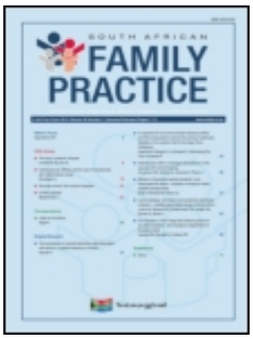

South African Family Practice

ISSN: 2078-6190 (Print) 2078-6204 (Online) Journal homepage: informahealthcare.com/journals/ojfp20

Original research: obesity prevalence and metabolic differences between obese and non-obese school adolescents in south-western Nigeria

Bridget Omisore, Akinlolu Omisore & Emmanuel Abioye-Kuteyi

To cite this article: Bridget Omisore, Akinlolu Omisore & Emmanuel Abioye-Kuteyi (2015) Original research: obesity prevalence and metabolic differences between obese and non-obese school adolescents in south-western Nigeria, South African Family Practice, 57:3, 172-176, DOI: 10.1080/20786190.2014.977010

To link to this article: https://doi.org/10.1080/20786190.2014.977010

Published online: 16 Mar 2015.

South African Family Practice 2015; 57(3):172–176
http://dx.doi.org/10.1080/20786190.2014.977010

S Afr Fam Pract
ISSN 2078-6190 EISSN 2078-6204

RESEARCH

Original research: obesity prevalence and metabolic differences between obese and non-obese school adolescents in south-western Nigeria

Bridget Omisore[a], Akinlolu Omisore[b]* and Emmanuel Abioye-Kuteyi[c,d]

[a] *Department of Family Medicine, State Specialist Hospital, Akure, Nigeria*
[b] *Department of Community Medicine, Osun State University, Osogbo, Nigeria*
[c] *Department of Community Health, Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria*
[d] *Department of Family Medicine, Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria*
Corresponding author, email: akinloluwaomisore@gmail.com

Background: Adolescent obesity is increasingly more common in low- and middle-income countries like Nigeria. Obesity has been associated with metabolic derangement in adolescents in developed countries. This study compared the metabolic parameters in obese and non-obese adolescents in a developing country.

Method: A cross-sectional study was performed on 1 000 adolescents selected by multi-stage sampling from eight secondary schools in Osun State, south-western Nigeria. Socio-demographic information was collected with the aid of a questionnaire. Using the International Obesity Task Force (IOTF) body mass index (BMI) cut-off points, 29 obese adolescents were identified, and 29 suitably matched controls selected. The means for the anthropometric indices [height, weight and waist circumference (WC)], as well as blood pressure (BP), fasting blood glucose and the blood lipid levels of the obese and non-obese participants were compared using an independent *t*-test and one-way analysis of variance. Data were analysed using SPSS® 16.0 version. A p-value < 0.05 was taken to be statistically significant.

Results: The mean age of the respondents was 13.7 years (standard deviation 2.04). Eight of 100 (7.7%) respondents were overweight and 2.9% obese. More female than male adolescents were overweight or obese. The means for the anthropometric indices and BP increased in general across the spectrum of weight categories, from normal weight to obese. Weight, BMI, WC, and systolic and diastolic blood pressure were significantly higher ($p < 0.05$) in the obese adolescents than in the non-obese controls. The controls had a significantly higher mean high-density lipoprotein value (1.46 mmol/l) than the obese adolescents (1.21 mmol/l).

Conclusion: Obese adolescents are at higher risk of metabolic diseases than non-obese adolescents. Obese adolescents in low- to middle-income countries should be targeted to adopt lifestyle changes.

Keywords: adolescent, International Obesity Task Force (IOTF), obese, obesity, metabolic

Introduction

Adolescents make up a fifth of the world's population, and at least four out of five adolescents live in developing countries.[1,2] Adolescence is a time of significant weight gain. The average (normal) weight gain during puberty is 14 kg for female, and 15 kg for male, adolescents.[3] Adolescents are faced with numerous health challenges, and one of these is the increasing prevalence of overweight and obesity.[3,4]

