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Body Mass Index and Lipid Profile: A Case Study of Female School Going Adolescents in Katsina Metropolis, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author AIY designed the study, wrote the first draft of the manuscript and the statistical analysis. Authors LS and SS managed the measurements of the clinical parameters of study participants and analyses of the study as well as literature review. All authors have read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aim: The study is aimed at analyzing blood samples from 192 females school going adolescents (randomly selected) in a public boarding secondary school in Katsina metropolis for the levels of serum total cholesterol (TC), high density lipoprotein cholesterol (HDL-CH), low density lipoprotein cholesterol (LDL-CH), and triacyl glycerol (TG) in order to ascertain a risk of cardiovascular disease (CVD).
Study Design: A cross sectional study was conducted among female adolescents aged between 13 to 18years, attending boarding secondary school within Katsina metropolis-Nigeria to assess their nutritional status.
Place and Duration of Study: Department of Biochemistry, Umaru Musa Yar'Adua University, Katsina-Nigeria. December 2008 to April 2009.
Methodology: We determined the body mass index (BMI) and lipid profile of female school going adolescents. An end point colorimetric method was used to estimate serum total cholesterol. Test kits obtainable from Randox Laboratories Limited were used to

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estimate serum HDL-cholesterol, serum LDL-cholesterol and triacyl glycerol.
Results: The results indicate that female adolescents in the age groups 14, 15, 16 and 17 had a significantly (P<0.05) higher mean BMI than the age group13 and 18. Mean TC levels were significantly (P<0.05) higher in the age groups 13, 14, 15 and 17. Mean HDL-CH values were significantly (P<0.05) higher in the age groups 13, 15 and 17. Mean LDL-CH and TG values were significantly (P<0.05) higher in the age groups 13 and 14.
Conclusion: Although the findings of this study revealed that the adolescent subjects had BMI which are within the normal weight range of WHO cut-off points (18.5 to 24.9kg/m^2) and a lipid profile indicative of low risk cardiovascular diseases. It is projected that most of our subjects will not have attendant complications associated with cardiovascular diseases. We recommend that similar study be conducted in private schools patronized by children of middle and high income groups.

Keywords: Adolescents; body mass index; serum lipids; cardiovascular disease; Katsina-Nigeria.

1. INTRODUCTION

Adolescents comprise a significant proportion of the world's population. The proportion of adolescents within a population group is also rising relative to other groups and an overwhelming proportion of young adolescents live in developing countries [1]. The health of adolescents attracted global attention in the past two decades as nutritional status during this period is an important determinant of health status [2]. More so overweight and obesity during adolescent period are associated with risk factors for obesity related diseases in adults [3].

Berenson and co-workers [4] have shown that atherosclerosis of the aorta and coronary artery was related to obesity in youth. Lin et al. [5] have reported that variations in body mass, subcutaneous fatness and total body fat in adolescents are significantly associated with variations in blood pressure and blood levels of lipoproteins, glucose and insulin in many populations of developed countries. The dearth of information on the nutritional status of adolescents in Katsina State necessitates the current work. This study was therefore undertaken to assess the nutritional status of adolescents in a selected secondary school in Katsina metropolis. Specifically, the study involved assessment of body mass index (BMI) and serum lipid profile (total cholesterol, HDL-cholesterol, LDL-cholesterol and triacyl glycerol).

2. MATERIALS AND METHODS

2.1 Study Population

A descriptive cross-sectional study was conducted among female students attending boarding secondary school within Katsina metropolis. Katsina occupies part of northern Nigeria. It is the capital of Katsina State, one of Nigeria's 36 States. It is also the headquarters of Katsina Local Government Area. The global location of the State is between latitude 12º 15' north of the equator and longitude 07º 30' east of the Greenwich Meridian with a total area of 24, 192 km^2 and a population of 3,878,344 as of 1991 census [6]. The objectives of the study were presented to the State Ministry of Education and the school principal in order to obtain their authorizations. A total of one hundred and ninety two

students were randomly selected from the boarding school in the metropolis for participation in the study. All participants were Hausa-Fulani and appeared apparently healthy and aged between 13-18 years.

