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The Study of Anthropometric Variables on Growth and Development of School Children in Zaria, Nigeria

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Abstract: Human populations consist of individuals who differ widely in body shape and size. Growth and development are intrinsic characteristics of childhood. Progress in growth and developmental milestones is age related, occurs in phases and has a normal pattern. There are different patterns of growth for particular age groups, from the prenatal period to adolescence. This study was conducted to compare the anthropometric variables of different age and sex group has associated to various degree of development. The study population comprised of 1,235 apparent healthy children (prepubertal 9-12 years: male, n = 248, female, n = 260; pubertal 13-15 years: male, n = 186, female, n = 193; adolescence 16-18 years: male, n =192, female, n = 156). Anthropometric measurements considered includes weight, height, Biepicondylar breadth of Humerus and femur, upper arm and calf circumferences, triceps; Subscapular; Supraspinale; and medial calf skinfold thicknesses. The results obtained shows a significant difference ($p<0.001$) in all variables in both sexes as there is an increase in the mean value of all parameters measured as the age increases. Female category showed higher value at 13-15 years of age than the males.

Key words: Body mass index, body weight, childhood, developmental stages, growth spurts, Zaria

INTRODUCTION

Growth and development are intrinsic characteristics of childhood. Growth is the increase in size of a child while development is the progressive acquisition of physical (motor), cognitive (thought), linguistic (communication) and social (emotional) skills and /or attributes. Progress in growth and developmental milestones is age-related, and has normal pattern. However, there is a range in age at which certain body size and developmental milestone are attained. Several factors, acting singly or in combination, influence the rate and pattern of growth and development. These factors include biologic, psychological and social factors.

Biologic factors which influence growth and development include genetic inheritance, intrauterine exposure to infections or teratogens, perinatal accidents or incidents causing illness and neurologic and hormonal maturation.

Psychologic factors which influence child development include the mother figure, feeding practices and child rearing environment. Social factors surrounding the parent-child include the nucleus family's socio-economic status, the extended family interactions, the cultural practices and geo-political societal milieu.

Human growth is age-related and occurs in phases. Thus, there are different patterns of growth for particular age-groups, from the prenatal period to adolescence. Factors such as sex, race, social class, nutrition and diseases affect the growth pattern. Growth is complete between the ages of 16 and 18, at which time the growing ends of bones fuse.

The development of anthropometry added new dimensions to the study of morphology which requires an understanding of the human body composition. Anthropometry is an important tool in the study and understanding of human biological variability, including, of course, morphological variation as a universally applicable, non invasive and inexpensive method (WHO, 1995). The present study was undertaken to compare the anthropometric variables of different age and sex group has associated to various degree of development.

MATERIALS AND METHODS

The present study was conducted in Zaria. The data utilized for this research were collected between May to July, 2008 from randomly selected twenty six educational institutions (primary and secondary school) which comprised of fourteen Governments - run schools and twelve private established schools in the four different zones of Zaria (Zaria, Sabongari, Samaru and Danmagaji), Kaduna State, Nigeria. The study sample consisted of

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Table 1: Mean and standard deviation of anthropometric parameters measured in male children according to developmental stages

Parameters	9-12 years (n = 248) Mean±SD	13-15 years (n = 186) Mean±SD	16-18 years (n = 192) Mean±SD	F-value	p-value
Weight (Kg)	32.95±5.84	44.12±7.06	55.47±5.34	743.619	<0.001
Height (cm)	136.08±7.96	153.83±6.03	164.73±5.95	987.390	<0.001
Body mass Index (Kg/m^2)	17.22±1.33	18.73±1.73	20.73±1.98	228.082	<0.001
Biepicondylar breadth of Humerus (cm)	5.23±0.65	6.00±0.50	6.45±0.04	228.082	<0.001
Biepicondylar breadth of Femur (cm)	7.32±0.88	8.83±5.32	8.47±0.65	15.709	<0.001
Upper arm circumference (cm)	18.98±1.57	21.63±2.12	24.26±2.61	343.742	<0.001
Calf girth (cm)	24.16±2.60	28.88±2.47	30.10±3.06	297.933	<0.001
Triceps skinfold (cm)	0.51±0.11	0.65±0.18	0.94±0.21	366.420	<0.001
Subscapular skinfold (cm)	0.38±0.09	0.51±0.15	0.87±0.22	545.320	<0.001
Supraspinale skinfold (cm)	0.36±0.09	0.48±0.15	0.87±0.25	507.091	<0.001
Medial calf skinfold (cm)	0.61±0.14	0.73±0.25	0.97±0.19	187.513	<0.001