Obesity has been recognised as a major global health threat, and increasingly, a public health concern.[5] The prevalence of obesity has reached alarming levels in both developed and developing countries, as well as in socio-economic groups, irrespective of age, sex or ethnicity.[6] It was formerly seen as a problem of the middle-aged and elderly, but in recent times, childhood obesity has reached epidemic proportions.[7–9] Body mass index (BMI), a measure of weight in relation to height, is widely used to assess body build or adiposity.[10] BMI changes during childhood differ between boys and girls, so age- and sex-specific reference data (centile cut-off points on charts) are used to assess fatness in children and adolescents.[11] The International Obesity Task Force (IOTF) cut-off points for children were obtained from sex-specific curves that pass through a BMI of 25 kg/m^2 and 30 kg/m^2 by age 18 years, for overweight and obesity, respectively.[12] Recent estimates of overweight and obesity in schoolchildren showed that 32% were overweight in the Americas, including 8% who were obese. The corresponding prevalence was 20% and 4%, respectively in Europe; 16% and 6%, respectively in the Near and Middle East; and 5% and 1%, respectively in the Asia-Pacific region.[13] A Nigerian study that used the IOTF cut-off points showed that the prevalence of overweight in adolescents at secondary school aged 12–18 years ranged from 0–8.1% in the male and female adolescents combined, while the prevalence of obesity ranged from 0–2.7% in the male, and from 0–1.9% in the female, adolescents.[14]

Obesity is one of the underlying causes of noncommunicable chronic diseases. It has become one of the leading causes of morbidity and mortality in both developed and developing countries.[5,15,16] Studies have shown that obesity is linked with noncommunicable disorders, including hypertension, insulin resistance, type 2 diabetes mellitus, hypercholesterolaemia, coronary heart disease, strokes and certain cancers.[17,18] Adolescent obesity is not just a current problem, but a potential cause of future health-related problems, including metabolic diseases. This has been well reported in the literature globally, perhaps with the exception of Africa. African studies were not included in a systematic review of studies on cardiometabolic risk variables in adolescents. Most of the studies were reported from Europe and America.[4] Thus, it was imperative to report the findings of this

study, carried out in a low to middle-income country, on the African continent. Studies have also shown that adolescent obesity is more likely to continue into adulthood, and obese adolescents express the same co-morbidities that are associated with adult obesity, both during early life and in adulthood.[5,7]

Thus, this study was designed to determine the prevalence of obesity in school adolescents and to assess the existence of metabolic risk factors in obese adolescents and suitably matched (non-obese) controls, using blood pressure (BP), fasting blood sugar, fasting blood glucose (FBG) and the lipid profile measurements.

Method

The study was carried out in the first quarter of 2012 in Osun State, south-western Nigeria. The State comprises three senatorial districts, each with two health zones, and 10 local government areas. Osun East senatorial district was selected randomly. Two communities were randomly chosen from both health zones in the district, and two co-education schools were randomly chosen from each community. The students in the selected schools were stratified by arm (class) and sex, and a sample proportionate to the school population and the male-female distribution was studied from each arm. Altogether, a total of 1 000 randomly selected subjects were studied with the aid of a facilitated self-administered, pre-tested and pre-coded structured questionnaire. The questionnaire obtained information on the socio-demographic characteristics of the respondents and the underlying factors for obesity. Anthropometric measurements (height, weight and waist circumference (WC)), as well as BP measurements, were recorded for each respondent. Data collection, which included the measurements, was carried out by trained health workers, mostly nurses.

BP was measured twice using Accoson® mercury sphygmomanometers with an appropriate-sized cuff, and the average of the two readings was taken as the final reading.[19] The first clear tapping Korotkoff sounds (phase I) were presumed to be the systolic blood pressure (SBP), while sound disappearance (phase V) was presumed to be the diastolic blood pressure (DBP).[20] The WC was measured midway between the tenth rib and the top of the iliac crest to the nearest 0.1 cm, using a non-stretchable tape measure.[21] Weight was measured to the nearest 0.1 kg with a United Nations Children's Fund bathroom scale, and height was measured to the nearest 0.1 cm using a stadiometer. Weight and height were measured with the respondents wearing light school uniforms, without head or footwear, and without accessories such as purses, bunches of keys and mobile phones, to avoid overestimation.[21] BMI was calculated using the formula: weight (kg)/height squared (m^2). The calculated BMI was used to classify respondents as normal weight, overweight or obese, using the IOTF age- and sex-specific cut-off points.

