

The Prevalence of Obesity as Indicated by BMI and Waist Circumference among Nigerian Adults Attending Family Medicine Clinics as Outpatients in Rivers State

Siminialayi I M B.Med Sc, MBBS, MSc^{*} Emem-Chioma P C B Med Sc, MBBS FMCP^{**} Dapper D V B Med Sc, MBBS, MSc

^{*} Department of Pharmacology, ^{**} Department of Physiology, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Port Harcourt

Abstract

Background: The prevalence of overweight and obesity in most developed countries and in urban areas of many less developed countries has been increasing markedly over the past twenty years. This study's aims were to determine the prevalence of obesity using BMI and waist circumference among Nigerian adults attending Family Medicine Clinics as outpatients and to assess the relative associations with CVD risk factors.

Methods: Subjects, who all volunteered for this study, reported at the study centres after an overnight fast, to be weighed (in kg), for their heights (in metres), blood pressure and waist circumference (in cm) measured, and their venous blood samples taken for lipid studies and fasting blood glucose estimation. Results were analysed using SPSS for windows software (version 11) and Epi Info (version 6.04d).

Results: The prevalence of obesity as determined by large waist circumference was 31.7% at the Okrika (rural) centre and 16.9% at the Port Harcourt centre. It was 16.3% at the Okrika centre and 14% at the Port Harcourt centre, as determined by BMI = 30 kgm⁻². Obesity as determined by BMI = 30 kgm⁻² is more prevalent among young adults (< 40 years) in Port Harcourt than at Okrika. Obesity by both definitions is more prevalent among females than among males ($p < 0.01$) and more among subjects older than 40 years. Both indices of obesity appear to be significantly associated with CVD risk factors.

Conclusion: Obesity in our environment is strongly associated with a family history of obesity and a sedentary lifestyle. It is therefore not surprisingly more prevalent among females and older members of society. Healthier eating and social habits, and increased physical activity need to be strongly encouraged.

Key words: Waist circumference, BMI, Obesity, Prevalence, Nigerians

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Introduction

Obesity is defined as an excess of adipose tissue.¹ The Prevalence of overweight and obesity in most developed countries and in urban areas of many less developed countries has been increasing markedly over the past twenty years.² The incidence of type 2 diabetes has increased by almost the same measure during this period, and is presumed to be a direct consequence of the obesity epidemic³. Indeed, many disorders occur with greater frequency in obese people; the most important and common of these being hypertension, type 2 diabetes mellitus, hyperlipidaemia, coronary artery disease, degenerative joint disease, and psychosocial disability.^{1,4} Approximately 60% of persons with obesity in the USA have metabolic syndrome as defined by the Third Report of the National (US) Cholesterol Education Program, Adult Treatment Panel.^{1,5} Also, epidemiological studies begun in the 1970s indicate that adiposity contributes to the increased incidence and/or death from cancers of the colon, breast (postmenopausal women), endometrium, kidney (renal cell), oesophagus (adenocarcinoma), gastric cardia, pancreas, gall bladder and liver.⁶

Until recently, obesity was considered to be the direct result of a sedentary lifestyle and chronic ingestion of excess calories.⁷ Although, without a doubt, the principal cause in some cases, there is now evidence for strong genetic influences on the development of obesity. Adopted children demonstrate a close relationship between their body mass index and that of their biologic parents, and genetic determinants of some types of obesity have now been established.¹ However, most human obesity develops from the interactions of multiple genes, environmental factors, and behaviour.¹

Adipose tissue in humans functions to store energy in the form of fat and triglyceride is the main storage lipid.

There are two main types of adipose tissue: subcutaneous and visceral. Subcutaneous adipose is largely defined as fat tissue between the skin and muscle, whereas visceral adipose tissue is found within the main cavities of the body, primarily in the abdominal cavity⁶. Abdominal visceral adipocytes are more metabolically active than abdominal subcutaneous adipocytes, as they have a high lipolytic activity and release large amounts of free fatty acids.⁶ Ideal measurements of adiposity should therefore consider both the amount and site of deposition of the adipose.