Table 2: Mean and standard deviation of anthropometric parameters measured in female children according to developmental stages

Parameters	9-12 years (n = 260) Mean±SD	13-15 years (n = 193) Mean±SD	16-18 years (n = 156 Mean±SD	F-value	p-value
Weight (Kg)	32.72±4.63	45.62±5.80	54.27±5.52	870.824	<0.001
Height (cm)	137.64±7.16	154.95±5.64	161.15±6.29	753.181	<0.001
Body mass Index (Kg/m^2)	17.20±1.32	18.94±1.64	20.89±1.99	256.978	<0.001
Biepicondylar breadth of Humerus (cm)	5.14±0.59	6.02±0.47	6.38±0.58	282.749	<0.001
Biepicondylar breadth of Femur (cm)	7.19±0.63	8.22±0.66	8.45±0.64	235.011	<0.001
Upper arm circumference (cm)	19.18±1.86	22.15±1.83	23.67±1.92	313.882	<0.001
Calf girth (cm)	24.50±2.30	28.74±2.62	30.03±2.89	273.227	<0.001
Triceps skinfold (cm)	0.51±0.12	0.76±0.18	0.97±0.24	348.848	<0.001
Subscapular skinfold (cm)	0.38±0.09	0.63±0.15	0.87±0.21	545.135	<0.001
Supraspinale skinfold (cm)	0.36±0.09	0.60±0.16	0.88±0.24	503.940	<0.001
Medial calf skinfold (cm)	0.58±0.14	0.85±0.23	0.99±0.21	255.419	<0.001

randomly selected 1,235 subjects (624 males and 611 females) between the age ranges of 9-18 years who were classified as Prepubertal (9-12 years: male, n = 248; female, n = 260), pubertal (13-15 years: male, n = 186; female, n = 193) and adolescence (16-18 years: male, n = 192; female, n = 156).

In accordance with standard techniques and procedures recommended by Lohman *et al.* (1988), the following anthropometric variables were considered: Body weight (measured to the nearest 0.5 Kg with a portable bathroom scale and subjects wearing minimal clothing), Height (measured with a portable anthropometer with an accuracy of 1mm or 0.1 cm, subjects were asked to inhale deeply and maintained fully erect position during the measurement). Biepicondylar breadth of humerus and femur were measured with a digital sliding caliper to the nearest 0.05cm.

Upper arm circumference and calf girth were measured to nearest 0.1 cm with a non-elastic measuring tape. Triceps, subscapular, supraspinale and medial calf skinfold thickness was measured with a slim guide skinfold caliper to the nearest 0.05 cm.

Statistical analyses: The descriptive statistics of the anthropometric variables were calculated for each group of different sex and age. Then, complete model of two factors with fixed effects ANOVA was used to evaluate the role of age and sex (and their possible interaction) on the anthropometric variations.

RESULTS

The developmental changes over the years were presented in Table 1 (for male) and Table 2 (for female). The results showed that there is increase in the parameters as age increases and are statistically significant ($p<0.001$).

The anthropometric parameter increases along the developmental stages in both male and female. Pubertal stage (13-15 years) in female showed higher mean values when compared to male, the mean weight (45.62±5.80) and mean height (154.95±5.64) in female were higher than male at the same stage.

DISCUSSIONS

The anthropometric measurements recorded in this study show higher mean values in male than female in most of the parameters considered except the skinfold thickness (Fig. 3-7) which shows higher mean values for female. This appreciates more at 13-15 years of age in a linear form signaling the acquisition of more fat from puberty as shown in the weight and height (Fig. 1 and 2). In contrast, no consistent secular trends were found for weight of white or black youths aged 12-17 years in United States (Harlan *et al.*, 1990).

