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A Cross-Sectional Study of Height, Weight, and Triceps Skinfold Measurements of Cherokee Indian Youths Ages 13-17

Ruby Allen Tompkins
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To the Graduate Council:

I am submitting herewith a dissertation written by Ruby Allen Tompkins entitled "A Cross-Sectional Study of Height, Weight, and Triceps Skinfold Measurements of Cherokee Indian Youths Ages 13-17." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

William M. Bass, Major Professor

We have read this dissertation and recommend its acceptance:

Mary Ann Bass, Richard L. Jantz, Francis S. Jones, John B. Gregg

Accepted for the Council:

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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

B

A CROSS-SECTIONAL STUDY OF HEIGHT, WEIGHT, AND TRICEPS SKINFOLD MEASUREMENTS OF CHEROKEE INDIAN YOUTHS AGES 13-17

A Dissertation

Presented for the

Doctor of Philosophy

Degree

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Ruby Allen Tompkins

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ABSTRACT

Anthropometric measurements of height, weight, and triceps skinfold were obtained from 266 Eastern Band Cherokee Indian youths ages 13-17. The data were compared to the United States national probability sample from the National Center for Health Statistics (HES), to a sample of American Indians from Minnesota, and to data on Whites from the Ten-State Nutrition Survey. The data were also examined for age, sex, and degree of Indian blood effects.

Differences between the Cherokee and Blacks and Whites from the HES sample were tested by a Bonferroni Post Hoc examination of means. There were no significant differences for height, but differences were significant for 9 of 16 comparisons of weight and for all 16 comparisons of triceps skinfold means.

Compared to the Minnesota Indian sample, the Cherokee are heavier and have thicker skinfold. Height values are essentially the same. The difference in skinfold values is greater between the males than between the females.

The Cherokee economic status is reported as poor and examination of the effect of economic status on growth was undertaken by comparing the Cherokee data on Whites from the Ten-State Nutrition Survey. The Cherokee have higher values for triceps skinfold with the differences being greater for the males than for the females. The Cherokee males are taller, and the females are similar in height but heavier than their age and sex peers from the Ten-State Survey sample.

An analysis of variance, using the General Linear Models Procedure was carried out to examine the effect of age, sex, and degree of Indian blood on growth. The females exceed the males in height, weight, and triceps skinfold values at age 13, but thereafter the males exceed the females in height and weight. The decrease in fatfold measurements for males after age 14 is concomitant with their growth spurt. The males show a greater trend toward a decrease in height with an increase in degree of Indian blood at age 13, and this trend and sex difference is most apparent at age 16. Also, at age 16, the sex difference decreases as the degree of Indian blood increases. The skewness values for height and triceps skinfold were not significant, but were for weight at ages 15 and 16 for the males and at ages 14-16 for the females. The relationship of weight to degree of Indian blood is significant. At ages 13 and 16, the sex difference is greater for those having between 0 and 1/4 percent Indian blood. At ages 14-16 there is a decrease in sex differences as the degree of Indian blood increases.

The Cherokee tend to be similar in height to Blacks, Whites, and Minnesota Indians. They are significantly heavier than their Black and White age and sex peers, and tend to be somewhat heavier than the Minnesota sample. The Cherokee difference in triceps skinfold is twofold. They have much greater fatfold values than their White, Black, and Minnesota peers, and they demonstrate considerably less sex differences in their fatfold measurements than their counterparts in the other three groups.

There is a close relationship between obesity and maturity-onset diabetes, and, though heredity is a factor, the stress of obesity can be a precipitating factor to the onset. A high percent of adult Cherokee demonstrate maturity-onset diabetes with concomitant vascular complications, infections, and neuropathies. Findings from the data collected in this study suggest that obesity may be a greater problem for the Cherokee than for Blacks and Whites. Comparison of nutrient intake and activity level with other groups might help clarify obesity trends seen in this study.

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CHAPTER I

INTRODUCTION

The period of growth which comprises the first 20 years of the human life span has been studiously analyzed resulting in a wealth of data and theories. Nevertheless, many questions remain unanswered. We do not know why an individual's complex patterns of growth produce a particular form of adult. Measures of physical growth are interpreted in relation to some expected value considered normal or usual for a child of a given age, sex, and genetic potential. The interpretation can then be placed in statistical terms, such as a statement of the likelihood that the measure in question would or would not have occurred in the distribution of values from the comparison population (Owen, 1973). The key words in the preceding statements are "genetic potential" and "comparison population."

Child growth is widely recognized as a sensitive index of the health and nutrition of a population (Johnston and Beller, 1976; Tanner, Whitehouse and Takaiski, 1966), and anthropometric data provide the most valid assessment of physical growth, body composition and nutritional status feasible for use in screening programs and standard physical examinations. Children at the extremes of the distributions are more likely to be either undernourished or overnourished or suffering from disease. The genetic growth potential of some ethnic groups, such as native Americans and those of Latin American or East Asian descent, is not well documented, and interpretation of their size relative to national reference standards should be made with care. Thus, it may be found that many individuals from these groups are outside the "normal" range, and a large proportion may be selected for further examination (Roche and McKigney, 1976).

Data have been collected on physical growth and development of North American Indians for 80 years (Adams and Niswander, 1968; Boas, 1940; Hrdlicka, 1900, 1935; Johnston and McKigney, 1978; Kraus, 1961; Kroska, 1965; Moore, 1969; Steggerda and Densen, 1936), but interpretation is difficult because the data pertain to ethnically diverse, geographically widespread and genetically distinct groups living under a variety of environmental conditions. Also, sampling techniques and analyses have varied considerably. Most of these studies have indicated below normal growth among native Americans when compared to accepted standards (Johnston and McKigney, 1978). Evidence indicates that though the health of the Indian family members has improved there remains too wide a gap between the health of Indian children and children of other American families.

The American Indian population represents about 0.3 percent of the total U.S. population, and since 1930, their rate of migration from rural to urban areas has been higher than for any other group. The median age of American Indians in 1960 was 17.3 years as compared to 19.5 years for the United States as a whole. Their birth rates are almost twice that of the United States population as a whole, while the infant mortality rate is higher. Post-neonatal mortality is more a reflection of the environmental conditions at home and this rate is almost three times as high as that for the United States as a whole.

Also, there is considerable evidence that the nutritional status of Indian children is substandard for a significant number (Wallace, 1973).

Analyzing data collected over the past 45 years, Moore (1969) concluded on the basis of the limited evidence available that American Indians probably do not share in the secular trend in physical growth, and that there is evidence of increased weight without increased height.

There are few current growth data available on native Americans, and the purpose of this study was to examine anthropometric data on height, weight and triceps skinfold of Cherokee Indian youths ages 13-17. The data were compared to the United States national probability samples from the Health Examination Survey (HES) on White and Black youths ages 13-17, and to data collected on a group of Minnesota native Americans to determine whether or not there were any ethnic differences for age and sex. An evaluation was made of the effect of age, sex, and degree of Indian blood on growth. Data from the Ten-State Nutrition Survey (TSNS) were used to compare the Cherokee data to other low income groups. Data from this study reflect the changes in size and shape associated with adolescence in a population of Cherokee Indians as compared to Whites, Blacks and Minnesota native Americans.

CHAPTER II

REVIEW OF THE LITERATURE

Growth (Birth to Twenty Years)

> "For everything there is a season and a time for every matter under the sun; a time to be born and a time to die . . . ."
>
> Ecclesiastes, Chapter 3

Although each individual grows and develops in his or her own way, each goes through a life cycle that is similar to that of all other human beings. Therefore, human development is generally predictable, passing from one level into the next from conception to death. Growth is a continuous orderly process, but the tempo of growth is not even, consequently it is more meaningful to ask in which stage of development is this individual than to ask how old is this individual (Beland and Passos, 1975; Boas, 1930; Garn, 1952; Krogman, 1972; Malina, 1975; Tanner, 1978).

Growth and/or development refer to the proportionate changes in size and the increasing complexity of functional units resulting from specialization and differentiation of cells. Differences in rate and pattern of growth exist between individuals, different races and geographical groups, between male and female and probably between recent and fossil men (Garn, 1952). It has been estimated that should the growth rate of the first post-conceptual month be continued until the postnatal age of 20 years the resultant mass would be (128,350) 1100 light years across (about the size of the known universe and expanding peripherally with nearly the speed of light) (Krogman, 1972). Obviously the rate of growth decelerates (except during adolescence) until attainment of adult stature which is usually indicative of cessation of growth (Malina, 1975).

The process of growth and development constitutes the link between the genotype and visible phenotype, and in order to understand the variations among adults, it is necessary to study this process from conception to adulthood. It is important to identify at what point differences become apparent, as well as to recognize the relationship of these differences to nutritional behavior, disease patterns, ecological factors, physical activity pursuits and other factors related to the local cultural setting (Falkner, 1962; Garn, 1952; Krogman, 1972; Malina, 1975; Tanner, 1978). Growth and development are perhaps the most plastic of our hereditary characteristics, adapting quite readily to environments. The human postnatal growth period is approximately 20 years (Krogman, 1972; Malina, 1975) which allows for an extremely long period of environmental interaction and thus for variation to set in. Although growth and development can be either inhibited or facilitated quite readily, alterations occur only within the limits established by the individual's genotype.

Problems in growth and development vary with the developmental stage and what may be important at one phase of growth may not constitute a problem at another (Garn, 1952; Krogman, 1972; Malina, 1975; Tanner, 1978). Scammon (1930) described the pattern of postnatal systemic growth as consisting of four basic growth curves, lymphoid, brain and head, general, and reproductive. The curves are based on the principle that by age 20 years, all systems will have attained 100 percent of their value, starting at birth with 0 percent. The four curves not only demonstrate the differential nature of development but also serve to emphasize potential sources of variation such as the consequences of early undernutrition on growth of neutral tissue or on the time of the adolescent spurt (Malina, 1975). These four curves are characteristic of humans, and are so basic that it is reasonable to conclude that they are genetically entrenched to the same degree in all children the world over. If there are any differences they are essentially environmental, not genetic (Krogman, 1972). The pattern of growth described by Scammon's curves may also reflect sexual, racial, and individual differences in development, and in the environmental modification of the rate and regularity of growth (Frisancho and Baker, 1970; Garn, 1952; Meredith, 1976; Roberts, 1953; Robson, Bazin and Soderstrom, 1971; Singh, 1970).

Factors Influencing Growth

The interaction of environment and heredity in the control of growth is highly complex and nonlinear (Tanner, 1978). For instance, though the factors of size and maturation rate are relatively independent of each other, they may show a relationship. Two individuals with the same potential for adult height may reach that height at different rates if one is an early maturer and the other is a late maturer (Malina, 1975). Or two children of different genotypes may be raised in a high socioeconomic environment, and A may grow to be five centimeters taller than B. However, if they are raised in a poor environment consisting of recurrent famine and chronic infection, both may end up smaller but B may be as tall or taller than A because his/her genes may be more suitable for the regulation of growth in marginal circumstances (Tanner, 1978). While many environmental factors influence the rate of growth, in the final analysis most of them are related to the level of nutrition in conjunction with infection (Eveleth and Tanner, 1976).

Data from the Ten-State Nutrition Survey of 1968-1970 (Garn and Clark, 1975) showed remarkably consistent socioeconomic effects on growth and development. Children of the poor grow less, and less well, than do children from more affluent levels. With increasing per capita income, increasing household income, and increasing incomes relative to needs, boys and girls are systematically taller and heavier, with greater circumferences (including head), and are advanced in skeletal maturity, dental development, and in such derived constants as the fat-free weight and skeletal mass. The generalizations hold within ethnic and racial groupings though at different levels for Blacks, Whites, and Meso-Americans.

Ethnic Differences

Races differ in a great many respects. An example is stature. Even in regions where malnutrition is common, taller lineages produce taller children. Size is not comparable between different human populations because of differences in trunk and limb length. It has generally been found that Black boys and girls are taller than their White peers through age 14 (Foster, Voors, Webber, Frerichs, and Berenson, 1977; Mierzejewska, 1970). However, the Health Examination

Surveys (1972; 1973) on children and youths up to age 17 years found that White and Black males displayed a consistent and remarkable similarity in height over the 12-year span. During the first several years, the Black boys tended to be slightly taller than the White boys by about the same margin that the White boys were taller during the last few years, but for the largest part of the age span, there were no consistent differences. However, the White boys consistently weighed more than the Black boys (except at ages 13 and 14 when the weights were essentially the same) over the 12-year span. This discrepancy in the height and weight growth patterns is explained by the differences in body components. The White boys have longer trunks and the Black boys have longer legs. The female pattern of racial differences was almost identical to the male pattern. These results are consistent with Krogman's (1970) findings in his study on healthy Philadelphia White and Black children ages 6 through 12. White children in the HES sample also demonstrated greater subcutaneous fat thickness than Blacks.

Racial differences in the size, proportions, form, and mineral content of the bones are well-documented for a number of groups. Individuals of Chinese and Japanese ancestry, whether American-born or born abroad, have less compact bone per unit of length than Americans of European descent (Garn, Pao, and Rihl, 1964). The weight to volume ratio is higher in Black skeletons and it appears that Black boys and girls have a higher mineral requirement for growth (Garn and Clark, 1976). It has long been known that Black infants are smaller than White infants at birth even though Black infants are developmentally advanced, and these dimensional differences at term are reversed within the next few years (Garn and Clark, 1976).

Eveleth and Tanner (1976) studied height curves of London children, well-off Chinese children in Hong Kong, and Afro-Americans from Washington, D.C. Though the D.C. children came from a relatively low income group in the United States, they enjoyed a more favorable environment than any African group studied in large numbers in Africa. They found that the European and Afro-American groups had almost identical curves for boys but that the African-descended girls were a little larger than the European girls. This was credited in part to the African girls having a swifter growth tempo. The Asiatic boys and girls were distinctly shorter, but growth delay was not considered to be the cause since their growth tempo was significantly faster than that of Londoners, and the adult height difference greater than the childhood difference. The conclusion is that this difference is due to differences in gene pool.

Ashcroft, Henegar, and Lovell (1966) studied the heights and weights of about 5000 Jamaican school children ages 11 through 17 of various ethnic groups, and of middle and upper socioeconomic class. They found that stature of Africans, Afro-Europeans and Europeans was similar, and that the Chinese were consistently smaller.

In a longitudinal study of American-born Japanese children, Greulich (1976) found them to be taller, heavier, and shorter-legged than men and women in Japan born the same years. Differences were greater in childhood than in adulthood probably due to the acceleration in the growth rate of the native Japanese and concomitant decline in that of the American-born Japanese during the intervening years.

Kano and Chung (1975) compared the heights and weights of over 6000 school children ages 11 through 17 years and found that Hawaii-Japanese boys are taller at earlier ages than Japanese boys in Japan, but the difference disappeared at age 16. Native Japanese girls are shorter than Hawaii-Japanese girls until age 13, but overtake them at age 14 and after age 15 exceed them in height. Similar patterns are found in weights of the females. The male Hawaii-Japanese remain consistently heavier, by 5 to 9 kilograms, than native Japanese.

The greatest differences between races, when all are growing up in good environments, are those of shape (Tanner, 1978). Australian Aborigines have the longest legs to sitting height followed by children of African ancestry. Japanese have proportionately shorter legs. These differences are observable at 4 years of age and probably earlier. Afro-Americans have somewhat longer legs to sitting height than Africans, and offspring of Japanese and Afro-American crosses fall between Japanese and Afro-Americans in this proportion (Eveleth, 1978).