2.2 Sampling Technique

A comprehensive list of all the female boarding schools in Katsina zonal inspectorate of Education was collected from the State Ministry of Education. The school for the study was then selected with the use of the simple random technique applied through the table of random numbers. With the use of stratified sampling technique; proportionate allocation was given to each age group to make up the required sample size depending on the population of the students in each age group [7].

All students within the study age groups were considered. However, in each age group, systematic sampling method was employed in which the students in each age group were given numbers serially according to their classroom register from class1 to class6, thereby giving each student an equal chance. The random number table was used to select the first number and thereafter students were picked at regular interval (sample interval) so as to meet the sample size requirement in each group. The sample interval was determined by dividing the total number of students in the age groups by the sample size: 1962/200=9.81=10 [7].

A total of 200 students were selected for the study, out of which 192 have complete data. Only those with complete data taken were included in the study analysis. Excluded from the study were non Hausa/Fulani and students that were ill.

2.3 Anthropometric Measurements

All measurements were made by persons trained on the proper techniques of measuring height and weight. Weighing scale was standardized by the technicians, and weight was taken based on internationally accepted standards for weight measurements. The weighing scales were calibrated each morning before weighing was done. The weight of each student was measured, with the student bare footed and with light clothing, using WEYLUX weighing scale, model 424J; Sliding Beam Column Scale, (Short Pillar with height of 560mm). The measurements were recorded to the nearest one (1) kilogram (Kg). Their height was measured using ACCUSTAT Ross Stadiometer, 44817, manufactured by Genentech Incorporated. The students were asked to stand erect with the heels, buttocks, upper back and occiput against the stadiometer. The measurements were recorded to the nearest 1cm. The BMI was then computed using the standard formula [BMI=weight (kg)/height (m^2)] [7].

2.4 Biochemical Measurements

Blood samples were obtained from each subject by veni puncture and the samples were allowed to clot at room temperature before being centrifuged to separate the serum and frozen prior to analysis. Serum TC concentration was measured by the end point colorimetric method [8] with the use of T60 spectrophotometer and test kits obtainable from Randox Laboratories Limited. In this method, the cholesterol was determined after enzymatic hydrolysis and oxidation. The indicator quinoneimine was formed from the reaction between hydrogen peroxide and 4-aminoantipyrine in the presence of phenol and peroxidase.

Serum HDL-Cholesterol was measured with a T60 spectrophotometer with test kits obtainable from Randox Laboratories Limited. In this method, low density lipoprotein and chylomicron fractions are precipitated quantitatively by addition of phosphotungstic acid in the presence of Mg^{2+} ions. After centrifugation, the cholesterol concentration in the HDL fraction which remained in the supernatant was then determined [9].

Serum LDL-Cholesterol concentration was measured with a T60 spectrophotometer with test kits obtainable from Randox Laboratories Limited. In this method, low density lipoproteins are precipitated by heparin at their iso-electric point (pH=5.04). After centrifugation, the HDL-Cholesterol and VLDL remained in the supernatant. The cholesterol concentration in the LDL fraction was determined by enzymatic method [10].

Serum Triacyl glycerol concentration was measured with a T60 spectrophotometer with test kits obtainable from Randox Laboratories Limited. In this method, the triglycerides are determined after enzymatic hydrolysis with lipases. The indicator is a quinoneimine formed from hydrogen peroxide, 4-amino phenazone and 4-chlorophenol under the catalytic influence of peroxidase [11].

2.5 Data Analysis

Data obtained were analyzed using Microsoft Excel and results were expressed as mean ± standard deviation. The analysis of variance was used to test for significant differences. Pearson's correlation coefficients between Age, BMI and serum lipids of the subjects were computed to establish whether there is a linear relationship between the measured variables. Also scatter diagrams were plotted to confirm a linear relationship. Statistical variations were considered significant at $p<0.05$.

