Prevalence of metabolic syndrome and its component traits among students in a Nigerian university

Salawu AA.[1], Akinboro AO.[2], Oloyede TW.[1], Kareem RA.[1] and *Ayodele OE.[2]

Abstract

Objectives: Metabolic syndrome (MetS) is associated with increased risk for type 2 diabetes mellitus, cardiovascular diseases (CVDs) and all-cause mortality. This cross-sectional study examined the prevalence of MetS and its component traits among students in a Nigerian university in whom there are limited data.

Methods: 173 students (109 females and 64 males) students aged 18 – 30 years with no prior diagnosis of any component trait of MetS participated in the study. We obtained anthropometry, blood pressure (BP), fasting plasma glucose (FPG) and complete lipid profile of the participants. MetS was defined using the modified National Cholesterol Education Program for Adult Treatment III Guidelines (NCEP ATP III), the International Diabetes Federation (IDF) and the Joint Interim Statement (JIS) criteria.

Results: The prevalence rates of MetS according to the NCEP-ATP III, IDF and JIS criteria were 4.0, 3.5 and 5.8% respectively. Elevated BP, FPG, increased waist circumference (NCEP) and low high density lipoprotein cholesterol (HDL-C) were present in 13.3%, 15.0%, 4.6%, and 46.2% participants respectively. Seventy seven (44.5%) and 19 (11.0%) participants had 1 or 2 MetS traits (NCEP III criteria). None of the participants had elevated triglyceride. The males had significantly higher mean FPG, and systolic BP while the females had significantly higher prevalence of low HDL-C. There was no statistically significant gender difference in the prevalence of MetS.

Conclusions: Nigerian university students have and are at risk of MetS. Screening and identification of MetS in this population will help in targeted intervention to reduce the risk of CVDs.

Key words: Metabolic syndrome, university students, Nigeria

*Corresponding Author: Prof. Ayodele Olugbenga Edward. E-mail address: gbengaayox@yahoo.com ayodele@lautech.edu.ng

[1]Department of Chemical Pathology, Ladoke Akintola University of Technology Teaching Hospital, Ogbomoso, Oyo State, Nigeria.

[2]Department of Internal Medicine, Ladoke Akintola University of Technology, Osogbo, Osun State, Nigeria.

Prévalence du syndrome métabolique et de ses traits constitutifs parmi les étudiants dans une université nigériane

Salawu AA.[1], Akinboro AO.[2], Oloyede TW.[1], Kareem RA.[1] and *Ayodele OE.[2]

Résumé

Objectifs: le syndrome métabolique (MET) est associée à un risque accru de diabète de type 2, les maladies cardiovasculaires (MCV) et la mortalité toutes causes confondues. Cette étude transversale a examiné la prévalence de syndrome métabolique et ses traits constitutifs parmi les étudiants dans une université nigériane dans lequel il existe des données limitées.

Méthodes: 173 élèves (109 femelles et 64 mâles) les étudiants âgés de 18 - 30 ans sans diagnostic préalable de tout trait composant du syndrome métabolique ont participé à l'étude. Nous avons obtenu l'anthropométrie, la pression artérielle (BP), la glycémie à jeun (FPG) et le profil lipidique complet des participants. MetS été définies en utilisant le programme modifié de National Cholesterol Education pour adultes Treatment Guidelines III (NCEP ATP III), la Fédération Internationale du Diabète (FID) et de la déclaration intérimaire mixte (JIS) critères.

Résultats: Les taux de prévalence du syndrome métabolique de fonction de la NCEP-ATP III, critères de la FID et JIS étaient de 4,0, 3,5 et 5,8% respectivement. BP plongée, FPG, augmentation de la circonférence de la taille (NCEP) et à faible taux de cholestérol des lipoprotéines de haute densité (HDL-C) étaient présents dans 13,3%, 15,0%, 4,6% et 46,2% respectivement participants. Soixante-dix sept (44,5%) et 19 (11,0%) les participants ont eu 1 ou 2 MetS traits (critères NCEP III). Aucun des participants avait élevé de triglycérides. Les mâles avaient significativement plus élevée FPG, et la pression artérielle systolique tandis que les femelles ont une prévalence significativement plus élevé de HDL-C bas. Il n'y avait aucune différence entre les sexes statistiquement significative de la prévalence du syndrome métabolique.