Age- and sex-matched controls were selected for the obese respondents by simple random sampling from the pool of respondents in the same class. FBG and lipid estimation were performed for the obese respondents and the controls, using commercially available kits for total lipids.[22] The Lipid Pro in vitro diagnostic technique, a lipid measuring system was used in this study.

The data were entered into a computer and analysed using SPSS® 16.0, and a p-value < 0.05 was considered to be statistically significant. Appropriate analyses, including an independent t-test and one way analysis of variance (ANOVA), were conducted. BMI was the main outcome measure.

Ethical approval was obtained from the Obafemi Awolowo University Teaching Hospitals Complex Research and Ethics Committee. Permission to carry out the project was obtained from the Osun State Ministry of Education, the local inspectorate of education in each local government area, and the authorities at each school where the research was carried out. Informed consent was obtained from the study participants and their parents. Educational status was defined as low and high. Respondents without formal education or with incomplete secondary education were determined to have a low educational status, while those who completed secondary education or tertiary education were considered to have high educational status. Similarly, socio-economic status (SES) was classified into two groups, i.e. high and low SES, based on a modified wealth index approach using ownership of household properties as the basis of classification.[23]

Results

Table 1 shows the socio-demographic characteristics of the respondents. Most of them were in the age group 10–13 years (early adolescence) and 14–16 years (mid adolescence). Both age groups comprised 91.5% of the total respondents. The mean age of the respondents was 13.73 years (standard deviation 2.04). 51.0% of the respondents were male. The majority of the participants were from the Yoruba tribe (93.5%). Nearly two thirds

Table 1: Socio-demographic characteristics of the respondents (n = 1 000)

Variable	*n*	%
Age group (years)*		
10–13 (early adolescence)	455	45.5
14–16 (mid adolescence)	460	46.0
17–19 (late adolescence)	85	8.5
Sex		
Male	510	51.0
Female	490	49.0
Ethnicity		
Yoruba	935	93.5
Other tribes	65	6.5
Father's educational status		
Low**	175	17.5
High***	651	65.1
Unknown	174	17.4
Mother's educational status		
Low**	219	21.9
High***	606	60.6
Unknown	175	17.5
Socio-economic status		
Low	516	51.6
High	484	48.4
School type		
Public	488	48.8
Private	512	51.2
Class		
Junior secondary	573	57.3
Senior secondary	427	42.7

*The mean age for the respondents was 13.73 years (standard deviation 2.04)
**Low (without formal education or with an incomplete secondary education)
***High (completed secondary education or a tertiary education)

(65.1%) of the respondents' fathers, and approximately three fifths (60.6%) of their mothers had a high educational status. Nearly half (48.4%) of the respondents came from a high socio-economic background. Less than half of them (48.8%) attended public schools. Nearly three fifths (57.3%) of the study particpants were in junior secondary school, and the remaining 42.7% in senior secondary school.

Overall, 77 (7.7%) and 29 (2.9%) of the study participants were overweight and obese, respectively, while 894 (89.4%) were of normal weight. A higher proportion of female than male respondents was overweight (10.2% vs. 5.3%) and obese (3.9% vs. 2.0%), and this difference was statistically significant (Table 2).

When the means for WC, and SBP and DBP were compared in relation to the weight category of the respondents using one-way ANOVA, there was a steep increase across the range of weight categories from normal weight to obese. For instance, the mean SBP increased from 101.6 mmHg in normal weight, to 113.1 mmHg in overweight, and to 116.7 mmHg in obese, respondents. A similar pattern was found with respect to the DBP and WC. The lowest values were found in respondents of normal weight, and the highest in the obese respondents. Mean BP and WC increased significantly across the weight categories from light to heavy ($p < 0.001$), as shown in Table 3.

Obese respondents were identified from the 1 000 respondents. From these, 29 obese respondents were randomly selected and sex- and age-matched with 29 non-obese control subjects for a comparison of metabolic parameters. The mean SBP and DBP of the obese respondents was significantly higher than that for the controls. Similarly, the mean low-density lipoprotein (LDL), cholesterol, triglycerides and FBG levels in the obese respondents were also significantly higher than that in the controls, while the mean high-density lipoprotein (HDL) levels was significantly lower in the obese patients than in the controls, as shown in Table 4.

