Original Article

Association of Body Mass Index and Serum Lipid Profile among Adolescents in Enugu, Nigeria

Christopher Bismarck Eke[1]*, Sylvester Ogbonna Ogbodo[2], Nnamdi Benson Onyire[3], Uzoamaka Vivian Muoneke[1], Mildred Oluchi Ukoha[4], Ogechukwu F Amadi[4], Joy N Eze[1] and Roland C Ibekwe[1]

[1]Department of Paediatrics, College of Medicine, University of Nigeria /University of Nigeria Teaching Hospital, Ituku- Ozalla, Enugu, Nigeria; [2]Department of Medical Biochemistry, College of Medicine, Enugu State University of Science and Technology, Enugu, Nigeria; [3]Department of Paediatrics, College of Medicine, Ebonyi State University, Abakaliki, Nigeria/Federal Teaching Hospital, Abakaliki, Nigeria; [4]Department of Paediatrics, Enugu State University of Science and Technology teaching Hospital, Enugu, Nigeria

Corresponding author:
Dr. Christopher B. Eke,
Department of Paediatrics,
University of Nigeria Teaching Hospital, Ituku-Ozalla,
Enugu, Nigeria,
E-mail: christopher.eke@unn.edu.ng

Abstract

Background: There has been rising burden of childhood obesity in most developing countries despite high prevalence of under nutrition. Obesity is associated with abnormal lipid levels that could result in a variety of metabolic and cardiovascular complications. **Objectives:** To determine the association of body mass index (BMI) and lipid profile in adolescents in Enugu metropolis. **Methods:** A cross – sectional analytical study was undertaken among children aged 10 -18 years old who were selected using multi-stage sampling. BMI and BMI percentile were determined while fasting serum lipid levels were determined using enzymatic methods. Data was analyzed using SPSS version 20.0 with level of statistical significance set at $p < 0.05$. **Results:** Three hundred and fifty children aged 10 to 18 years were studied. 2.6% and 10.0% were obese and overweight respectively. The prevalence of the different abnormal lipid profile including hypertriglyceridaemia, low level of high density lipoprotein cholesterol (HDL-C), hypercholesterolaemia, and high level of low density lipoprotein cholesterol (LDL-C) were: 13.4%, 9.4%, 6.3% and 5.4% respectively. Hypercholesterolaemia, hypertriglyceridaemia and increased LDL-C levels were significantly associated with increasing body mass index in the study subjects. **Conclusion:** Overweight and obesity is common among the study subjects and those with higher BMI particularly the older ones tend to have abnormal lipid profile. **Recommendation:** Assessment of BMI should be incorporated into school health programme and those with overweight/obesity subjected to routine lipogram in order to timeously apply preventive as well as therapeutic measures in order to save lives.

Keywords: Body Mass Index; Abnormal lipid profile; Children

Introduction

Rising prevalence of obesity and overweight has been reported globally, and obesity is now a leading nutritional disorder requiring urgent attention. [1,2] The International obesity Task Force (IOTF) has alerted that 1 in 10 children is overweight, with not less than 155 million school children affected globally. [3] About 30 to 45 million of the overweight children are classified as obese, accounting for 2-3% of the world's children aged five to 17 years of age. [3,4]

Obesity earlier considered a problem of high income countries is now on the rise in most low and middle income countries particularly in urban settings. [5,6] Studies in Nigeria on overweight and obesity in children have used different diagnostic criteria but highlighted the high prevalence of body weight disorders with rates of obesity ranging from 0.84% to 11.3% been reported by various workers in different geopolitical zones of the country. [7-9]

Obesity reflects a complex condition which is influenced by a wide range of genetic, metabolic, cultural, environmental, socio-economic, and behavioural factors. It is the convergence of these forces, biological and technological that has produced the current obesity epidemic in sub- Saharan Africa countries including Nigeria. [10]

Studies have reported an association between overweight and abnormal lipid levels in children, and longitudinal increase in relative weight was significantly associated with changes in this risk factor. [11-15] Obesity in older children has been shown to be a predictor of adult obesity independent of parental weight, [16] and is associated with increase in mortality during adulthood resulting from coronary heart disease. [17]

The mechanisms relating overweight and obesity to cardiovascular risk are not clearly defined, and the association of obesity with cardiovascular risk factors of hyperlipidaemia and hypertension form the insulin resistance syndrome. [18]

Hypercholesterolaemia has been associated with cardiovascular disease (CVD). Similarly formation of atherosclerotic plaque has been linked with the elevation of non- high density lipoprotein cholesterol, [19] while dyslipidaemia is directly linked with carotid artery elasticity, intima- media thickness, brachial flow- media dilation, flow- mediated dilation from childhood to adulthood. [20,21]