The study of American Indian birth weights reported by Adams and Niswander (1968; 1973) found the American Indians to be heavier compared to other racial and ethnic groups. Johnston and McKigney (1978) studied heights, weights, and skinfolds of urban native Americans from Minneapolis ranging in age from 22 days through 19 years, and compared the data to United States national probability samples from the National Center for Health Statistics. The native Americans, in general, were slightly shorter, consistently heavier, and had thicker skinfolds except for males below 6 years of age. While most populations of native Americans are on the average shorter than their white American age and sex peers, some populations are near the mean or taller. In particular, greater stature is associated with Indians from the Plains area of the United States as well as the area to the North, including many Canadian Indian samples.

Kroska (1965) did a comparative physical growth study of Minnesota White and Indian children ages 6 through 12 to determine age, sex, and ethnic group differences in skeletal, fat, and muscle development. White boys of all ages were taller and heavier than their male Indian peers. The means of the youngest White girls indicated them to be heavier and taller than the youngest Indian girls. Otherwise, those from 8 through 12 years were approximately the same weight and height. Shoulder width of the oldest Indian girls was greater than that of White girls. Upper arm skinfolds in the youngest White boys were significantly greater than their male Indian peers. White boys had larger muscles than their male Indian peers, and White and Indian females were equal in muscle size.

Environmental Differences

During growth, adaptation to a particular environment may occur either by the shaping of individual characteristics into the environmental mold, or through natural selection of those characteristics which confer an advantage for survival in that environment (Malcolm, 1970). Hiernaux (1964) studied the weight/height relationship during growth in Africans and Europeans and concluded that acting on a similar gene pool, better environmental conditions result in an accelerated growth in birth height and weight together with a heavier weight for a given stature. He felt that South African populations exhibit a potential for a relative weight for height at least equal to that of Europeans and North American White populations. This tendency is more strongly expressed in the female.

Habicht, Martorell, Yarbrough, Malina, and Klein (1974) compared height and weight data of children from birth to 7 years of age between and within developing countries and developed countries. They found differences of 3 percent for height and 6 percent for weight in those who were well-nourished but of different ethnic backgrounds. In contrast, differences between the above group and children of similar ethnic and geographic backgrounds who lived in the poor urban and rural areas of developing countries approached 12 percent in height and 30 percent in weight. Differences in growth associated with social class were many times those which can be attributed to ethnic factors alone.

Johnston, DeChow, and MacVean (1975) demonstrated similar findings in skinfold data on a sample of upper socioeconomic class children and youths residing in Guatemala City. The skinfold thickness of the Guatemalan and European children of their study did not differ despite the fact that genetic differences had been demonstrated. Comparison between the children in the study and children from either the United States or London suggested that populations from different ethnic backgrounds, reared in the same environments, display age changes more similar to each other than they do to their counterparts living in different environments. The overall similarity is greater for males than for females, suggesting that males respond more readily to environment than do females.

Sex Differences

Sex difference in maturation rate is probably the most obvious indicator of genetic regulation of growth and development. Females mature more rapidly than do males, and this priority is apparent during the fetal period. This advantage holds true whether children belong to an early maturer or late maturer category (Krogman, 1972; Tanner, 1978). Differences between the sexes in body shape are not obvious at the younger ages, but develop around puberty as body components for each sex grow at different rates.

The sex difference in tempo of growth becomes apparent halfway through the fetal period when the skeleton is some 3 weeks more advanced in females than in males. At birth, the maturation differences is about 4 to 6 weeks, and by puberty is 2 years. Girls are physiologically more advanced in other organ systems also, which may possibly account for the reason more girls than boys survive at birth, whatever the general level of perinatal mortality (Tanner, 1978). Some studies have found that during the early prenatal period the male is advanced over the female in development of the hand skeleton (Garn, Burdi and Babler, 1974), palatal closure (Burdi and Silvey, 1969), and early prenatal dental development (Garn and Burdi, 1971).

The sexes differ in sitting height relative to leg length, males having longer legs to trunk than females, but this relationship is not manifested until puberty. In many populations, girls actually have somewhat longer legs to trunk than do boys in early childhood (Eveleth, 1978). The Health Examination Survey (HES) (Hamill, Johnston, and Lemeshow, 1973) on youths ages 12 to 17 found that sitting height constitutes an increasingly large proportion of stature with each year of adolescence for both Blacks and Whites, but found a striking sex difference. The females of each race had a greater proportionate sitting height than did males. Though males are slightly heavier and taller from birth until puberty, females become temporarily taller and heavier due to a 2-year acceleration in their adolescent growth spurt. Adult height sex differences are due primarily to the longer growth period of males (Bock, Weiner, Peterson, Thissen, Murray, and Roche, 1973; Roche and Davila, 1972). The greatest sex dimorphism occurring at puberty is in the shoulders and the hips, with the males developing broader shoulders and the females developing broader hips.

Eveleth (1975) found that among Negroid, European, and American Indian populations sex dimorphism was greatest among American Indians and least in Negroid populations. The greater sex dimorphism among American Indians seems to point to genetic rather than environmental factors. It would be difficult to conceive of American Indians as a whole better nourished than Europeans as a whole, though it is conceivable that boys are treated better in that society than girls.

From a strictly descriptive viewpoint, body composition measures clearly differentiate males from females. Studies of skinfold measurements show greater thickness for females than for males (Johnston and Beller, 1976; Krogman, 1972; McCammon, 1970; Tanner, 1978). Examining data on the body compositions of Black, White and Puerto Rican newborns, Johnston and Beller (1976) found that with all ethnic groups combined the mean triceps skinfold of females is some 10 percent greater than that of males. Considering that the adipose organ is laid down only during the last weeks of the prenatal period this presents a marked sex difference.

Anthropometry in the Study of Growth and Development

Anthropometry is the traditional and probably the most basic tool used in the study of growth. The number of measurements that can be taken is almost limitless, and the purpose of a study determines the methods to be used (Garn and Shamir, 1958; Malina, 1975; Montagu, 1960). It is important that the investigator be consistent in using landmarks and techniques on each subject included in a particular survey whether on individuals or groups, and that these be recorded and described. Since the human body is quite variable it may be noted that the anatomical structures are not always what or where the textbooks show them to be (Hertzberg, Churchill, Dupertuis, White, and Damon, 1963).

Nearly all techniques for individual growth appraisal employ measures of height and weight. These are the two most commonly used anthropometric dimensions (Malina, 1975), along with the measurement of skinfold thickness which has more recently become an accepted practice. A major percentage of body fat lies immediately beneath the skin in the form of subcutaneous tissue which can easily be measured with special calipers. Based on the assumption that skinfold thickness is an indication of the amount of subcutaneous fat, skinfold measurements provide a means for estimating body fat (Brozek, 1960; Durnin and Rahaman, 1967; Garn and Shamir, 1958; Hertzberg et al., 1963; Johnston, DeChow and MacVean, 1975; Malina, 1975; Seltzer and Mayer, 1965; Tanner and Whitehouse, 1955; Wormersley and Durnin, 1977).

The triceps skinfold site has the advantages of requiring little exposure, and being readily accessible in individuals of both sexes in most cultures. The skinfold is located on the dorsum of the upper arm at the level midway between the lateral margin of the acromial process of the scapula and the olecranon process of the elbow (Brozek, 1963). Also, the technique is simple, the calipers are relatively inexpensive and easily transportable, and with proper instructions and a minimum of demonstration by an experienced person, the user can obtain reproducible measurements.

Damon (1965) studied the difference in measurements obtained when lifting the skinfold with one hand versus using both hands, and between measurements taken on the right arm and left arm. He concluded that skinfolds should be lifted between two hands and measured on the left side. However, the values which he found to be larger with a one-handed pinch were not significant, and existence of a standardized body of data outweighs the slight advantage to be gained by modifying current practices.

Because of fairly rapid changes in the layer of the subcutaneous fat over relatively small distances at certain areas of the body surface, the sites should be clearly defined and carefully identified prior to measuring skinfolds in a given individual (Brozek, 1960). Distribution of skinfold measurements skew considerably in the general population (Tanner and Whitehouse, 1955) and the direction as well as the amount of skewness of fatness varies from age to age (Garn, 1972; Garn and Clark, 1975). Johnston et al. (1975) in comparing the distribution of skinfolds of European and Guatemalan school children from the highest socioeconomic levels of Guatemala City found skewness to the right with greater skewness in the subscapular than the triceps, and greater skewness in both measurements in the males. The median triceps fold of males declines during the early years of adolescence and is shown to be associated with the growth spurt (Hamill et al., 1973; Tanner, 1978). Johnston et al. (1974a; 1974b) suggest that the racial differences in skewness are hereditary in the triceps but due to environmental causes in the subscapular difference. Skinfold measurements help clarify the relationship between height and weight, and are a clinically acceptable means of assessing body fatness (Owen, 1973).

Standardization of skinfold calipers is necessary for universal comparability of fatfold measurements. The accepted national recommendation is a caliper designed so that in spite of existing differences in construction the caliper pressure at the contact surface be kept at the standard value of 10 gm/mm^2, and with a contact surface of 20 to 40 millimeters (Montagu, 1960; Seltzer and Mayer, 1965). Skinfold calipers meeting these requirements include the Lange Skinfold Caliper and the Harpenden Skinfold Caliper.

Conclusion

There are little current growth data on native Americans, and most studies conducted over the past 80 years have indicated below normal growth when compared to accepted standards. In this study, height, weight, and triceps skinfold data were examined in a cross-sectional study of Cherokee Indian youths residing in Cherokee, North Carolina, to test the hypotheses that there are no differences in the height, weight, and triceps skinfold measurements between Cherokee Indian youths ages 13-17 and their Black and White age and sex peers. Since American Indians have been economically disadvantaged compared with other ethnic groups in the United States, the data were compared to growth data selected from other low income groups in the Ten-State Nutrition Survey. Examination of data collected on a group of urban native Americans in Minnesota (Johnston and McKigney, 1978) was undertaken to compare the data to those collected on the Cherokee Indian group. Findings of this study should augment existing fragmentary knowledge of the physical growth of American Indians.

CHAPTER III

MATERIALS AND METHODS

The youths comprising this sample were attending the high school located on the Cherokee Indian Reservation near the Great Smoky Mountain National Park in North Carolina. The report on a population and economic study of the Eastern Band of Cherokee Indians (1974) describes the Reservation's 56,573 acres as predominantly rural nonfarm with about 97 percent of its population so classified. About 80 percent of the acreage is forest land, and there are approximately 1,857 acres currently in use as residential. The basic economy has changed from one of farming and industry into one in which tourism has become the major activity. This is supplemented by light industry and a variety of government activities.

At one time, the Cherokee Indian Tribe numbered about 25,000 people. They occupied the seven states of Virginia, Kentucky, North and South Carolina, Tennessee, Georgia, and Alabama. Between 1789 and 1835, the Cherokee Nation ceded their land east of the Mississippi River, and in 1836, the majority of them were moved to Oklahoma. According to the United States Population Estimated Census of 1970, the total Eastern Band of Cherokee population was reported to be 5,392. In 1975, the Tribal Enrollment Office recorded the population to be 8,381 with 5,550 living on the Cherokee lands and 2,831 living off the lands (1974).

The economic status of the Eastern Band of Cherokee is considered poor. Almost 80 percent of the families have incomes below the poverty level of $3,000. The majority of personal income is derived from

Federal employment, local wage work, lease money (for Cherokee land), crafts for tourist trade, and welfare. The percent of Cherokee population under age 16 is 45.44, and the median school years completed is 9. About 22 percent of the adult males have less than 5 years of schooling.

According to Cherokee hospital records for the fiscal year 1978-1979 (1978), the 10 most common reasons for outpatient visits ranked by workload were:

1. Respiratory Disease
2. Circulatory System Disease.
3. Endocrine, Metabolic, Blood Disorders.
4. Obstetrical-Gynecological.
5. Trauma.
6. Neuropsychiatric Disease.
7. Gastrointestinal Disease.
8. Musculo-skeletal Disease.
9. Skin Disease.
10. Genito-Urinary Tract Disease.

Respiratory disease appears as number one because it includes common upper respiratory conditions such as the common cold, and ear, nose and throat infections. The major problems which are hospital-related revolve around diabetes and related problems and are listed above as the second and third most common reasons for outpatient visits.

Sample

The young people who participated in this study were enrolled in the Cherokee Indian High School in grades 8, 9, and 10, and ranged in age from 13-17. Table 1 is a summary of sample sizes by age and sex for each measurement. Complete data are available only for those who were present on the days the measurements were taken (3 days in a 2-week span). Participation was voluntary. Measurements were taken during a

TABLE 1

SAMPLE SIZE BY AGE AND SEX FOR HEIGHT, WEIGHT, AND TRICEPS SKINFOLD MEASUREMENTS

AGE	VARIABLE	MALE	FEMALE	TOTAL
13	Height	24	15	39
	Weight	24	15	39
	Triceps Skinfold	24	15	39
14	Height	44	37	81
	Weight	44	37	81
	Triceps Skinfold	40	35	75
15	Height	36	53	89
	Weight	35	53	88
	Triceps Skinfold	32	49	81
16	Height	29	23	52
	Weight	26	24	50
	Triceps Skinfold	25	23	48
17	Height	1	4	4
	Weight	1	4	5
	Triceps Skinfold	1	4	5

scheduled class period which included a presentation on growth. Age was self-reported, and degree of Indian blood was obtained from Tribal records. Tribal records of degree of blood have been kept for many years and each child's degree of blood is recorded on his or her permanent school record. Fractions with a 32 or 64 in the denominator are not uncommon. Even a fraction of 128 appears which indicates a knowledge of 7 generations (Pollitzer, Hartmann, Moore, Rosenfield, Smith, Hakim, Schmidt and Leyshon, 1962). Table 2 is a summary of the breakdown of degree of blood by frequency of percent.

Methods

Measurements taken include standing height, weight and triceps skinfold. Using an anthropometer the height was taken with the student standing erect in stocking feet, heels together, and head in approximate Frankfort plane position. Weight was measured on a balanced beam scale with the students removing only their shoes. All males and females wore jeans or slacks and a shirt. The triceps skinfold was measured on the dorsum of the right arm midway between the acromial process and the olecranon process with a Lange caliper. Height was recorded to the nearest tenth of a centimeter, weight was recorded to the nearest half pound, and the skinfold was estimated to the nearest half millimeter.

Univariate statistics were calculated by sex for each age group and included means, medians, standard deviations, skewness, standard error of the mean, and percentiles. A three factor (age, sex, degree of blood) fixed effects analysis of variance (ANOVA) was carried out using the General Linear Models Procedure (SAS Package). This approach yields

TABLE 2

SUMMARY OF PERCENT OF FREQUENCY FOR EACH CATEGORY OF DEGREE OF BLOOD

Percent of Degree of Blood	Number	Percent	Cumulative Percent
0 - .25	53	18.728	19.728
.25 - .50	91	32.155	50.883
.50 - .75	58	20.495	71.378
.75 - 1.0	81	28.622	100.000

1.0 equals full-blood.

partial sums of squares for testing F (Barr, Goodnight, Sall and Helwig, 1976). It is a more conservative approach and was used because the layout of the design was unbalanced. The ANOVA was done in order to examine the effects of age, sex, and degree of Indian blood on height, weight and triceps skinfold. A Bonferroni examination of means for height, weight and triceps skinfold was used to compare the Cherokee youths to their Black and White age and sex peers. The Bonferroni procedure was used because the contrasts were not orthogonal and cell sizes were unequal. Also, the alpha level can be controlled thus reducing the probability of making a Type I error (Neter and Wasserman, 1974).

Data from the Ten-State Nutrition Survey (1972) were used to compare the Cherokee to Whites from a low income sample. Comparison to other Indians was made using data collected on a Minnesota Indian group by Johnston and McKigney (1978).

