www.ajbrui.net

Reference Growth Values for Adolescents Aged 12-18 Years in a Nigerian Community

Akinpelu A.O[*], Oyewole O.O[**] and Oritogun K.S[***]

**Department of Physiotherapy, College of Medicine,University of Ibadan, Ibadan.*
***Department of Physiotherapy, Olabisi Onabanjo University Teaching Hospital, Sagamu, Ogun State.*
****Department of Medical Microbiology and Parasitology,Olabisi Onabanjo University, Sagamu.*

ABSTRACT: The purpose of this study was to generate growth reference values of Nigerian adolescents from Sagamu, present percentile charts for BMI, triceps skinfold (TSF), abdominal skinfold (ASF) and body weight and height and to compare their BMI 85th and 95th percentiles with those of USA and Cyprus. The study was a cross-sectional survey, including a representative sample of 1638 healthy adolescents in Sagamu ages 12-18 years, who were assessed during 2006 school year. Their body weight, height, BMI, triceps and abdominal skinfolds were assessed. Crude percentiles of these variable and BMI curves are presented. The mean weight, height, BMI, TSF and ASF were 46.2±11.7, 1.55±.32, 18.92±2.83, 6.4±3.0 and 6.9±2.6 for all males respectively while that of all females were 46.1±8.2, 1.55±.07, 19.19±2.54, 14.1±5.3 and 12.7±4.3 respectively. The 85th and 95th BMI percentile values are lesser in Nigerian adolescents in all ages compared with their peers in USA and Cyprus. The growth reference values in this study may provide a useful tool to assess body fat and nutrition status of Nigerian adolescents in Ogun state and possibly south western Nigeria in the absence of national references.

KEY WORD: *Weight, height, body mass index, skinfold, percentiles*

INTRODUCTION

Recording body weight and height on standard percentile charts is an essential tool for monitoring growth, and therefore, used as long-term health indicator in children and adolescents (Hasan et al, 2001; Savva et al, 2001). To assess the norms of these parameters for a given country, growth charts have to be established locally. Where local charts are not available, the World Health Organization has recommended the use of the National Center for Health Statistics (NCHS) reference charts for children below the age of 5 years. However, the use of the NCHS data after the age of 5 years as a reference in different ethnic groups has been queried (Chinn et al, 1996). It has been suggested however, that locally generated norms/charts would be more realistic (Sanusi, 2003). No such charts existed so far for Nigerian adolescents.

Obesity had reached epidemic proportion worldwide especially in the developed nation both in children and adults (Deckelbaum and Williams, 2001; Chhatwal et al, 2004; Wang and Lobstein, 2006). In Nigeria, the prevalence has been shown to be increasing (Akesode and Ajibode, 1983; Owa and Adejuyigbe, 1997).

The body mass index (BMI) is not a direct measure of body fat or lean tissue, but it is the most widely investigated and most useful indicator of health problems that are associated with under and overweight (Health Canada, 2003). The BMI is often used to determine the level of health risk associated with obesity (Wood, 2006). Practitioners use the BMI to assess overweight and obesity. Body weight alone can be used to follow weight loss and to determine efficacy of therapy. The BMI is the favored measure of excess weight to use in epidemiological studies to estimate relative risk of disease and it correlates both

Manuscript received: September 2007; Revision Accepted July 2008

Address for correspondence: *PMB 2001, Sagamu, Nigeria.* oyewoleye@yahoo.co.uk

with morbidity and mortality (HighBeam, 1999). Body mass index values during childhood and adolescence are important risk factors for the presence of adult overweight or obesity and the attendant risk factors of increased morbidity and mortality (Guo et al, 2002).

Skinfold thickness measurements are said to provide an estimate of the size of the subcutaneous fat depot, which in turn provides an estimate of the total body fat. Triceps skinfold has been shown to predict total fat content well in male children and adolescents (Sarria et al, 2001). Skinfold thickness was related to a high risk profile regarding coronary heart disease (CHD), hence can be used to predict CHD (Twisk et al, 1998). In general skinfold measurement contribute only marginally to improved prediction of risk of ischaemic heart disease (IHD) as measured by BMI, but central obesity, as measured by the subscapular skinfold, is predictive of IHD independently of BMI (Yarnell et al, 2001).