Generally dyslipidaemia is also associated with overall cardiovascular risk factors (obesity, diabetes mellitus, hypertension and smoking). [19,22]

How to Cite this Article: Eke CB, et al. Association of Body Mass Index and Serum Lipid Profile among Adolescents in Enugu, Nigeria. Ann Med Health Sci Res. 2018;8:404-410

The American Academy of pediatrics suggests that obese children because of their high risk of developing coronary vascular disease are in need of cholesterol screening irrespective of family history or other risk factors. [23]

Nigerian studies mainly from the South West and Northern geopolitical zones have reported varying relationships between body mass index and lipid profile in children [24-26] with the former, [21,22] reporting no relationships compared to the latter. [24]

Considering the health related impact of dyslipidaemia, gap exists in our setting with gross paucity of data on the relationship between lipids profile and body mass index in children particularly in the Southeastern Nigeria including Enugu State the study locale, which is home to over 17million people, [27] with varying nutritional and cultural ways of life.

Moreover Nigeria is currently an economy in transition with influences on weight gain as well as BMI in children, resulting from combined effects of globalization, resurgence of middle class and urbanization and high propensity to consume cheap, high energy dense foods and physical inactivity likely to increase development of obesity which has been linked to the development of dyslipidaemia with resultant development of insulin resistance as well as cardiovascular complications.

There is need therefore to determine the relationship between BMI and lipid profile in children in our setting to enable appropriate interventions to save lives as well as minimize economic costs of managing the associated morbidity. Hence, the aim of the current study was to determine the relationship between body mass index and serum lipid levels among secondary school children in Enugu urban, Nigeria.

Methods

This was a cross – sectional analytical study conducted among secondary school children in Enugu urban (consisting of three local governments areas namely: Enugu East, Enugu North and Enugu South local government areas) between July 1st to 31st, 2015.

Study sample size determination

The sample size for the study was calculated using the formula below. [28]

$N = Z^2pq/d^2$

Where n = the desired sample size when the population is more than 10.000.

Z = the standard variation usually set at 1.96 (which corresponds to 95% confidence interval).

P = The population in the target population estimated to have a particular characteristic (Prevalence of overweight in 3240 children aged 9- 16 years in Benue State, North Central Nigeria by Musa et al. was 9.7%; which is equal to 0.97) [9]

q = 1.0 – p i.e., 1.0 - 0.097 = 0.903.

d = degree of accuracy desired; set at 0.05.

Therefore, the minimum sample size, n= n = $(1.96)^2(0.097)(0.903)/(0.05)^2$

Hence applying the formula stated above, the minimum sample size was 135 subjects.

An attrition rate of 20% was anticipated, so the adjusted minimum sample size will be 162 school children.

However, considering the fact that only about 35.1% of eligible children are attending secondary school in Nigeria, [29,30] decision was taken to double the sample size to make conclusions to be drawn from the study more representative.

Schooling system in study locale

Enugu is the capital city of Enugu State South, Nigeria. Enugu State has an estimated population of about 3 million people, [30] while Igbo is the major ethnic group and language.

In Nigeria, children under 15 years of age account for about 43 to 45% of the 177 million Nigerian population. [30]

Evidence from the Nigerian Demographic and Health Survey reveals that among children of secondary school age, 35.1% were attending secondary schools. Thus the secondary school net attendance rate in Nigeria could be shielding the fact that many children are in school at a level that is not appropriate for their age. [30] The secondary school age in Nigeria is from 12 to 17 years, however in the southern parts of Nigeria children much younger than 12 years could well be found already in secondary schools.

Study sampling/population

A multi-staged sampling method was used to select the study population who were secondary school children as follows: A list of all the public and private secondary schools in the five densely populated areas of Enugu urban was drawn from where schools were selected by simple random sampling. There were about 80 secondary schools (public and private) spread over the five densely populated areas of the Enugu metropolis (Abakpa Nike, Trans Ekulu/ Government Reserved Area, GRA, Emene, Achara Layout/Uwani, and New Haven/Independence Layout). One school was selected by simple random sampling method from each of these areas and included three co-educational, one all boys and one all girls schools. Each school has Junior Secondary classes I to 3 and Senior Secondary classes 1 to 3 (i.e., Classes I to VI overall).

Each class has an average of about 150 students. Among the selected schools, the students were stratified according to their classes and in each class they were further stratified based on their sex. From the class register the subjects were subsequently selected by application of systematic sampling method where the first child was selected by simple random sampling and every other 5th child was also selected. Ten children were selected from each class and about 75 children from each school, and a total of five schools were sampled giving a total of 375 children selected. Twenty five selected children dropped out from the study due to lack of parental consent in 21 while 4 were scared of blood- letting even after series of counseling, giving a drop -out rate of 6.7%. In all three hundred and fifty (350) subjects were studied.