CHAPTER IV

RESULTS AND DISCUSSION

Age and Sex Differences

The analysis of variance (Table 3) yielded an overall F ratio for height that was significant at the .0001 level of probability, for weight at .009, and for triceps skinfold at 0.4.

For the variable, height, the F ratio for the main effects of age and sex was found to be significant at the .0001 level of probability, and for degree of blood at a .001 level. Table 4 was constructed from the univariate statistics calculated for height, weight, and triceps skinfold by age and sex, along with sample size of each group. Data from Table 2 were used to compare the mean values for each age by sex (Figure 1) and show that at age 13 the females tend to be only slightly taller than the males. From ages 14 through 16, the males continue to increase in height a total of 15.14 centimeters while the females show a total increase of only 2.4 centimeters. The change reflected between ages 13 and 14 may represent the sex difference in tempo of the adolescent growth spurt. This pattern is similar to the findings of Johnston and McKigney (1978) in their study of data collected on the Minneapolis American Indians.

Examination of the relationship of height to degree of Cherokee blood was undertaken by graphing the mean height in centimeters for each sex against the degree of blood for ages 13 through 16 (Figures 2, 3, 4 and 5). Insufficient numbers precluded inclusion of age 17. Students

TABLE 3

ANALYSIS OF VARIANCE SUMMARY (GENERAL LINEAR MODELS PROCEDURE) ON CHEROKEE DATA FOR HEIGHT, WEIGHT, AND TRICEPS SKINFOLD

SOURCE	DF	SS (Partial)	MS	F
FOR HEIGHT				
Model	36	8730.41729	242.51159	6.74*(.0001)
Error	225	8098.48885	35.99328	
Corrected Total	261	16828.90614		
Age	4	2050.7651		14.24*(.0001)
Sex	1	2060.1088		57.24*(.0001)
Age X Sex	4	294.7397		2.05
Degree Blood	3	577.9778		5.35*(.001)
Age X Degree Blood	12	369.3449		0.86
Sex X Degree Blood	3	223.4528		2.07
Age X Sex X Degree Blood	9	208.9402		0.64
FOR WEIGHT				
Model	36	64946.7775	1804.0771	1.72*(.009)
Error	222	232504.7228	1047.3185	
Corrected Total	258	297451.5003		
Age	4	15092.0109		3.60*(.007)
Sex	1	1434.6148		1.37
Age X Sex	4	3758.1990		0.90
Degree Blood	3	459.0851		0.15
Age X Degree Blood	12	12775.5713		1.02
Sex X Degree Blood	3	11158.8238		3.55*(.01)
Age X Sex X Degree Blood	9	5822.8957		0.62
FOR TRICEPS SKINFOLD				
Model	36	1674.9087	46.5252	1.03 ns
Error	207	9343.3867	45.1371	
Corrected Total	243	11018.2955		
Age	4	313.0170		1.73
Sex	1	147.9992		3.28
Age X Sex	4	94.0074		0.52
Degree Blood	3	166.5623		1.23
Age X Degree Blood	12	448.5421		0.83
Sex X Degree Blood	3	222.6138		1.64
Age X Sex X Degree Blood	9	189.1067		0.47

TABLE 4

SAMPLE SIZE, MEAN, STANDARD DEVIATION, STANDARD ERROR OF THE MEAN, AND THE 5TH, 25TH, 50TH, 75TH, AND 95TH PERCENTILES BY AGE AND SEX FOR THE CHEROKEE DATA ON HEIGHT

SEX AND AGE	N	$\overline{X}$	S	$S_{\overline{X}}$	PERCENTILES 5th	25th	50th	75th	95th
MALE									
13	15	159.14	4.57	1.18	151.0	154.85	159.7	162.87	165.32
14	37	167.68	6.26	1.03	158.85	163.02	167.0	170.7	177.44
15	53	169.90	7.04	0.96	155.15	166.12	169.9	173.52	181.65
16	23	174.28	6.96	1.45	161.71	168.47	174.95	178.87	183.54
17	4	175.77	5.05	2.52	170.5	170.5	173.5	176.8	181.2
FEMALE									
13	24	159.49	5.71	1.16	149.5	155.5	158.3	162.6	169.96
14	44	159.26	5.56	0.83	152.5	155.5	157.8	162.5	167.38
15	36	160.85	6.58	1.09	148.36	156.8	160.4	166.3	169.9
16	29	162.42	4.23	0.78	154.51	159.3	161.7	165.27	169.16
17	1	160.5							

Variable: Height (cm).

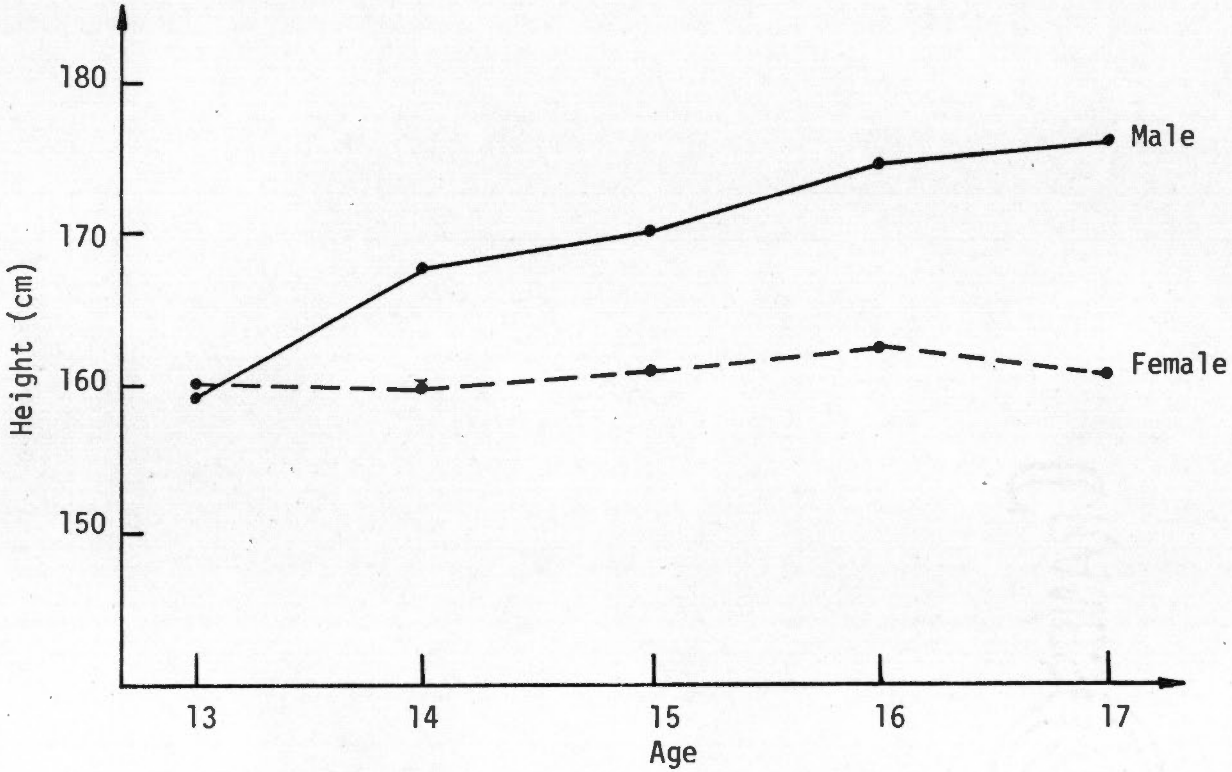

Figure 1. Mean Height of Cherokee Males and Females Ages 13-17.

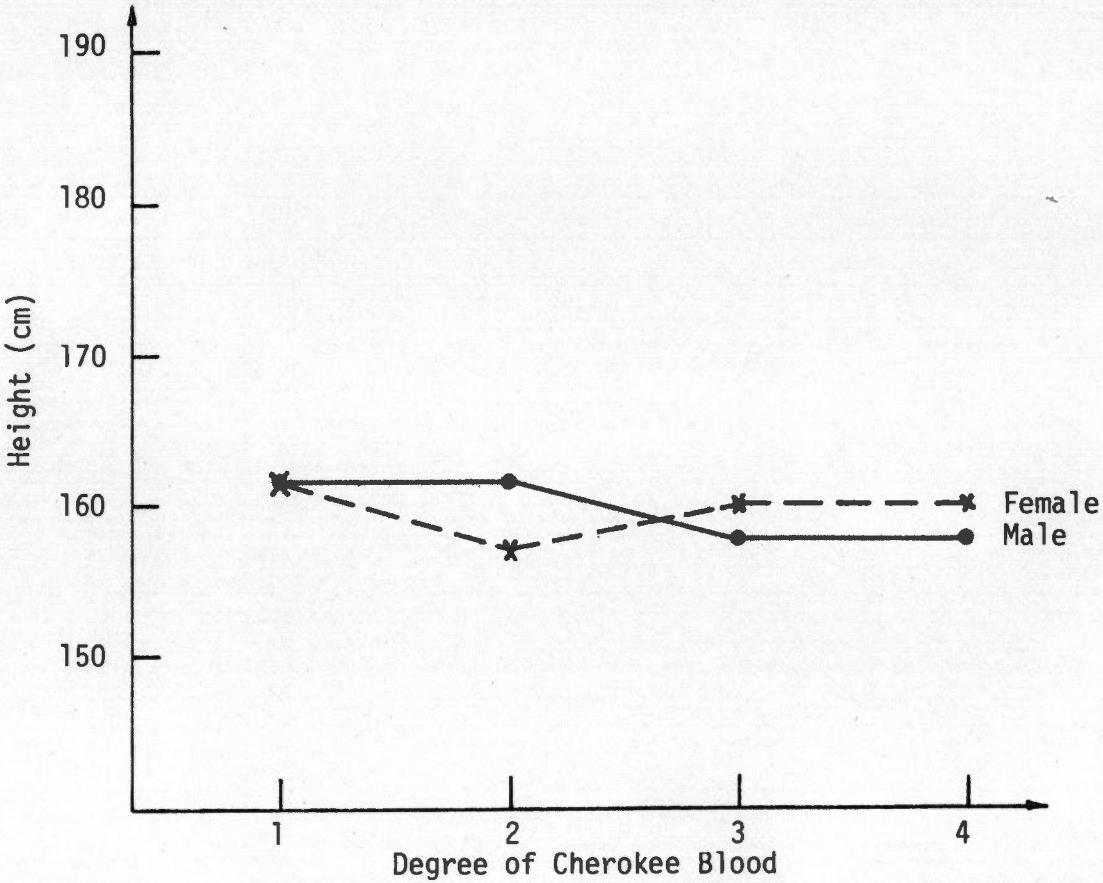

Figure 2. Relationship of Degree of Cherokee Blood to Height for Males and Females Age 13.

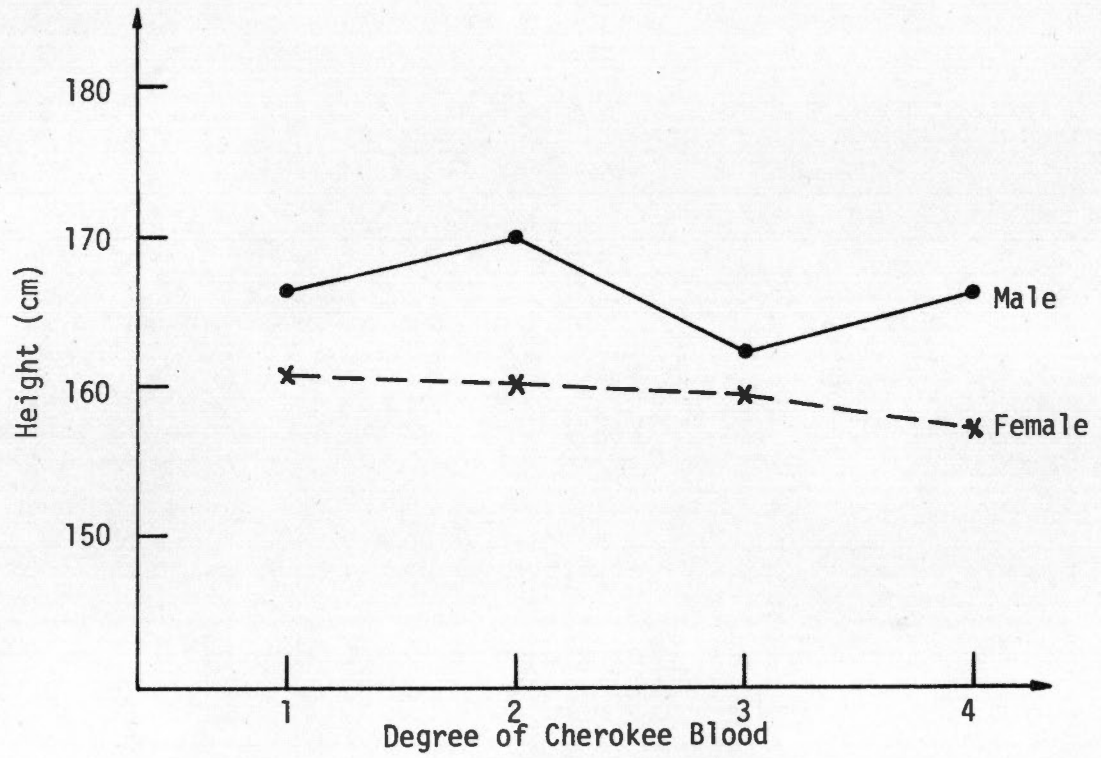

Figure 3. Relationship of Degree of Cherokee Blood to Height for Males and Females Age 14.

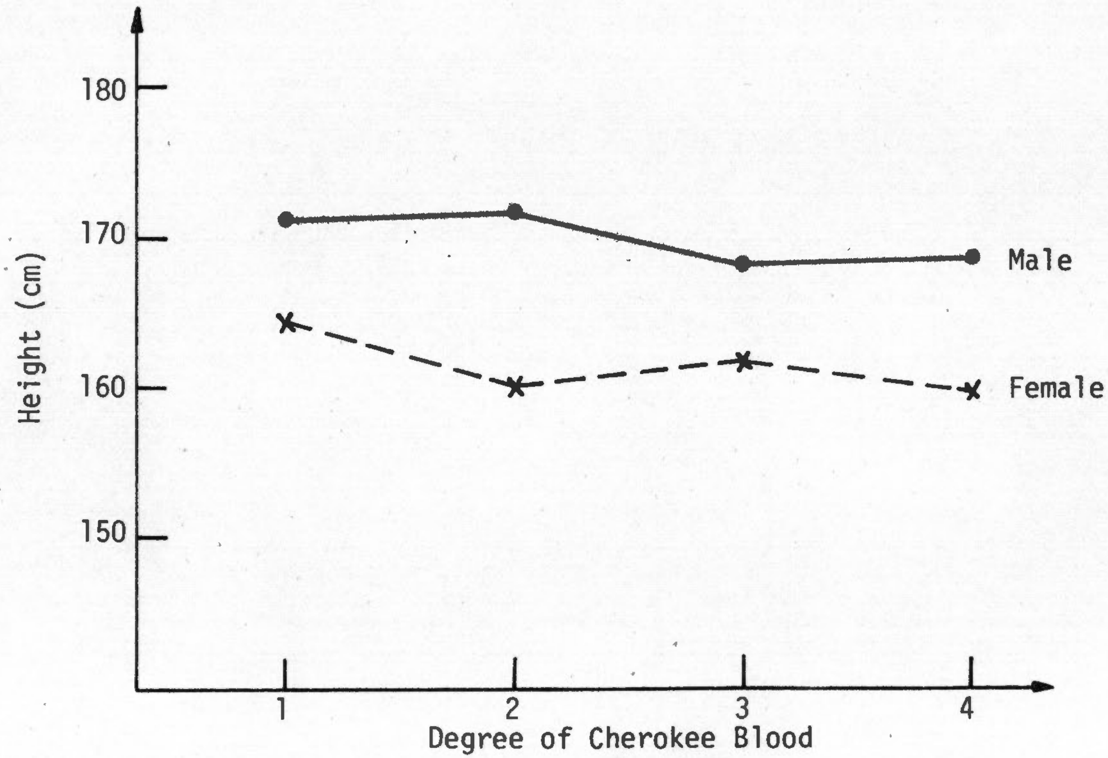

Figure 4. Relationship of Degree of Cherokee Blood to Height for Males and Females Age 15.