3. RESULTS

Table 1 shows the mean BMI and serum lipid levels of the subjects according to age. Mean BMI values were significantly ($p<0.05$) higher in the age groups 14, 15, 16 and 17 (21.60kg/m^2, 21.10kg/m^2, 21.15kg/m^2 and 21.90kg/m^2) than in the groups 13 and 18 (20.60kg/m^2 and 20.60kg/m^2). Mean serum TC values were significantly ($p<0.05$) higher in the age groups 13, 14, 15 and 17 (3.79mmol/L, 3.92mmol/L and 4.07mmol/L) than in the age groups 16 and 18 (3.24mmol/L and 3.55mmol/L). Mean serum HDL-CH values were significantly ($p<0.05$) higher in the age groups 13, 15 and 17 (1.17mmol/L, 1.15mmol/L and 1.10mmol/L) than in the age groups 14, 16 and 18 (0.95mmol/L, 0.92mmol/L and 0.94mmol/L). Mean serum LDL-CH values were significantly ($p<0.05$) higher in the age groups 13 and 14 (1.98mmol/L and 2.23mmol/L) than in the age groups 15, 16, 17 and 18 (1.65mmol/L, 1.49mmol/L, 1.58mmol/L and 1.58mmol/L). Mean TG values were significantly ($p<0.05$) higher in the age groups 13 and 14 (1.37mmol/L and 1.34mmol/L) than in the age groups 15, 16, 17 and 18 (1.18mmol/L, 1.03mmol/L, 1.19mmol/L and 1.13mmol/L).

Table 1. Mean body mass index and serum lipid levels in female school going adolescent subjects according to age

Age (years)	BMI (Kg/m^2)	TC (mmol/L)	HDL-CH (mmol/L)	LDL-CH (mmol/L)	TG (mmol/L)
13 (n=24)	20.60±0.10	*3.77±0.24	*1.17±0.10	*1.98±0.90	*1.37±0.18
14 (n=15)	*21.60±1.10	*3.92±0.42	0.95±0.12	*2.23±0.35	*1.34±0.15
15 (n=9)	*21.10±0.60	*4.07±0.51	*1.15±0.08	1.65±0.23	1.18±0.01
16 (n=24)	*21.15±0.65	3.24±0.26	0.92±0.15	1.49±0.39	1.03±0.16
17 (n=48)	*21.90±1.40	*4.02±0.52	*1.10±0.03	1.58±0.30	1.19±0.00
18 (n=72)	20.60±010	3.55±0.05	0.94±0.13	1.58±0.30	1.13±0.06

Values are mean±standard deviation with asterisk super scripts in the same column are significantly (P<0.05) higher

BMI=Body mass index; TC=Total cholesterol; HDL-CH=High density lipoprotein cholesterol; LDL-CH=Low density lipoprotein cholesterol; TG=Triacyl glycerol

Except for LDL-CH and TG concentrations, no significant correlations were found between age, BMI and the concentrations of serum lipids in our subjects. There was a significant decrease in LDL-CH and TG with age (Tables 2 and 3).

Table 2. Correlation between BMI and serum lipids of female school going adolescents

Anthropometric parameter	Serum lipid	Correlation
BMI	TC	0.434663
BMI	HDL-CH	-0.05828
BMI	LDL-CH	0.079712
BMI	TG	0.003467

Table 3. Correlation between age and serum lipids of female school going adolescents

Parameter	Serum lipid	Correlation
Age	TC	-0.27446
Age	HDL-CH	-0.43571
Age	LDL-CH	-0.75915
Age	TG	-0.74887

When we plotted the serum TC concentration versus BMI, a weak positive correlation was observed (Fig. 1) but with age a weak negative correlation was observed (Fig. 5). With serum HDL-CH and BMI, a very weak negative correlation was noted (Fig. 2) but with age a weak negative correlation was observed (Fig. 6). The plot of serum LDL-CH and TG concentrations gave a strong negative correlation with age (Fig. 7 and 8), whereas they gave a very weak positive correlation with BMI (Fig. 3 and Fig.4).