Discussion

This study showed that at least one out of 10 ten adolescents (10.6%) was either overweight or obese using the IOTF cut-off points. This is slightly higher than the figure obtained in similar previous studies in Nigeria, where the combined prevalence of both overweight and obesity was considerably less than 10%.[24–26] However, this figure is lower than that obtained in most parts of the world, especially in Europe and America, where the combined prevalence is usually in excess of 20%.[27] However, developing

Table 2: Weight category and sex of the respondents ($n = 1\,000$)*

Sex	Weight category			*n* (%)
	Normal weight (%) *n* = 894	Overweight (%) *n* = 77	Obese (%) *n* = 29	
Male	473 (92.7)	27 (5.3)	10 (2.0)	510 (100.0)
Female	421 (85.9)	50 (10.2)	19 (3.9)	490 (100.0)

*Degrees of freedom = 2, $\chi^2 = 12.29$, $p = 0.002$

Table 3: Comparison of the means for the waist circumference and blood pressure of the respondents by weight status using one-way analysis of variance

Variable	Weight category		
	Normal weight *n*= 894	Overweight *n* = 77	Obese *n* = 29
Mean SBP (mmHg)*	101.6 ± 13.2	113.1 ± 11.2	116.7 ± 15.1
Mean DBP (mmHg)**	65.1 ± 9.6	72.6 ± 7.8	74.7 ± 12.1
Mean WC (cm)***	67.5 ± 6.3	80.3 ± 6.4	88.5 ± 11.2

DBP: diastolic blood pressure, SBP: systolic blood pressure, WC: waist circumference
*The *F* statistic and *p* for the mean systolic blood pressure is 44.40 and < 0.001, respectively
**The *F* statistic and *p* for mean diastolic blood pressure is 33.85 and < 0.001, respectively
***The *F* statistic and *p* for the mean waist circumference is 268.88 and < 0.001, respectively

Table 4: A comparison of the means of some of the parameters in the obese respondents ($n = 29$) and the non-obese controls ($n = 29$) using an independent *t*-test

Parameter	Obese (*n* = 29)		Control (*n* = 29)		Statistic		
	Mean	SD	Mean	SD	Mean difference	*t*-statistic	*p*
WC (cm)	88.5	11.2	67.8	6.3	–20.83	–8.75	< 0.001*
SBP (mmHg)	116.7	15.0	100.2	14.6	–16.45	–4.23	< 0.001*
DBP (mmHg)	74.7	12.1	65.4	8.8	–9.31	–3.75	0.001*
HDL (mmol/l)	1.21	0.31	1.46	0.37	0.26	2.86	0.006*
LDL (mmol/l)	2.30	0.73	1.98	0.61	–0.31	–1.79	0.079
Cholesterol (mmol/l)	4.00	0.63	3.95	0.67	–0.04	–0.26	0.790
Triglycerides (mmol/l)	1.07	0.35	0.94	0.21	–0.13	–1.74	0.090
FBG (mmol/l)	5.7	0.7	5.6	0.5	–0.12	–0.67	0.506

DBP: diastolic blood pressure, FBG: fasting blood glucose, HDL: high-density lipoprotein, LDL: low-density lipoprotein, SBP: systolic blood pressure, SD: standard deviation, WC: waist circumference
*Statistically significant at $p < 0.05$

countries, like Nigeria, need to constantly monitor the obesity situation and to establish adequate measures against the emerging global epidemic.