Conclusions: les étudiants universitaires nigérians ont et sont à risque de syndrome métabolique. Le dépistage et l'identification des MetS dans cette population contribueront à une intervention ciblée pour réduire le risque de maladies cardio-vasculaires.

Mots clés: syndrome métabolique, des étudiants universitaires, Nigeria

*Auteur correspondant: Prof. Ayodele Olugbenga Edward. E-mail: gbengaayox@yahoo.com ayodele@lautech.edu.ng

[1]Department of Chemical Pathology, Ladoke Akintola University of Technology Teaching Hospital, Ogbomoso, Oyo State, Nigeria.

[2]Department of Internal Medicine, Ladoke Akintola University of Technology, Osogbo, Osun State, Nigeria.

INTRODUCTION

Metabolic syndrome (MetS) refers to clustering of cardiovascular risk factors (CVRFs) which include obesity, hypertension, dyslipidaemia, and insulin resistance (1). Metabolic syndrome is associated with increased risk for type 2 diabetes mellitus (T2DM), cardiovascular diseases (CVDs) and all-cause mortality (2-4). At the individual and community levels, awareness of components of MetS is masked by the lack of overt symptoms and this in turn may lead to increased prevalence of non-communicable diseases (NCDs) such as DM and CVDs (3,4). Reports show that 81% (29 million) of NCDs deaths occurred in low- and middle-income countries (LMIC) (5,6). Also, age-standardized death rates from NCDs in LMIC are respectively 65% and 85% higher than for men and women in high-income countries (5,6). In addition, the percentage of premature deaths was 4% in high-income countries (HIC) compared to 42% in low-income countries (LIC) (5,6). Thus, LMIC bear an inordinate burden of NCDs.

Published reports indicate that MetS has its root in childhood and young adult years, and the prevalence of MetS increases with age (7). Young adults in the university represent a critical population in transition and many reports have shown that university students make poor lifestyle and health choices such as unhealthy diets, lack of physical activity and regular exercise, use of tobacco and consumption of alcohol which in turn predispose them toward developing MetS (8-10). These unhealthy lifestyle choices are partly being driven by proliferation of fast food outlets, increasing computer and technology usage with consequent reduction in time spent in other activities (8 -10). In addition, university students do not perceive themselves to be at risk for developing chronic diseases such as CVDs and as such fail to make health-promoting choices (10). Since lifestyle choices and routines formed during these transitional years have the potential of impacting the long-term health of university students, screening and identification of MetS in this population will help in targeted intervention to decrease the risk of CVDs.

The prevalence of MetS in university students from published reports ranged from 0.6 – 13% (8-16). These reports have come largely from middle- and high-income countries (8-16). Although there is a dearth of publications on the prevalence of MetS in university students in Nigeria, there are few reports on the prevalence of individual component traits of MetS (17-19). Reports from Nigeria showed that the prevalence of overweight, obesity, and hypertension in university students ranged from 10.7 – 26%, 3 – 8% and 5 – 17% respectively (17-19). In view of the substantial variability by gender and ethnicity in the prevalence and component traits of MetS and the dearth of publications in university students from Nigeria, we embarked on this study to determine the prevalence of MetS and its individual component traits in students in a Nigerian university using the modified National Cholesterol Education Program (NCEP) for Adult Treatment Panel III Guidelines (NCEP ATP III) (2), the International Diabetes Federation (IDF) criteria (20), and the Joint Interim Statement (JIS) criteria (21).

MATERIALS AND METHODS

The study was carried out at the Ladoke Akintola University of Technology Teaching Hospital (LTH), Ogbomoso, Oyo State, Nigeria. The study population consisted of medical and nursing students attending Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The sample size (N) was determined using the formula: $N = P(100 - P) / (SE)^2$ where P is the prevalence from a previous study (12%), and standard error (SE) is confidence interval divided by 1.96 = 5/1.96 = 2.55. The calculated sample size N = 163. We, however, recruited 173 participants for the study. The students were recruited through in-class announcements and word-of-mouth. Participants were informed that their participation was voluntary and they could withdraw from the study at any time without any adverse consequences.