Permission for the study

Ethical approval for the study was sought from the Health Ethics and Research Committee of the University of Nigeria Teaching Hospital, Ituku- Ozalla, Enugu. Permission to conduct the study was obtained from the Ministry of Education Enugu State, Nigeria, while consent was obtained from the respective school principals and parents/ caregivers while assent was obtained from respective study participant.

Questionnaire

A semi- structured questionnaire was designed for the study. Information obtained from the semi-structured questionnaire designed for the study included: biodata of each child and parents (age as at the last birth day which was confirmed with the birth certificate of each child from the respective school records, sex, parental highest educational attainment and occupation).

Each child's social classification was derived using the method proposed by Oyedeji. [31,32] Here the social class of each child was determined based on the occupational status and highest educational attainment of the parents. The scores were summed and the mean (approximated to the nearest whole number) obtained. The mean score was used to assign the child to one of the socio-economic classes (1 to V). The social classes of the subjects were further stratified into upper (social classes I and II), middle (social class III) and lower (social classes IV and V).

Procedure for field work

Two research assistants who were post intern doctors were trained for two consecutive days by the investigators, who are Paediatricians. In the course of the training, the investigators and research assistants practiced on how to administer and fill the questionnaires, and method of collection of the blood samples.

The questionnaire has been previously validated in a similar Nigerian Study. [25] Also the questionnaire was pre- tested among 20 students in two schools and 95% of them found the content of the questionnaire unambiguous prior to the commencement of the actual study. The two schools used for the pretesting were subsequently excluded from the actual study.

Prior to the commencement of the study the investigators and research assistants visited the selected schools to familiarize themselves with the school authorities and students of the selected schools. During the familiarization visits the students & teachers were given a brief talk on overnutrition and abnormal lipid profile/dyslipidaemia and its association with metabolic syndrome Also, the objective of the study was explained to the students. The selected students were given a consent form to take home to their parents for approval and signing and brought back the next day. On the following days, the respective school halls were used for the retrieval of the consent forms.

One semi-structured questionnaire per student was administered and completed by the investigators and each student.

All participants were measured by one of the researchers who is familiar with anthropometric measurements to ensure reliability.

Anthropometric Measurements

Height and body weight were measured according to the protocol of the International Society for the advancement of kinanthropometry (ISAK). [33] Height was measured to the nearest 0.1 cm in bare feet with participants standing upright against a mounted stadiometer. Weight was measured to the nearest 0.1 kg with the participants lightly dressed using a portable manual weighing scale (Tanita HD 314, Creative Products, MI, USA). The weighing scale has a maximum recordable weight of 110 kg. At the beginning of each measurement day, accuracy of the weighing scale was checked by using a known standardized weight placed on the scale. Before each measurement, the scale was usually turned to zero to correct for zero error.

Body mass index (BMI) was determined using weight (in kilogramme, Kg) divided by height (metres, m) squared. i.e., Kg/m^2. Children with BMI ≥ 95th percentile for age and sex and between 85th percentile to 95th percentile for age and sex were considered as obese and overweight respectively. [34]

Procedure for sample collection

The study participants were instructed to observe an overnight fast for a period of at least 12 hours prior to the sample collection. On the morning of the sample collection in each school, the researchers were early at the school and the fasting blood samples collected between 8 am to 10 am.

A total of 5.0 ml of venous blood was collected from each subject into a sterile plain glass test tube. The blood was allowed to stand at room temperature to clot and retract. It was then centrifuged at 5000 rpm for 10 minutes and the serum separated. This was stored frozen at -20°C till needed for analysis. Laboratory analyses were done in batches of 50 samples each. Duplicate analysis was done for each sample, to ensure proficiency in testing, and the average taken.

The serum concentrations of the lipid parameters, total cholesterol (TC), High Density Lipoprotein Cholesterol (HDL-C), Triglycerides (TG) were determined by the spectrophotometric methods using reagent kits (Cromatest kits) prepared by Linear Chemicals SL (Spain).

The products instructions were strictly followed to produce reliable results. The serum Low Density Lipoprotein- Cholesterol (LDL-C) values were calculated using Friedewald formula. [35] The manufacturer's instructions for the products were strictly followed to ensure reliable results.

Benefits of the study to the participants

Subjects found to be overweight/obese as well as abnormal lipid profile were referred to the Division of Paediatric Gastrornterology, Hepatology, and Nutrition at University of Nigeria Teaching Hospital, Enugu for further evaluation and management while those with normal BMI were given adequate health education on how to remain healthy with good balanced diet and regular physical activity.