In this study, both overweight and obesity were more common in the female, than in the male, adolescents. This is in keeping with other studies in developing countries.[26,28] In a study carried out in Osun State, Nigeria, the prevalence of overweight was 3.2% [male adolescents (1.1%) and female adolescents (5.0%)], while only 0.5% of urban-based female adolescents and no male adolescents were obese.[26] An Indian study also recorded a higher frequency of overweight and obesity in urban female adolescents (10.36%) and rural female adolescents (1.02%), compared to urban male adolescents (7.67%) and rural male adolescents (0.5%).[28] However, some studies have reported a higher prevalence of overweight and obesity in males than females,[29,30] while others have reported an equal to, or near-equal, prevalence, in both males and females, especially in developed countries.[13] The higher prevalence of overweight and obesity in female adolescents in this study might be owing to physiological changes, such as hormonal variations with respect to their age. Female adolescents tend to have a growth spurt and to develop secondary sexual characteristics a little earlier than adolescent males of the same age. The greater percentage of overweight and obese respondents in this study were in the early adolescence group (aged 10–13 years), when pubertal growth spurt takes place in females. Many national studies, including the National Demographic Health Survey (NDHS) of South Africa 2003, in which 8% of adolescent females were reported to be obese compared to 1% of male adolescents, have shown that adolescent obesity is far more common in females than in males.[31] The 2008 NDHS in Nigeria also revealed that a high percentage (22%) of Nigerian women were either overweight or obese.[32] The reasons for the prevalence of overweight and obesity in females generally is not well known and could be the subject of further research.

The means of the SBP, DBP and WC were higher in the overweight and obese adolescents than in those of normal weight. This is in keeping with previous studies.[33,34] This was not unexpected as obesity is a well-known risk factor for hypertension. The pattern between the BMI and the WC was also similar, that is, the higher the BMI, the higher the WC. However, the WC and/or waist to hip ratio is a better measurement of central adiposity than BMI, and hence of cardiovascular risk.[35]

Additional metabolic risk factors (parameters indicative of a possible risk of metabolic disease) were determined in the obese respondents and suitably matched controls in this study. This was performed to assess whether or not obesity had an effect on other parameters, apart from the and WC, which were measured in the study participants. Thus, the plasma levels of HDL, LDL, cholesterol, triglycerides and FBG, which may be indicative of present or future metabolic disease, were determined in the obese and non-obese controls. Higher mean values of FBG, LDL, cholesterol and triglycerides were recorded in the obese respondents, as well as a significantly lower mean HDL value, compared to the controls. Since the higher the HDL, the less the likelihood of metabolic disease,[4] the lower mean value in the obese respondents suggests that they were more at risk of metabolic disease than the controls. Obesity is a known risk factor for impaired glucose tolerance and dyslipidaemia. The trend in previous studies, including those conducted on adolescents, is to associate obesity with increased cardiovascular or metabolic risk factors.[4,8,36]

The findings in this study revealed that obesity in adolescents was associated with "metabolic derangement", as evidenced by their higher mean values for SBP and DBP, LDL, cholesterol, triglycerides and FBG, compared to the non-obese controls, and also their lower value for cardioprotective HDL. This corroborates the fact that obesity is a risk factor for cardiovascular disease, even though the study was carried out on a young population in a low- and middle-income country. Hopefully, this study will contribute to the scientific knowledge base and provides an evidence-based platform for future interventions on adolescent overweight and obesity in low- and middle-income countries.

A possible limitation of this study was the uncertainty surrounding whether the study participants fasted for blood test purposes (to determine their blood sugar and lipid profile), as requested. However, they were encouraged to do so, and an incentive (a token amount of money) which had been promised to them beforehand, was given to them once the tests were complete.

Conclusion

Overweight and obesity are fairly common health problems, and collectively affected more than a tenth of the adolescent respondents in this study. This is higher than the figures reported in many previous studies performed in Osun State and in Nigeria, which corroborate the fact that overweight and obesity is a growing epidemic, even in developing countries. Thus, low- to middle-income countries, in which a low prevalence of adolescent obesity has been reported, need to prevent adolescent obesity. Policies and programmes that focus on population-level intervention with regard to adolescent obesity prevention, such as those that promote public awareness of obesity, and its causes, effects, complications and management; and those which restrict the marketing of food that is high in salt, fat and sugar, especially to children and adolescents; need to be encouraged. More female, than male, respondents, were overweight and obese in this study. A significantly higher mean for SBP, DBP and WC was reported in the overweight and obese respondents than that in those of normal weight. Slightly higher mean values for fasting blood sugar, total cholesterol and LDL, and a significantly reduced mean HDL value, were recorded in the obese respondents than in the non-obese suitably matched controls. The higher BP, increased WC (truncal obesity) and reduced mean HDL value in the obese respondents may be important indicators of near or future risk of metabolic disease.

Declaration – Appreciation is extended to the management of Obafemi Awolowo University Teaching Hospitals Complex for partly funding the work of the first author with respect to the thesis that she undertook as a resident there.

