

Bone Growth in Two Prehistoric Indian Populations

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Abstract

The diameter of the adult radius was compared in two prehistoric Indian populations which differed markedly in diet. The Indian Knoll population of the Archaic Period was a hunting and gathering group. The Pete Klunk Mound Group population of the Middle Woodland or Hopewell Period supplemented its hunting and gathering with part-time agriculture. Therefore, the diet of the Hopewell population was larger and more varied than that of the Indian Knoll population. Statistically significant differences in radius diameter were shown to exist both inter- and intrapopulationally. Males of both populations were larger than females. Males and females of the Hopewell group were larger, respectively, than males and females of the Indian Knoll group. These population differences in bone diameter are attributed to differences in the aboriginal diets.

The effect of nutrition on circumferential growth of the radius bone was examined in two prehistoric Indian populations, the Indian Knoll of Kentucky and the Pete Klunk-Hopewell of Illinois. The Indian Knoll population (dated between 2500 and 2000 B.C.) represents the Archaic Period of Eastern United States prehistory. The subsistence activities of this group were centered exclusively around hunting and gathering in the vicinity of the Green River. The Hopewell, a more recent population (dated between 50 B.C. and 250 A.D.) represents the Middle Woodland Period. This group also relied on hunting and gathering but supplemented these activities with part-time agriculture in the Illinois River Valley. The hypothesis tested is that due to agriculture and, as a consequence, a larger and more varied diet, the amount of bone growth in the Hopewell population would be greater than that of the Indian Knoll population.

Materials and Methods

Only well-preserved, intact radii from adult males and females were studied. The sampled radii represented individuals ranging in age from 20 to 70 years. The sample was made up of 121 males and 54 females from Indian Knoll and 45 males and 46 females from Hopewell. Those radii which evidenced obvious pathology such as periostitis or arthritis were not used. The width or diameter of each radius was measured at two sites: a cortical or compact bone site at a point one third the shaft length as measured from the styloid process and a trabecular or spongy bone site, at a point one tenth the distance from the styloid process. A photon absorptiometric technique developed by Cameron (1) was employed to measure both width and bone mineral content of each radius. A monoenergetic photon beam from a low energy radionuclide, iodine-125, was passed across the width of the bone. Changes of transmittance, which are directly proportional to the bone mineral mass in the scan path, were measured with a scintillation detector-pulse height analyzer system (3). Data from each scan or measurement were transferred to paper tape by means of an eight channel Tally Paper Tape Punch. An IBM Tape to Card Converter trans-

TABLE 1. *Mean widths of radial diaphysis (cortical) and distal radius (trabecular). Width values in millimeters.*

Site	Indian Knoll			Hopewell			Difference		
	N	Width	Standard Deviation	Coefficient of Variation	N	Width		Standard Deviation	Coefficient of Variation
Males									
Cortical	121	13.3	1.57	11.8	45	14.4	1.38	9.6	1.1 (7.6%)
Trabecular	121	22.5	1.92	8.5	45	23.8	2.26	9.5	1.3 (5.5%)
Females									
Cortical	54	11.2	1.23	10.9	46	13.1	1.50	11.4	1.9 (14.5%)
Trabecular	54	20.1	1.63	8.1	46	21.5	1.77	8.2	1.4 (6.5%)

ferred the data to the standard 80-column cards. A computer program for calculation of radius width was written by Dr. David M. Smith of the Indiana University Medical Center and was made available for this study.

Results

Table 1 presents data on the width of the radii used in this study. In all cases the average width of the Hopewell radius exceeds that of the Indian Knoll radius. This relationship is especially evident in the 14.5%

TABLE 2. *Comparison of mean cortical and trabecular widths by sex and culture using Student's t. Indian Knoll (IK) and Hopewell (H).*

Site	Comparison	Value	Significance
Cortical	IK Males vs. H. Males	4.19	$p < 0.001^{**}$
	IK Females vs. H. Females	6.96	$p < 0.001^{**}$
Trabecular	IK Males vs. H. Males	3.74	$p < 0.001^{**}$
	IK Females vs. H. Females	4.12	$p < 0.001^{**}$
Cortical	IK Males vs. IK Females	8.71	$p < 0.001^{**}$
	H. Males vs. H. Females	4.32	$p < 0.001^{**}$
Trabecular	IK Males vs. IK Females	8.00	$p < 0.001^{**}$
	H. Males vs. H. Females	3.45	$p < 0.001^{**}$
Cortical	IK Males vs. H. Females	0.75	$p > 0.20$
Trabecular	IK Males vs. H. Females	3.09	$0.001 < p < 0.01^{*}$

*Significant

**Highly Significant

difference in average cortical width between the two female samples. In Table 2, Student's t-tests show that when Indian Knoll males are compared to Hopewell males or when Indian Knoll females are compared to Hopewell females, the differences in average radius width are very highly significant at the 0.001 level of confidence. Size differences are further indicated when the Hopewell females are compared to Indian Knoll males. No statistically significant difference between their respective cortical widths could be found despite a statistically significant sexual dimorphism within each population with males being larger than females (Table 2).