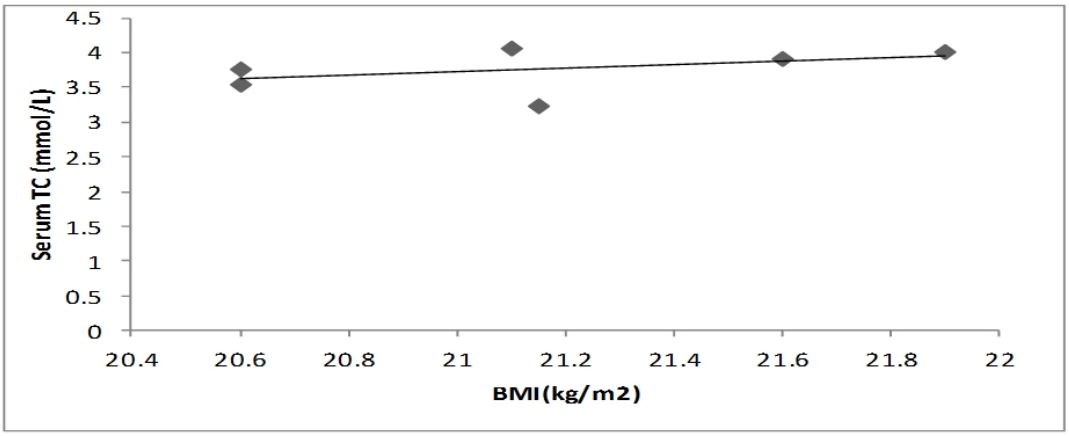

Fig. 1. The relation between BMI and serum TC of female adolescent subjects

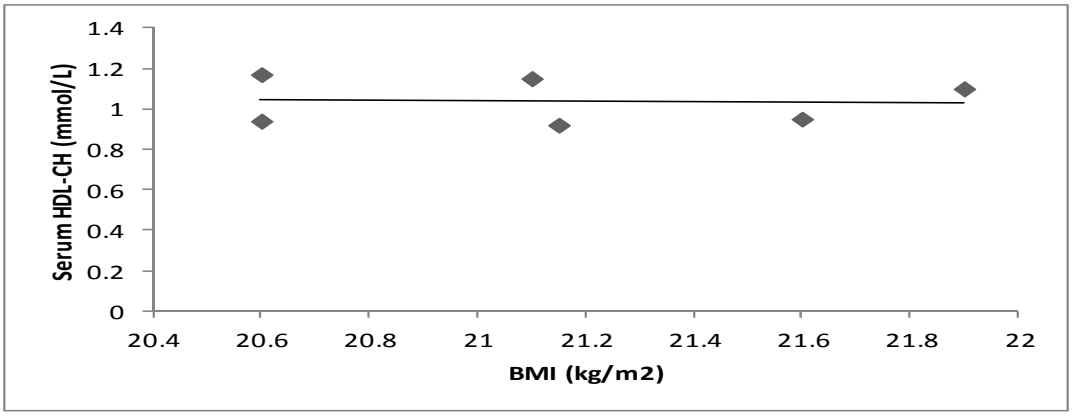

Fig. 2. The relation between BMI and serum HDL-CH of female adolescent subjects

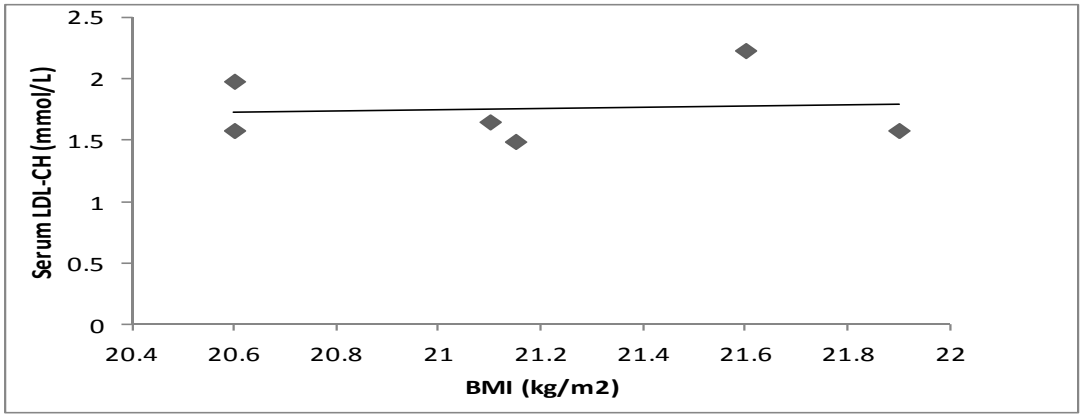

Fig. 3. The relation between BMI and serum LDL-CH of female adolescent subjects

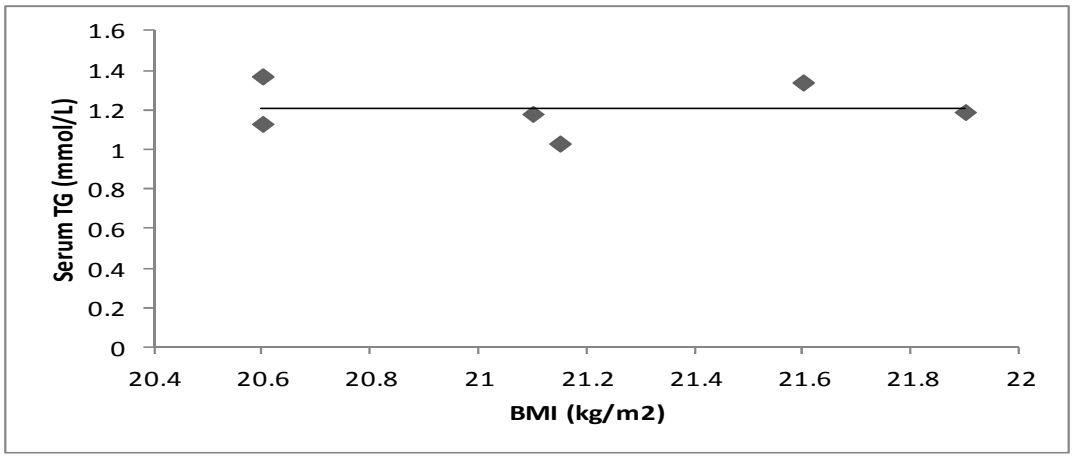

Fig. 4. The relation between BMI and serum TG of female adolescent subjects

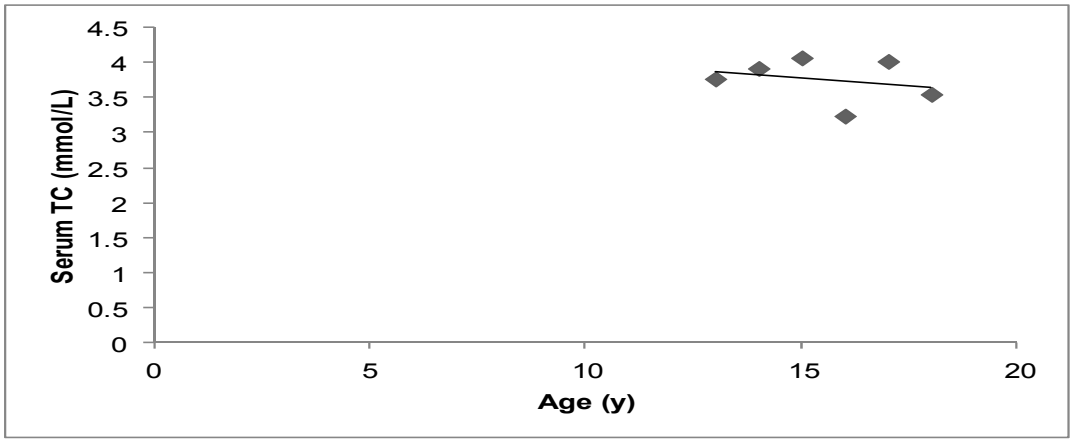

Fig. 5. The relation between age and serum TC of female adolescent subjects

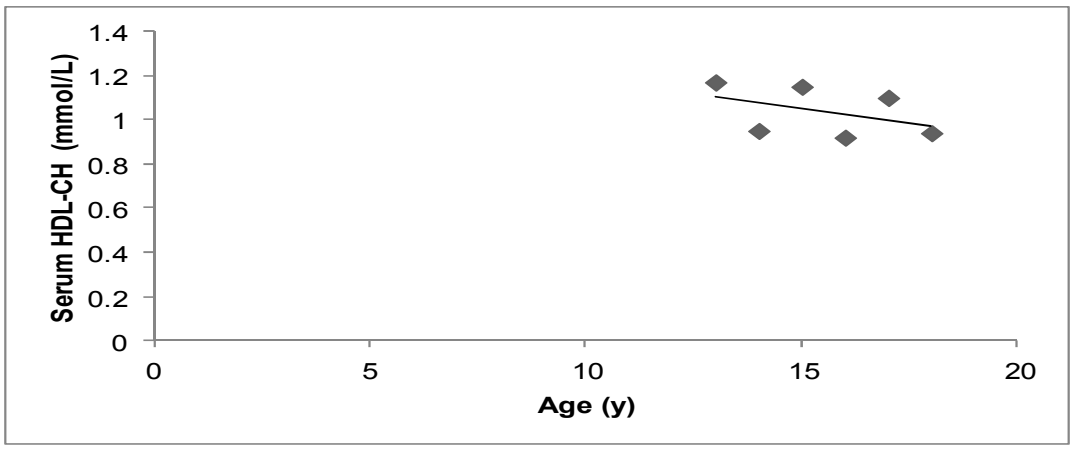

Fig. 6. The relation between age and serum HDL-CH of female adolescent subject

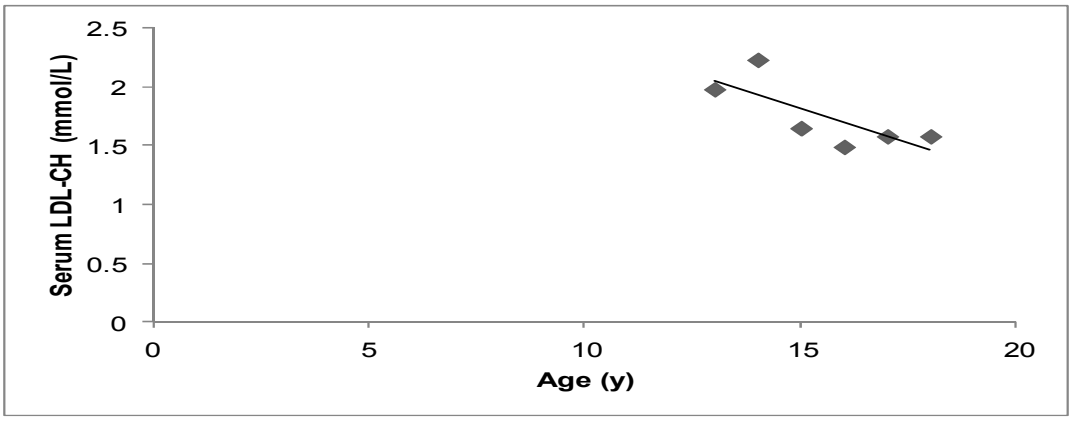

Fig. 7. The relation between age and serum LDL-CH of female adolescent subjects