Definition of abnormal lipid profile/dyslipidaemia

The National Heart, Lung, Blood Institute (NHLBI) panel definition of dyslipidaemia in 2011 was used for the study. [36] The NHLBI offers guidelines for lipid screening in children and adolescents. The cut- off points delineate lipid values as acceptable, borderline and abnormal were:

Acceptable (mg/dl): Total cholesterol (TC) < 170, LDL-C < 110, HDL-C >45, Triglyceride (TG) level <90.

Table 1: Socio-demographic characteristics of study subjects.

Variables	Total (n=350)	Percent (%)
Age:		
10 – 12 years	116	33.1
13 – 15 years	117	33.4
16 – 18 years	117	33.4
Sex:		
Male	175	50.0
Female	175	50.0
Social class:		
1	67	19.1
2	70	20.0
3	93	26.6
4	83	23.7
5	37	10.6

Table 2: Body Mass Index (BM1) classification of study subjects.

BMI Classification	Frequency (n=350)	Percent (%)
Underweight	9	2.6
Normal weight	297	84.9
Overweight	35	10.0
Obese	9	2.6
Total	**350**	**100.0**

Table 3: Prevalence of dyslipidaemia according to BMI classification.

BMI/Dyslipidaemia	Underweight (n=9)	Normal weight (n=297)	Over-weight (n=35)	Obese (n=9)	Total (n=350)	p-value
High Total Cholesterol	0 (0.0)	13 (4.4)	2 (5.7)	7 (77.8)	22 (6.3)	0.007
High LDL – C	0 (0.0)	13 (4.4)	3 (33.3)	3 (33.3)	19 (5.4)	0.053
High Triglycerides	2 (22.2)	22 (7.4)	6 (17.1)	6 (88.7)	47 (13.4)	0.000
Low HDL – C	2 (22.2)	29 (9.8)	1 (2.9)	1 (2.9)	33 (9.4)	0.105

Table 4: Comparison of mean TC, LDL – C, HDL – C and triglycerides with BMI classification.

Serum lipids	Underweight (n=9)	Normal weight (n=297)	Over-weight (n=35)	Obese (n=9)	Total (n=350)	P-value
Total Cholesterol (mg/dl)	150.1 ± 28.31	160.3 ± 24.14	167.7 ± 25.27	217.6 ± 48.99	162.3 ± 26.81	0.000
LDL - C (mg/dl)	94.9 ± 25.31	99.0 ± 21.54	98.2 ± 43.5	105.1 ± 22.62	99.5 ±22.49	0.435
HDL – (mg/dl)	37.4 ± 13.75	36.1 ± 7.71	34.3 ± 8.85	31.4 ± 10.54	34.5 ± 8.93	0.351
Triglycerides (mg/dl)	11.89 ± 15.29	125.7 ± 7.43	135.4 ± 13.08	135.7 ± 19.52	121.2 ± 16.67	0.000

P –value calculated by ANOVA comparing the means of the variables for the 4 categories of BMI classification

Table 5: Comparison of prevalence of dyslipidaemia according to stage of adolescence and social class.

Dyslipidaemia	Early Adolescence (n=116)	Mid- Adolescence (n=117)		Late Adolescence (n=117)	Total (n=350)		P-value
High TC	2 (1.7)	9 (7.7)		11 (9.4)	22 (6.2)		0.025
High LDL – C	3 (2.6)	6 (5.1)		10 (8.5)	19 (5.4)		0.071
Low HDL – C	3 (2.6)	21 (17.9)		9 (7.7)	33 (9.4)		0.448
High Triglycerides	5 (4.3)	27 (23.1)		15 (12.8)	47 (13.4)		0.206
Social Class	**SEC 1 (n=67)**	**SEC 2 (n=70)**	**SEC 3 (n=93)**	**SEC 4 (n-83)**	**SEC 5 (n=37)**	**Total (n=350)**	**P-value**
High TC	9 (13.4)	4 (5.7)	3 (3.2)	3 (3.6)	3 (8.1)	22 (6.3)	0.081
High LDL – C	5 (7.6)	4 (5.7)	4 (4.3)	4 (4.8)	4 (8.5)	19 (5.4)	0.522
Low HDL – C	7 (10.4)	2 (2.9)	10 (10.8)	11 (13.3)	11 (29.7)	33 (9.4)	0.434
High Triglycerides	10 (14.9)	11 (15.7)	13 (13.9)	10 (12.0)	10 (27.0)	47 (13.4)	0.283

Table 6: Comparison of mean TC, LDL – C, HDL – C and triglycerides according to the stage of adolescence.