Students who were $\geq$18 years old and $\leq$ 30 years and who agreed to participate in all data collection phases were included in the study. We excluded students who were pregnant and/or breast feeding; those with clinical thyroid disease; those diagnosed to have hypertension,

diabetes, or hyperlipidaemia prior to the commencement of the study; those on blood-pressure, blood-glucose or lipid-lowering medications; those on weight-control medications or supplements; and those who declined to participate in the study.

The study was in two stages. The first stage involved explaining the aims of the study, the inclusion and exclusion criteria and the study protocol to the participants. The students who met the criteria for the study and agreed to participate in the study were then asked to proceed to the second stage of the study which took place at the Metabolic Clinic Laboratory of LTH, Ogbomoso, Oyo State, Nigeria. Participants were instructed to fast overnight (8 – 12 hours), and to maintain proper hydration by drinking water freely. On presentation at the Metabolic Clinic Laboratory, participants were required to complete a structured questionnaire to obtain information such as gender, age, smoking status, alcohol intake status, history of intentional physical activity, and family history of hypertension, diabetes, and hyperlipidaemia.

The weight (kg) to the nearest 0.1kg and height (m) to the nearest 0.1cm were obtained with the participants in light clothing and without shoes using the stadiometer and weighing scale (Heightiometer and weighing scale RG2-160, Lincoln Mark Medical, England) respectively. The body mass index was calculated from weight/height^2 (kg/m^2). Body mass index was classified as follows :< 18.5 kg/m^2 as underweight; 18.5 – 24.9 kg/m^2 as normal weight; 25.0 – 29.9 kg/m^2 as overweight; and ≥30 kg/m^2 as obese (22). Waist circumference (WC) was measured midway between iliac crest and lowest rib and hip circumference (HC) at the level of the greater trochanters using a non-stretchable tape measure. The waist: hip ratio was calculated by dividing the WC by the HC (i.e. WC/HC). The blood pressure (BP) and pulse rate (PR) of the participants were obtained using A&D UA767 digital manometer which has been validated by the British Hypertension Society (23). Blood pressure was taken using appropriate cuff after ensuring that participant had rested for at least 5 minutes. Three BP and PR readings were taken for each participant and the average of the two last readings calculated and used as the current BP and PR readings of the participant.

Overnight fasting blood specimens were obtained by venipuncture under sterile condition. Blood samples were centrifuged using a bench-top centrifuge at 3000rpm for 5 minutes and the plasma stored until laboratory analysis. Fasting plasma glucose was obtained using the glucose oxidase method. Concentration of total cholesterol (TC), its fractions and triglycerides (TG) were assessed enzymatically using commercially available reagents (Randox Laboratories Ltd, UK) (24). The HDL-C was determined from the supernatant after other fractions were separated by precipitation techniques using sodium phosphotungstate and magnesium chloride (24). The concentration of low density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald equation for participants with TG level < 4.5 mmol/L (25). Accuracy was ensured using commercial quality control sera. Participants with abnormal BP readings, lipid profile and FPG results had their BP, lipid profile and FPG re-checked. Participants with any persistent abnormal findings were counseled and referred to the health facility of their choice.

Definition of Metabolic Syndrome

Metabolic syndrome was defined using three sets of criteria: the modified National Cholesterol Education Program (NCEP) for Adult Treatment Panel III Guidelines (NCEP ATP III) (2), the International Diabetes Federation (IDF) Criteria (20), and the Joint Interim Statement (JIS) of the International Diabetes Federation Task Force on Epidemiology and Prevention, National Heath, Lung and Blood Institute, American Heart Association, International Atherosclerosis Society and International Association for the Study of Obesity (Table 1) (21). Table 1 shows the different cut-off values of the constituent traits of MetS using various definitions. Metabolic syndrome using the updated NCEP ATP III criteria was defined by the presence of ≥3 component traits (2). Metabolic syndrome using the IDF definition (20) was identified by the presence of increased waist circumference (WC

≥94 cm in males, ≥80 cm in females for sub-Saharan Africa) plus any other two (2) component traits while MetS using the JIS definition (21) requires the presence of ≥3 component traits.