Many methods of estimating total body fat have been developed and include imaging methods such as computed tomography (CT) and magnetic resonance imaging (MRI), which are able to distinguish between subcutaneous and visceral abdominal adipose tissue. Both are however expensive for large-scale epidemiological studies. Definitions for reporting healthy weight, overweight, and obesity have therefore been based historically, on anthropometric rather than clinical measures of adiposity.^{1,6}

One of the simplest anthropometric indices of adiposity is weight adjusted for stature (height) and the body mass index (BMI) or Quetelet's index, is the most popular of these indices. The BMI defined as weight (in kilograms) divided by the height (in meters) squared, provides a single estimate of adiposity (regardless of height) that can be compared across studies and across populations.⁶ Many studies have found a correlation between BMI and densitometry estimates of body fat composition in adult populations.⁷ The validity of BMI as a measure of adiposity is further supported by its association with obesity-related risk factors such as blood triglycerides, total cholesterol, blood pressure and fasting blood glucose levels. BMI could be a less valid indicator of adiposity among the elderly, who tend to have a shift of fat from peripheral to central sites.⁸ For such populations and with evidence of health risks associated with abdominal (visceral) fat, waist circumference, a measure of central adiposity is preferred.⁶

INTERHEART was the first international study to establish that obesity is a cardiovascular risk factor that is statistically significant in basically all of the world's populations⁹. A second large trial, the International Day for the Evaluation of Abdominal Obesity (IDEA) study, has shown that waist circumference is a stronger predictor of CVD outcomes than BMI and that each increase in waist circumference of 14 cm for men and 14.9 cm for women increased the likelihood of an individual having

cardiovascular disease by between 21% and 40%¹⁰. Studies in Nigeria have reported a greater prevalence of obesity among females than males¹¹⁻¹³ and that BMI and other anthropometric measurements increase progressively with age.¹³

This paper reports the prevalence of obesity as determined by BMI and waist circumference estimations among Nigerian adults attending outpatient family medicine clinics at two locations; Okrika (a rural riverine community of Rivers State) and Port Harcourt (the cosmopolitan capital city of Rivers State).

Materials and Methods

Subjects for this study, which was carried out between May and June of 2006, were recruited on the basis of an informed consent, voluntarily given. Pregnant women and patients with ascites or other forms of obvious edema, as well as disabled and non-ambulatory patients who could not stand for height and weight measurements were excluded. A total of 207 subjects were recruited from Braithwaite Memorial Hospital (BMH) in Port Harcourt and 240 subjects from Okrika General Hospital, in Okrika.

Weight was taken (in kg) with the subject's standing bare feet, in their light clothing, and with their pockets free of objects that might add to their weights e.g. key rings, mobile telephones, wallets etc, using a weighing scale (Seca, UK). The height was taken with a height meter (combined with the weighing scale), with the subjects standing upright, their backs straight, and heels against the scale. The pointer was pressed firmly against the scalp and the measurement read off on the scale (in meters).

The BMI was calculated by dividing measured weight in kilograms by the height in meters squared i.e. weight (kg)/height (m²).

Waist circumference of the subjects was recorded using a measuring tape. The iliac crest was first identified by palpation and then the tape placed around the waist, at the level of the iliac crest in a horizontal plane, parallel to the floor. The tape was snug but did not compress the skin. Subjects were asked to inhale and then exhale. The measurement was taken at the end of a normal expiration, in centimeters¹⁴.

To assess the relationship with obesity-related risk factors, blood pressure was determined by auscultation¹⁵; fasting blood sugar by glucose oxidase method¹⁶; total cholesterol as described by Emeis et al¹⁷

and serum triglycerides as described by Gibbons and Ballantyne¹⁸.

Obesity is defined in this study as BMI = 30 kg/m²,^{1,5} or waist circumference = 102 cm (40 inches) in men or = 88cm (35 inches) in women⁵. High blood pressure is defined as blood pressure greater than or equal to 130/85 mmHg, impaired blood glucose as greater than or equal to 6.1 mmol/L and hypertriglyceridaemia as serum triglyceride level greater than or equal to 1.7 mmol/L. All definitions are based on the ATP III criteria for diagnosis of metabolic syndrome⁵.

Results were analysed using SPSS for windows software (version 11) and Epi Info (version 6.04d).

Results

Waist Circumference

At the Okrika study center, 76 (31.7%) subjects had large waists or abdominal adiposity as defined by ATP III (Table 3). Of these subjects, 72 (94.7%) were females and 4 (5.3%) were males. The mean age of the subjects with abdominal obesity (large waist circumference) was 50.56 years (range 20-90 years). The mean waist circumference of the females (88.32 cm; n=152) was significantly higher than that of the males in this group (82.67 cm; n=88) (p<0.01).