The results obtained show a significant recognition in the developmental changes that occurs in the growth and development of Human. From the table, there was

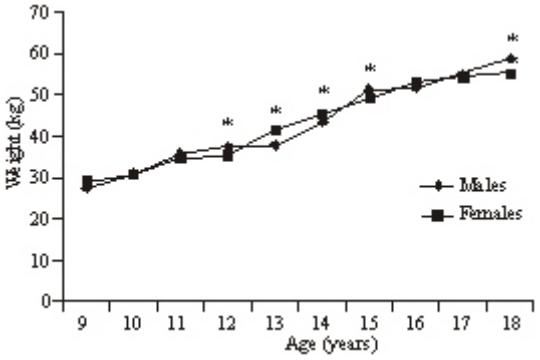

Fig. 1: Mean and standard deviation of weight measured in male and female according to age group, *: p<0.05, **: p<0.001

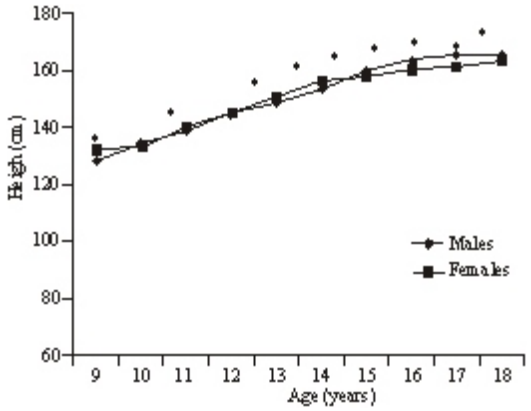

Fig. 2: Mean and standard deviation of height measured in male and female according to age group, *: p<0.05, **: p<0.001

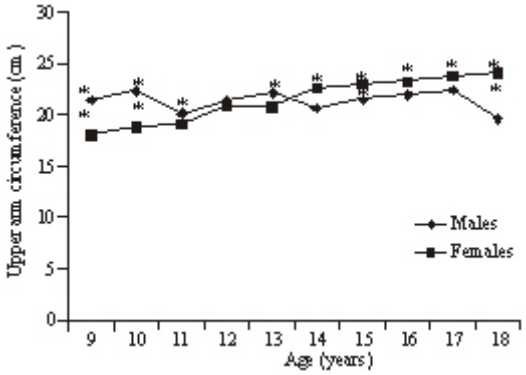

Fig. 3: Mean and standard deviation of upper arm circumference measured in male and female according to age group, *: p<0.05, **: p<0.001

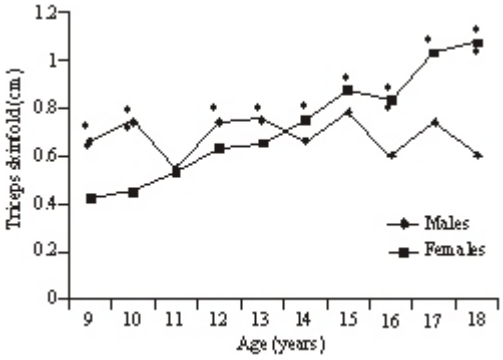

Fig. 4: Mean and standard deviation of triceps skinfold measured in male and female according to age group, *: p<0.05, **: p<0.001

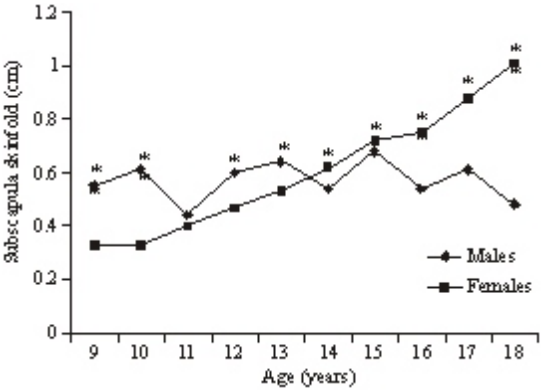

Fig. 5: Mean and standard deviation of subscapular skinfold measured in male and female according to age group, *: p<0.05, **: p<0.001