Ethical Approval for the study was obtained from the Research Ethics Committee of the Ladoke Akintola University of Technology Teaching Hospital, Ogbomoso, Oyo State, Nigeria.

Statistical analysis

Categorical variables were expressed as proportions and continuous variables as means ± standard deviation. Comparisons between 2 and ≥3 continuous variables were analyzed using the Student t-test and analysis of variance (ANOVA) respectively. The chi-squared test was used to determine the degree of association of categorical variables with the Fisher's test applied when appropriate. The prevalence of individual metabolic traits that make up MetS and the prevalence of MetS as defined by various criteria were determined. The level of agreement between the various definitions of MetS was determined using the kappa (k) statistics (26). The level of agreement was classified as poor if k = 0.20, fair if k = 0.21 – 0.40, moderate if k= 0.41 – 0.60, substantial if k = 0.61 – 0.80 and very good if k > 0.80 [26]. All p values were two-tailed, and values ≤0.05 were considered as being statistically significant. All statistical analyses were done using the Statistical Package for Social Sciences (SPSS) software, version 16 (SPSS, Chicago, IL).

RESULTS

The study population consisted of 173 students made up of 109 (63%) females and 64 (37%) males. Table 2 shows the demographic, lifestyle, anthropometric and biochemical characteristics of the study population. The mean age of the study population was 23.7 ± 2.5 years with the males being significantly older than the females (24.7 ± 2.5 vs. 23.1 ± 2.2 years, p < 0.001). More males had history of current alcohol intake than females. None of our study population had history of past or current cigarette smoking. The males were significantly taller than the females. The mean BMI was 22.2 ± 3.5 kg/m^2 with the females having significantly greater BMI than the males (22.6 ± 3.7 vs. 21.5 ± 3.0 kg/m^2, p = 0.027). The respective prevalence rates of overweight and obesity in our study cohort were 8.1% and 4.6%. The males had significantly higher mean FPG (5.1 ± 1.7 vs. 4.8 ± 0.8 mmol/L, p = 0.026) and SBP (121 ± 15 vs. 108 ± 11 mm Hg, p < 0.001) but comparable mean DBP (71 ± 11 vs. 69 ± 9.0 mm Hg, p = 0.143). There were no gender differences in the mean TC, HDL-C, TG, and LDL-C levels.

Table 3 shows the gender distribution and differences in the individual component traits of MetS and the prevalence of MetS using the three criteria. The most prevalent traits were low HDL-C (46.2%) and elevated blood sugar (15.0%). The prevalence of abdominal obesity using the IDF and JIS criteria is higher (14.5%) when compared with the ATP criteria (4.6%). None of our study participants had elevated TG (i.e. TG ≥1.7 mmol/L). A significantly higher proportion of females had low HDL-C when compared to males (56.9% vs. 28.1%, p < 0.001). On the other hand, the male participants had significantly higher prevalence of elevated FPG (25.0% vs. 9.2%, p = 0.005) and elevated BP (23.4% vs. 7.3%, p = 0.003). None of the participants had FPG ≥ 7.0 mmol/L while 14 (8.1%) had hypertension defined as SBP ≥140 mm Hg and/or DBP ≥90 mmHg. Nine (64.3%) out of the 14 participants with hypertension had positive family history of hypertension (p = 0.001). The prevalence rates of MetS according to NCEP, IDF and JIS criteria were 4.0%, 3.5% and 5.8% respectively (Table 3). Metabolic syndrome was commoner in the males using the NCEP criteria while it was commoner in the females using the IDF criteria. The frequency of occurrence of MetS was the same in both genders using the JIS criteria. However, there was no statistically significant gender difference in the prevalence of MetS using the three criteria.

Table 4 shows the mean values and number of the component traits of MetS according to BMI categories. There were no statistically significant differences in the various component traits of MetS across various BMI categories except the WC with the NCEP criteria,

5 (71.4%) of the participants with MetS had normal BMI while 2 (28.6%) had BMI $\geq$ 25.0 kg/m^2 (Table 4). The concordance between the definitions of MetS was very good ($k = 0.815$, $p < 0.001$) [NCEP vs. JIS]; substantial ($k = 0.739$, $p < 0.001$) [IDF vs. JIS] and moderate ($k = 0.441$, $p < 0.001$) [NCEP vs. IDF].

