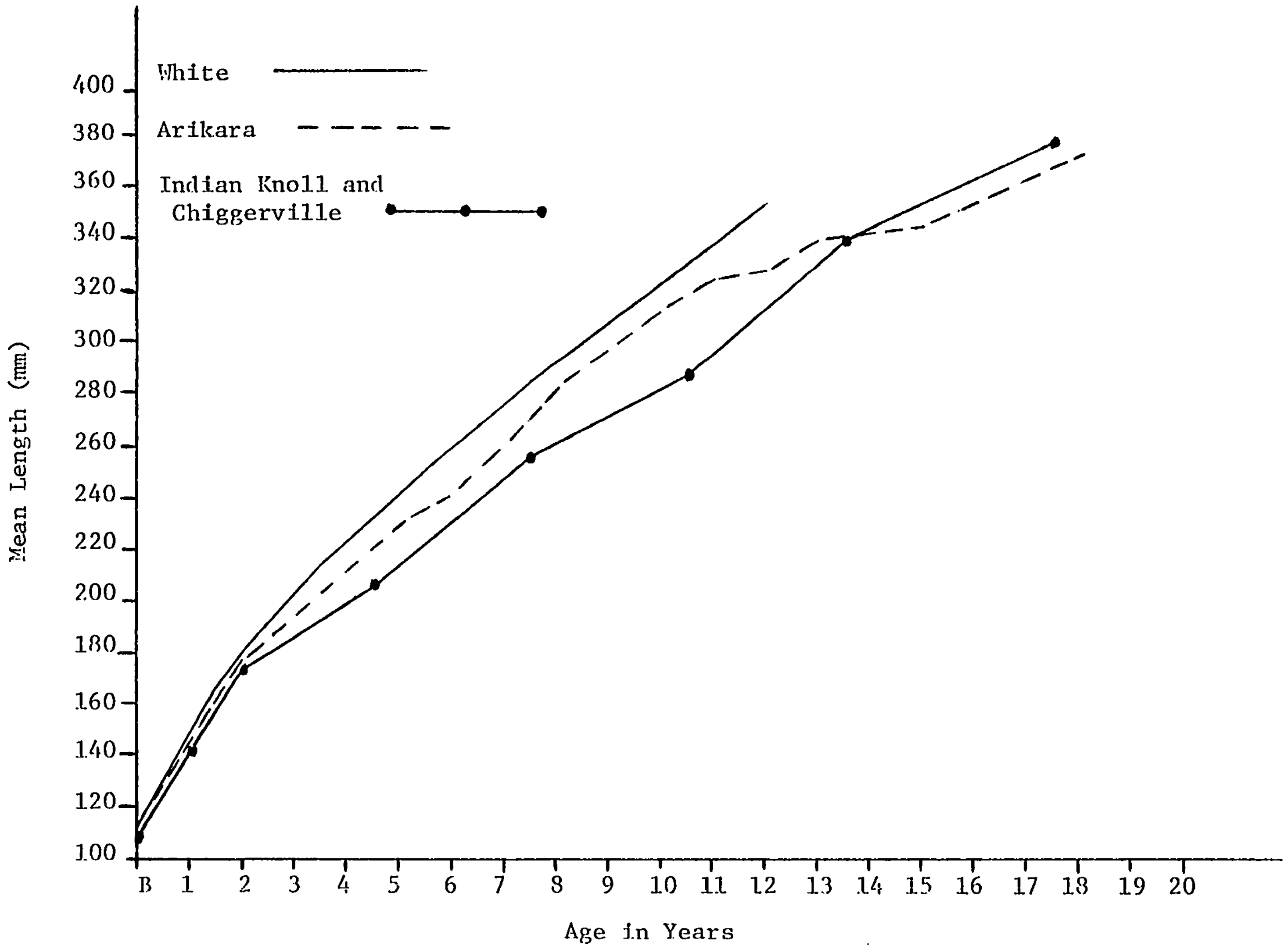

Figure 12. Growth of the Tibia.