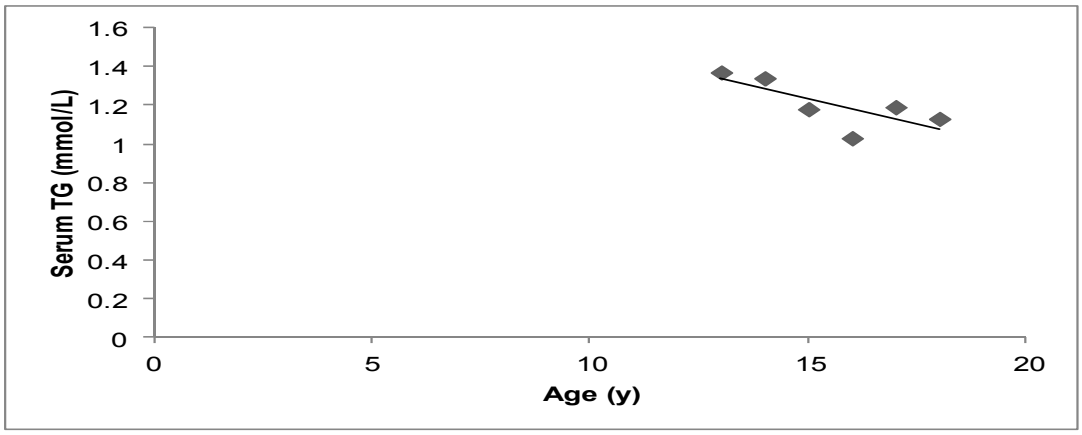

Fig. 8. The relation between age and serum TG of female adolescent subjects

4. DISCUSSION

This study shows that mean BMI values recorded for both age groups correspond to mild thinness on the BMI reference data [12]. The mean BMI of the female adolescents in this study is in accordance with studies carried out in other parts of Nigeria [12,13,14]. The BMI of this study subjects are also similar to what was reported from south west Nigeria [15]. In the past, the World Health Organization made no specific recommendations for adolescent anthropometry, but advocated the National Centre for Health Statistic (NCHS) of the United States reference data for younger children [16], which include standard deviations (SD) and percentiles of height and weight through the adolescent years [16]. Body mass index was recommended