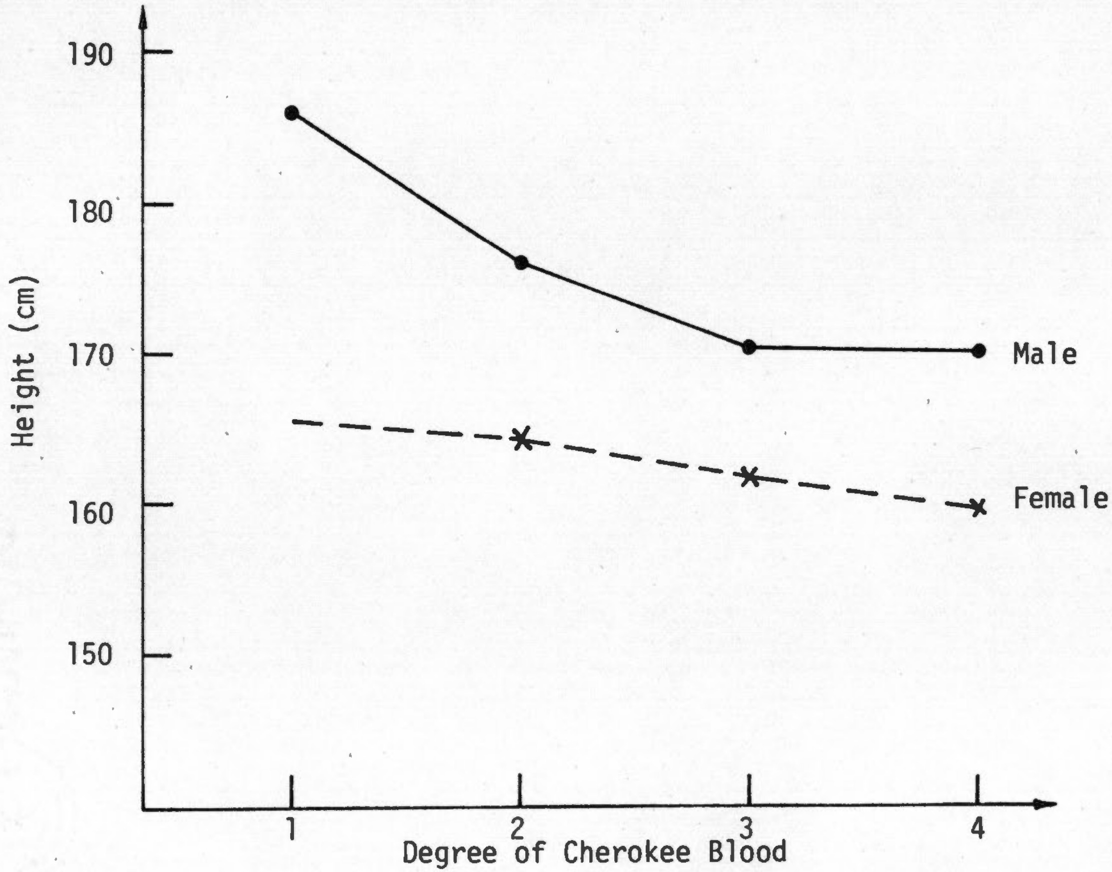

Figure 5. Relationship of Degree of Cherokee Blood to Height for Males and Females Age 16.

having between zero and one-fourth Cherokee blood represent category one, and those having three-fourths to full blood represent category four. No obvious trend is seen for females at age 13, but males show a tendency to decrease in height with an increase in degree of blood. The trend is evident in both sexes ages 14 through 16. The trend is most obvious at age 16.

The partial sum of squares for weight yielded a significant F value for age at a .007 level of probability, and for the interaction of sex and degree of blood at a .01 probability level (Table 3, p. 26). Data from Table 5 were used to plot mean weight in kilograms against ages 13 through 17 for each sex (Figure 6). The pattern is similar to that of height in that the females are heavier than the males at age 13, but thereafter the males are heavier at all ages. The pattern for height differs from weight in that the distribution of height is essentially gaussian while that of weight is typically skewed. All values for weight are skewed to the right with high values occurring farther from the mean more often than do low weight values.

Table 6 is a summary of the tests for significance of skewness less than, or equal to a .05 probability level for height, weight, and triceps skinfold. Calculations were based on the formula

$$t_s = \frac{(g_1 - v_1)}{s_{g1}} \quad \text{where}$$

g_1 is the sample statistic, $v_1 = 0$, and s_{g1} equals the standard error of g1 or the square root of 6 divided by n, df = infinity (Sokal and Rohlf, 1969). Skewness of height was not significant for males ages 13 and 14, but was significant at a .001 level of probability for age

TABLE 5

SAMPLE SIZE, MEAN, STANDARD DEVIATION, STANDARD ERROR OF THE MEAN, AND THE 5TH, 25TH, 50TH, 75TH, AND 95TH PERCENTILES BY AGE AND SEX FOR THE CHEROKEE DATA ON WEIGHT

SEX AND AGE	N	$\overline{X}$	S	$S_{\overline{X}}$	PERCENTILES 5th	25th	50th	75th	95th
MALE									
13	15	52.63	8.46	2.18	41.21	45.18	51.68	56.64	65.14
14	37	66.80	14.36	2.36	46.28	54.55	67.0	74.95	92.74
15	53	67.52	15.0	2.05	48.94	58.46	63.40	72.97	95.05
16	24	72.64	15.77	3.22	49.59	61.26	69.40	76.57	103.87
17	4	67.56	3.97	1.98	63.28	63.28	65.09	70.72	71.08
FEMALE									
13	24	59.64	14.10	2.87	39.0	46.84	57.43	71.62	83.37
14	44	60.23	14.86	2.23	43.06	49.55	53.6	69.82	90.9
15	35	65.62	16.91	2.85	43.63	52.64	59.23	71.45	96.8
16	26	63.47	14.83	2.91	46.89	53.71	59.0	67.45	91.06
17	1	56.76							

Variable: Weight (Kg).

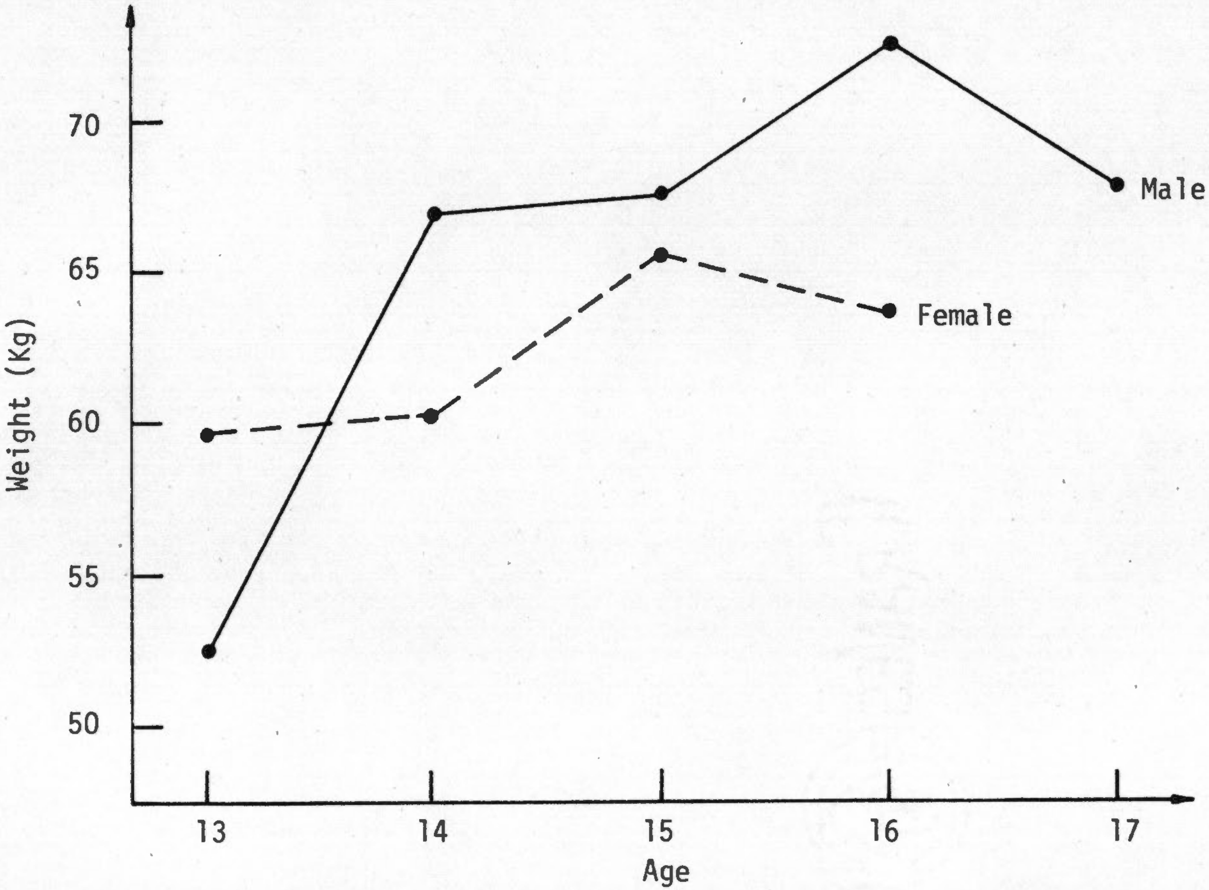

Figure 6. Mean Weight of Cherokee Males and Females Ages 13-17.

TABLE 6

SUMMARY OF TEST OF SIGNIFICANCE FOR SKEWNESS BY AGE AND SEX FOR HEIGHT, WEIGHT, AND TRICEPS SKINFOLD DATA ON CHEROKEE

VARIABLE	AGE	SEX	SKEWNESS	t_s
Height	13	M	-.145823	-0.2305
		F	.527982	1.0559
	14	M	.0646537	.4026
		F	.37689	.3692
	15	M	-.188813	.5611
		F	-.251671	.4082
	16	M	-.690387	.4264
		F	.481303	.4548
Weight	13	M	.657099	1.0389
		F	.376119	.7522
	14	M	.560277	1.3913
		F	.89304	2.419 *
	15	M	1.56248	4.7033**
		F	1.23061	2.9722*
	16	M	1.13159	2.2631*
		F	1.72318	3.587 **
Triceps Skinfold	13	M	1.12304	1.7756
		F	1.12304	2.2460*
	14	M	.01898	.0458
		F	.50632	1.3395
	15	M	.302481	1.09
		F	.581369	1.3426
	16	M	.237777	.5107
		F	.796865	1.6266

*Significant at the .05 level.

**Significant at the .001 level.

15 and at .05 for age 16. The female values were not significant at age 13 but were at age 14 (.05), 15 (.05), and 16 (.001). The mean weight for males increases a total of 20.1 kilograms and for females a total of 3.83 kilograms.

Examination of the relationship between sex and degree of blood was undertaken by graphing the relationship of weight to degree of blood by sex for ages 13-16 (Figures 7, 8, 9, and 10). The overall pattern for males shows a trend toward an increase in weight with an increase in degree of blood up to age 16. At age 16, there is a decrease in weight as degree of blood increases. At ages 13 and 15, the female values, overall, are greater than the males', but at ages 14 and 16, the male values are greater than the females'. At ages 14-16, the values for the sexes tend to be closer as the degree of blood increases.

The overall F value for the variable triceps skinfold was not significant at the .05 level of probability. The partial sum of squares values did not yield significant F ratios for main effects (age, sex, degree of blood) or interactions (age by sex, age by degree of blood, sex by degree of blood, age by sex by degree of blood) less than or equal to .05.

Table 7 and Figure 11 are statistical and graphic presentations of data on the triceps skinfold measurements. At ages 13, 15, and 16, the female mean is higher than the male mean. There is a greater difference in the means at age 13 than at ages 14, 15, and 16. The males follow essentially the same pattern demonstrated for height and weight. That is, there is a sharp increase between ages 13 and 14 but a slight decrease from age 15 to 16 which may be a reflection of the

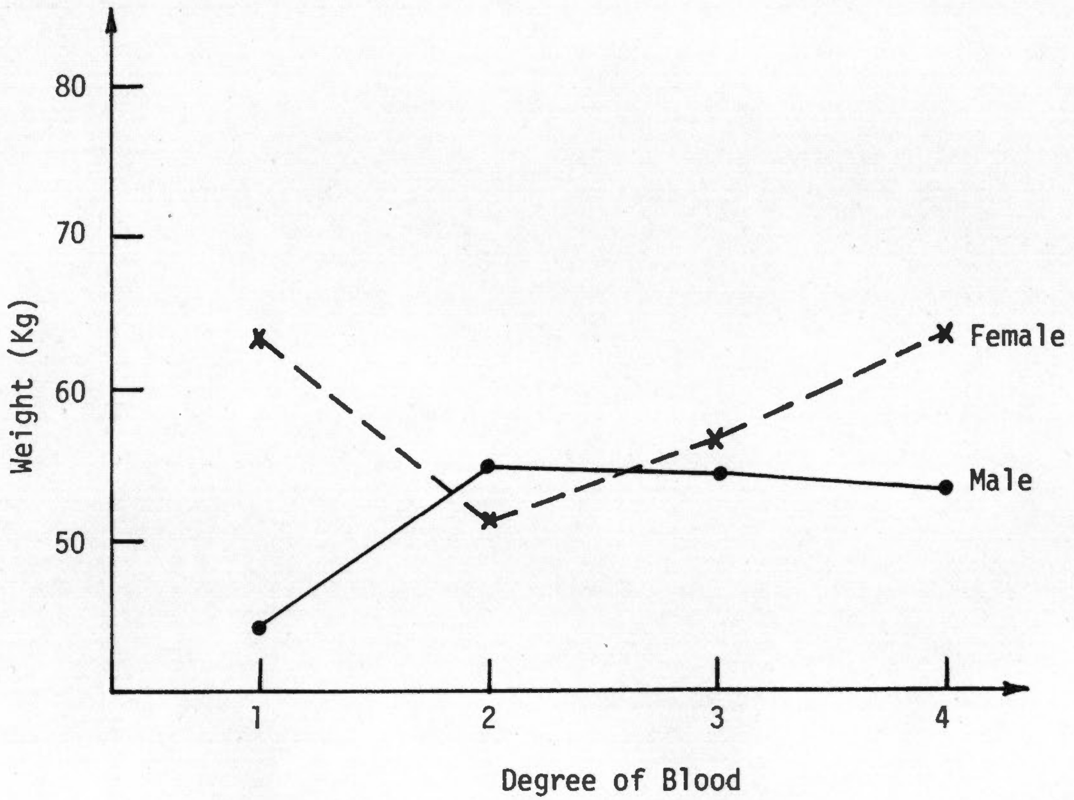

Figure 7. Relationship of Weight and Degree of Blood for Males and Females Age 13.