Discussion

In the earlier stated hypothesis, bone growth was predicted to be greater in the Hopewell population than in the Indian Knoll population. The data on radius width show this to be true. However, to fully test the hypothesis it must be shown that bone width and diet are related and that significant nutritional differences exist between the two populations. Garn

(2) has shown that bone width is related to caloric sufficiency to the extent that average bone diameter or width may be 15% narrower among the malnourished of a population. The data in Tables 1 and 2 are taken to indicate significant nutritional differences.

The archaeological data also suggest nutritional differences. Excavation of the Indian Knoll site has categorically demonstrated that this population was pre-agricultural (8). Farming implements such as shell hoes and floral remains of domesticated species are absent. The remains of shellfish and mollusca were found interspersed throughout the refuse or cultural debris of the site. The heavily forested area around the Green River provided the Indian Knoll people with a variety of foodstuffs. Remains of hickory nuts, walnuts, and acorns are reported by Webb (8) along with hammerstones which were employed to process the nuts. An abundance of deer, *Odocoileus virginianus*, indicates its importance as a meat source. In fact, of 27,756 animal fragments identified, 23,177 were from *O. virginianus*. Atlatls or spear throwers were found in association with burials and probably were used to kill both deer and wild turkey, *Melaegris gallopavo*.

The Green River provided staples other than just mollusca, for fish were also a significant component of the diet. Webb (8) describes the deer ulnae and tibiae which were fashioned into fish hooks. Skeletal remains of the drumfish, *Aplodinotus grunniens*, were scattered throughout the debris of the midden. Migratory waterfowl such as the Canada goose, *Branta canadensis*, were also found.

The Middle Woodland Period of North American prehistory emerged at least 2,000 years after occupation at Indian Knoll was terminated. The former Period, then, is represented by cultures which benefited from a longer experience adapting to the New World environments. The hunting and gathering society of Indian Knoll did not alter the normal habitats of the natural flora and fauna. As stated above, shellfish were merely gathered, nuts collected, and deer hunted. In contrast, the later Early Woodland cultures which antedate the Middle Woodland cultures actually modified the floral environment to their own advantage. Various excavations of Early Woodland sites have shown remains of plants not naturally indigenous to those areas. Archaeologists infer that the Indians intentionally introduced species whose existence depended upon human management. This took the form of cultivation and selective removal of other plants which might have been competitors. These plants used by man are cultigens, the earliest of which were: *Helianthus annuus*, sunflower; *Iva* sp., marsh elder; *Cucurbita pepo*, squash; *Lagenaria siceraria*, gourd; and *Chenopodium album*, goosefoot or lamb's quarters.

An Early Woodland Kentucky site near Indian Knoll has yielded human fecal material which reflects subsistence activities. Watson (7) reports that the feces at Salts Cave contained hickory, acorn, sunflower seeds, *Chenopodium*, and *Iva*. The latter three probably represent the earliest cultigens in this eastern woodlands area. Significant too were remains of two tropical exotic plants, squash and gourd. Cultivated plants made up 45% of the bulk of the Salts Cave feces. The intermediacy of

this site relative to the Indian Knoll and Hopewell cultures has been shown by radiocarbon dates of 710 ± 200 B.C.

The original stimulus to cultivate was probably a product of cultural diffusion from Mesoamerica where, for example, squash, gourd, and corn are indigenous. The adoption of incipient agriculture in the Early Woodland Period provided the Hopewellians of the Middle Woodland a tested, successful behavioral adaptation. The evidence is impressive that by Middle Woodland times, horticulture had become widely practiced in both the Ohio and Mississippi River Valleys where it was to persist until contact times.

The village site that adjoined the mounds which contained the Hopewell skeletons is today covered by a town and highway and therefore beyond archaeological recovery. Examination of other Middle Woodland sites can, however, provide a picture of Klunk-Hopewell subsistence activity. The McGraw site of Ross County, Ohio, is situated in the flat bottomland or flood plain of the Scioto River. Such riverine locations, even today, are the best areas for agriculture. Prufer (4) reports the discovery of a medium-sized ear of corn in the middle stratum of the site. One may posit, therefore, that, following in the tradition of the Early Woodland, Hopewellians were introducing and propagating alien plants. Prufer maximizes the significance of the corn and believes that this community's primary economic activity was farming based on a shell hoe technology. Secondary activities in order of decreasing importance were shellfish collecting, hunting, and wild plant collecting. Prufer reasons that the nearby burial mounds, which are large in size and rich in material content, could have been built only with the support of a stable agricultural economy.