as the basis for anthropometric indicators of thinness and overweight during adolescence [17]. BMI was divided into four categories according to the WHO cut-off points with corresponding interpretations (<18.5kg/m^2, underweight; 18.5 to 24.9kg/m^2, normal weight; 25.0 to 29.9kg/m^2, overweight; ≥30.0kg/m^2, obese respectively) [18].

BMI as a measure of weight relative to height is a clinical diagnostic tool used to classify underweight, overweight and obesity in adults. Stefanig et al. [19] demonstrated that BMI

relates directly to total cholesterol, VLDL and LDL-CH, though; the present findings revealed that normal weights reflect a low risk cardiovascular disease. However, as the BMI increases, deposition of lipoprotein especially LDL-CH increases in the cardiovascular system leading to their concomitant atherosclerosis, a potential cardiac destroyer.

Finding from this study also showed that the mean serum HDL-CH and TG levels for all the age groups fall within the range of values considered acceptable for African Americans [20,21]. With the exception of the mean serum LDL-CH for age group 14, the mean serum LDL-CH levels of all the age groups obtained in the study fall below the LDL-CH values reported for subjects from Kano State, Nigeria [22] and US general population [20]. While TC levels were low when compared with ranges seen in US population [21]. This finding is in line with observations reported from other States in Nigeria [22,23,24]. Although, adolescent anthropometry has been observed to vary significantly worldwide [25]. The height, weight and BMI are higher than what was reported by Yusuf et al. [7] but similar to what was reported by Atiku and Yunusa [26].