DISCUSSION

The prevalence of MetS in this study was 4.0% by NCEP ATP III criteria, 3.5% by IDF criteria and 5.8% by JIS criteria. The differences in the definition of MetS will account for the different rates of MetS obtained in this study. The IDF criteria requires the compulsory presence of abdominal obesity in addition to two other component traits before the diagnosis of MetS can be made and this will explain the least prevalence using this criteria. The prevalence of MetS in our participants falls within the reported range of 0.6% to 13% (8 -16). The prevalence of 4.0% using the NCEP ATP III criteria was higher than 3.7% reported in college students by Fernandes et al [11], 1.3% by Huang et al (13), and 1.7% by de Freitas et al. (14). However, our figure is lower than 4.6% by Yen et al (16), and 12.0% by Topé and Rogers (2).

With the exception of the report by Topé and Rogers (12) which was in African American population, other reports were in predominantly Caucasian, Asian or mixed race populations (8-11, 13–16). Ethnicity, lifestyle choices and age are all known to impact the prevalence of MetS and this may partly explain the differences in prevalence in all these studies. For instance, whilst current cigarette smoking was reported in 4.1 to 6.9% of participants in some studies (10), none of our participants gave history of current or past smoking. Consistent with report by Morrell et al (10), current alcohol consumption was more prevalent in males compared to females. However, the prevalence rate of alcohol in our cohort of 2.3% is much lower than 74.7% in males and 60.6% in females reported by Morell et al (10). The background knowledge of our participants, being medical and nursing students, about the health hazards of smoking and alcohol intake could have influenced their lifestyle choices.

Table 5 compares the findings of our study with some published studies. The reported gender differences in the prevalence of MetS in college students vary. While Fernandeset al (11) and Huang et al (13) reported higher prevalence rates in females, Morell et al (10), Topé and Rogers (12) and de Freitas et al (14) reported higher prevalence in males. We found a higher prevalence in males compared with females based on the NCEP ATP III and JIS definitions. On the other hand, the prevalence was higher in females compared to males when the IDF definition was used. This is similar to the report by Topé and Rogers (12) when IDF definition was used. This finding can be explained by the fact that the IDF definition requires the compulsory presence of abdominal obesity which was significantly higher in our female participants.

The commonest MetS traits in our cohort were low HDL-C, elevated FPG and abdominal obesity (JIS and IDF definitions). The prevalence of low HDL-C in our study population was significantly higher in females when compared to males, consistent with reports by Topé and Rogers (12), Fernandes et al [11], Huang et al (13) and Yen et al (16) (Table 5). However, Morell et al (10) reported a higher prevalence of low HDL-C in males compared to females (Table 5). Studies had shown that impaired fasting glucose (IFG) is associated with development of diabetes later in life although the reported estimates vary widely (27).

It is estimated that 382 million adults have diabetes globally with 19.8 million in Africa as at 2013 (28). This global prevalence is expected to rise to 592 million by 2035. Africa's population of adults with diabetes is projected to increase to 41.4 million by 2035 representing 109% increase, which is the largest increase in all regions of the world [28]. Also, IFG has been associated with elevated risk of CVD and premature mortality (3,27). Twenty six (15.0%) of our participants had impaired fasting glucose and are thus at risk of developing diabetes, CVD and premature mortality. In other to prevent this calamitous increase of diabetes in Africa, and particularly among our emerging adult population, lifestyle measures such as increase in

physical activity, dietary modifications and encouragement of weight loss in overweight and obese individuals must be promoted in this population. The prevalence of elevated BP in our participants of 13.3% is higher than 3.7% reported by Huang et al (13) and 4.1% reported by Yen et al (16). However, our figure is much lower than 62.1% and 21.2% reported in males and females by Morell et al (10).