This study was undertaken to construct percentile curves for BMI, presents percentile charts for triceps skinfold, abdominal skinfold and body weight and height in a representative sample of adolescents, ages 12 to 18 years, from Sagamu, Ogun state, Nigeria and to compare these curves to the curves of other countries.

MATERIALS AND METHODS

Sampling Technique: We carried out a cross-sectional survey of secondary school students in Sagamu local government area of Ogun state, Nigeria during 2006 school year. There are 31 secondary schools in the area, 16 public and 15 private schools. The sample of 11 schools (8 public and 3 private) was drawn by stratifying the school into public and private schools and randomly selecting schools with probability proportional to size (There are more students in the public than private schools). The sample of schools was drawn by the help of zonal education authority. Participants were drawn from the selected schools. In all 1638 (790 male and 848 female) apparently healthy students were selected. Their age ranged between 12 and 18 years.

Procedure: Ethical approval was sought and obtained for this study from the Institutional Review Committee of University of Ibadan and University College Hospital, Ibadan. Informed consent was sought from the participants and their parents; permission was sought from local education authority and the principals of the selected schools. The nature, purpose and procedure of the study were explained to the participants in detail. The biodata of each participant was taken: this included age (as at last birth day) and sex.

Anthropometric Measurements: Weight and height were measured using portable weighing scale (Camry model BR9012 made in China) and height meter (Wunder, made in China) respectively as described in previous study (willet, 1990). The BMI was then computed using a standard formula [BMI= weight (kg)/height ^{2} (m ^{2})].

The American College of Sports Medicine guidelines for skinfold measurement was followed to measure triceps and abdominal skinfold thickness using Skinfold caliper (FAT-O-METER, Novel products Inc., Pat. No.4.233.743). The triceps skinfold was taken at the level of mid-point between the acromion and olecranon processes and 5cm adjacent to the umbilicus to the right side for abdominal skinfold thickness as described by ISAK (2001). Two readings were taken on each site and the average was used in the computation.

Statistical Analysis: Crude percentiles were calculated for body weight and height, BMI, triceps and abdominal skin folds separately for boys and girls in 1-year intervals using SPSS version 11.0 statistical software. The BMI percentiles were smoothed using excel package models. The 85th and 95th percentiles for BMI were compared with published percentiles from Cyprus and USA.

RESULTS

A total of 1638 secondary school children participated in this study. They comprised 790(48.2%) males and 848 (51.8%) females. One thousand four hundred and twelve were from 11 public secondary schools and 226 from 3 private secondary schools in Sagamu local government area of Ogun State, Nigeria. The ratio of students sample in the school type was 6.25:1(public: private schools), whereas the whole population's ratio is 5.33:1. The mean values and SDs for body weight and height, BMI, triceps skinfold and abdominal skinfold by age and gender are shown in table 1.There is a gradual increase in body weight, height and BMI in both sexes except at the female's height of ages 16 and 18 years old and male's BMI at age 15 years old. The male's triceps skinfold seem to decrease with age groups i.e. (ages 12, 13-14, 15-17 and 18 years) while the female's triceps skinfold were gradually increased with age save ages 17 and 18 that were the same.

Table 1: Mean Value (±SD) for Body Weight, Height, BMI, TSF and ASF of Participants.