At the Port Harcourt study center, 35 (16.9%) had large waist circumference (Table 3). Of this number, 32 (91.4%) were females while 3 (8.6%) were males. The mean age of all those with large waists was 44.60 years (range 21-62 years). The mean waist circumference was 90.3 cm (n=72) for females and was significantly higher (p <0.01) than the mean for males (80.49 cm; n=135).

RELATIONSHIP BETWEEN WAIST CIRCUMFERENCE AND OTHER RISK FACTORS

30 (39.5%) of the 76 Okrika subjects with large waist circumference as defined by ATP III, admitted a family history of obesity, as opposed to 41(25%) of those with normal waist circumference. A chi square test of independence shows this difference to be significant (p <0.05). 54 (71.1%) of these subjects with large waist circumference also had high systolic blood pressure (BP=130 mm Hg) while 42 (55.3%) had high diastolic blood pressure (=85 mm Hg), as opposed to 74(45.1%) and 47(28.7%), respectively, among those with normal waist circumference. The prevalence of systolic hypertension among those with large waist circumference was significantly higher than in those with normal waist circumference (p<0.01).

19 (25%) of the 76 subjects with large waist circumference had hypertriglyceridaemia (=1.7mmol/L) as against 17(10.4%) of those with normal waist circumference. The difference in hypertriglyceridaemia was significant (p<0.01). 10 of the subjects with abdominal obesity (13.2%) had total cholesterol greater than 6.0 mmol/L and this was not statistically different from those with normal waist circumference. Finally, 18 (23.7%) of the Okrika subjects with large waists, also had high fasting blood sugar as defined by ATP III (as opposed to 17 or 10.4% of those with normal waist circumference). This difference in the prevalence of impaired fasting blood sugar between those with large waist circumference (abdominal obesity) and those with normal waist circumference was statistically significant (p<0.01).

At BMH, 14(40%) of the 35 subjects with large waist circumference as against 34(19.8%) of those with normal waist circumference had a family history of obesity (P<0.01). 6(17.1%) had high serum triglyceride levels, and 8(22.9%) had high fasting blood sugar levels as against 29(16.9%), and 13(7.6%) of those with normal waist circumference, respectively. All differences were significant using chi square test of independence (association; p<0.05) except the difference in triglyceride levels. 17 of the 35 with large waist circumference (48.6%) had systolic hypertension as defined by ATP criteria (SBP≥130 mmHg) and 12(34.3%) had diastolic hypertension (DBP≥85 mmHg), compared to 56(32.6%) and 36(20.9%) of those with normal waist circumference. Both differences were however not statistically significant (χ^2 p>0.05).

There was a positive correlation (Pearson) between waist circumference and systolic blood pressure (p<0.01) as well as diastolic blood pressure (p<0.05) that was significant for two tails. There was also a positive correlation between waist circumference and fasting blood sugar (p<0.01 for 2 tails), serum triglyceride (p<0.01 for 2 tails) and with serum total-cholesterol (p<0.01 for 2 tails).

At BMH, 25 (71.4%) of the 35 subjects with large waists had metabolic syndrome as defined by ATP III diagnostic criteria (MS_ATP III). At Okrika, of the 76 subjects with large waist circumference, 59 (77.6%) had MS_ATP III.

BMI

At the Okrika center, 39 (16.3%) subjects (35 or 89.74% females and 4 or 10.26% males), had BMI greater or

equal to 30. They were aged between 20 and 90 years, with a mean age of 52.15 years. At the Port Harcourt center, the prevalence of obesity as determined by BMI =30 was 14%.Of the 29 subjects with high BMI, 18 (62.1%) were females and 11 (37.9%) were males. The average of those with high BMI at BMH was 38.10 years (range 18-60 years)

Relationship between Bmi and Other Risk Factors

At the Okrika center, 33 of the 39 subjects with high BMI (84.6%) had systolic hypertension while 27 (69.2%) had diastolic hypertension. 9 (23.1%) had impaired fasting blood glucose, 14 (35.9%) had hypertriglyceridaemia, and 5 (12.85%) had total cholesterol greater than 6.0 mmol/L. All of these findings were significantly higher than the figures in subjects with BMI<30 mg/m² (p<0.01).

At the Port Harcourt study center, of the 29 subjects with obesity as determined by BMI =30 kg/m², 4 (13.8%) had hypertriglyceridaemia (p>0.05), 2 (6.9%) had high total cholesterol (p>0.05), 4 (13.8%) had impaired fasting blood glucose (p>0.05), 16 (55.2%) had systolic hypertension (p<0.05) and 11 (37.9%) had diastolic hypertension (p<0.01).