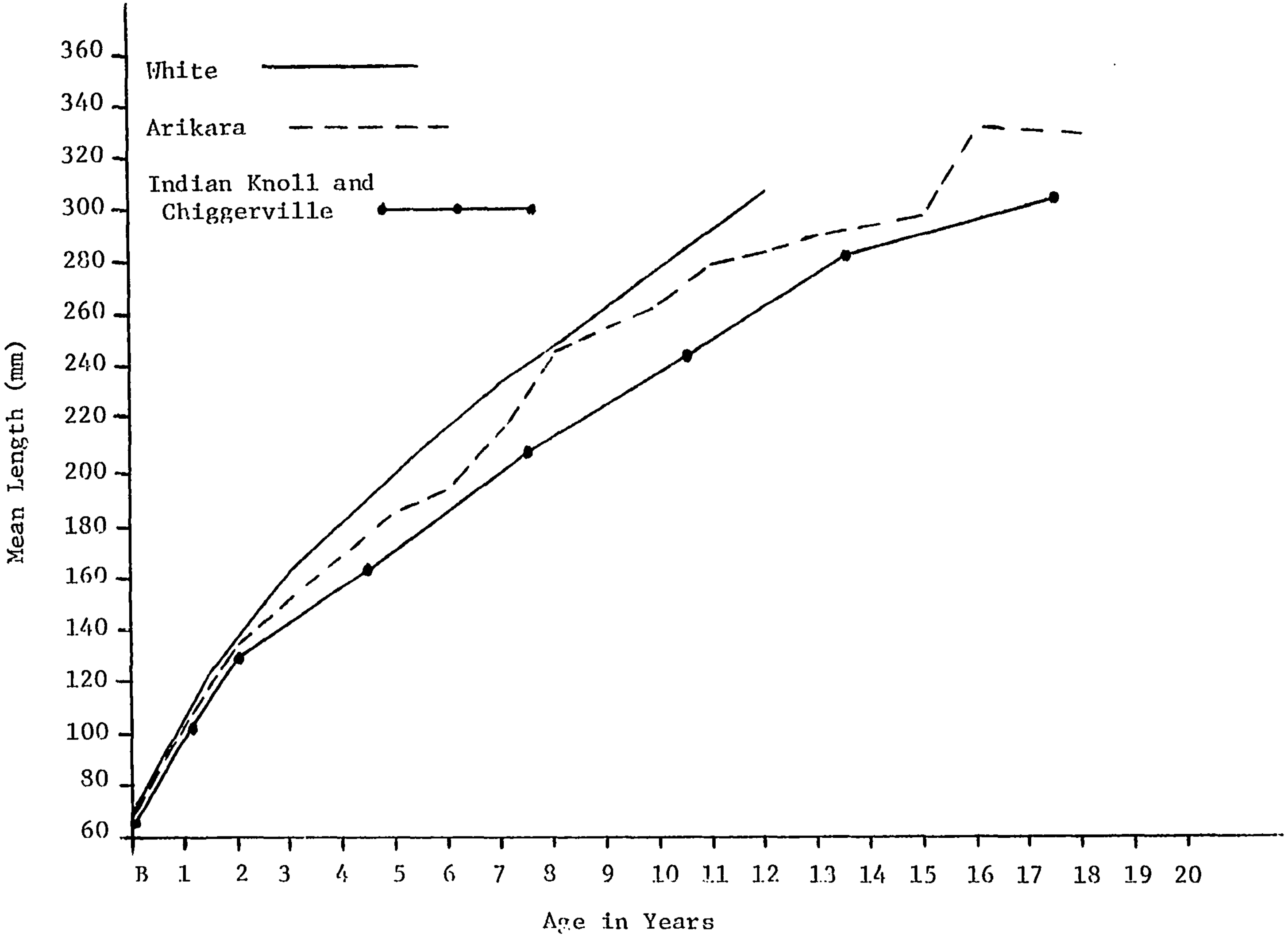

Figure 13. Growth of the Fibula.

In a few instances, the growth curves for Arikara are above those of the white population such as after the 7-year interval for the ulna and radius. This is most likely due to the small sample size of the Arikara population in the older age groups since some age groups are represented by only 1 individual.

Shown in Figures 14 and 15 (pp. 47-48) are the curves comparing the velocity of growth for the femur and tibia between birth and 12 years of age. The roughness of the curves for the Indian samples is due to the small sample sizes and inability to age skeletal populations accurately to 1-year age intervals. This aging problem necessitates the estimation of 1-year growth rates from 3-year age categories which contain individuals of all ages within the 3 years. With small samples, by chance alone, 1 3-year age group may consist of individuals clustered toward 1 end or the other of the age group, thus resulting in an inaccurate representation of the actual growth between this age group and the next.