Conflict of interest – The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this paper.

Acknowledgement – The authors wish to acknowledge the Permanent Secretary, Ministry of Education, Osun State; and the local inspectorates of education, principals, teachers and students involved in the project. They also appreciate the contribution made by doctors, nurses, other health workers and students in the data collection process.

References

1. UNICEF. Progress for children; a report card for adolescents. 2012 Apr 10 [cited 2014 May 8]. Available from: http://www.unicef.org/media/files/PFC2012_A_report_card_on_adolescents.pdf
2. Blum R, Nelson Mmari K. The health of young people in a global context. J Adolesc Health. 2004;35:402–18. http://dx.doi.org/10.1016/j.jadohealth.2003.10.007

3. Nicholl, D, Viner D. Clinical review: eating disorders and weight problems. BMJ. 2005 [cited Jul 25 2010];330:950–3. doi:10.1136/bmj.330.7497.950. Available from: www.bmj.com>Education
4. Van Vliet M, Heymans MW, Von Rosenstiel IA, et al. Cardiometabolic risk variables in overweight and obese children: a worldwide comparison. Cardiovasc Diabetol. 2011;10:106. doi:10.1186/1475-2840-10-106.
5. Chukwunonso ECCE, Ijeh II. Obesity in young-adult Nigerians: variations in prevalence determined by anthropometry and bioelectrical impedance analysis, and the development of % body fat prediction equations. Int Arch Med. 2012;5:22. doi:10.1186/1755-7682-5-226.
6. Rena IK, Demosthenes BP. The epidemic of obesity in children and adolescents in the world. Cent Eur J Publ Health. 2006;14(4):151–9.
7. Nader PR, O'Brien M, Houts R, et al. Identifying risk for obesity in early childhood. Pediatrics. 2006;118:e594–e601. http://dx.doi.org/10.1542/peds.2005-2801
8. Kelishadi R. Childhood overweight, obesity, and the metabolic syndrome in developing countries. Epidemiol Rev. 2007;29:62–76. http://dx.doi.org/10.1093/epirev/mxm003
9. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. Int J Pediatr Obes. 2006;1:11–25. http://dx.doi.org/10.1080/17477160600586747
10. Ogden CL, Carroll MD, Flegal KM. High body mass index for age among US children and adolescents, 2003–2006. JAMA. 2008;299:2401–5. http://dx.doi.org/10.1001/jama.299.20.2401
11. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of overweight and obesity in the United States, 1999–2004. JAMA. 2006;295:1549–55. http://dx.doi.org/10.1001/jama.295.13.1549
12. Cole TJ, Bellizzi MC, Flegal KM, et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ. 2000;320:1240–43. http://dx.doi.org/10.1136/bmj.320.7244.1240
13. Lobstein T, Bauer L, Uauy R. Obesity in children and young people: a crisis in public health. Obes Rev. 2004;5(Suppl 1):1–104.
14. Akinpelu O, Oyewole OO, Oritogun KS. Overweight and obesity: does it occur in Nigerian adolescents in an urban community? Int J Biomed Health Sci. 2008;4(1):11–7.
15. Okpara IC, Adediran OS, Odia OJ, et al. The relationship between measures of obesity and echocardiographic determinants of left ventricular hypertrophy in Nigerian adults. Internet J Cardiol. 2009;9(2). Available from: https://ispub.com/IJC/9/2/11826
16. Akpa MR, Mato CN. Obesity in Nigeria: current trends and management. Nigerian Med Pract. 2008;54(1):11–5.
17. Orluwene CG, Nnatuanya I. Association of metabolic biomarkers of cardiovascular disease in overweight and obese children in Emohua Local Government Area of Rivers State, Nigeria. IOSR J Dent Med Sci (JDMS). 2012 Sep–Oct;1(3):40–6.
18. Weiss R, Kaufman FR. Metabolic complications of childhood obesity-identifying and mitigating the risk. Diabet Care. 2008;31(2):S310–6. http://dx.doi.org/10.2337/dc08-s273