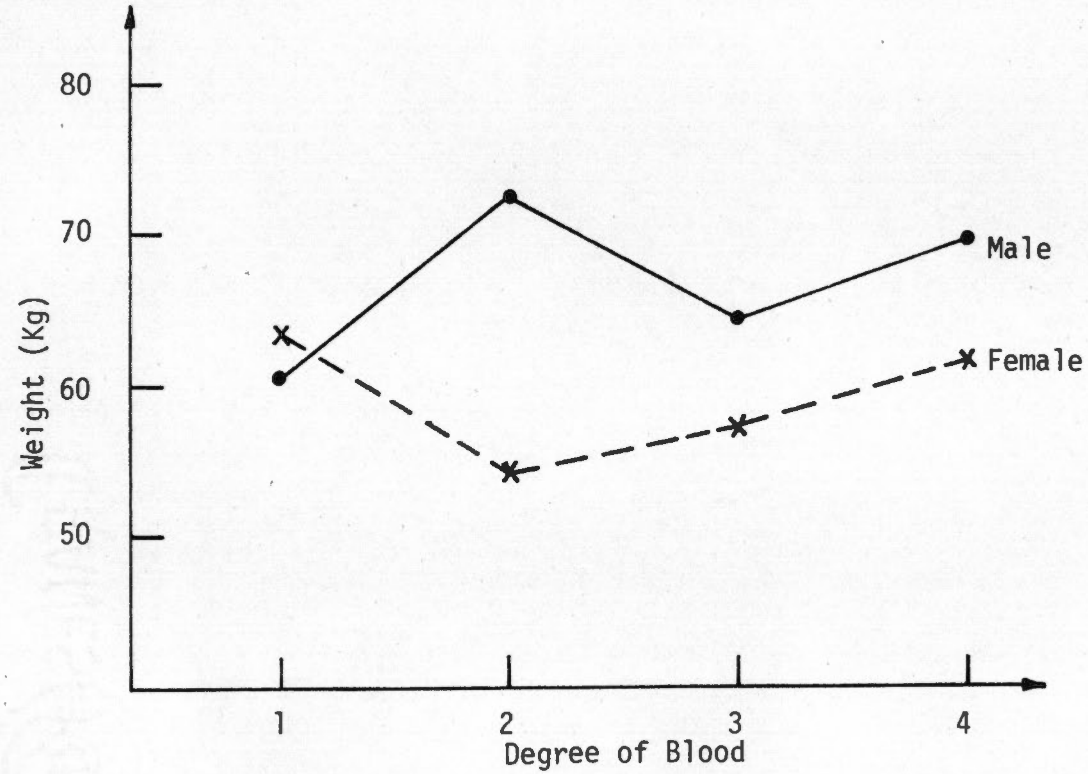

Figure 8. Relationship of Weight and Degree of Cherokee Blood for Males and Females Age 14.

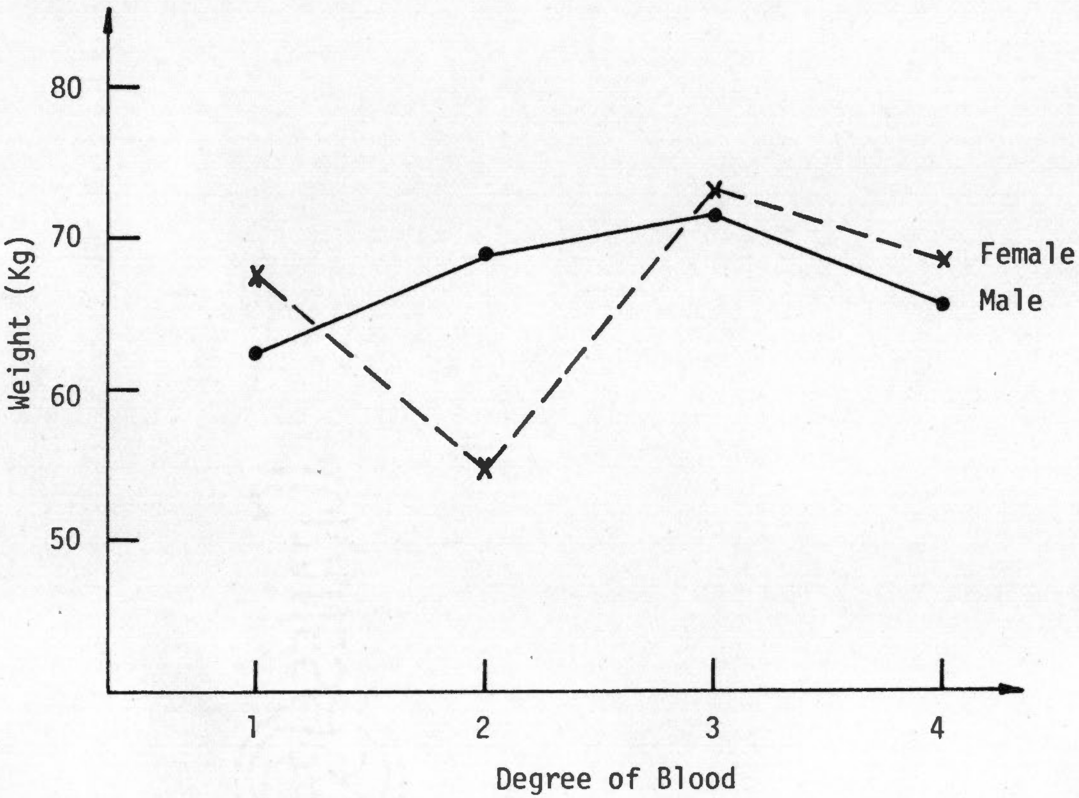

Figure 9. Relationship of Weight and Degree of Cherokee Blood for Males and Females Age 15.

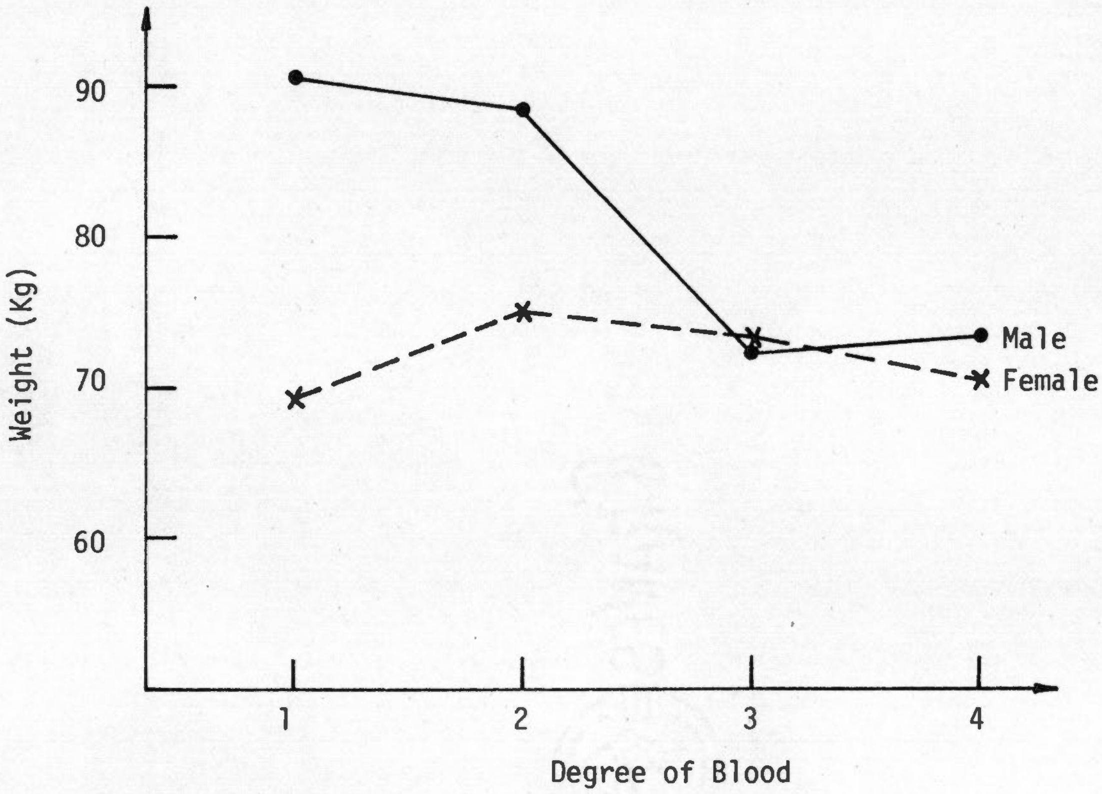

Figure 10. Relationship of Weight and Degree of Cherokee Blood for Males and Females Age 16.

TABLE 7

SAMPLE SIZE, MEAN, STANDARD DEVIATION, STANDARD ERROR OF THE MEAN, AND THE 5TH, 25TH, 50TH, 75TH, AND 95TH PERCENTILES BY AGE AND SEX FOR THE CHEROKEE DATA ON TRICEPS SKINFOLD

SEX AND AGE	N	$\bar{X}$	S	$S_{\bar{X}}$	PERCENTILES 5th	25th	50th	75th	95th
MALE									
13	15	14.2	6.03	1.55	7.0	8.37	14.25	16.62	22.12
14	35	18.77	5.58	0.94	9.0	15.62	18.5	21.37	27.37
15	49	18.85	6.21	0.88	8.0	15.0	18.25	22.0	30.25
16	23	17.64	7.34	1.53	7.22	11.0	18.0	23.12	28.27
17	4	21.5	5.74	2.87	13.0	13.0	23.0	25.0	25.0
FEMALE									
13	24	18.79	7.14	1.45	6.6	14.0	17.0	23.0	30.0
14	40	18.80	6.4	0.97	10.5	14.0	17.5	23.0	29.0
15	32	21.98	7.65	1.35	11.3	16.5	19.7	27.5	35.4
16	25	19.98	7.68	1.53	10.25	13.12	18.75	23.0	31.99
17	1	16.0							

Variable: Triceps Skinfold (mm).

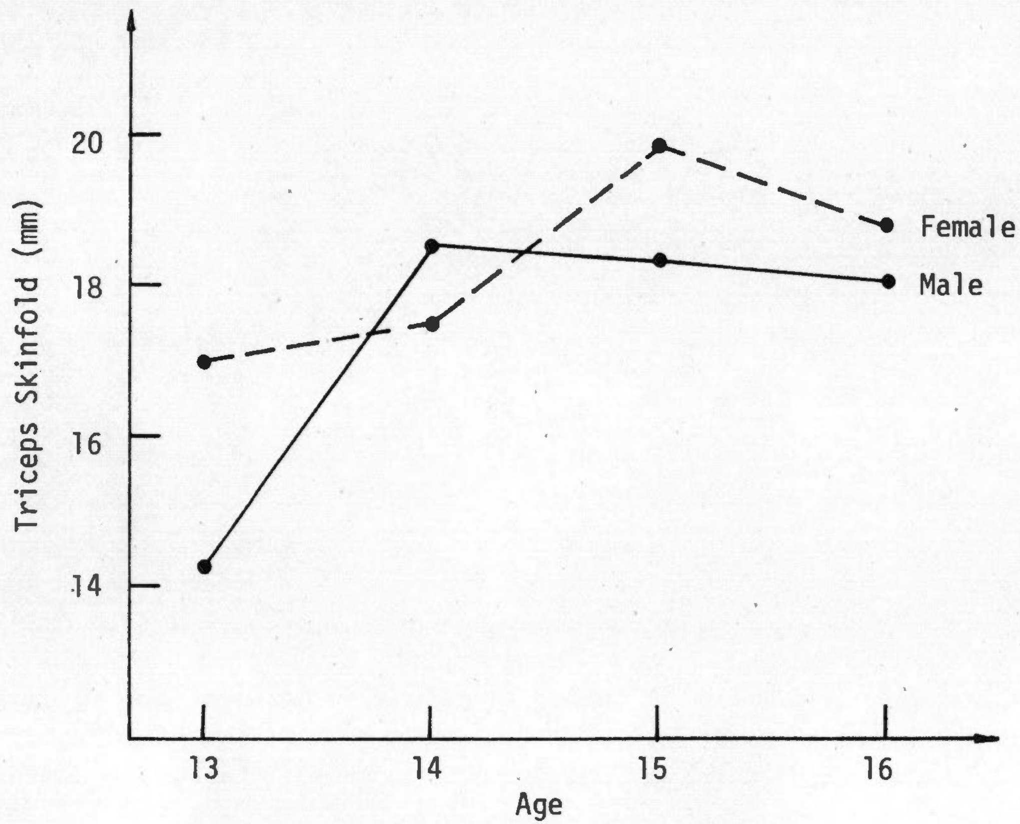

Figure 11. Mean Triceps Skinfold for Cherokee Males and Females Ages 13-16.

growth spurt. Hamill et al. (1973) and Tanner (1965) demonstrated that a decrease in fat thickness is associated with the growth spurt.

Comparison with the Minnesota Indian Sample

Figure 12 is a comparison of the height, weight, and triceps skinfold means, from data in Tables 3, 4, and 5 (pages 26, 27, and 34) of the Cherokee with those of the urban native Americans (Table 8) studied by Johnston and McKigney (1978). The males of both populations follow essentially the same pattern of a steady increase in height up to age 15. After that, the Cherokee continue to increase in height while the Minnesota Indians show a slight decrease. By age 17, the difference is 6.1 centimeters. The females of both groups exhibit a similar pattern in the trend to increase in height and their means are virtually the same.

The pattern for weight is similar for ages 13, 14, and 15, but at age 16, the Cherokee show an increase and the Minnesota urban native Americans show a decrease. At age 17, the means are about the same. The Cherokee males tend to be heavier than the Minnesota males, and the Cherokee females tend to be heavier than the Minnesota females who also show an earlier decrease in weight than the Cherokee do.