What all these graphs may be showing is the secular trend towards earlier maturation noted in studies on living people (Tanner, 1962, 1968). This was also shown by Johnston (1962) in his comparison of Indian Knoll infants and children from birth to 5.5 years to American whites. The differences became significant after 2 years of age.

No one is certain why the secular trend has occurred, but better nutrition and generally improved environmental circumstances are usually given the credit. It could be postulated that diet played a major role in determining the differences shown between these 3 populations. The Kentucky Archaic populations were hunters and gatherers and probably had the least dependable food supply throughout the year, while

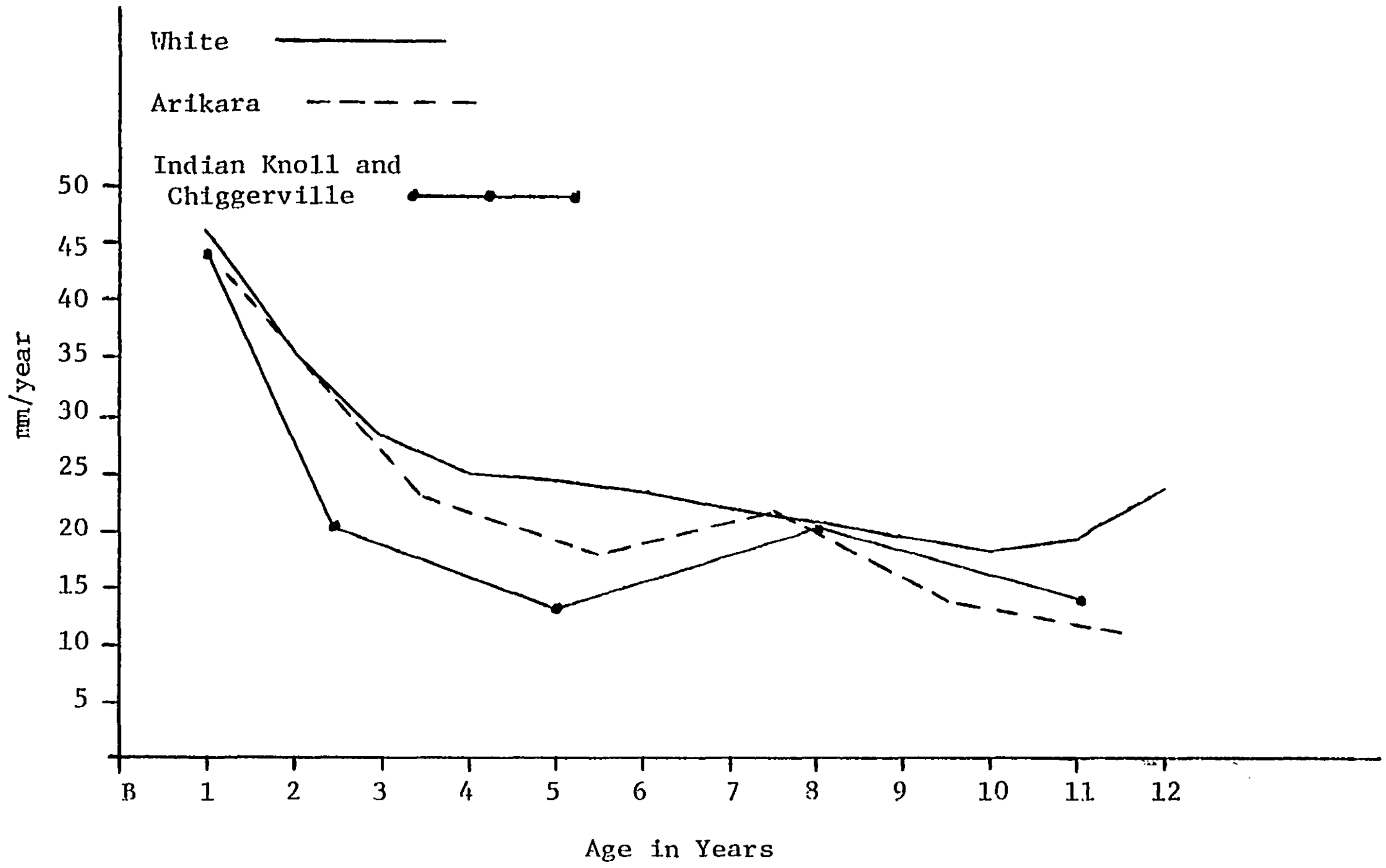

Figure 14. Velocity of Growth of the Femur.