Age(yrs)	Sex	number	weight(kg)	height(m)	BMI(kg/m2)	TSF(mm)	ASF(mm)
12	male	83	34.9(5.7)	1.43(.08)	16.97(1.74)	7.1(3.7)	6.6(3.1)
	Female	99	39.2(7.5)	1.47(.07)	18.02(2.42)	11.9(5.4)	11.2(4.6)
13	male	101	35.9(6.0)	1.44(.08)	17.09(1.44)	6.6(2.7)	6.3(2.4)
	Female	126	41.4(6.6)	1.51(.07)	18.17(2.10)	12.2(4.4)	11.6(4.0)
14	male	126	41.7(7.8)	1.51(.08)	18.23(2.05)	6.6(2.7)	6.5(2.2)
	Female	162	44.5(7.6)	1.54(.07)	18.72(2.42)	12.9(4.8)	12.4(4.4)
15	male	129	42.4(8.2)	1.54(.10)	17.77(1.66)	6.2(2.7)	6.7(2.2)
	Female	140	47.6(6.9)	1.57(.06)	19.38(2.33)	14.2(4.6)	12.8(3.3)
16	male	149	51.9(10.4)	1.59(.09)	20.34(3.49)	6.2(2.9)	7.0(2.7)
	Female	157	48.5(7.1)	1.57(.06)	19.58(2.66)	15.8(5.2)	13.6(3.9)
17	male	88	56.7(8.1)	1.64(.06)	20.59(2.58)	6.2(3.2)	7.5(2.7)
	Female	94	51.4(6.3)	1.59(.06)	20.38(2.20)	16.4(5.2)	14.4(4.5)
18	male	114	58.3(8.3)	1.67(.07)	20.86(2.56)	6.1(3.2)	7.7(2.5)
	Female	70	52.6(7.3)	1.58(.06)	20.93(2.45)	16.4(6.1)	13.8(4.9)
12-18	male	790	46.2(11.7)	1.55(.32)	18.92(2.83)	6.4(3.0)	6.9(2.6)
	Female	848	46.1(8.2)	1.55(.07)	19.19(2.54)	14.1(5.3)	12.7(4.3)

***Key:** BMI: body mass index   ASF: abdominal skinfold*

Table 2: Percentiles for Body Weight (kg) of Participants

Age (yrs)	Sex	Percentile								
		5th	10th	15th	25th	50th	75th	85th	90th	95th
12	Male	28.00	30.00	30.00	32.00	34.00	37.00	40.00	42.00	44.80
	Female	30.00	30.00	32.00	35.00	38.00	42.00	45.00	50.00	59.00
13	Male	29.00	29.00	30.00	30.00	35.00	40.00	42.00	45.00	48.80
	Female	33.00	34.00	35.00	35.00	40.00	46.00	48.95	50.00	53.00
14	Male	30.70	33.00	33.00	34.00	43.00	46.25	50.00	51.60	56.00
	Female	31.00	35.00	37.45	40.00	44.00	49.00	53.00	55.00	58.85
15	Male	30.50	33.00	33.00	35.00	42.00	49.00	51.00	54.00	57.00
	Female	39.00	40.00	41.00	43.00	46.00	51.00	55.00	56.00	60.90
16	Male	35.00	39.00	40.00	44.00	52.00	58.00	62.50	65.00	70.00
	Female	40.00	41.00	42.00	44.00	47.00	52.00	55.00	57.20	59.30
17	Male	40.45	42.90	46.00	51.00	56.00	62.00	63.65	64.10	68.00
	Female	42.50	43.50	45.00	47.00	51.00	55.00	57.75	60.00	64.25
18	Male	45.75	48.00	50.00	53.75	58.00	63.25	65.00	66.00	78.00
	Female	42.00	43.00	45.00	47.75	52.00	57.25	62.35	63.00	65.00