Comparison of the triceps skinfold means shows the Cherokee males and the males from Minnesota to be within 1 centimeter of each other at age 13, but the Cherokee mean increases 5.0 centimeters by age 15 and then shows a slight decrease. The Minnesota mean drops just over 4 centimeters from age 14 to 15 and levels off. The greatest difference, 10.0 centimeters, occurs at age 15. The Cherokee females demonstrate

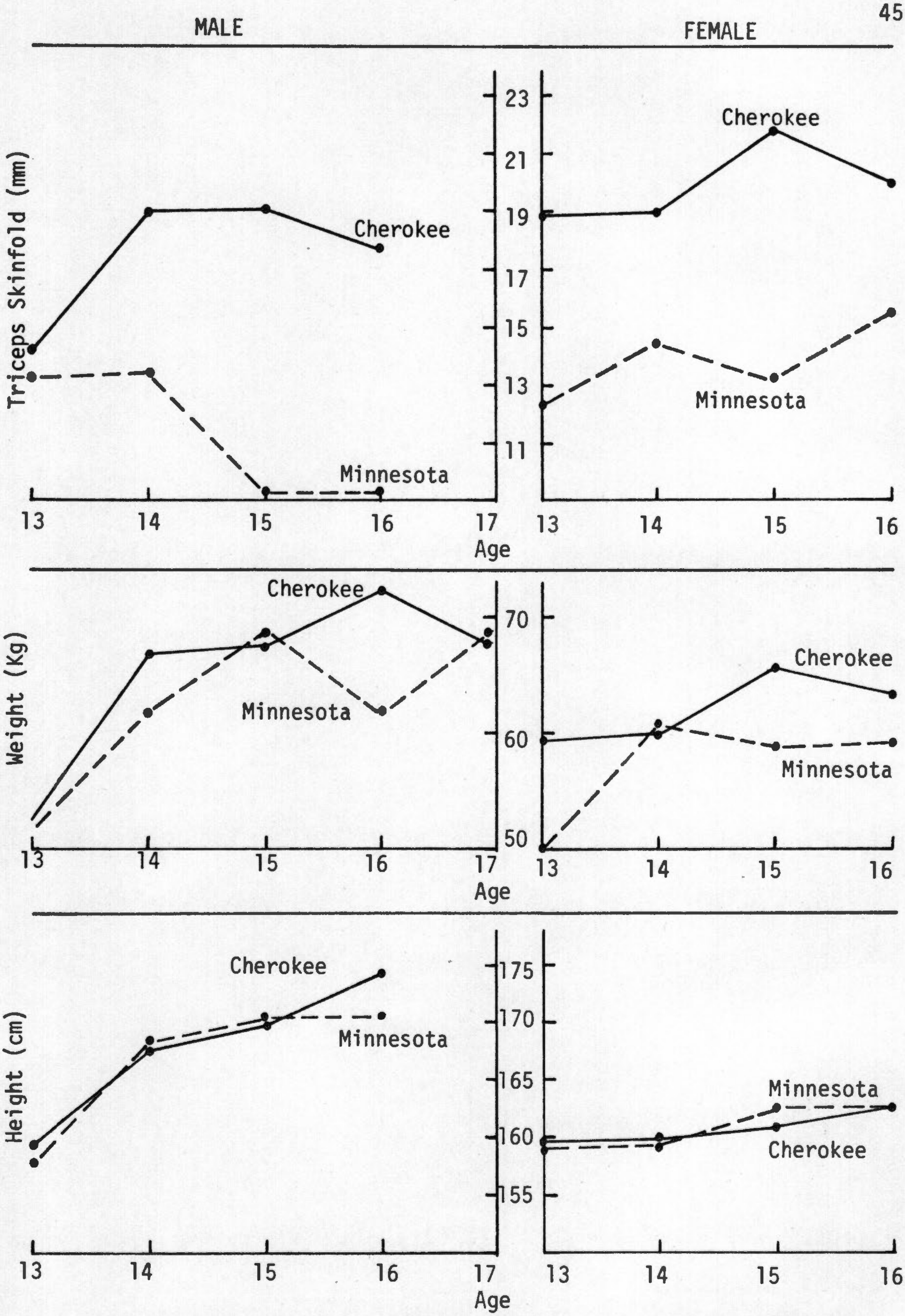

Figure 12. Comparison of Means for Height, Weight, and Triceps Skinfold Between Cherokee and Minnesota Urban Indian Sample.

TABLE 8

SUMMARY OF SAMPLE SIZE, MEAN AND MEDIAN BY AGE AND SEX FOR TRICEPS SKINFOLD MEASUREMENTS OF THE MINNESOTA INDIAN SAMPLE

	MALE			FEMALE		
AGE	N	$\overline{X}$	M	N	$\overline{X}$	M
13	16	157.4		20	159.0	
14	11	168.1		23	159.2	
15	11	170.1		19	162.5	
16	14	170.1		19	162.0	
17	7	169.7		9	161.0	
13	16	51.3		20	49.1	
14	11	61.4		23	60.6	
15	12	68.9		19	58.9	
16	14	61.3		19	59.4	
17	7	68.2		9	57.5	
13	6	13.2	12.3	10	12.2	15.0
14	3	13.5	9.5	10	14.6	14.8
15	2	9.0	9.0	10	13.3	13.5
16	5	9.1	7.5	13	15.5	15.0
17	5	9.2	9.5	6	17.6	17.5

greater measurements at all ages over their Minnesota counterparts. While the general trend in both groups is toward an increase the difference in means between ages 13 and 16 is 1.1 centimeters for the Cherokee females and 3.3 centimeters for the Minnesota females.

The overall picture is similar to the one between the Cherokee and their White and Black age and sex peers. The Cherokee tend to be the same height but heavier than their Minnesota counterparts and to have greater skinfold means. For the males, the skinfold difference is less for ages 13 and 14 but similar to the differences for Whites and Blacks at ages 15 and 16. There is a greater difference in the means between the Cherokee and Minnesota females than there is between the Cherokee and Black or White females.

Comparison with the Ten-State Nutrition Survey Sample

The Ten-State Nutrition Survey of 1968-1970 was designed to study a population drawn from the lower half of the income spectrum, and with the lowest incomes disproportionately represented. Data were presented for two Income Ratio Groups designated Low Poverty Income (0.00-0.74) and High Poverty Income (2.25-2.99). A ratio of 1.0 designates the poverty level (Garn and Clark, 1975). The mean triceps fatfold data from the Low Poverty Income Ratio Group for White males and females were used for comparison to the Cherokee data. Comparisons were made to determine whether or not there are any differences between the Cherokee and White youths from an income level designated as poor. Mean triceps fatfold values are higher for the Cherokee, and the differences are greater for the males than for the females. The medians for height and weight of both groups were compared by age and sex. The Cherokee males are taller and heavier than the White males. The Cherokee females are similar in height but heavier than their White counterparts. These findings are similar to the Cherokee and HES sample comparisons. The only difference being in height of males which was similar for the Cherokee-HES comparison.

Ethnic Differences

Height, weight, and triceps skinfold data from the Health Examination Survey (HES) were used to test the hypotheses that there are no significant differences in the height, weight, and triceps skinfold measurements of Cherokee Indian youths and North American Black or White youths ages 13 through 17. The mean square error (MSE) value was calculated for each variable (height, weight, and triceps skinfold) by obtaining the sum of squares for each of the 24 cells, totaling and dividing by n-23 (degrees of freedom). The sum of squares was calculated by multiplying the variance by cell size minus one for each cell. A Bonferroni post hoc comparison of means was carried out to identify significant differences. The F values were tested at the .005 level of probability. Table 9 is a summary of the 16 comparisons for height none of which were found to be significant. Therefore, the hypothesis for height could not be rejected. Table 10 is a summary of the comparisons made for weight. Nine of the comparisons were found to be significant and the hypothesis for weight was rejected. Table 11 is a summary of the comparisons made on triceps skinfold and all 16

TABLE 9

RESULTS OF BONFERRONI POST HOC EXAMINATION OF MEANS FOR HEIGHT (CHEROKEE VERSUS WHITE AND BLACK AGE AND SEX PEERS)

CONTRAST	SS(L)	F
Age 13		
1. Cherokee males vs White males	9.14	
2. Cherokee males vs Black males	4.5	
3. Cherokee females vs White females	16.0	
4. Cherokee females vs Black females	5.0	
Age 14		
1. Cherokee males vs White males	1.33	
2. Cherokee males vs Black males	100.0	1.8466
3. Cherokee females vs White females	220.0	4.0719
4. Cherokee females vs Black females	161.33	2.9792
Age 15		
1. Cherokee males vs White males	144.15	2.6684
2. Cherokee males vs Black males	8.33	
3. Cherokee females vs White females	120.33	2.2221
4. Cherokee females vs Black females	16.0	
Age 16		
1. Cherokee males vs White males	1.5	
2. Cherokee males vs Black males	0.25	
3. Cherokee females vs White females	4.0	
4. Cherokee females vs Black females	6.25	

MSE = 54.15079.
$F(1,\infty)$ = 7.88 at .005.

TABLE 10

RESULTS OF BONFERRONI POST HOC EXAMINATION OF MEANS FOR WEIGHT (CHEROKEE VERSUS WHITE AND BLACK AGE AND SEX PEERS)

CONTRAST	SS(L)	F
Age 13		
1. Cherokee males vs Black males	50.0	
2. Cherokee males vs White males	104.14	
3. Cherokee females vs Black females	1729.8	9.7258*
4. Cherokee females vs White females	2070.25	11.6400*
Age 14		
1. Cherokee males vs Black males	3660.25	20.5798*
2. Cherokee males vs White males	3267.0	18.3688*
3. Cherokee females vs Black females	901.3333	5.067
4. Cherokee females vs White females	1922.0	10.8065*
Age 15		
1. Cherokee males vs Black males	3675.0	20.6628*
2. Cherokee males vs White males	1352.0	7.6016
3. Cherokee females vs Black females	2500.0	14.0563*
4. Cherokee females vs White females	2640.3333	14.8453*
Age 16		
1. Cherokee males vs Black males	1320.1667	7.4226
2. Cherokee males vs White males	1444.0	8.1189*
3. Cherokee females vs Black females	500.0	2.8112
4. Cherokee females vs White females	756.25	4.2520

MSE = 177.85565.
C.V. $F(1,\infty) = 7.88$ at .005.

TABLE 11

RESULTS OF BONFERRONI POST HOC EXAMINATION OF MEANS FOR TRICEPS SKINFOLD (CHEROKEE VERSUS BLACK AND WHITE AGE AND SEX PEERS)

CONTRAST	SS(L)	F
Age 13		
1. Cherokee males vs White males	165.14	9.6083*
2. Cherokee males vs Black males	406.125	23.6292*
3. Cherokee females vs White females	625.0	36.3638*
4. Cherokee females vs Black females	924.8	53.8068*
Age 14		
1. Cherokee males vs White males	2700.0	157.0919*
2. Cherokee males vs Black males	3136.0	182.4593
3. Cherokee females vs White females	456.3333	26.5504*
4. Cherokee females vs Black females	901.3333	52.4415*
Age 15		
1. Cherokee males vs White males	4608.0	268.1035*
2. Cherokee males vs Black males	4880.3333	283.9484*
3. Cherokee females vs White females	1121.3333	65.2416*
4. Cherokee females vs Black females	1521.0	88.4591*
Age 16		
1. Cherokee males vs White males	1445.0	84.1173*
2. Cherokee males vs Black males	1837.5	106.9097*
3. Cherokee females vs White females	240.25	13.5782*
4. Cherokee females vs Black females	583.2	33.9318*

MSE = 17.18739.
C.V. $F(1,\infty)$ = 7.88 at .005.

comparisons were found to be significant so that the hypothesis for triceps skinfold was rejected.

Figures 13 and 14 are graphic presentations of mean heights from the data in Table 12. Although there were no significant differences between the Cherokee and their Black and White counterparts, the graphs show that the Cherokee males are slightly shorter than Black and White males at age 13, shorter than Whites but taller than Blacks at ages 14 and 15, and essentially the same as both Blacks and Whites at age 16. The Cherokee females, at age 13, are slightly taller than the Black and White females, but shorter at ages 14 and 15, and taller than Black females but shorter than White females at age 16.

Figure 15 is a graphic presentation of data from Table 13 and shows the comparisons of mean weights for males. There were no significant differences between the Cherokee and their Black or White counterparts at age 13, nor between the Cherokee and White males at age 15, or for the Cherokee and Black males at age 16. The greatest differences occurred between the Cherokee and their Black and White counterparts at age 14, and between the Cherokee and their Black counterparts at age 15.

Figure 16 presents the data from Table 13 for females. There were significant differences between the Cherokee females and both their Black and White counterparts at ages 13 and 15. At age 16, there were no significant differences, and at age 14, there was a significant difference between the Cherokee and their White sex peers but not between the Cherokee and their Black counterparts. The greatest differences between the Cherokee and their Black and White counterparts occur at age 15.

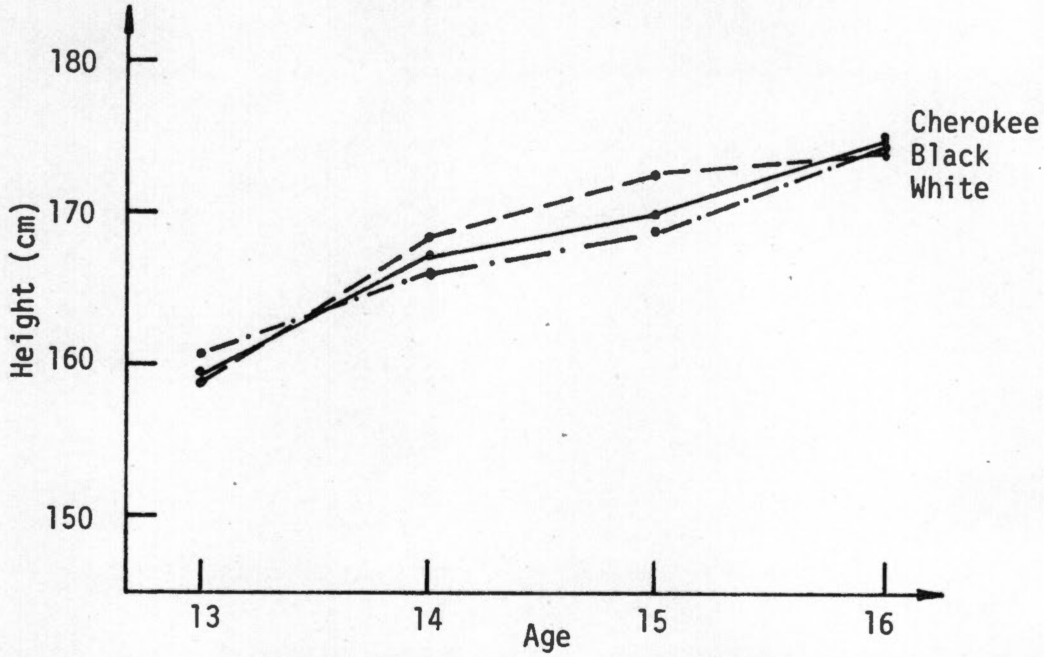

Figure 13. Comparison of Mean Height Between Cherokee Males Ages 13-16 and their White and Black Counterparts from the HES Sample.

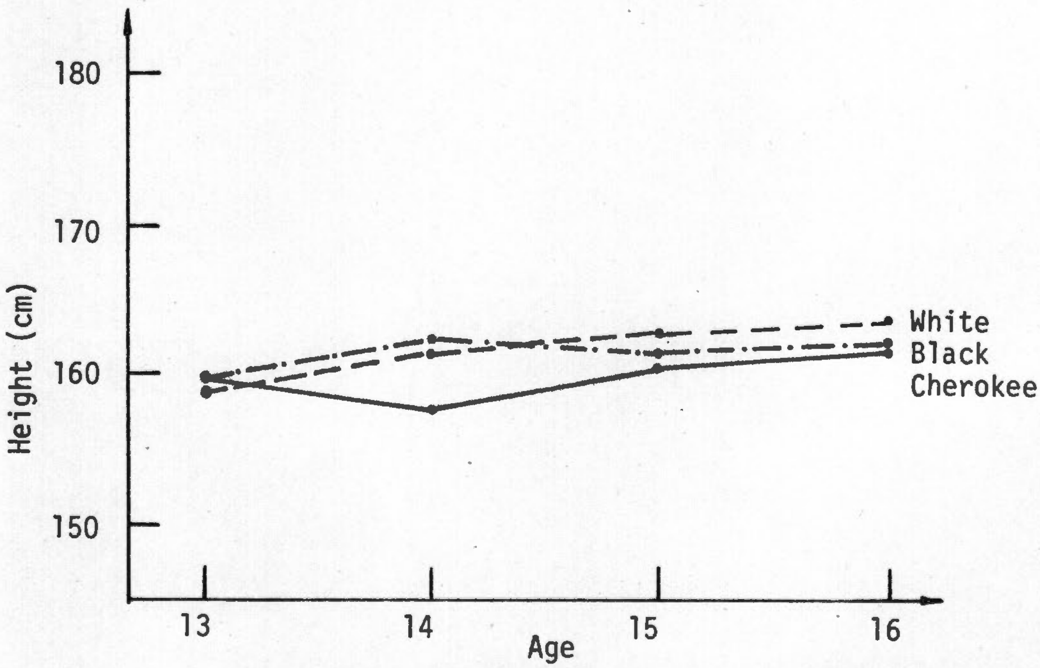

Figure 14. Comparison of Mean Height Between Cherokee Females Ages 13-16 and their White and Black Counterparts from the HES Sample.