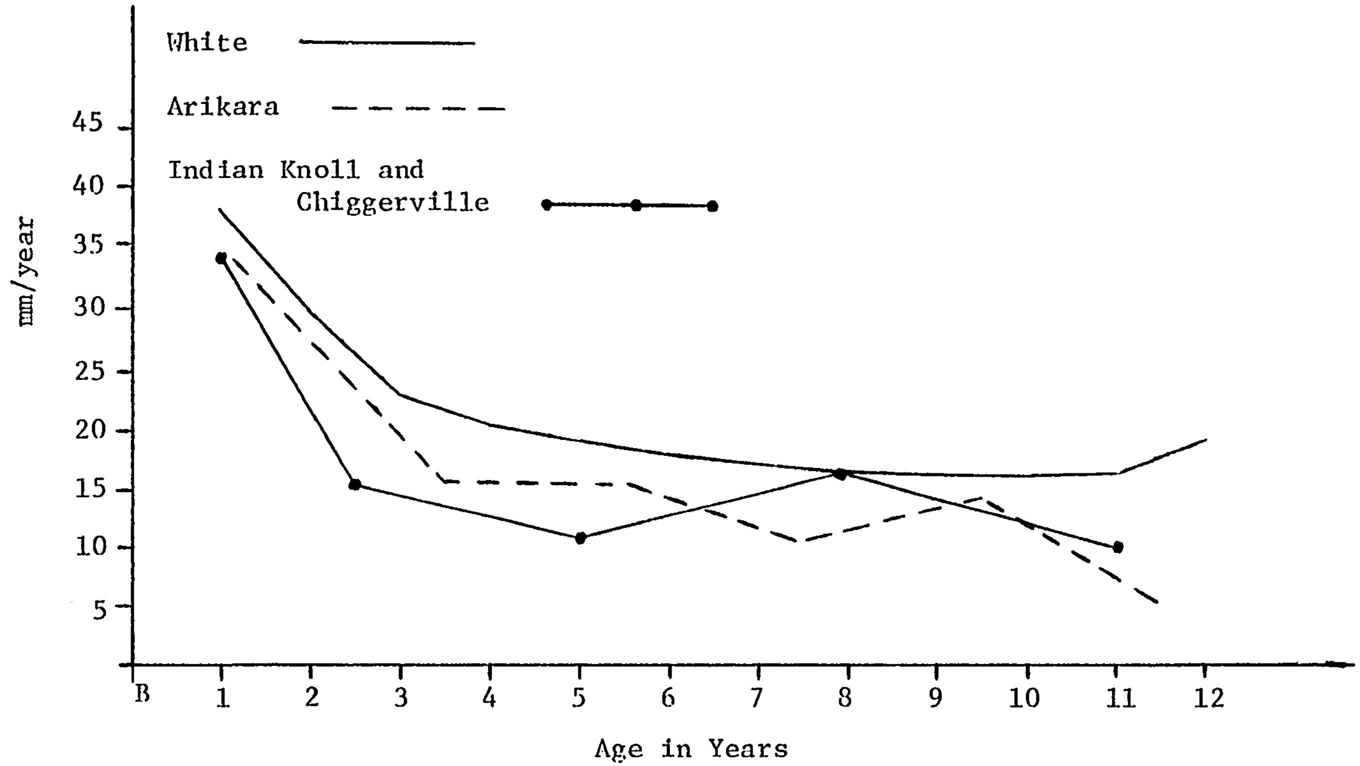

Figure 15. Velocity of Growth of the Tibia.

the Arikara were agriculturalists in addition to being hunters and gatherers and probably had a more dependable food supply due to their being able to store agricultural surpluses for the lean periods of the year. The white population undoubtedly had the best diet of all groups studied.