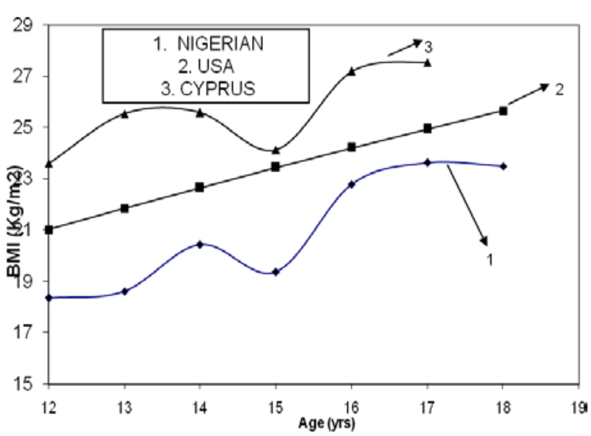

Fig. 1A:COMPARISON OF 85TH PERCENTILE OF BMI IN Nigerian, USA and Cypriot BOYS

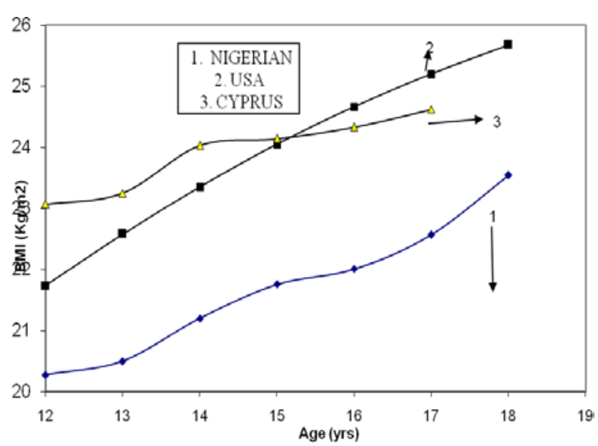

Fig.1B: COMPARISON OF 85TH BMI PERCENTILE IN Nigerian, USA and Cypriot GIRLS

Figures 1A and B present the comparison of the 85th percentile for BMI of this study with CDC (USA) and Cyprus curves for boys and girls respectively. A similar comparison for the 95th percentile is shown in figures 2A and B.

As is obvious from figures 1 and 2, boys and girls in Nigeria (Sagamu) compare more favorably with boys and girls from USA and Cyprus. Both 85th and 95th percentiles are lesser in Nigerian adolescents. The 85th percentile in Nigerian boys and girls are lesser by 2 to 2.8kg/m^2 and 1.5 to 2kg/m^2 respectively when compared with their USA counterpart at ages 12 to 18 years.

Similar differences are observed in Cyprus boys and girls (~4 to 5kg/m^2 in boys and 2 to ~3kg/m^2 in girls at ages 12 to 17 years). The 95th percentile are also lesser by ~3 to ~4kg/m^2 and~2 to ~5kg/m^2 in Nigerian boys and girls respectively when compared with USA adolescents at ages 12 to 18 years. Also boys and girls from Nigeria are lesser in their 95th percentile by ~5 to ~6kg/m^2 and 2.6 to 5kg/m^2 respectively when compared with their counterpart from Cyprus at ages 12 to 17 years.

The abdominal skin fold of boys and girls increases with age with exception of males ages 13 and 14years. The percentiles of body weight, height, BMI, triceps skinfold and abdominal skinfold are presented in tables 2 to 6 respectively.

Table 3: Percentiles for Body Height (M) of Participants

Age (yrs)	Sex	Percentile								
		5th	10th	15th	25th	50th	75th	85th	90th	95th
12	Male	1.30	1.34	1.37	1.38	1.43	1.47	1.52	1.53	1.55
	Female	1.35	1.38	1.39	1.43	1.47	1.52	1.55	1.56	1.58
13	Male	1.33	1.35	1.36	1.39	1.44	1.50	1.54	1.58	1.59
	Female	1.41	1.43	1.44	1.46	1.50	1.55	1.58	1.60	1.62
14	Male	1.40	1.40	1.41	1.45	1.50	1.56	1.60	1.63	1.67
	Female	1.41	1.44	1.46	1.50	1.54	1.59	1.61	1.63	1.65
15	Male	1.38	1.40	1.44	1.46	1.54	1.61	1.64	1.67	1.72
	Female	1.47	1.49	1.51	1.53	1.57	1.61	1.62	1.64	1.66
16	Male	1.45	1.46	1.50	1.54	1.60	1.66	1.69	1.70	1.76
	Female	1.48	1.50	1.51	1.54	1.58	1.61	1.64	1.65	1.66
17	Male	1.54	1.56	1.58	1.60	1.64	1.68	1.71	1.72	1.77
	Female	1.50	1.51	1.52	1.54	1.58	1.63	1.66	1.67	1.70
18	Male	1.57	1.59	1.59	1.62	1.68	1.72	1.75	1.77	1.78
	Female	1.51	1.52	1.53	1.54	1.58	1.61	1.64	1.68	1.71