19. Kumar D. A comparison of the risk factors for the coronary artery diseases among the rural and urban male high school students in Vellore district, Tamilnadu: a school based cross sectional study. Healthline. 2011;2(2):24–7.
20. Taksande A, Chaturvedi P, Vilhekar K, et al. Distribution of blood pressure in school going children in rural area of Wardha district, Maharashatra, India. Ann Pediatr Cardiol. 2008 Jul–Dec;1(2):101–06.
21. McCarthy HD, Ellis SM, Cole TJ. Central overweight and obesity in British youth aged 11–16 years: cross sectional surveys of waist circumference. BMJ. 2003;326(7390):624–627 http://dx.doi.org/10.1136/bmj.326.7390.624
22. El-kholy TA, Al Abbadi HA, Qahwaji D, et al. A comparison of dietary intake with recommended dietary allowances (RDA) for colorectal cancer patient before and after different modulates of treatment. HealthMED. 2014;8(1):3–11
23. Isiugo-Abanihe UC, Oyediran KA. Household socioeconomic status and sexual behaviour among Nigerian female youth. Afr Popul Stud. 2004;19(1):81–98
24. Akinpelu O, Oyewole OO, Oritogun KS. Overweight and obesity: does it occur in Nigerian adolescents in an urban community? Int J Biomed Health Sci. 2008;4(1):11–7.
25. Ben-Bassey UP, Oduwole AO, Ogundipe OO. Prevalence of overweight and obesity in Eti-Osa LGA, Lagos, Nigeria. Obes Rev. 2007 Nov;8(6):475–9. http://dx.doi.org/10.1111/obr.2007.8.issue-6
26. Olumakaiye MF. Prevalence of underweight: a matter of concern among adolescents in Osun State, Nigeria. Pak J Nutr. 2008;7(3):503–8.
27. Del Mar Bibiloni M, Pons A, Tur JA. Prevalence of overweight and obesity in adolescents: a systematic review. [cited n 2014 May 9]. ISRN obesity2013.Article ID 392747. doi:10.1155/2013/329247. Available from: http://www.hindawi.com/journals/isrn/2013/392747/
28. Saraswathi YS, Najafi M, Gangadhar MR. Prevalence of childhood obesity in school children from rural and urban areas in Mysore, Karnataka, India. J Life Sci. 2011 [cited 2012 Apr 26];3(1):51–5. Available from: http://www.krepublishers.com/02-Journals/JLS/JLS-03-0-000-11
29. Unnithan AG, Syamakumari S. Prevalence of overweight, obesity and underweight among school going children in rural and urban areas of Thiruvananthapuram Educational District, Kerala State (India). Internet J Nutr Wellness. 2008;6:2. Available from: https://ispub.com/IJNW/6/2/7073
30. Chen TJ, Modin B, Ji CY, et al. Regional, socioeconomic and urban-rural disparities in child and adolescent obesity in China: a multilevel analysis. Acta Paediatr. 2011 [cited 2012 Apr 26];100(12):1583–1589. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.1651-2227.2011.02397.x/abstract
31. Department of Health, Medical Research Council, OrcMacro. South Africa Demographic and Health Survey 2003. Pretoria: Department of Health; 2007. p. 211.
32. National Population Commission. Federal Republic of Nigeria. National Demographic Health Survey (NDHS) 2008. 2009 Nov. p. 212.
33. Chou Y, Pei J. Risk factors of adolescent obesity in Taiwan and its association with physical activity, blood pressure and waist circumference. Asian J Sports Med. 2010 Dec;1(4):214–22.
34. Pinho AP, Brunetti IL, Pepato MT, et al. Metabolic syndrome in overweight/obese female adolescents. Rev Paul Pediatr. 2012;30(1). Available from: http://dx.doi.org/10.1590/S0103-05822012000100008
35. Semiz S, Özgören E, Sabir N, et al. Body fat distribution in childhood obesity: association with metabolic risk factors. Indian Pediatr. 2008;45:457–62.
36. Da Silva IT, De Souza Timm A, Damasceno NRT. Influence of obesity and cardiometabolic makers on lipoprotein-associated phospholipase A2 (Lp-PLA2) activity in adolescents: the healthy young cross-sectional study. Lipids Health Dis.. 2013;12(19). doi:10.1186/1476-511X-12-19

Received: 22-02-2014 Accepted: 18-06-2014