None of our participants had elevated TG in contrast to prevalence rates of 4.1% - 17.5% by other workers [8-16]. Reports have shown that people of African descent tend to have normal TG in the presence of low HDL-C (29,30). This has been termed "triglyceride paradox" by some workers since TG is expected to be high in the presence of low HDL-C which is the classical "dyslipidaemia of insulin resistance" (30). The mechanisms proposed to explain this finding of normal TG in the presence of low HDL-C in people of African descent include higher lipoprotein lipase (LPL) activity in blacks compared to whites; lower apolipoprotein C III (which inhibits LPL activity) levels in blacks than whites; and non-inhibition of LPL activity by insulin resistance in blacks, such that blacks are able to clear TG from the circulation even when there is insulin resistance (38,39) (29,30). These mechanisms all lead to greater clearance of TG-rich lipoprotein in blacks than whites. This informed the argument by many workers that the present cut-off value of TG used in the diagnosis of MetS will need to be lowered in people of African descent in order to improve the predictive value of MetS in the early diagnosis of CVDs and type 2 diabetes mellitus (30).

We did not find any association between presence of overweight /obesity and MetS in our study participants. In fact, 71.4% of our participants with MetS had normal BMI. This is at variance with some reports. Forty percent and 25% of the participants with MetS were obese in reports by Topé and Rogers (12) and de Freitas et al (14) respectively. Thus, in our population of university students, the absence of overweight/obesity does not protect against the development of MetS.

Our study has a number of limitations. First, we cannot completely rule out inherent selection bias because we recruited only students who voluntarily presented at the Metabolic Clinic after the invitation. Thus, students who are particular about their health status may have been over-represented. However, our sampling technique was similar to that used in other published studies. Second, our study population was smaller than that of most published studies though comparable to that of Fernandes et al (11). Third, we did not do thyroid function test in our cohort, so there is a likelihood that we could have missed out sub-clinical thyroid disease. Fourth, our study was carried out in a public university in the southwestern part of the country and our results may not be generalisable to all the universities in the country taking into consideration variations in socioeconomic status, age and lifestyle choices in the different universities across the nation. Lastly, we included only students in health sciences in contrast to some studies that included all academic majors and colleges (11-14). This is, however, not peculiar to our study alone. Another study by Morell et al (8) involved students enrolled in an introductory nutrition course. The use of the fairly recent JIS criteria to define MetS and the fact that our report is one of the few reports on MetS on university students from the continent are the strengths of this paper.

CONCLUSION

In conclusion, we found out that Nigerian university students have and are at risk of developing MetS. The most prevalent MetS component traits were low HDL-C and elevated blood sugar. In view of the fact that MetS is associated with future development of CVDs and T2DM, failure to identify young adults with MetS results in lost opportunity to prevent these conditions. In order to determine the burden and improve the awareness of MetS, university students should be effectively screened for MetS and its component traits. Also, lifestyle choices such as dietary modifications and increased physical activity, which are known to effectively prevent the development of MetS should be encouraged in this emerging adult population. This study underscores the need for more research in this young adult population to aid in

the development of interventions to help prevent or reduce the prevalence of MetS and its future health consequences.

Conflict of interest: No conflicts of interest declared.

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Table 1 Definitions of metabolic syndrome using the NCEP-ATP III, IDF, and JIS Criteria

Risk Factors	NCEP-ATP III	IDF	JIS
Definition criteria	**Any 3 of the following 5 factors:** abdominal obesity, low HDL-C, hypertriglyceridaemia, high blood pressure, high fasting glucose	Abdominal obesity is measured with waist circumference **Plus any two of the following:** low HDL-C, hypertriglyceridaemia, high blood pressure, high fasting glucose	**Any 3 of the following 5 factors:** abdominal obesity, low HDL-C, hypertriglyceridaemia, high blood pressure, high fasting glucose
Obesity	Waist circumference ≥ 102 cm in males and ≥88 cm in females	Waist Circumference ≥ 94 cm in males, ≥80 cm in females (for sub-saharan Africa),	Waist Circumference ≥94 cm in males, ≥80 cm in females (for sub-saharan Africa),
HDL-C	HDL-C < 1.036 mmol/L (40 mg/dL) in males and 1.295 mmol/L (50 mg/dL) in females	HDL-C < 1.036 mmol/L (40 mg/dL) in males and 1.295 mmol/L (50 mg/dL) in females	HDL-C < 1.036 mmol/L (40 mg/d/) in males and 1.295 mmol/L (50 mg/dL) in females
Triglyceride	serum TG ≥1.695 mmo/L (150 mg/dL),	serum TG ≥1.695 mmo/L (150 mg/dL),	serum TG ≥1.695 mmo/L (150 mg/dL),
Blood pressure	systolic blood pressure (SBP) ≥130 mm Hg and /or diastolic blood pressure (DBP) ≥85 mm Hg	systolic blood pressure (SBP) ≥130 mm Hg and /or diastolic blood pressure (DBP) ≥85 mm Hg	systolic blood pressure (SBP) ≥ 130 mm Hg and /or diastolic blood pressure (DBP) ≥85 mm Hg
Fasting plasma glucose	fasting plasma glucose (FPG) ≥5.6 mmol/L) (100 mg/dL)	fasting plasma glucose (FPG) ≥5.6 mmol/L (100 mg/dL)	fasting plasma glucose (FPG) ≥5.6 mmol/L (100 mg/dL)