TABLE 12

SUMMARY BY AGE AND SEX OF SAMPLE SIZE, MEAN AND MEDIAN FOR HEIGHT FOR CHEROKEE AND THEIR WHITE AND BLACK AGE AND SEX PEERS FROM THE HES SAMPLE

	CHEROKEE						WHITE						BLACK					
	MALE			FEMALE			MALE			FEMALE			MALE			FEMALE		
AGE	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M
13	15	159.1	159.7	24	159.5	158.3	542	159.9	159.4	490	158.7	158.9	80	159.7	160.9	91	159.8	159.5
14	37	167.7	167.0	44	159.3	157.8	527	166.9	168.2	484	161.4	161.1	88	165.7	166.1	101	161.5	162.1
15	53	169.9	169.9	36	160.9	160.4	525	171.6	172.3	425	162.4	162.6	84	170.4	168.9	73	161.7	161.5
16	23	174.3	174.4	29	162.4	161.7	496	174.4	174.3	441	162.8	163.3	57	174.0	174.5	93	161.9	161.7
17	4	175.8	173.5	1	160.5		417	175.7	175.9	393	163.0		69	174.5	174.2	74	162.7	164.1

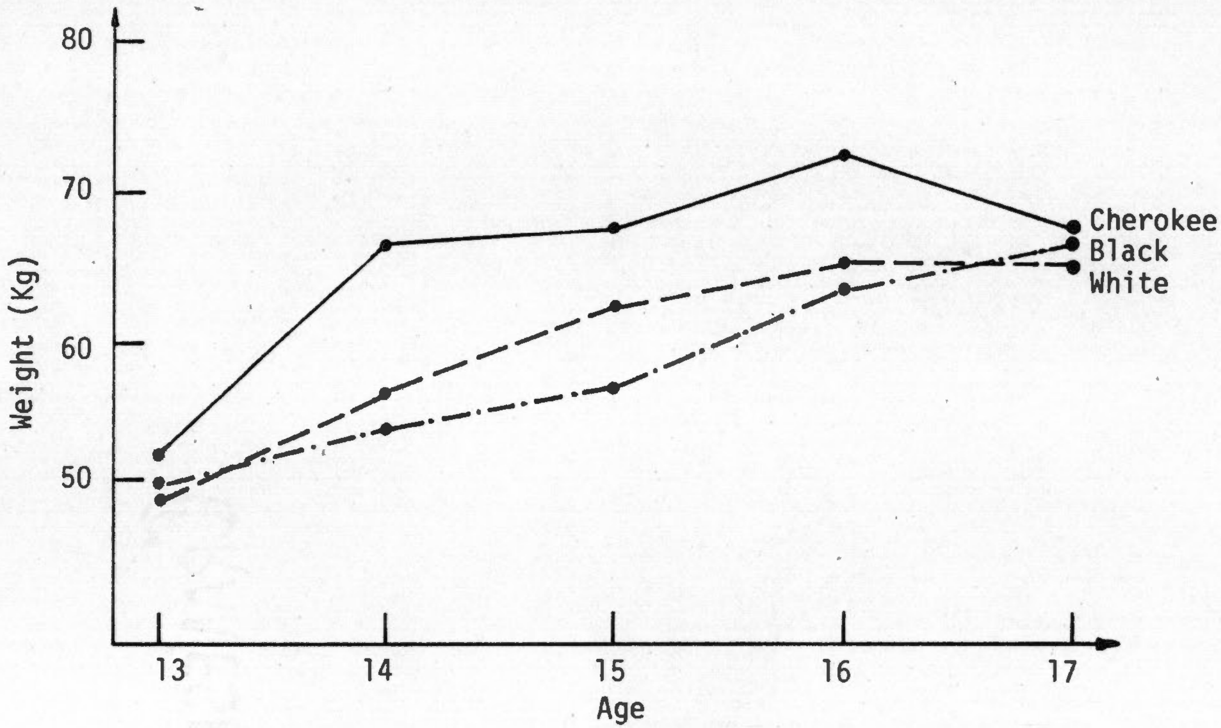

Figure 15. Comparison of Mean Weight Between Cherokee Males Ages 13-17 and their White and Black Counterparts from the HES Sample.

TABLE 13

SUMMARY BY AGE AND SEX OF SAMPLE SIZE, MEAN AND MEDIAN FOR WEIGHT OF CHEROKEE AND THEIR WHITE AND BLACK AGE AND SEX PEERS FROM THE HES SAMPLE

	CHEROKEE						WHITE						BLACK					
	MALE			FEMALE			MALE			FEMALE			MALE			FEMALE		
AGE	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M
13	15	52.6	51.7	24	59.6	57.4	549	49.9	48.3	490	50.5	49.0	80	50.6	48.6	91	50.3	47.3
14	37	66.8	67.0	44	60.2	53.6	527	56.9	55.6	484	54.0	52.3	88	54.7	52.9	101	55.0	53.4
15	53	67.5	63.4	35	65.6	59.2	525	62.3	61.2	425	56.7	55.0	84	57.0	56.3	73	55.6	53.8
16	24	72.6	69.4	26	63.5	59.0	496	65.0	63.4	441	58.0	55.8	57	63.7	62.9	93	58.5	55.1
17	4	67.6	65.1	1	56.8		417	65.2	66.5	393	57.4	55.6	69	66.7	63.7	74	58.9	58.5

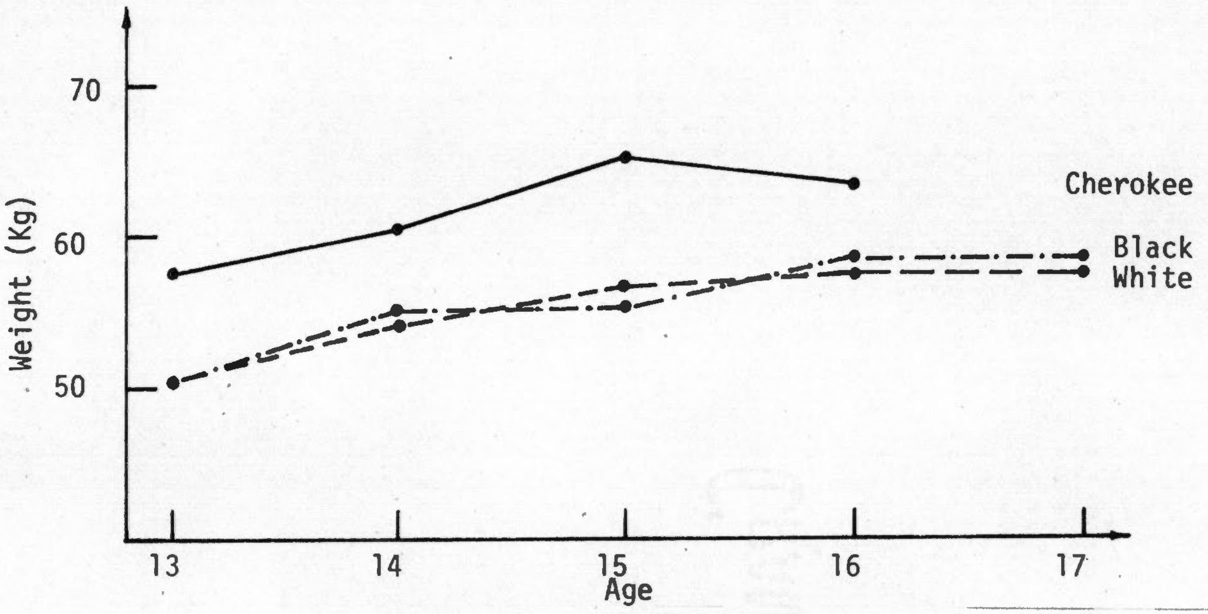

Figure 16. Comparison of Mean Weight Between Cherokee Females Ages 13-16 and their White and Black Counterparts from the HES Sample.

Data from Table 14 present the distribution of triceps skinfold for each ethnic group. The distributions differ in two ways in both sexes. The means for the Cherokee (Figures 17 and 18) are considerably higher than are those for either the Blacks or Whites, and while the Cherokee males show an increase between ages 13 and 14 followed by a decrease from ages 15 to 16, their Black and White counterparts show a downward trend from ages 13 through 16.

The National Center for Health Statistics (NCHS) Growth Charts for males and females ages 2-18 are used as a reference for comparison of the range of percentile values for the Cherokee. Figures 19 and 20 show the 5th, 25th, 50th, 75th, and 95th percentiles for height and weight of the Cherokee plotted on the NCHS Growth Charts. Figure 19 shows the values for the Cherokee males fall within the 5th to the 95th percentile range. However, at ages 13 and 14, the 25th, 50th, and 75th percentiles tend to be higher for the Cherokee, but at ages 15 and 16, they tend to have the same values of height for age. The values for the Cherokee females (Figure 20) fall within the range of the reference population and the values of height for ages 13-16 at the 25th, 50th, and 75th percentiles are similar to the NCHS height for age values.

The range of values for weight differ considerably between the Cherokee and the reference population. Those of both sexes of the Cherokee are higher and lie outside the upper extreme centiles. The 25th percentiles fall on the 50th percentile curve of the reference population, and the 50th percentile curve at the 75th percentile curve of the reference population, and the 75th percentile curve around the 90th and 95th percentile curves of the reference population.

TABLE 14

SUMMARY BY AGE AND SEX OF SAMPLE SIZE, MEAN AND MEDIAN FOR TRICEPS SKINFOLD FOR CHEROKEE AND THEIR WHITE AND BLACK AGE AND SEX PEERS FROM THE HES SAMPLE

	CHEROKEE						WHITE						BLACK					
	MALE			FEMALE			MALE			FEMALE			MALE			FEMALE		
AGE	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M	N	$\overline{X}$	M
13	15	14.2	14.3	24	18.8	17.0	542	10.8	9.4	490	13.8	12.7	80	8.5	7.2	91	12.0	9.0
14	35	18.8	18.5	40	18.8	17.5	526	9.8	8.2	484	15.1	14.2	88	7.6	6.4	101	13.6	12.5
15	49	18.9	18.3	32	21.9	19.7	525	9.3	7.8	424	16.1	15.1	84	6.8	6.4	73	14.1	12.8
16	23	17.6	18.0	25	19.9	18.8	495	9.1	7.6	440	16.8	16.0	57	7.1	6.7	93	14.9	13.1
17	4	21.5	23.0	1	16.0		417	9.2	7.7	392	16.8	16.3	69	7.7	6.1	74	14.5	13.4

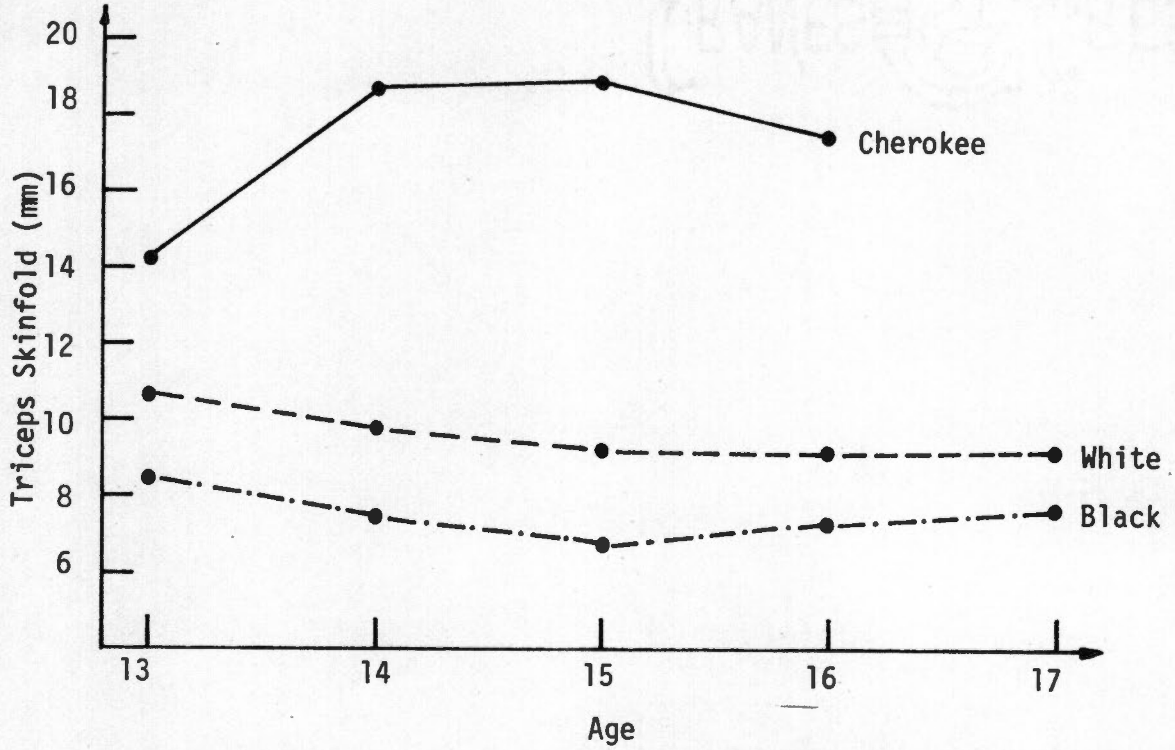

Figure 17. Comparison of Mean Triceps Skinfold Between Cherokee Males Ages 13-16 and their White and Black Counterparts from the HES Sample.

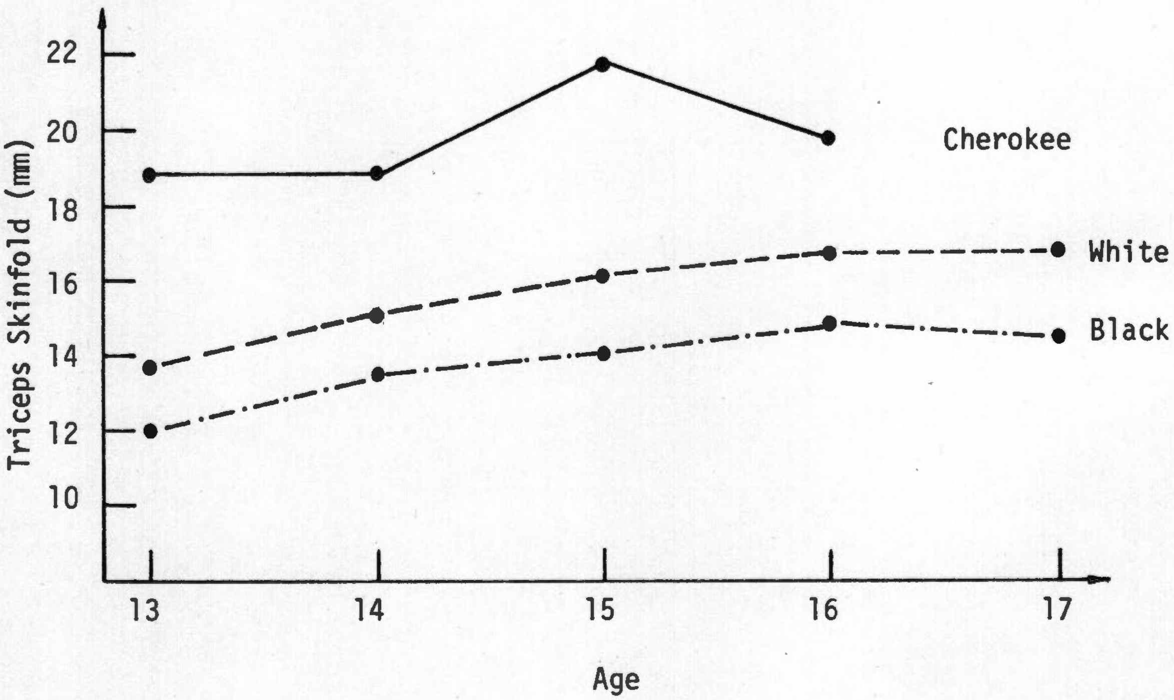

Figure 18. Comparison of Mean Triceps Skinfold Between Cherokee Females Ages 13-16 and their White and Black Counterparts from the HES Sample.