Serum lipids	Early Adolescence (n=116)	Mid- Adolescence (n=117)	Late Adolescence (n=117)	Total (n=350)	P-value
Total Cholesterol (mg/dl)	158.9 ± 25.14	162.5 ± 22.99	168.7 ± 30.99	162.3 ± 26.81	0.012
LDL - C (mg/dl)	96.7 ± 22.93	102.1 ± 24.10	103.1 ± 24.10	99.50 ± 22.49	0.038
HDL – (mg/dl)	36.3 ± 9.69	34.4 ± 8.93	33.3 ± 8.79	34.5 ± 8.936	0.049
Triglycerides (mg/dl)	119.00 ± 12.98	121.53 ± 16.66	123.85 ± 19.10	121.17±16.67	0.520

Table 7: Bivariate analysis of the risk factors for dyslipidaemia among subjects.

Dyslipidaemia/Risk factor	Correlation Coefficient (r)	p-value
High Total cholesterol		
Age	0.095	0.062
Sex	-0.008	0.876
Social class	-0.054	0.287
BMI Classification	0.324	0.000*
High TG		
Age	0.034	0.498
Sex	0.044	0.380
Social class	-0.009	0.860
BMI Classification	0.376	0.000*
High LDL - C		
Age	0.078	0.144
Sex	0.066	0.216
Social class	-0.010	0.851
BMI Classification	0.168	0.002*
Low HDL - C		
Age	-0.046	0.397
Sex	-0.001	0.991
Social class	-0.034	0.534
BMI Classification	0.066	0.223

Borderline: HDL- C < 45 mg/dl; LDL- C ≥ 100 mg/dl; TC = 170 mg/dl; and TG >130 mg/dl.

Abnormal (High): HDL- C <35 mg/dl, LDL- C ≥ 130 mg/dl, TC ≥ 200 mg/dl and TG > 130 mg/dl.

Data analysis

Data was analyzed using the statistical package for social sciences (SPSS) software version 20.0. Descriptive analyses were performed. Mean TC, LDL- cholesterol, HDL- cholesterol, and triglycerides (TG) values were then analyzed for the different groups of BMI classifications and compared by using analysis of variance (ANOVA) while bivariate analysis was used to determine the predictive risk factors for abnormal lipid profile. The level of statistical significance was set at $p < 0.05$.

Results

A total of 350 subjects comprising 175 males and females each were studied.

They were aged 10 to 18 years old. The mean age for the males was 13.89 ± 2.1 years while that of the females was 14.34 ± 1.89 years (p = 0.89).

The social class distribution of the subjects was 67(19.1%), 70(20.0%), 93(26.6%), 83(23.7%) and 37(10.6%) respectively for socioeconomic classes 1, 2, 3, 4 and 5 as shown in Table 1.

The mean weight for males was 46.93±11.93 kg while that of the females was 50.90 ± 9.36 kg.

The mean height was 149.26 ±26 cm and 155.23 ± 7.39 cm for the males and females respectively.

The mean BMI in Kg/m^2 for the male and female subjects was 20.65 ± 3.83 and 21.08 ± 3.21 respectively (p= 0.89). Majority of the subjects had normal weight, 297(84.9%), while 35(10.0%) and 9(2.6%) were overweight and obese respectively as shown in Table 2.

The prevalence of the different abnormal lipid levels including hypertriglyceridaemia 13.4% (47), low HDL-C 9.4% (23), hypercholesterolaemia 6.3% (22), and increased LDL-C 5.4% (19) respectively [Table 3].

Table 3, shows that the different BMI percentile classification (underweight, normal weight, overweight and obese), had one form of abnormal lipids (high TC, high LDL, high TG and low HDL) or the other. However, the subjects with over nutrition (overweight and obese had more of the abnormal lipid profiles particularly total cholesterol, LDL- C, and triglycerides ($p<0.05$).

Similarly, subjects that were overweight and obese had high mean values for TC, and triglycerides (p = 0.000) respectively and lower mean values for HDL – C (p = 0.351) compared to normal and underweight subjects as shown in Table 4.

Table 5 shows the various socioeconomic class distribution (social classes I to V) and the forms of abnormal lipid profile including high total cholesterolaemia, hypertriglyceridaemia, high LDL- C as well as low HDL- C, however none showed any significant statistical relationship [Table 6].

Older subjects in mid- and late adolescence respectively had higher mean values for total cholesterol, LDL – C and triglycerides while the mean HDL – C was lower in them compared to children in early adolescence (p = 0.049) as shown in Table 6.

On further statistical analysis using bivariate analysis of the different risk factors for the abnormal lipid profile including age, sex, social class and BMI classification; the latter (BMI classification) showed statistical significant difference (p= 0.000) for high total cholesterol, high triglyceride and high LDL – C respectively as shown Table 7.