We found a positive correlation between BMI and age (p<0.01), systolic blood pressure (p<0.05) and fasting blood sugar (p<0.01), serum triglyceride (p<0.01) and total cholesterol (p<0.01).

29 (74.4%) of the Okrika subjects with BMI = 30 had metabolic syndrome as defined by ATP III diagnostic criteria while at Port Harcourt, of the 29 subjects with BMI greater than 30kg/m², 17 (58.6%) had MS_ATP III.

Table I: Age and Sex Distribution of Okrika Subjects.

Age groups	Male subjects	Female subjects	Total
19	2 (0.83%)	5 (2.08%)	7 (2.91%)
20-29	39 (16.25%)	36 (15%)	75 (31.25%)
30-39	8 (3.33%)	13 (5.42%)	21 (8.75%)
40-49	6 (2.5%)	37 (15.42%)	43 (17.92%)
50-59	10 (4.17%)	15 (6.25%)	25 (10.42%)
60-69	10 (4.17%)	28 (11.67%)	38 (15.84%)
70-79	9 (3.75%)	13 (5.42%)	22 (9.17%)
80-89	3 (1.25%)	5 (2.08%)	8 (3.33%)
90	1 (0.42%)	- (0%)	1 (0.42%)
Total	88(36.7%)	152 (63.3%)	240 (100%)

Table II: Age and Sex Distribution of BMH Subjects

Age group	Male Subjects	Female Subjects	Total (%)
10-19 yrs	7 (3.4%)	0 (0%)	7 (3.4%)
20-29 yrs	73 (35.27%)	16 (7.73%)	89 (43.0%)
30-39 yrs	22 (10.64%)	20 (9.66)	42 (20.3%)
40-49 yrs	23 (11.11%)	15 (7.3%)	38 (18.4%)
50-59 yrs	5 (2.42%)	15 (7.3%)	20 (9.7%)
60-69 yrs	4 (1.93%)	6 (2.9%)	10 (4.8%)
70-79	1 (0.5%)	0 (0%)	1 (0.5%)
Total	135 (65.2%)	72 (34.8%)	100%

Table III: Prevalence of Abdominal Obesity

Status	Okrika Subjects		BMH Subjects	
	Frequency	Percent	Frequency	Percent
Absent	164	68.3	172	83.1
Present	76	31.7	35	16.9
Total	240	100	207	100

Obesity = WC = 102 cm in males and = 88 cm in females

Table IV: Prevalence of Obesity (BMI = 30)

Status	Okrika subjects		BMH Subjects	
	Frequency	Percent	Frequency	Percent
Absent	201	83.8	178	86
Present	39	16.3	29	14
Total	240	100	207	100

Table V: Comparison of Age, Sex Distribution and Prevalence Rates between BMH and Okrika

Study Center	Mean Age	Sex		Prevalence Rates	
		Male	Female	By WC	By BMI
BMH	34.46	135 (65.2%)	72 (34.8%)	16.9%	14%
Okrika	44.31	88 (36.7%)	152 (63.3%)	31.7%	16.3%
Test of Significance	P < 0.01	P < 0.01	P < 0.01	P < 0.01	P > 0.05

Discussion

The prevalence of abdominal obesity (waist circumference = 102 cm in males and = 88 cm in females) was 31.7% (94.7 % females and 5.3% males) at the Okrika study center and 16.9% (91.4% females and 8.6% males) at the Port Harcourt study center (p <

0.01) (Table 3). The prevalence of obesity as determined by BMI greater than or equal to 30kg/m^2 was 16.3% (89.4% females, 10.26% males) at the Okrika Study center and 14% (62.1% females, 37.9% males) at the Port Harcourt study center ($p > 0.05$) (Table 4). 32 (42.1%) of the 76 subjects with abdominal obesity at the Okrika study center had BMI = 30kg/m^2 while at the Port Harcourt study center, 18 (51.4%) of the 35 subjects with abdominal obesity had BMI = 30kg/m^2 . On the contrary, 82.1% of those with BMI = 30kg/m^2 had abdominal obesity (large waists) at the Okrika study center while 62.1% had abdominal obesity at the Port Harcourt study center. It thus appears that an individual with a high BMI is more likely to also have a large waist circumference than the other way around. A patient with excess fat will rarely have a small waist and a larger waist is linked to worse outcomes¹⁹.