Although malnutrition during childhood delays growth, the body has great recuperative powers so that in times of better nutrition the body will speed up its growth rate until it has caught up to its genetically-determined growth curve, after which it proceeds as before. Only severe malnutrition, prolonged throughout a large part of the growth period, may cause permanent stunting. The same process occurs during a major illness, although minor illnesses do not seem to affect the growth rate (Tanner, 1962).

But, in comparisons using unrelated populations, genetic differences between the populations could account for some of the differences observed in the rates of growth. This genetic difference was demonstrated on studies of black and white children where blacks at birth are ahead of whites in skeletal ossification and are also advanced in motor behavior (Tanner, 1962).

Changes in limb proportion can be studied by relating measurements of one limb to another, as in Figure 16 (p. 50) where the combined lengths of the humerus and radius are plotted against those for the femur and tibia for the 3 populations. All 3 curves tend to coincide indicating that proportionality of the arm to the leg is the same for all 3 groups even though significant size differences exist.

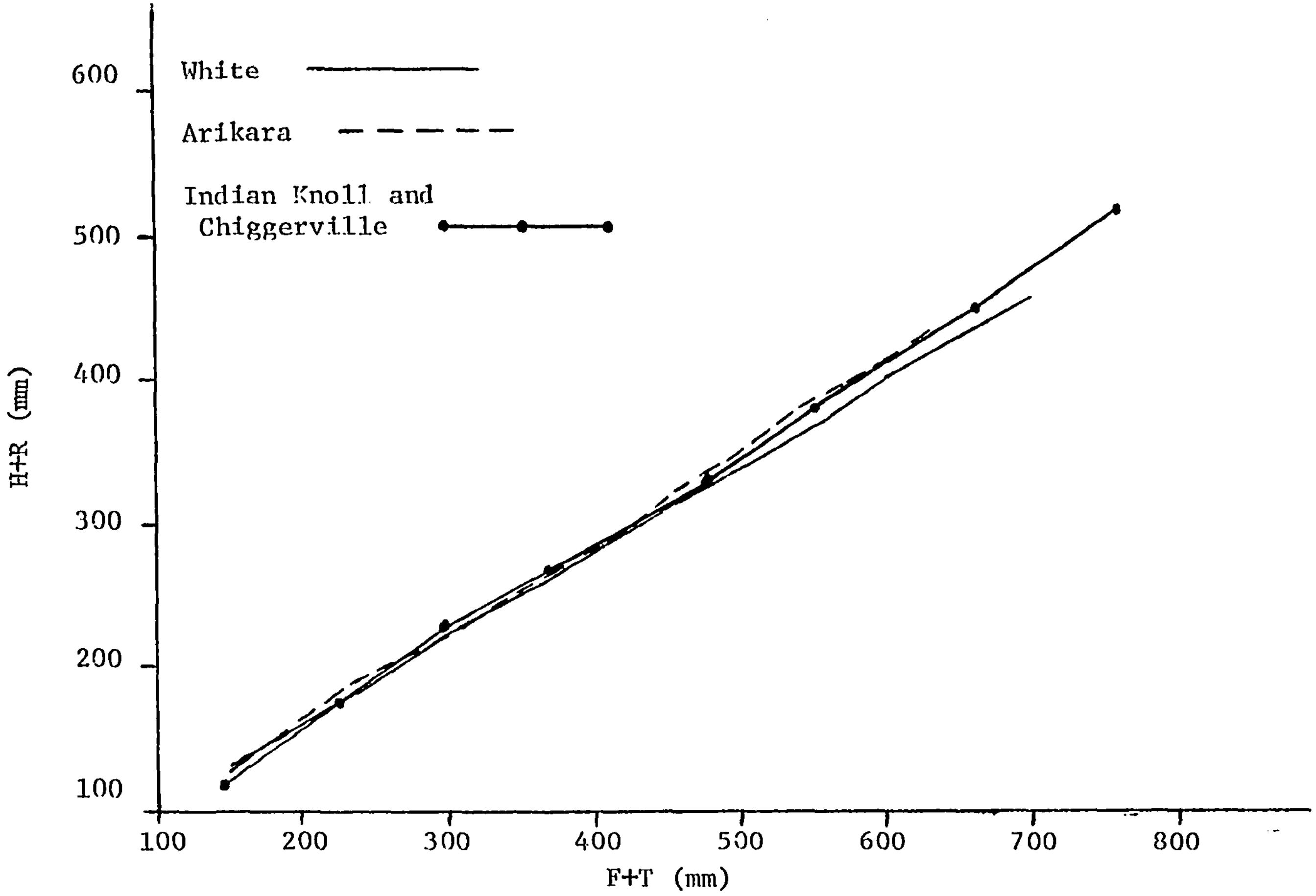

Figure 16. Sums of Means of Humerus and Radius (H+R) Plotted Against Femur and Tibia (F+T).

In addition to the secular trend towards earlier maturation, some studies have shown a less pronounced trend toward increased stature (Tanner, 1962, 1968; Miller, 1970). Tanner (1968) observed this trend in many European populations and Miller (1970), comparing the measurements of Apache men taken in 1940 to measurements on their sons in 1967, noticed an average increase in stature of 1.3 cm. Miller also noticed that the men measured in 1940 reached maximum average height earlier than those measured in 1967; this finding is contrary to the worldwide trend toward earlier maturation.

The problem of a trend toward increased stature has been questioned by Huber (1968). Studying the lengths of long bones in ancient and modern populations, Huber has reached the conclusions that mean lengths of bones from earlier series exceed or equal those of most modern ones, and in particular, maximum stature of the present American white male population is not greater than that of its antecedents of 1500 years ago. This trend towards increased stature found by other researchers may result from their not taking into consideration the trend towards earlier maturation, since people today will be taller than people of the same age years ago. If an actual increase in stature is documented for a period of time, it may be due to a return to old levels after a momentary fluctuation downward (Huber, 1968). This may be what was happening in Miller's study.