Middle Woodland sites in Illinois have also yielded corn. Vickery (6) reports finds from the Jasper Newman site of Moultrie County (50 ± 140 B.C.) and the Macoupin site of Jersey County. In Calhoun County where the Klunk-Hopewell site is located, the Peisker site (180 ± 130 , 70 ± 120 , 250 ± 20 A.D.) and Ansell site (250 ± 150 A.D.) also contained corn. Both Illinois and Ohio Hopewell climates were capable of supporting the corn plant.

Judging from the above village or occupation sites, one can categorically state that Hopewellian Indians of the lower Illinois River Valley had expanded the exploitative potential of their environment through farming activities. This is not to say, though, that the Valley itself was not already naturally endowed with a diversity of food resources. Struever (5) has shown the easy availability and abundance of hickory nuts and acorns; *Iva* and *Chenopodium*; deer; geese and ducks; and fish. Both population density and residential stability increased during Hopewellian times. The number and size of burial mounds attest to the population increase while numerous storage pits and earth ovens in close association with a house at the Apple Creek site in Madison County, Illinois, attest to the residential stability. This increase in population density and residential stability is taken to indicate the larger and more varied diet of the Hopewell people over that of their forebearers, the Archaic Indians of Indian Knoll.

The larger and more varied diet of the Hopewell people is considered to be the primary variable which accounts for their bone growth being greater than that of the Indian Knoll people who did not supplement their hunting and gathering with part-time agriculture. There is the possibility, though, that genetics is partly involved. The effective breeding size of the two populations was small. Inbreeding was therefore probably operating in both and contributing to an increase in homozygosity and decrease in overall genetic variability. Since Hopewell populations were larger and since they participated in an extensive trade network, outbreeding was probably more characteristic than in earlier Archaic times. If outbreeding were more common among Hopewellians, their larger bone diameter could be partly explained. For example, hybrid vigor in the form of increased stature has been observed among the offspring of outcrosses between European sailors and Polynesian women. This is not taken, however, to detract from the significant nutritional differences between the two populations.

Conclusions

1) The diet of a Middle Woodland-Hopewell population from the lower Illinois River Valley has been shown to differ from that of an Archaic population from the Green River in Kentucky. The latter population relied exclusively on hunting and gathering while the former enjoyed a larger and more varied diet due to the adoption of part-time agriculture to supplement hunting and gathering.

2) Statistically significant differences in radius diameter or width were shown to exist both inter- and intrapopulationally. Males of both populations were larger than females. Males and females of the Hopewell group were larger, respectively, than males and females of the Indian Knoll-Archaic group. These population differences in bone diameter are attributed to differences in the aboriginal diets.

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Literature Cited

1. CAMERON, J. R., and J. SORENSON. 1963. Measurement of bone mineral in vivo: An improved method. *Science* 142:230.
2. GARN, S. M. 1970. The earlier gain and the later loss of cortical bone. C. C. Thomas Press, Springfield, Illinois. 146 p.

3. JOHNSTON, C. C., D. M. SMITH, PAO-LO YU, and W. P. DEISS. 1968. *In vivo* measurement of bone mass in the radius. *Metabolism* 17:1140-1153.
4. PRUFER, O. H. 1965. The McGraw Site: A study in Hopewellian dynamics. Vol. IV. Cleveland Museum of Natural History. Cleveland, Ohio. 144 p.
5. STRUEVER, S. 1968. Woodland subsistence-settlement systems in the lower Illinois Valley, p. 285-312. *In* S. R. BINFORD and L. R. BINFORD (eds.) *New Perspectives in Archaeology*. Aldine Press, Chicago, Illinois. 373 p.
6. VICKERY, K. D. 1970. Evidence supporting the theory of climatic change and the decline of Hopewell. *Wis. Archeol.* 51 :57-76.
7. WATSON, P. J. 1969. The Prehistory of Salts Cave, Kentucky. Rep. Invest. No. 16. Illinois State Museum. Springfield, Illinois. 86 p.
8. WEBB, W. S. 1946. Indian Knoll. The University of Kentucky Reports in Anthropology. IV (3), Part I. University of Kentucky Press. Lexington, Kentucky. 254 p.