As can be seen from the figures above, obesity as defined by large waist circumference and BMI = 30kg/m^2 are both more prevalent in the Okrika study centre ($p < 0.01$) and among the female subjects studied ($p < 0.01$). Compared to the mean age of the Okrika (44.31 years) and Port Harcourt study populations (34.46 years) the mean age of the subjects with abdominal obesity at both centers was much higher (50.56 years and 44.60 years, respectively; $p = 0.055$). The mean age of the subjects with BMI = 30kg/m^2 was also higher at both centers (52.15 years and 37.52 years; $P < 0.01$). Also, only 21.1% of those with abdominal obesity at Okrika and 28.6% at Port Harcourt were aged less than 40 years. 20.5% of those with BMI = 30kg/m^2 at the Okrika center were aged less than 40 years but interestingly 55.2% of obese subjects (BMI = 30kg/m^2) at the Port Harcourt center were aged less than 40 years ($p < 0.01$). Obesity among young adults is thus more prevalent in Port Harcourt than in Okrika. However, this proportion represents 11.60% of all those aged less than 40 years at the Port Harcourt study center (Table 2) or 7.73% of the Port Harcourt study population. The prevalence of both abdominal obesity (large waist circumference) and generalized obesity (BMI = 30kg/m^2) increase with age and are more prevalent among those with a family history of obesity. We found a stronger correlation between age and waist circumference (0.307, $P < 0.01$) than between age and BMI (0.293, $P < 0.01$) among the Okrika subjects and an even stronger correlation (0.456, $p < 0.01$) and (0.178, $p < 0.05$) respectively, at BMH.

The higher prevalence of obesity among the Okrika subjects may be attributed to the fact that the Okrika subjects were older ($p < 0.01$) than the BMH subjects and

there were more females in the Okrika study population than in the BMH study population ($p < 0.01$). The greater prevalence of obesity among young adults in Port Harcourt (capital city of Rivers State) is expected^{2,20}. Obesity increases with age as physical activity diminishes and abdominal obesity arises as peripheral fat is diverted to central sites^{8,20}. Women are generally less physically active than men^{20,21}.

It has been previously reported that obesity is more prevalent in female Nigerians^{11,12} and that abdominal obesity and BMI increase with age^{13,22}. Additionally, in Okrika in particular, but also in most riverine communities of Rivers State, women of child bearing age, as part of the local "iria" ceremony are put in "fattening rooms" for several weeks, in an attempt to make them more "beautiful" and therefore more attractive to potential suitors. The higher prevalence of obesity among women in this study is therefore expected.

Obesity as determined by BMI is associated with a greater proportion of the obesity related risk factors than abdominal obesity as determined by waist circumference. For instance, 84.6% of the subjects with BMI greater than 30 at the Okrika study center had systolic hypertension compared with 77.1% of those with large waist circumference. 69.2% had diastolic hypertension compared with 55.3% and 35.9% had hypertriglyceridaemia compared with 25%. The difference was not consistent and not as much with the Port Harcourt subjects. Abdominal obesity was however associated with a greater proportion of subjects with metabolic syndrome as defined by ATP III, in both Okrika (77.6% compared to 74.4%; $p > 0.05$) and Port Harcourt (71.4% compared to 58.6%; $p > 0.05$).

It has been reported that waist circumference is a stronger predictor of CVD outcomes than BMI¹⁰ and that obesity, particularly abdominal adiposity worsens the prognosis of patients with CVD²³. However, we cannot say on the basis of our findings that waist circumference or BMI is a better indicator of cardiovascular risk. Large waist circumference and BMI = 30kg/m^2 seem to be associated significantly with cardiovascular risk factors.

Conclusion

Obesity as defined by BMI greater than 30kg/m^2 and by waist circumference greater than or equal to 102 cm in men and greater than or equal to 88 cm in women, is more prevalent in Okrika than in Port Harcourt. It is also more prevalent in women than in men and among older

subjects at both centers. Obesity as defined by BMI greater than 30 kg/m² is more prevalent among young adults (age < 40 years) in Port Harcourt than in Okrika. However only 11.6% of the subjects aged less than 40 years were obese and only 7.73 % of the Port Harcourt study populations were obese. Both Waist circumference and BMI had strong correlation with obesity-related cardiovascular risk factors. We recommend that

enlightenment on healthy eating and social habits, as well as increased physical activity be strongly encouraged by all health care providers.

Limitations

This study is limited by the fact that it is hospital based, patients were ill and by the fact that subjects were recruited on volunteer basis.