A comparison of estimated statures from archaeological sites separated by a long period of time (3000 to 5000 years) did not show any significant increase in stature. Stature of Chiggerville males was 168.47 ± 3.24 cm using Trotter and Gleser's (1958) formula for Mongoloid males, or 165.82 ± 3.417 cm using Genoves' (1967) formula for Mesoamericans. These measurements were compared to the estimated statures of males from the historic Lasanen site (Clute, 1971). At Lasanen, male stature was 169.48 ± 3.24 cm using Trotter and Gleser's formula or 167.76 ± 3.417 cm using Genoves' formula. These differences cannot be significant, considering the length of time separating these populations. The non-significance of the observed statures can be shown by comparing the measurements of the long bones themselves. The range of measurements on the femur and tibia at Lasanen clearly fell within the ranges of the long bones at Chiggerville and Indian Knoll.

What these data suggest is that there is a secular trend towards earlier maturation, but that there is no or very little trend towards increased stature within the last 4000 years or so; although there were probably minor fluctuations in maximum stature occurring throughout this time period as there are today.

CHAPTER IV

CONCLUSIONS

Any study of biological relationships between populations should consider all the data that is available. These data include not only the skeletal data, but the archaeological data as well. A study of this type will provide the most accurate picture of biological and cultural relationships.

Whenever possible, the biological relationships should be determined by using cranial measurements and non-metric traits of the skeleton to provide a more reliable representation of the similarities and differences between populations than 1 method alone could do. Unfortunately, most studies on skeletal populations do not include data on non-metric skeletal variants. And the studies that do include these variants often do not include enough variants for a meaningful comparison. This was the case in this study, when trying to compare Chiggerville to Indian Knoll and Adena using non-metric traits.

Although the number of variants needed for a reliable comparison has not been determined, I would be hesitant to rely on any comparison that was based on less than 15 or 20 variants. It is hoped that the study of non-metric skeletal variants will become as routine in osteological studies as the measurements of crania are now.

Another aspect of skeletal studies that has been frequently overlooked is the study of sub-adult individuals. Aside from occasional uses in demographic and paleopathological studies, the majority of osteological reports deal mainly with the adult material. As was shown in this study, and others, the measurement of sub-adult skeletons can yield significant information on human growth. Therefore, I urge that any studies of skeletal populations that contain sub-adult material include data on the measurements of these individuals. This information will then be available to other researchers.