Discussion

The current study has demonstrated that there is a very strong correlation between high body mass index (as evident in overweight and obesity) with abnormal lipid profile including hypercholesterolaemia, hypertriglyceridaemia and a high LDL – C among subjects.

Similar reports have been corroborated by other workers. [12-15,37-39] However, some studies on the relationship of BMI and lipid profile in children have reported no associations particularly in parts of Northern Nigeria, [25,26] and South-South, Nigeria. [40] The lack of association between body mass index and serum lipids in some of the studies from northern Nigeria, [21,22] were among the children of pastoralists known to consume high fat diet (including cow's milk and other dairy products like "fura da nunu" known to have low serum total cholesterol and triglyceride concentrations and low energy in addition to their increased physical activity and possible genetic endowments.

All the children in the current study were older children/adolescents who resided in an urban area of Enugu the capital city of Enugu State southeast Nigeria. Children living in many urban areas of Nigeria are currently experiencing rapid weight gains resulting from physical inactivity as well as change from eating the traditional high carbohydrate, high fibre and unsaturated fats to the consumption of ready to eat, fast food, and cheap Western diets that are energy dense with high saturated fats, hence the high incidence of abnormal lipid profile in children in the current study. [6]

Obesity in older children is a known predictor of adult obesity and longitudinal studies in adult populations point to a strong association with cardiovascular disease risk. [37] The burden of these likely cardiovascular diseases and insulin resistance syndrome including type 2 diabetes mellitus (DM) have been reported to have poor outcomes in developing countries of sub-Saharan Africa owing to limited economic resources, high prevalence of infectious diseases as well as poor infrastructural facilities to cope with the complications. [6]

Obesity particularly visceral adiposity is known to lead to insulin resistance and contributes to cardiovascular diseases through the action of free fatty acids especially visceral fats which block the insulin signal pathways directly and thus interrupts insulin action as well as insulin secretion, [2] and adipocyto-kines such as TNF - , adiponection, resistin and leptin synthesized and secreted by adipolytes. [41-43]

Though age did not show significant association with the different abnormal lipids, the subjects in late adolescence were found to have higher levels of mean total cholesterol, TG, LDL – C and lower mean HDL – C pointing to a possibility that older adolescents may have high BMI with likelihood of developing abnormal lipid levels. Obesity in older children/adolescents like in the current study is an important determinant of adult obesity independent of adult weight and is associated with increased mortality during adulthood from coronary heart disease. [17] The different plasma lipids have been shown to be under multi-factorial control involving genetic as well as environmental factors including geographical, socio cultural, economic, dietary habits, age and gender differences. [44,45]

Sex did not show any association with the different types of abnormal lipid profile among study subjects.

Some studies have shown stronger associations between BMI and serum lipids in males compared to females. [1,46] Sex differences in levels of abnormal lipid profile could be due to sex related differences in body composition which start early in life due to the actions of the sex steroid hormones. [46,47]

No associations between social class and abnormal lipid profile were observed among the study subjects, despite the fact that the majority of them were from high and middle socioeconomic backgrounds. Higher income and in deed high socioeconomic class has been shown to be a predisposing factor to development of obesity with its associated complications including dyslipidaemia in developing countries. [4,6] including Nigeria, the study locale.

In the current study, children with overweight and obesity had higher total cholesterol levels compared to children with normal BMI or underweight. Similar findings have been reported by other workers. [20,48,49]

Similarly study subjects with higher BMI had significantly higher levels of triglycerides. Also other workers have corroborated similar findings. [48,49] The LDL – Cholesterol levels of the overweight and obese subjects were significantly higher than that of those with normal BMI as have been reported by previous workers. [37,49]

LDL – C has been identified as a major atherogenic compound as it not only loads macrophages with cholesterol for the formation of foam cells but also because it is chemotactic for circulating monocytes, is cytotoxic and can adversely alter coagulation pathway.[49]

Children with higher BMI show positive associations with low HDL – Cholesterol as equally observed in the current study. In a similar study, the Bogalusa Heart study on 9167 children aged 5 to 17 years old who were overweight tend to be 3.4 times more likely to have low HDL – Cholesterol and 12.6times more likely to have hyper – insulinaemia. Higher levels of HDL – Cholesterol bears a positive effect on the risk of atherosclerosis and coronary heart disease that is the higher the level of HDL – Cholesterol the lower the risk of atherogenesis.[39]

Conclusion

Overweight and obesity is common among the study subjects. Subjects with high BMI particularly the older ones tend to have abnormal lipid profile including high total cholesterol, high triglycerides, high LDL – Cholesterol and decreased levels of HDL – Cholesterol with their attendant risks later in life.