Table 4: Percentiles for Body Mass Index (kg/m2) of Participants

Age (yrs)	Sex	Percentile								
		5th	10th	15th	25th	50th	75th	85th	90th	95th
12	Male	14.42	15.18	15.63	15.98	16.89	17.83	18.35	19.54	20.65
	Female	14.74	15.43	15.65	16.39	17.60	19.03	20.28	21.23	23.46
13	Male	14.96	15.31	15.54	16.11	16.96	17.86	18.61	19.22	19.98
	Female	15.24	15.77	16.02	16.64	17.98	19.24	20.50	21.55	22.63
14	Male	15.11	15.56	15.95	16.60	18.33	19.81	20.44	20.72	21.62
	Female	15.27	15.78	16.30	17.09	18.45	20.22	21.20	22.18	23.17
15	Male	15.01	15.53	16.06	16.60	17.67	18.80	19.37	19.68	20.50
	Female	16.20	16.67	17.21	17.76	18.95	20.45	21.76	22.71	23.85
16	Male	15.81	16.66	17.12	18.08	20.17	21.79	22.80	24.22	26.57
	Female	16.02	16.64	17.06	17.77	18.90	21.44	22.01	22.77	24.17
17	Male	16.42	16.93	17.76	18.65	20.54	22.40	23.63	24.02	25.31
	Female	16.90	17.67	18.26	18.90	20.44	21.49	22.57	23.42	24.37
18	Male	17.40	17.77	18.12	18.95	20.56	22.49	23.49	24.62	26.07
	Female	17.24	17.81	18.13	19.21	20.70	22.69	23.54	24.66	25.40