References

1. Baron RB. Nutritional Disorders. In: Current Medical Diagnosis and Treatment, (McPhee SJ, Papadakis MA and Tierney LM, eds). McGraw Hill Medical, New York, 46th edition, 2007; 1290-1296.
2. Heymsfield SB. In: Handbook of Obesity: Etiology and Pathophysiology (Bray G and Bouchard C. eds). Merce and Decker, New York, 2004; 33-79.
3. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS. Prevalence of obesity, diabetes, and obesity-related health risk factors 2001. JAMA 2003; 289 (1): 76-9.
4. McDermott AY. Clinical Nutrition and Obesity Conference Coverage: Selected Presentations from the 20th Annual Practical Approaches to the Treatment of Obesity; Medscape General Medicine 2006; 8(4): 61.
5. Third Report of the National Cholesterol Education Program Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Executive Summary. Bethesda, Md.: National Institutes of Health, National Heart Lung and Blood Institute, 2001 (NIH Publication no. 01-3670).
6. Calle EE and Kaaks R. Overweight, obesity and cancer: epidemiological evidence and proposed mechanisms. Nature Reviews Cancer, 2004; 4(8): 579-591.
7. Willet WC. Nutritional Epidemiology. Oxford University Press, New York, 1998: 244-273.
8. Borkman G, Hultz D, Gerzof S, Robbins AH, and Silbert CK. Age changes in body composition revealed by computed tomography. J. Gerontol, 1983; 36: 673-677.
9. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais R, Varigos J, Lisheng L; INTERHEART Study Investigators. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART Study): Lancet. 2004; 364 (9438): 912-4.
10. Haffner SM, Despres J-P, Balkau B on behalf of the IDEA Study Group. Waist Circumference and Body Mass index are both independently associated with cardiovascular disease. The International Day for the Evaluation of Abdominal Obesity (IDEA) Survey. J Am Coll Cardiology, 2006; 47(Suppl. A): 842-846.
11. Amodu PH, Mbah IO, Lawson L. Prevalence of obesity and dyslipidaemia in hypertensives seen in Abuja, Nigeria. Scan J Clin Lab Invest 2004; Suppl; 240: 14-17.
12. Fadupin GT, Joseph EU, Keshinro OO (2004). Prevalence of obesity among type 2 diabetics in Nigeria: a case study of patients in Ibadan, Oyo State. Afr J Med Sci, 2004; 33(4): 381-4.
13. Ansa VO, Odigwe CO and Anah MV. Profile of body mass index and obesity in Nigerian children and adolescents. Niger J Med, 2001; 10(2): 78-80
14. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Gordon DJ, Krauss RM, Savage PJ, Smith SC, Spertus JA, Costa F. Diagnosis and Management of Metabolic Syndrome. Circulation, 2005; 112: 2735-2752.
15. Ganong WF. Review of Medical Physiology. Appleton and Lange, Stamford, Connecticut, 18th Edition, 1997; 536-552
16. World Health Organization (WHO). Blood Safety and Clinical Technology: Guidelines on Standard Operating Procedures for Clinical Chemistry. Available at: http://www.searo.who.int/EN/Section10/Section17/Section53/Section481_1753.htm Last updated July 2006 and accessed March, 2007.
17. Emeis JJ, van Gent CM, and van Sabben CM. An enzymatic method for the histochemical localization of free esterified cholesterol separately. The Histochemical Journal, 1977; 9 (2): 197-204.
18. Gibbons VB and Ballantyne FC. Triglyceride estimation in high density lipoproteins. Med Lab Sci, 1981; 38(3): 277-279.
19. Romero-Corral A, Montori VM, Sommers VK, Korinek J, Thomas RJ, Allison TG, Mookadam F, Lopez-Jimenez F. Association of body weight with total mortality and with cardiovascular events in coronary artery disease: a systematic review of cohort studies. Lancet; 2006; 368 (9536): 624-5, 666-678.
20. Federal Ministry of Health, Nigeria. The Final Report of a National Survey on Non-communicable Diseases in Nigeria (Akinkugbe, OO ed.), 1997; 4: 5-10.
21. Rana JS, Li TY, Mason JE and HU FB. Obesity a greater risk than inactivity in women. Diabetes Care, 2007; 30: 53-58.
22. Grundy SM. Does a diagnosis of metabolic syndrome have value in clinical practice? Am J Clin Nutr, 2006; 83(6): 1248-51.
23. Dagenais GR, Yi Q, Mann JFE, Bosch J, Pogue J and Yusuf S on behalf of the heart outcomes prevention evaluation (HOPE) Study investigators (2005). Am Heart J, 2005; 149 (1): 54-60.