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APPENDIX A

Reference Population Used for the Calculation of T-Scores

	Mean	S.D.
Maximum length	178.9	6.00
Maximum breadth	137.9	4.63
Minimum frontal breadth	92.5	4.14
Basion bregma height	137.2	4.23
Auricular height	117.6	3.72
Bizygomatic breadth	136.6	4.46
Upper facial height	71.7	3.13
Basion prosthion length	98.5	4.17
Nasal height	51.9	2.41
Nasal breadth	25.8	1.54
Orbital height	34.3	1.65
Maxillo-alveolar length	53.6	2.24
Maxillo-alveolar breadth	64.9	3.09
Symphysis height	35.2	2.24
Bigonial breadth	100.8	5.03
Minimum breadth of ascending ramus	34.6	2.38

APPENDIX B

Cranial Non-Metric Traits

Trait present	Total*		Right		Left	
	#	%	#	%	#	%
Mandibular torus	5/51	9.80	5/47	10.64	4/49	8.16
Acc. mental f.	8/54	14.81	5/46	10.87	4/50	8.00
Mylohyoid bridge	11/50	22.00	8/39	20.51	4/38	10.53
Palatine torus	1/21	4.76				
Trochlear spur	5/34	14.70	2/29	6.90	4/23	17.39
Complete metopism	0/42	0.00				
Zygomatico-facial f.	37/48	77.08	32/41	78.05	30/35	85.71
Supra-orbital f. comp.	21/51	41.18	16/44	36.36	15/42	35.71
Frontal notch or f.	37/50	74.00	23/35	65.71	25/38	65.79
Acc. infra-orbital f.	3/11	27.27	1/7	14.28	2/6	33.33
Suture in infra-orbital f.	3/12	25.00	2/8	25.00	1/8	12.50
Os japonicum	0/44	0.00	0/39	0.00	0/31	0.00
Ossicle at lambda	4/33	12.12				
Bregmatic bone	0/28	0.00				
Sagittal ossicle	0/20	0.00				
Lambdoid ossicle	8/25	32.00	6/22	27.27	6/24	25.00
Coronal ossicle	0/17	0.00	0/15	0.00	0/15	0.00
Parietal notch bone	0/27	0.00	0/25	0.00	0/22	0.00
Ossicle at asterion	4/23	17.39	3/19	15.79	4/19	21.05

*for bilateral traits, this figure represents the percentage of individuals who possessed the trait on at least one side.

Appendix B Continued

Trait Present	Total #	Total %	Right #	Right %	Left #	Left %
Mastoid ossicle	5/17	29.41	3/10	30.00	2/14	14.28
Fronto-temporal artic.	1/9	11.11	0/7	0.00	1/7	14.28
Parietal f.	17/33	51.51	13/30	43.33	10/29	34.48
Auditory exostosis	16/53	30.19	12/49	24.49	14/51	27.45
Foramen of Huschke	8/48	16.66	4/41	9.76	8/42	19.05
Condylar facet double	0/27	0.00	0/22	0.00	0/19	0.00
Precondylar tubercle	0/15	0.00	0/11	0.00	0/9	0.00
Anterior condylar canal double	5/30	16.67	3/25	12.00	3/23	13.04
F. spinosum open	7/19	36.84	5/14	35.71	3/9	33.33
F. ovale open	1/22	4.54	1/18	5.55	1/12	8.33

APPENDIX C

Post-Cranial Non-Metric Traits

Trait	Total*		Right		Left	
	#	%	#	%	#	%
Unfused acromial epiphysis	0/23	0.00	0/15	0.00	0/13	0.00
Suprascapular f.	0/9	0.00	0/6	0.00	0/5	0.00
Septal aperture	17/52	32.69	10/40	25.00	14/45	31.11
Supratrochlear spur	0/50	0.00	0/40	0.00	0/43	0.00
Acetabulum pit absent	8/23	34.78	3/18	16.67	7/19	36.84
Innominate: accessory sacral facet	4/27	14.81	4/25	16.00	0/21	0.00
Tibial tuberosity spur	1/26	3.85	0/20	0.00	1/22	4.54
Popliteal line spurring	4/27	14.81	3/24	12.50	2/23	8.69
Squatting facet	26/28	92.86	20/22	90.91	23/25	92.00
Calcaneus: anterior-middle facets discrete	25/48	52.08	20/40	50.00	20/39	51.28
Talus: Os trigonum absent	12/44	27.27	12/41	29.27	10/37	27.03

*for bilateral traits, this figure represents the percentage of individuals who possessed the trait on at least one side.