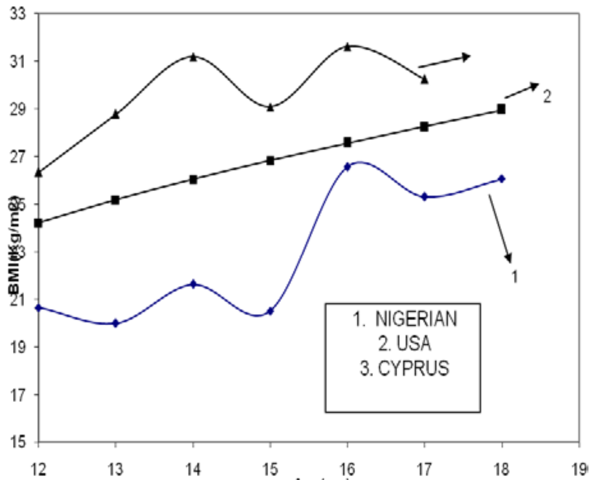

Fig.2A: COMPARISON OF 95TH BMI PERCENTILE IN Nigerian, USA and Cypriot BOYS

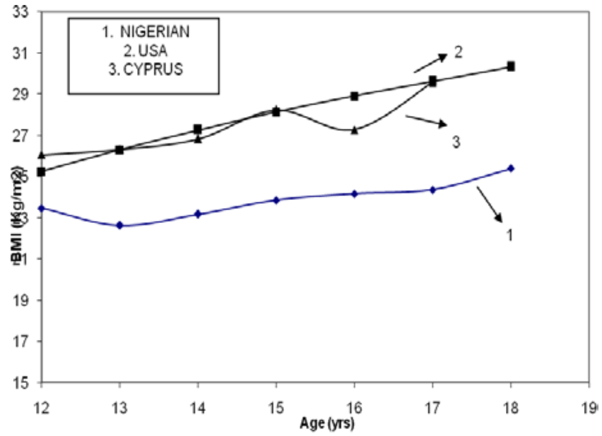

Fig. 2B: COMPARISON OF 95TH BMI PERCENTILE IN Nigerian, USA and Cypriot GIRLS

Table 5: Percentiles for Triceps Skinfold (mm) of Participants

Age (yrs)	Sex	Percentile								
		5th	10th	15th	25th	50th	75th	85th	90th	95th
12	Male	3.00	4.00	4.50	5.00	6.50	8.00	10.00	10.80	15.54
	Female	5.50	6.00	6.50	8.00	11.00	15.50	17.00	20.00	22.50
13	Male	3.00	4.00	4.00	5.00	6.00	8.00	9.85	10.00	11.90
	Female	6.00	7.50	8.00	9.00	11.25	15.00	17.50	18.65	21.32
14	Male	3.00	4.00	5.00	5.00	6.00	7.63	9.00	10.00	11.00
	Female	7.00	7.15	9.00	10.00	11.75	16.00	18.00	19.00	24.00
15	Male	3.00	4.00	4.00	5.00	5.00	7.00	9.00	10.00	11.00
	Female	8.00	9.00	9.50	11.00	13.00	17.00	19.00	20.45	22.95
16	Male	3.00	4.00	4.00	4.50	5.50	7.00	8.75	9.50	11.00
	Female	8.00	9.40	10.70	12.00	15.00	19.00	21.00	23.00	25.00
17	Male	3.00	4.00	4.00	4.00	5.00	7.00	8.83	10.00	12.55
	Female	8.00	9.25	10.00	12.00	16.25	20.00	22.00	23.00	25.50
18	Male	4.00	4.00	4.00	5.00	5.25	6.13	7.88	8.75	9.88
	Female	7.10	9.00	10.00	12.00	15.75	21.00	24.35	25.95	27.00

Table 6: Percentiles for Abdominal Skinfold (mm) of Participants

Age (yrs)	Sex	Percentile								
		5th	10th	15th	25th	50th	75th	85th	90th	95th
12	Male	3.10	4.00	4.00	4.50	6.00	8.00	9.00	9.50	11.50
	Female	6.00	6.50	7.00	8.00	10.00	14.00	15.00	16.00	22.50
13	Male	3.05	4.00	4.00	4.00	6.00	7.75	9.00	10.00	11.00
	Female	6.00	7.00	8.00	8.88	11.00	14.00	15.50	17.00	20.33
14	Male	4.00	4.00	4.50	5.00	6.00	7.63	8.50	9.15	10.33
	Female	6.00	8.00	9.00	10.00	11.25	14.00	17.28	19.00	22.00
15	Male	4.00	4.00	5.00	5.00	6.00	8.00	9.00	10.00	11.00
	Female	8.03	9.00	9.00	10.00	13.00	15.00	16.00	17.00	18.00
16	Male	4.00	4.00	5.00	5.00	6.50	8.00	9.25	10.00	12.00
	Female	7.95	9.00	10.00	11.00	13.00	16.00	17.15	19.00	21.10
17	Male	4.00	4.45	5.00	6.00	7.00	9.00	10.00	11.10	13.28
	Female	8.50	10.00	10.00	11.00	13.25	16.25	18.75	20.50	24.13
18	Male	4.82	5.00	5.50	6.00	7.00	9.00	10.00	10.00	11.00
	Female	7.00	8.00	9.00	10.00	12.75	17.00	19.35	20.90	22.45

DISCUSSION

This study presents data on body weight and height, BMI, triceps and abdominal skinfolds from a representative sample of Nigerian secondary school adolescents, ages 12 to 18 years from Sagamu. We also constructed (for the first time) BMI percentile curves for this age group.

Anthropometric indicators are useful both at an individual and population level. At an individual level, anthropometric indicators can be used to assess compromised health or nutrition well being (de Onis and Habicht, 1996). This information can be valuable for screening children for interventions and for assessing the response to interventions. At the population level, anthropometry can be used to assess the nutrition status within a country, region, community, or socioeconomic group, and to study both the determinants and consequences of malnutrition. This form of monitoring is valuable both for the design and targeting of health and nutrition interventions.

Skinfold measurement has been widely used to assess body composition in the past. They are simpler and less expensive than hydrostatic weighing or other laboratory-based techniques for body composition analysis (Mei et al, 2007). After the outlay for purchase of calipers, the costs are minimal. However, measurement can vary from tester to tester depending on skill and experience. Expert panels have recommended measuring triceps and subscapular skinfold thicknesses as part of the in-depth medical assessment of children and adolescents with age- and gender-specific BMI ≥95th percentile or ≥30 (which ever was smaller) or age- and gender-specific BMI ≥ 85th percentile but <95th percentile or equal to 30 (which ever was smaller) Himes and Dietz, 1994. However, Mei et al (2007) reported in contrast to the recommendations of expert panels that skinfold measurements do not seem to provide additional information about excess body fat beyond BMI-for-age alone if the BMI-for-age is >95th percentile.