Key: NCEP-ATP III - National Cholesterol Education Program for Adult Treatment Panel III Guidelines, IDF-International Diabetes Federation (IDF), JIS- Joint Interim Statement (JIS), HDL-C – high-density lipoprotein cholesterol, TG - triglyceride

Table 2. Baseline characteristics of the study population

Participants' Characteristics	Total, n=173 (%)	Female, n=109 (%)	Male, n = 64 (%)	P value
Mean age ± SD (years)	23.7 ± 2.5	23.1 ± 2.2	24.7 ±2.5	< 0.001
History of alcohol intake				0.002
Current	4 (2.3)	1 (0.9)	3 (4.7)	
Past	8 (4.6)	1 (0.9)	7 (10.9)	
Never	161 (93.1)	107 (98.2)	54 (84.4)	
Family history of hypertension				0.096
Yes	41 (23.7)	20 (18.3)	21 (32.8)	
No	119 (68.8)	80 (73.4)	39 (60.9)	
Don't know	13 (7.5)	9 (8.3)	4 (6.2)	
Family history of diabetes mellitus				0.458
Yes	23 (13.3)	12 (11.0)	11 (17.2)	
No	138 (79.8)	90 (82.6)	48 (75.0)	
Don't know	12 (6.9)	7 (6.4)	5 (7.8)	
Family history of stroke				0.509
Yes	14 (8.1)	9 (8.3)	5 (7.8)	
No	149 (86.1)	92 (84.4)	57 (89.1)	
Don't know	10 (5.8)	8 (7.3)	2 (3.1)	
Family history of ischaemic heart disease				0.839
No	163 (94.2)	103 (94.5)	60 (93.8)	
Don't know	10 (5.8)	6 (5.5)	4 (6.2)	
Mean weight ± SD (kg)	60.4 ± 10.2	58.7 ± 10.2	63.3 ± 9.7	0.004
Mean height ± SD (m)	1.65 ± 0.08	1.61 ± 0.06	1.72 ± 0.08	< 0.001
Mean waist circumference ± SD (cm)	73.9 ± 8.0	73.6 ± 8.4	74.4 ± 7.5	0.509
Mean hip circumference ± SD (cm)	90.9 ± 9.4	93.1 ± 9.9	87.1 ± 7.3	< 0.001
Mean body mass index ± SD (kg/m^2)	22.2 ± 3.5	22.6 ± 3.7	21.5 ± 3.0	0.027
Body mass index classification				0.114
Underweight	14 (8.1)	8 (7.3)	6 (9.4)	
Normal	137 (79.2)	82 (75.2)	55 (85.9)	
Overweight	14 (8.1)	12 (11.0)	2 (3.1)	
Obese	8 (4.6)	7 (6.4)	1 (1.6)	
Systolic blood pressure (mm Hg)	113 ± 14	108 ± 11	121 ± 15	< 0.001
Diastolic blood pressure (mm Hg)	69 ± 10	69 ± 9	71 ± 11	0.143
Pulse rate (/min)	76 ± 12	78 ± 12	74 ± 14	0.023
Fasting plasma glucose (mmol/L)	4.8 ± 1.2	4.6 ± 0.8	5.1 ± 1.7	0.026
Total cholesterol (mmol/L)	3.58 ± 1.05	3.59 ± 1.16	3.57 ± 0.84	0.866
HDL-C ± SD (mmol/L)	1.40 ± 0.59	1.38 ± 0.54	1.44 ± 0.67	0.519
LDL-C ± SD (mmol/L)	1.91 ± 0.99	1.94 ± 1.0	1.87 ± 0.87	0.644
Triglyceride ± SD (mmol/L)	0.63 ± 0.27	0.64 ± 0.27	0.64 ± 0.27	0.58
Creatinine ± SD (µmol/L)	81.1 ± 20.6	82.5 ± 17.1	92.3 ± 24.5	0.006