Recommendations

Assessment of BMI should be incorporated into school health programme and those with overweight/obesity subjected to routine lipogram estimation so that preventive as well as therapeutic measures could be timeously applied in order to save lives.

Conflict of Interest

The authors disclose that they have no conflicts of interest.

References

1. Choi JW, Pai SH, Kim SK. Association between total body fat and serum lipid concentration in obese human adolescents. Ann Clin Lab Sci Summer 2002;32:3271-3278.
2. Huang KC, Lin RCY, Kormas N, Lec LT, Chen CY, Gill TP, et al. Plasma leptin is associated with insulin resistance independent of age, body mass index, lipids, and pubertal development is non-diabetic adolescents. International Journal of Obesity 2004;28:470-475.
3. IOTF demands action on childhood Obesity crisis. Available from: http://www.iaso.org/popout.asp? Accessed: 30th June, 2009.
4. Sebanjo IO, Oshikoya KA. Obesity and blood pressure levels of adolescents: in Abeokuta, Nigeria. Cardiovas. J. Afr. 2012;23:260-264.
5. Bloomgarden Z. Prevention of Obesity and diabetes. Diabetes care 2003;1:3172-3178.
6. Eke CB, Ubesie AC, Ibe BC. Challenges of childhood obesity in a developing economy: a review. Niger J Paed 2015;42:169-179.
7. Opara DC, Ikpeme EE, Ekanem US. Prevalence of stunting, underweight and obesity in school aged children in Uyo, Nigeria. Pakistan Journal of Nutrition 2010;9:459-466.
8. Yusuf SM, Mijinyawa MS, Musa BM, Gezawa ID, Uloko AE. Overweight and obesity in Kano, Nigeria. J. Metabolic Synd 2013;2:126.
9. Musa DI, Toriola al, Monyeki MA, Lawal B. Prevalence of childhood and adolescent overweight and obesity in Benue State, Nigeria. Tropical Medicine and International Health 2012;17:1369-1375.
10. Dong C, Wang S, Price RA. Interacting genetic loci on chromosomes 20 and 10 influence extreme human obesity. Am J human Genet 2003;72:115-124.
11. Scott A, Ejikeme CS, Clottey EN, Thomas JG, Obesity in sub-Saharan Africa: development of an ecological theoretical framework. Health promotion International Advance Access 2012;1-13. DOI: 10.1093/heapro/das038.
12. Troiano RP, Flegal KM. Overweight children and adolescents: description, epidemiology and demographics Pediatrics 1998;101:497-504.
13. Flegel KM, Cawoll MD, Kuczmarski RJ, Johnson Ch. Overweight and obesity in the United States: prevalence and trends, 1960 – 1994. Int. J Obes Metab Disord 1998;22:39-47.
14. Meral F. Association of body mass index and lipid profiles in children. Open Journal of Pediatrics 2015;5:141-146.
15. Manios Y, Dimitrion M, Moschonis G, Kocaoglu B, Sur H, Keskin Y, et al. Cardiovascular disease risk factors among children of different socioeconomic status in Istanbul, Turkey: Directions for Public Health and Nutrition Policy. Lipids in Health and Disease 2004;3:11-18.
16. Whitaker RD, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. N Engl J Med 1997;337:869-873.
17. Sinaiko AR, Donahue RP, Jacobs DR, Prineas RJ. Relation of weight and rate of increase in weight during childhood and adolescence to body size, blood pressure, fasting insulin, and lipids in young adults. Circulation 1999;99:471-1476.
18. Godsland IF, Stevenson JC. Insulin Resistance: Syndrome or tendency? Lancet 1995;346:100-103.
19. McGill HC Jr, McMahan MA, Zieske AW, Sloop GD, Walcott JV, Troxclair DA, et al. Association of coronary heart disease risk factors with the intermediate lesion of atherosclerosis in youth. The pathobiological determinants of atherosclerosis in youth (PDAY) Research Group Arterioscler Thromb Vasc Biol 2000;20:1998- 2004.
20. McGill HCJr, McMahan CA, Zieske AW, Malcom GT, Tracy RE, Strong JP. Effects of nonlipid risk factors in atherosclerosis in youth with a favourable lipoprotein profile. Circulation 2001;103:1546-1550.
21. Li S, Chen W, Sinivasan SR, Bond MG, Tang R, Urbina EM, et al. Childhood cardiovascular risk factors and carotid vascular changes in adulthood: the Bogalusa Heart Study. JAMA 2003; 290: 2271- 2276.
22. Juonala M, Viikari JS, Ronnemaa T, Mariniemi J, Jula A, Loo BM, et al. Associations of dyslipidaemias from childhood to adulthood with carotid intima- media thickness, elasticity and brachial flow mediated dilation in adulthood: the cardiovascular risk in young Finns study. Arterioscler Thromb Vasc Biol 2008;28:1012- 1017.
23. Daniels SR, Greer FR. The Committee on nutrition lipid screening and cardiovascular health in childhood: Clinical Report. Pediatrics 2008;122:198-208.
24. Nwaiwu O, Ibe BC. Relationship between serum cholesterol and body mass index in Nigerian school children aged 2 – 14years. J Trop Pediatr 2015;6:126-130.
25. Shuaibu L, Yar'adua AI, Suleiman S. Body mass index and lipid profile: A case study of female school going adolescents in Katsina metropolis, Nigeria. British Journal of Applied Science and Technology 2014;4:3665-3677.
26. Glew RW, Margaret W, Carole AC, Samuel MC, Michael C, Selina ON, et al. cardiovascular disease risk factors and diet of Fulani pastoralist of Northern Nigeria. Am J Clin Nutr 2001;7:730-736.