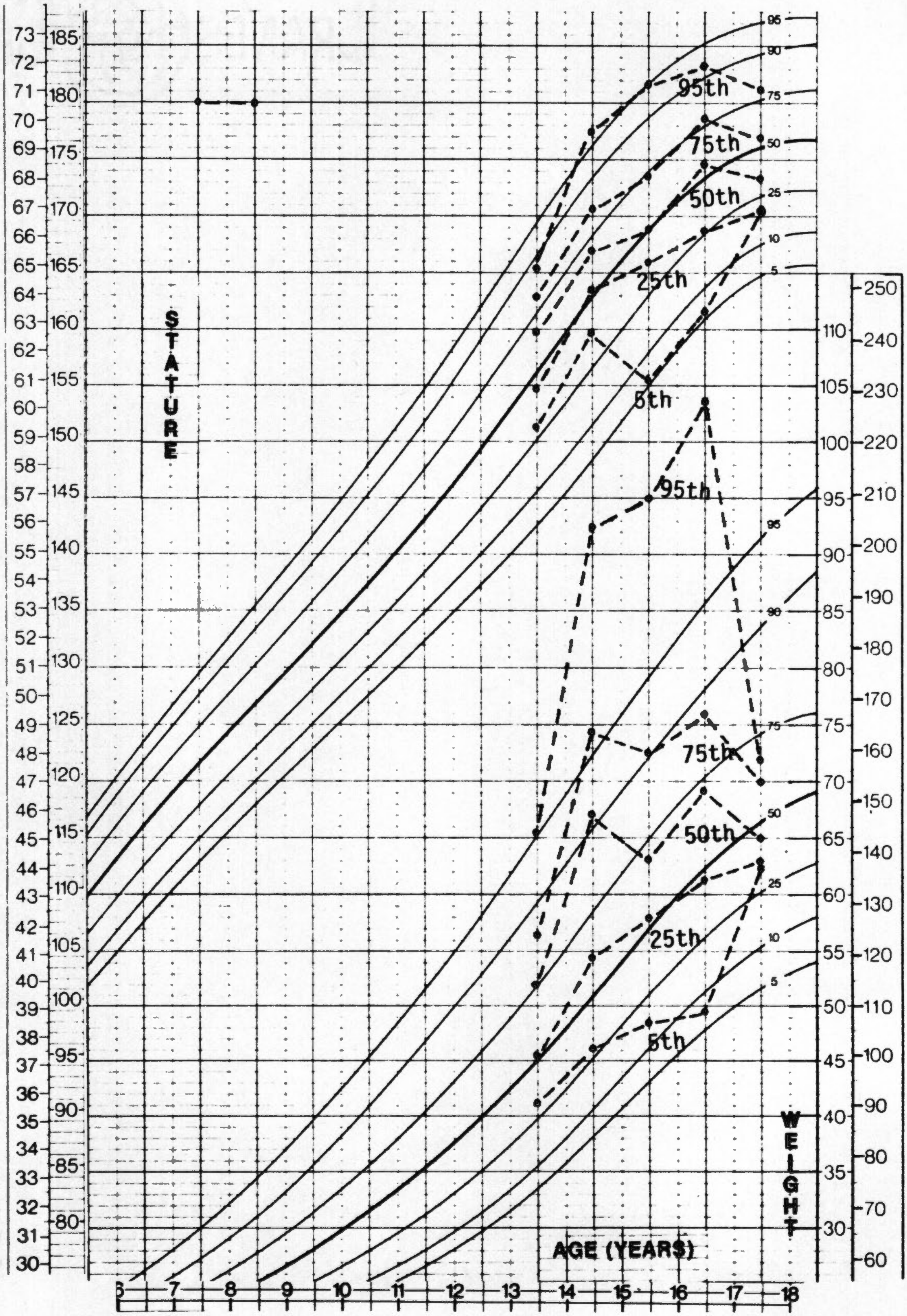

Figure 19. Comparison of the 5th, 25th, 50th, 75th, and 95th Percentiles of the Cherokee Males Ages 13-16 to the Growth Curves of the National Center for Health Statistics.

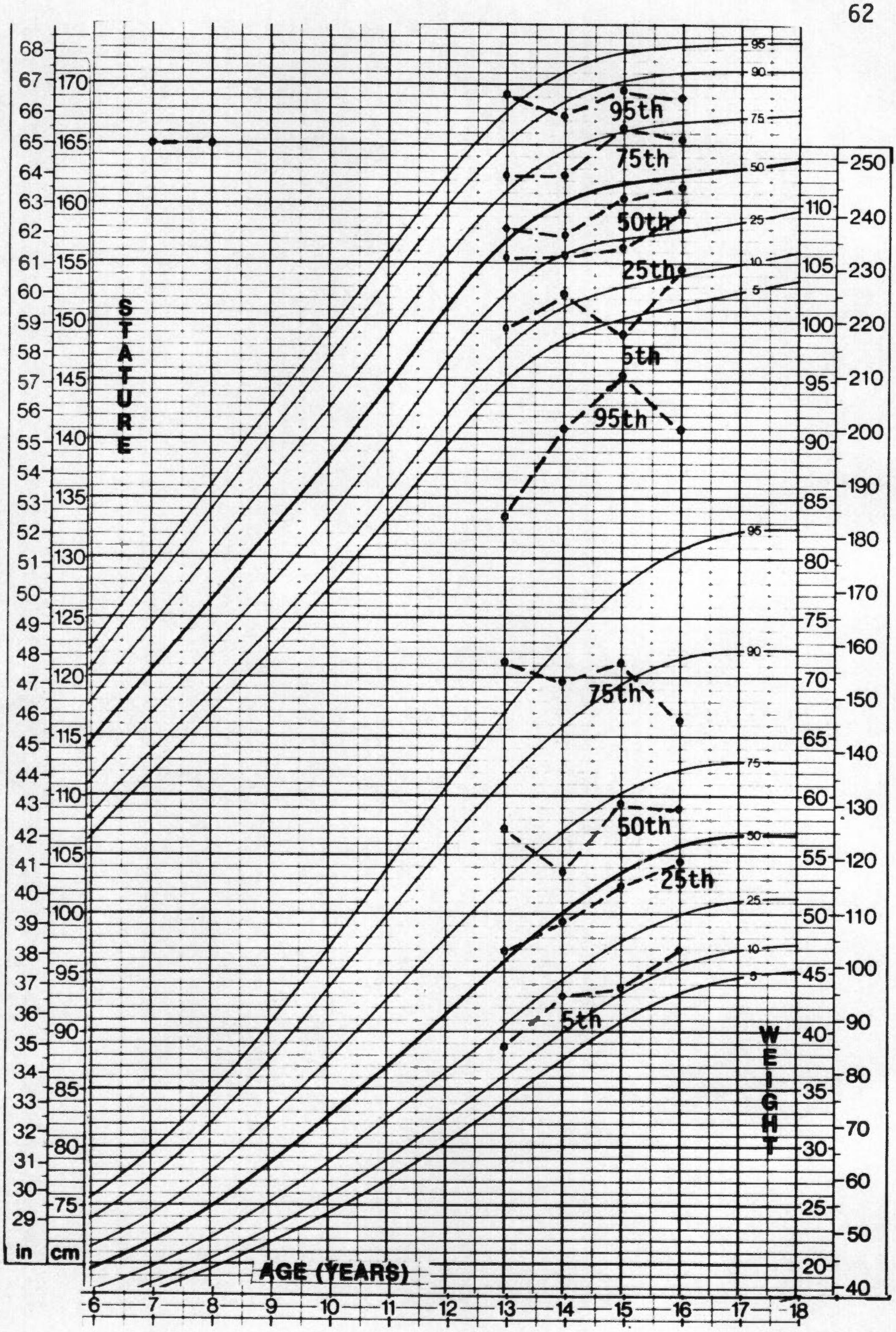

Figure 20. Comparison of the 5th, 25th, 50th, 75th, and 95th Percentiles of the Cherokee Females Ages 13-16 to the Growth Curves from the National Center for Health Statistics.

The skewness of height (Table 4, page 27) was not significant for either sex, but the skewness of weight (Table 4, page 27) was significant for females age 14, and for both males and females ages 15 and 16.

Discussion

Although no significant differences were found in height between the Cherokee and their Black and White age and sex peers, the graphs (Figures 13 and 14, page 53) show a tendency for the female Cherokee to be shorter than the Black and White females and the Cherokee males to be slightly shorter than their White counterparts but slightly taller than their Black counterparts. The data indicate that by age 13, the Black and White males are already taller than their female peers. The Cherokee males do not exceed the Cherokee females in height until after age 14. These ethnic differences may be an indication that the Cherokee males are a year behind the Black and White males in the growth spurt. The Cherokee females follow the same pattern as their Black and White counterparts. The pattern is similar in all three ethnic groups in that the males show a greater total increase in height than the females.

Although the Cherokee were not found to be significantly different from the other groups in height, they were significantly heavier with significantly greater fatfolds than their Black and White age and sex peers. The significant difference in the fatfold measurement is clearly seen in Figures 17 and 18 (page 60). The patterns for the females are similar in the overall trend toward increasing values with age. The patterns for the males differ in one respect. The downward trend is apparent in the Blacks and Whites from age 13 on, but the decrease in the Cherokee values does not occur until age 16. The sample size for age 17 was 4 and the mean fatfold was 21.5. It would be impossible to conclude, from the limited evidence, whether or not the trend is to increase, decrease or level off. Since the data for height suggest the possibility of a tempo difference in the adolescent growth spurt for the Cherokee, this delay in decreased fatfold values might also be related to the delay in the adolescent growth spurt. The differences in weight and fatfold values for males tend to be greater than the differences for females except at age 13. Also, the differences tend to be greater between the Cherokee and Blacks than between the Cherokee and the Whites.

CHAPTER V

SUMMARY

Problem and Findings

Height, weight, and triceps skinfold measurements were obtained from 266 Eastern Band Cherokee Indian youths ages 13-17. The data were collected in the latter part of the school year of 1979, and compared to the United States national probability samples from the Health Examination Survey (HES), to a sample of Minnesota urban native Americans, and to data from the Ten-State Nutrition Survey of 1968-1970 (TSNS). The data were also examined for within sample age, sex, and degree of Indian blood effects.

Comparisons of the Cherokee data to data from their Black and White counterparts in the HES sample show that the Cherokee are not significantly different in height from their Black and White peers. Differences in weight are significant for 9 of the 16 comparisons with the Cherokee males weighing more than their Black and White counterparts at age 14, their Black sex peers at age 15, and their White sex counterparts at age 16. The Cherokee females are significantly heavier than their Black and White counterparts at ages 13 and 15, and their White sex peers at age 14. The Cherokee have significantly greater skinfold thicknesses for all 16 comparisons.

Examination of differences between the Cherokee and their counterparts in the Minnesota Indian sample show the Cherokee to be consistently heavier and to have a thicker skinfold. Height values are essentially equal with the exception of males after age 15 when the Cherokee tend to increase in height and the Minnesota Indians level off. The Cherokee and Minnesota Indians have similar patterns in relation to height and weight in that the males do not exceed the females in height and weight until after age 13. The HES study shows the Black and White males already exceed their female counterparts in height at age 13. However, the Cherokee and Minnesota Indians differ considerably in their triceps skinfold measurements with the Cherokee having greater thicknesses. The difference in values is greater between the males than between the females.

Compared to their White age and sex peers for both Income Ratio Groups in the Ten-State Nutrition Survey, the Cherokee have higher values for triceps fatfold with the differences being greater for the males than for the females. The Cherokee males are taller and heavier than their counterparts and the females are similar in height but heavier than their age and sex peers.

The Cherokee data were analyzed for age, sex, and degree of blood effects. At age 13, the females exceed the males in height, weight, and triceps skinfold values, but thereafter, the males exceed the females in height and weight. Except for age 14, the females continue to exceed the males in fatfold measurements. The decrease in fatfold measurements after age 14 for the males is concomitant with their growth spurt. The males show a trend toward a greater decrease in height with an increase in degree of Indian blood at age 13 than do the females, and this trend and sex difference is most apparent at age 16. Also, at age 16, the sex difference decreases with an increase in degree of Indian blood.

The height curve is essentially gaussian as is the triceps skinfold distribution, but the values for weight are skewed. The skewness is not significant at ages 13 and 14 for the males, but is significant at a .001 level of probability at age 15, and .05 at age 16. The female values are significantly skewed at ages 14 (.05), 15 (.05), and 16 (.001). All significant values are skewed to the right indicating that the weights are drawn out at the right tail. The relationship of weight to degree of Indian blood is significant. At ages 13 and 16, the sex difference is greater for those having between zero and one-fourth percent Indian blood, and the values are reversed. That is, at age 13, the females have a higher value and at age 16, the males weigh more than the females. At ages 14-16, there is less sex dimorphism as the degree of Indian blood increases.

The Cherokee tend to be similar in height to their Black, White, and Minnesota Indian counterparts. They are significantly heavier than their Black and White counterparts and tend to be somewhat heavier than their counterparts from the Minnesota sample. The greatest difference is in triceps skinfold measurements, and they differ in two ways. The Cherokee have much greater fatfold values than either their White, Black, or Minnesota peers, and they demonstrate considerably less sex difference in the fatfold measurements than their counterparts in the other three groups.

Comparison of the Cherokee to another low income group (TSNS) shows the Cherokee to be taller, heavier, and to have a thicker triceps fatfold. Income is one of the more common socioeconomic indicators used as a basis for comparison of data. However, low income can be offset by financial assistance from other sources, physical environment, and other factors which sometimes make comparisons misleading.

Based on a recommendation from the Center for Disease Control in Atlanta, Georgia (Read, 1979), the NCHS Growth Charts were used for growth standards. The small sample studied makes use of the 5th and 95th percentiles questionable but the 25th, 50th, and 75th percentiles for weight show the Cherokee values to be greater at all age levels than comparable values on the Growth Charts. In fact, the range of values for weight differ considerably between the Cherokee and the reference population with the Cherokee values falling well outside the upper extreme percentiles. The values for height are similar to the NCHS height for age values.

Need for Future Studies

The age range in this study is one in which individual variation is most apparent during the developmental years. It would be helpful in clarifying ethnic similarities and differences found in this study to acquire anthropometric data on preadolescents and adults and compare them to data on Black, White, and other Indian age and sex peers. Indicators which would enhance understanding of differences in body growth patterns and dimensions are skeletal age assessment by age and sex (covering the developmental age span), stature/sitting height ratios, age at menarche, pubertal development, and subscapular fatfold measurements. The HES study (1974a) suggests that racial differences in subscapular fatfold measurements result primarily from environmental factors, but that those in triceps skinfold thickness result from both environmental and hereditary differences. Environmental differences would result in differentials in skewness while hereditary differences would result in a shift in the distribution with corresponding differences in the median.

Comparison of nutrient intake and activity level with other groups might help clarify obesity trends seen in this study. There is a close relationship between obesity and maturity-onset diabetes, and, though heredity is a factor, the stress of obesity can be a precipitating factor to the onset. A high percent of the adult Cherokee demonstrate maturity-onset diabetes with concomitant vascular complications, infections, and neuropathies. Data collected on the Cherokee and presented here suggest that obesity may be a greater problem for the Cherokee than for their Black and White counterparts.

Comparison of the Eastern Band with the Western Band of Cherokee might clarify the similarities and differences related to heredity and environment. In summary, results of this study reveal a need for further research into growth patterns over a wider age span of this population as compared to other ethnic groups and native Americans.

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