In recent years, BMI has been increasingly accepted as a valid indirect measure of adipose tissue in both children and adolescents for survey purposes. Age- and gender-specific BMI cut-off points are needed when classifying overweight and obesity in young people (Wang and Lobstein, 2006). But what is the ideal reference population? It is obvious that the percentiles for weight and height from countries with high socioeconomic status, such as western Europeans, cannot be used for starving countries such as those of central Africa (Savva et al, 2001). Similarly, it is questioned whether BMI plots from the United States can be used for other populations. The genetic background of different ethnic groups is also a significant, and perhaps more important, confounder in the distribution of BMI and its relation to body fatness (Deurenberg et al, 1998). Therefore, the reference values in this study will be found useful for Nigerian adolescents in Ogun state and possibly western Nigeria in the absence of national references. The present study shows that the girls were heavier and taller than the boys up to age of 16 years when the boys took over. Similar trend was observed for their percentiles. This observation was consistent with that of Adekolu-John (1987) who suggested that growth generally stops earlier in females than in males. The females also show higher BMI, TSF and ASF than the males through the ages. The same observation was observed in the percentiles of these parameters. This was the same with report of Al-sendi et al, 2003; Gultekin et al, 2005 and Kavak, 2006 who reported that at this young age there is clear evidence of sexual dimorphism in fat patterning, with girls showing greater subcutaneous adiposity, which is mainly contributed by the triceps fat.

The comparison of 85th and 95th BMI percentile of our sample with curves of adolescents from Cyprus and USA indicates that adolescents from Nigerian are not as heavy as their peers from these countries. This observation might be due to the fact that the developing country like Nigeria has double burden of under- and overnutrtion compare with USA and Cyprus where prevalence of obesity is high (Wang and Lobstein, 2006). In relation to USA and Cyprus reference values, it seems that Nigerian adolescents from Sagamu appears to have near normal BMI though there is evidence of increased prevalence of overweight in our recent study from this population (Akinpelu et al, 2008). This observation might be explained in the light of current prevalence of overweight and obesity worldwide. The current prevalence of overweight and obesity varies considerably worldwide. North America, Europe, and parts of the Western Pacific have the highest prevalence of overweight among children (approximately 20 - 30%). Parts of South East Asia and much of sub- Saharan Africa appear to have the lowest prevalence. South and Central America, Northern Africa and Middle Eastern countries fall in between (Wang and Lobstein, 2006). The evidence of increased prevalence of obesity was also reported by Akesode and Ajibode (1983) who showed high prevalence of obesity in Nigerian school children. These findings have important public health implications given recent evidence linking childhood and adolescent obesity to increased risk of obesity and morbidity in adulthood. In Nigeria where there is a nutrition transition with a double burden of over and under-nutrition, public-health programs and policies should be developed or adjusted to promote healthy growth and prevent stunting-related central adiposity. Therefore, programs to prevent the development of overweight and obesity in children and adolescents should be given a high priority.

In summary, we presented growth reference values of Nigerian adolescent from Sagamu. The upper BMI limits of adolescents in this environment are lesser than their counterpart from USA and Cyprus. In the absence of national references the values presented in this study will be found useful in Ogun state and possibly western Nigeria to assess nutritional status and health risk of adolescents.

REFERENCES

Adekolu-John EO (1987): Anthropometric indices of nutritional state of people of Kainji Lake area of Nigeria. Nig J Nutr Sci 8: 115-29

Akesode FA and Ajibode HA (1983): Prevalence of obesity among Nigerian school children. Social Science and Medicine 17(2):107-11

Akinpelu AO, Oyewole OO and Oritogun KS (2008): Overweight and obesity: does it occur in Nigerian adolescents in an urban community? International Journal of Biomedical and Health Sciences (In press).