27. Anyaeche C. The 2006 Nigeria Census figures. Availablefrom:http://www.nigeria.World.com/articles/2007/jan/112.html. Accessed:25thOctober, 2015.

28. Araoye MO. Sample Size determination in research methodology with statistics for health and social sciences, Ilorin: Nathadox publishers; 2004:115-122.

29. National Population Commission. Nigeria's over 167 million population: Implications and challenges, Nigeria, 2011. Available from: http://www.population.gov.ng/. Accessed: 20th October, 2015.

30. Nigeria Demographics profile 2014 Available from:http://www.indexmundi.com/nigeria/demographics_profile.html

31. Accessed:28thDecember, 2014.

32. Huebler S. International Education Statistics: Age and level of education in Nigeria. Available from: http://www.huebler.blogspot.com/2005/12/age and level of education in Nigeria Accessed: 4th March, 2015.

33. Oyedeji GA. Socio-cultural backgrounds of hospitalized children in Ilesha. Nig. J. Paediatr 1985;12:111-117.

34. Needlman R. Assessment of growth. In: Behrman RE, Kilegman RM, JensonHB, eds. Nelson textbook of pediatrics, WB Saunders, USA.2004:61.

35. Needlman R. Assessment of growth. In: Behrman RE, Kilegman RM, Jenson HB, eds. Nelson textbook of pediatrics, WB Saunders, USA.2004:61.

36. Friedwald TW, Fredrickson DS, Levy RJ. LDL – Cholesterol estimation. Clin Chem 1972;18:499-501.

37. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents; National Heart, lung, and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: Summary report. Pediatrics 2011;128:S213-256.

38. Chu NF. Prevalence and trends of obesity among school children in Taiwan. The Taipei children Heart study. Int. J of Obesity 2001;25:170-176.

39. Kouda K, Nakamura N, Tokunaga K, Takeuchi H. Trends in levels of cholesterol in Japanese children from 1993 through 2001. J. Epidemiol 2004;14:78-82.

40. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of weight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. Pediatrics 1999;103:1175-1182.

41. Odey FA, Ekanem, EE, Udo AE, Ntia I. Lipid profiles of apparently healthy adolescents in Calabar, Nigeria. Cent. Afr. J. Med. 2007;53:11-18.

42. Rexrode KM, Manson JE, Henne-Kens CH. Obesity and cardiovascular disease. Curr. Opin Cardio 1996;11:490-495.

43. Shuldiner AR, Yang R, Gong DW. Resistin, Obesity and insulin resistance: the emerging role of the adipocyte as an endocrine organ. N Engl J Med 2001;345:1345-1346.

44. Hart C, Ecob R, Smith GD. People, places, and coronary heart disease risk factors: a multilevel analysis of the Scottish heart health study archive. Soc. Sci. Med 1997;45:893-902.

45. Akuyam SA, Isah HS, Ogala W. Evaluation of serum lipid profile of under- five Nigerian children. Ann Afr Med 2007;6:119-223.

46. Evaluation of serum lipid profile of under- five Nigerian children. Ann Afr Med 2007;6:119-223.

47. Shirasawa T, Ochiai H, Ohtsu T, Nishimura R, Morimoto A, Hoshino H, et al. LDL – Cholesterol and body mass index among Japanese school children: a population – based cross – sectional study. Lipids in Health and disease 2013;12:77.

48. Wells JC. Sexual dimorphism of body composition. Best Pract Res Clin Endocrinol Metab 2007;21:415-430.

49. Post P. Victoria CG, Lima RC, Post P. Weight gain in childhood and blood lipids in adolescence. Acta Paedatrics 2009;98:1024-1028.

50. Yoon JM. Dyslipidemia in children and adolescents: when and how to diagnose and treat. Pediatr Gastroenterol Hepatol Nutr 2014;17:85-92.