The trend of relative low anthropometric measures observed compared to global standard is similar to what was reported in other parts of Africa [15,27,28]. This apparent difference has been attributed to malnutrition and recurrent parasitic infections seen in African children [29,30,31].

A positive correlation was found between BMI and the serum concentrations of TC and LDL-CH in the adolescent girls (Figs. 1 and 3). Also a negative correlation was observed between BMI and HDL-CH (Fig. 2). Although our study differs from earlier studies carried out in Nigeria [22,32]. The findings of our study are in line with several studies which have shown consistent positive independent association between excess body weight and TC levels [33,34,35,36,37,38]. However, the female adolescents in our study are Hausa/Fulani, whom earlier studies had shown that the Fulani consumed a diet which is high in fat [22,39].

Glew et al [22] studied Fulani pastoralists living in Jos plateau of north central Nigeria consuming a high fat diet, that have low serum total cholesterol and triglyceride concentrations in which the researchers concluded that a low energy intake, healthy life style and genetic features unique to the Fulani may help to account for why their diet does not result in elevated total or LDL-Cholesterol concentrations. As all our subjects are Hausa/Fulani, the argument of Glew et al. [22] may by extension also apply to our subjects and our study confirms the earlier findings in northern Nigeria [21,22,23].

Also in line with our study (Table 2), the Bogalusa heart and Muscatine studies demonstrated a positive correlation between BMI, TC and LDL-CH levels; and a negative correlation for HDL-CH [35,40].

Majority of the girls in the age groups 15, 16, 17 and 18 used to observe the voluntary Islamic fasting of Mondays and Thursdays which may explain the low values for LDL-CH seen in the age groups. However, the findings of this study for female adolescents in the 18 years age group had the lowest mean BMI coupled with the group having the highest subjects representation is a cause for concern. Because low pre-pregnancy BMI and short stature are risk factors for poor birth outcomes and obstetric complications [41], as almost half (46%) of women in Nigeria are married by age 18 [41].

The plots of serum lipid concentrations of our subjects gave a negative correlation with age. The possible explanation for this trend in decrease serum lipid concentrations with age may

be due to the culture of weekly voluntary fasting being observed by must of our subjects in the higher age groups. The very low serum cholesterol concentration may likely predispose our subjects to hemorrhagic stroke in the future especially among those who have high blood pressure [42].

Our study is among the first study on anthropometric indices and lipid profile among female adolescents in Katsina, Nigeria. We also appreciate the fact that our study has limitations. The major disadvantage of our study is the small sample size. The small sample size is a result of low female enrolment in schools, as the north western part of Nigeria which Katsina falls under have the highest proportion of persons with no education in Nigeria; roughly seven in ten women and half of men [40]. It has also been reported that overweight and obesity increases by age from 7% among women age 15-19 to 34% among women age 40-49 in Nigeria [40]. However, with a mean BMI of 21.15kg/m^2, we project that most of our subjects will not have attendant complications associated with cardiovascular diseases because our study has shown there is a significant decrease in serum lipid concentrations with age (Table 3). The cross-sectional nature of the study makes generalization of our findings to the entire population difficult. Notwithstanding, the result of this study can be extrapolated to populations with similar socioeconomic attributes. Though our findings are by no mean novel, they confirm previous reports of low prevalence of overweight and obesity among adolescents in Nigeria [7]. The study also provides baseline data for similar studies in the future especially in Northern-Nigeria where such data are lacking.

5. CONCLUSION AND RECOMMENDATIONS

Although the findings of this study revealed that the adolescent subjects had BMI which are within the normal weight range of WHO cut-off points (18.5 to 24.9kg/m^2) and a lipid profile indicative of low risk cardiovascular diseases. It is projected that most of our subjects will not have attendant complications associated with cardiovascular diseases. We recommend that similar study be conducted in private schools patronized by children of middle and high income groups.

ETHICAL APPROVAL

Authors hereby declare that written permissions were obtained from appropriate authorities and all experiments have been performed in accordance with the ethical standards laid down in the 1964 declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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