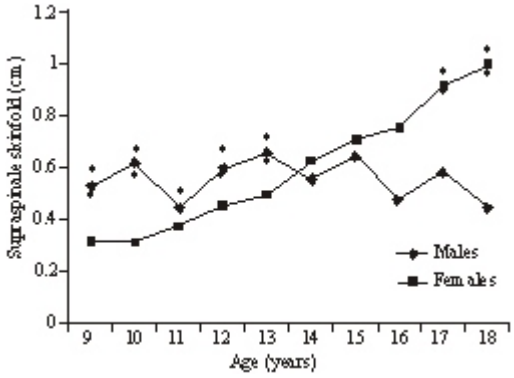

Fig. 6: Mean and standard deviation of supraspinale skinfold measured in male and female according to age group, *: p<0.05, **: p<0.001

tremendous increase in mean values for each anthropometric parameters measured across developmental stages. Remarkable significant change was recorded at 13-15 years in both sexes. The mean value obtained for weight, height and skinfold thickness from this study were compared with World Health Organization (WHO)/National Centre for Health and Statistics (NCHS) recommended standards. The report

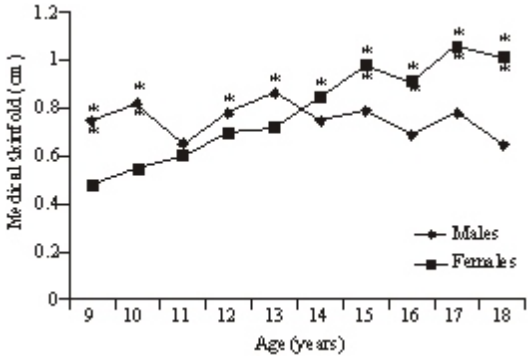

Fig. 7: Mean and standard deviation of medial skinfold measured in male and female according to age group, *: p<0.05, **: p<0.001

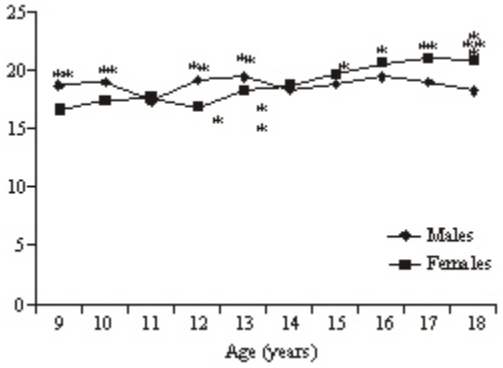

Fig. 8: Mean and standard deviation of Body mass Index among various age groups in male and female, *: p<0.05, **: p<0.001

here is not different from other studies which reported higher values for males (Bailey *et al*., 1982; Vizmanos *et al*., 2001). This also agrees with the earlier work of Shukla *et al*. (1977) and Singh *et al*. (1972). Reports from other studies indicated the same trend of results for males being higher in variables studied even before adult age (Ali and Ohtsuki, 2001; Falk *et al*., 2001).

The result also revealed that females were both heavier and taller at pubertal stage of development than males (Fig. 1 and 2). Thereafter, the males then overtook the females in values for the respective anthropometric variables and maintain this lead up to the adolescent. The probable reason for this female ascendency could be attributed to the fact that on the average, girls began their adolescent growth spurt (which shoots up their growth rate) at an earlier age than do the boys (Shamssain, 1991; Didia and Ogunranti, 1986; Eveleth and Tanner, 1976; Tanner, 1962).

Another interesting thing to note is that the BMI (Fig. 8) are higher in female (at pubertal and adolescence stage), this is so because there may be an increase in the weight of females due to hormonal influence during puberty. Other investigations showed no significant difference in the height and weight in prepubertal ages but differences begin to set in after puberty (Vizmanos *et al*., 2001; Sanna and Soro, 2000).

Only height and weight shows increase with age (Fig. 1 and 2) while other parameters are inconsistent. The females demonstrated higher mean values in weight and BMI at age 13-15 years, this may be due to the effect of puberty as reported by Frisch (1980, 1987) that females must attain a certain weight to begin reproductive cycles, and BMI is a factor of body weight. Although, normal Body Mass Index was obtained in female at age 16-18years. The relative weight although easily obtained, reflects bone and muscle mass as well as adipose tissue. Additionally, the body mass index is moderately correlated with height during growth (Garn *et al*., 1986).

CONCLUSION

This investigation confirmed growth spurts in both sexes at pubertal stage of development. It also shows that puberty occurs within the age range of 13-15 years in female and at later stage in male. The dimorphism differences in the anthropological variables in the population were investigated, with males having higher values than the females. Information emanating from this study confirms the result obtained by earlier researchers (Shamssain, 1991, 1989; Pawloski *et al*., 2004).

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