Al-sendi AM, Shetty P and Musaiger AO (2003): Anthropometric and body composition indicators of Buhraini adolescents. Annals of Human Biology 30(4):267-79

Chhatwal J, Verma M, and Riar SK (2004): Obesity among pre-adolescent and adolescents of developing country (India). Asia Pacific Journal of Clinical Nutrition 13(3): 231-235.

Chinn S, Cole TJ and Preece MA (1996): Growth charts for ethnic populations in UK (letter). Lancet 347: 839-840

de Onis M and Habicht J-P. (1996): Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee. American Journal of Clinical Nutrition 64:650-680

Deckelbaum RJ and Williams CL (2001): Childhood Obesity: The Health Issue. Obesity Research 9:S239-S243

Deurenberg P, Yap M and van Staveren WA (1998): Body mass index and percent body fat: a meta analysis among different ethnic groups. International Journal of Obesity and Related Metabolic Disorder 22:1164-1171

Gultekin T, Akin G and Ozer BK (2005): Gender differences in fat patterning in children living in Ankara. Anthropol. Anz. 63(4):427-37

Guo S.S, Wu W, Chumlea W.C and Roche A (2002): Predicting overweight and obesity in adulthood, from body mass index values in childhood and adolescence. American Journal of Clinical Nutrition 76: 653-658.

Hasan MA, Batieha A, Jadou H, Khawaldeh AK, and Ajilouni K (2001): Growth status of Jordanian school children in military-founded schools. European Journal of Clinical Nutrition 55: 380-386.

Health Canada (2003): Canadian guidelines for body weight classification in adults.

HighBeam (1999): Clinical guidelines: identification, evaluation and treatment of overweight and obesity in adults. Family Economics and Nutrition Review 12(1): 59-62

Himes JH and Dietz WH (1994): Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. American Journal of Clinical Nutrition 59:307 –316

International Society for the Advancement of Kinanthropometry (ISAK) (2001): International standards for anthropometric assessment. ISAK

Kavak V (2006): The determination of subcutaneous body fat percentage by measuring skinfold in teenagers in Turkey. International Journal of Sport Nutrition and Exercise Metabolism 16(3):296-304

Mei Z, Grummer-Strawn LM, Wang J, Thornton JC, Freedman DS, Pierson, Jr, RN, Dietz WH and Horlick M (2007): Do skinfold measurements provide additional information to body mass index in the assessment of body fatness among children and adolescents? Pediatrics 119(6): e1306-e1313

Owa JA and Adejuyigbe O (1997): Fat mass percentage, body mass index and upper arm circumference in a healthy population of Nigerian children. Journal of Tropical Pediatrics 43: 13-19.

Sanusi RA (2003): Development and evaluation of weight and height reference standard for young adults (18-24 yrs) in Ibadan, Nigeria. African Journal of Biomedical Research 6(3): 133-136.

Sarria A, Moreno L.A, Garcia-Llop L.A, Fleta J, Morellon M.P and Bueno M (2001): Body mass index, triceps skinfold and waist circumference in screening for adiposity in male children and adolescents**.** Actar Paediatrics 90(4): 387-92.

Savva SC, Kourides Y, Tornaritis M, Epiphanion-Savva M, Tafouna P and Kafatos A (2001): Reference Growth Curves for Cypriot Children 6 to 17 Years of Age. Obesity Research 9:754-762

Twisk J.W, Kemper H.C, van Mechelen W, Post G.B and van Lenthe F.J (1998): Body fatness: longitudinal relationship of body mass index and the sum of skinfolds with other risk factors for coronary heart disease**.** International Journal of Obesity and Related Metabolic Disorder 22(9): 915-22.

Wang Y and Lobstein T (2006): Worldwide trends in childhood overweight and obesity. International Journal of Pediatrics Obesity 1:11-25.

Willet W (1990): Nutritional Epidemiology. Oxford, Oxford University Press Inc. 217-219

Wood R.J (2006): Body mass index. Top Endsport Network

Yarnell J.W, Patterson C.C, Thomas H.F and Sweetnam P.M (2001): Central obesity: predictive value of skinfold measurements for subsequent ischaemic heart disease at 14 years follow-up in the Caerphilly Study**.** International Journal of Obesity and Related Metabolic Disorder 25(10): 1546-9