APPENDIX D

Sub-Adult Post-Cranial Measurements

Burial Number	Dental Age	Clavicle: Max. Length	Humerus: Max. Length	Humerus: A-P dia.	Humerus: M-L dia.	Humerus: Max. width prox. epip.	Radius: Max. length	Ulna: Max. length	Ilium: Max. dia.	Femur: Max. length	Femur: A-P dia. at midshaft
2	15-20 yr									379.0	22.0
17	F-B		64.5	5.0	5.0			61.5			
23	3-6 yr		151.0	10.0	10.0						
26	12-15 yr		280.0	175.0	20.0	48.5	220.0	245.0	138.0		
31	9-12 yr	99.0	232.0		14.0			189.0			18.0
33	3-6 yr			10.0	9.5			118.0		183.0	11.0
57	B-1 yr		106.0	9.0	7.0		87.0				8.5
63	1-3 yr								59.0	138.0	10.0
68	9-12 yr										
69	1-3 yr		135.5	10.0	9.0			113.0	66.0		10.0
70	1-3 yr	67.0		9.5	13.0	21.0		112.0	68.0	174.0	13.5
71	B-1 yr	58.5	100.0	10.0	9.0		77.0	88.0	53.0	128.0	10.0
75	B-1 yr	61.0		8.0	7.5				47.0	106.5	8.5
80	B-1 yr			8.0	7.0		73.0				
85	B-1 yr		100.0	8.0	7.0		77.5	86.0			7.0
88	F-B		67.0	5.0	5.5		55.5		33.5	77.0	6.5
94	15-20 yr		293.5	16.0	17.0	44.0	218.5	238.0		412.0	23.0
106	F-B		62.0	5.0	4.5		52.0	59.0	33.0	72.0	5.5
110	6-9 yr	94.0									
111	6-9 yr	86.0	194.0	11.0	11.5	32.0	149.0			272.5	15.0
113	12-15 yr		271.0	16.0	18.0	43.5	209.0	227.0		376.0	23.0
124	6-9 yr		193.0	13.5	11.5	30.0				266.0	18.0

Appendix D Continued

Burial Number	Femur: M-L dia. at midshaft	Femur: Max. head dia.	Femur: Max. width distal epiph.	Tibia: Max. length	Tibia: A-P dia. at nutrient f.	Tibia: M-L dia. at nutrient f.	Tibia: Max. width prox. epiph.	Tibia: Max. width distal epiph.	Fibula: Max. length	Talus: Max. length	Talus: Max. width	Calcaneus: Max. length	Metatarsal I: Max. length
2	18.0									51.0	43.0		
17													
23													
26		42.0	75.0	313.0	24.0	24.0	73.0	43.0		56.0	41.0	75.0	
31	17.0			251.0	24.0	18.0				45.5			
33	11.5	18.5		150.5	12.0	11.5		15.0					24.0
57	8.0				10.0	8.0							
63	11.5			114.5	10.5	11.0							
68				214.0	19.0	15.5				40.0	30.0		35.0
69	11.5	17.5	37.5		14.0	12.5	29.0						
70	11.5	18.0	37.0		12.5	16.0	29.0	20.0				32.5	
71	9.0			104.5	10.5	9.5	15.5		100.5	16.5	12.5	21.0	18.0
75	8.0				7.0	8.0							
80					10.0	8.5							
85	9.0			66.5	7.0	7.0							12.0
88	6.5												
94	20.5	38.0		334.0	27.5	18.5	63.0	38.5		45.0	35.0	66.0	56.0
106	6.5												
110		31.0	55.0				49.0			35.0	34.0		36.0
111	16.0	29.5	54.0	225.0	18.0	15.0	50.0	33.0	216.5	40.0	29.0	50.0	39.5
113	18.5	39.5		311.0	27.0	20.0	67.0			53.0	39.0	67.0	46.0
124	17.0	30.0	57.0	226.0	20.0	18.0	51.0		221.0	38.0	28.0	49.5	37.5