Key: SD– standard deviation, HDL-C - high density lipoprotein cholesterol, LDL-C – low density lipoprotein cholesterol

Table 3. Gender distribution of the component traits of metabolic syndrome and metabolic syndrome in university students according to the NCEP ATP III, IDF and JIS Definitions

Criteria	Total, n = 173 (%)	Female, n = 109 (%)	Male, n = 64 (%)	P value
Elevated BP (%)	23 (13.3)	8 (7.3)	15 (23.4)	0.003
Waist circumference				
ATP (%)	8 (4.6)	7 (6.4)	1 (1.6)	0.261
IDF & JIS (%)	25 (14.5)	24 (22.0)	1 (1.6)	< 0.001
Low HDL-C (%)	100 (46.2)	62 (56.9)	18 (28.1)	< 0.001
Elevated FPG (%)	26 (15.0)	10 (9.2)	16 (25.0)	0.005
Elevated TG (%)	0	0	0	-
Metabolic syndrome				
NCEP (%)	7 (4.0)	2 (1.8)	5 (7.8)	0.054
IDF (%)	6 (3.5)	5 (4.6)	1 (1.6)	0.294
JIS (%)	10 (5.8)	5 (4.6)	5 (7.8)	0.380
Number of MetS criteria (NCEP)				0.086
0 (%)	70 (40.5)	39 (35.8)	31 (48.4)	
1 (%)	77 (44.5)	55 (50.5)	22 (34.4)	
2 (%)	19 (11.0)	13 (11.9)	6 (9.4)	
≥3 (%)	7 (4.0)	2 (1.8)	5 (7.8)	

Key: NCEP ATP III – National Cholesterol Education Program for Adult Treatment Panel III, IDF – International Diabetes Federation, JIS – Joint Interim Statement , Bp – blood pressure, HDL-C – high density lipoprotein cholesterol, FPG – fasting plasma glucose, TG - triglyceride

Table 4. The mean values and number of the component traits of metabolic syndrome (NCEP criteria) according to Body mass index categories

Metabolic syndrome components	**BMI Classification**				
	Underweight	Normal	Overweight	Obese	P value
Mean WC ±SD	65.6 ± 5.6	72.8 ± 5.9	82.9 ± 5.8	91.38 ± 10.4	< 0.001
Mean SBP ± SD	112.3 ± 10.8	112.5 ± 14.3	114.6 ± 13.7	112.8 ± 13.4	0.959
Mean BP ± SD	69.8 ± 9.1	68.9 ± 9.9	72.0 ± 8.9	71.4± 10.9	0.649
Mean FPG ± SD	4.8 ± 1.1	4.8 ± 1.3	4.8 ± 1.1	4.0 ± 1.1	0.402
Mean TG ± SD	0.70 ± 0.26	0.63 ± 0.27	0.69 ± 0.26	0.54 ± 0.27	0.438
Mean HDL-C ± SD	1.40 ± 0.57	1.42 ± 0.61	1.33 ± 0.50	1.29 ± 0.40	0.820
Number of metabolic syndrome trait (NCEP)					<0.001
0	6 (8.5)	60 (85.7)	2 (2.9)	2 (2.9)	
1	7 (9.1)	60 (77.9)	9 (11.7)	1 (1.3)	
2	1 (5.3)	12 (63.2)	2 (10.5)	4 (21.0)	
≥3	0 (0.0F	5 (T1.4F	1(14.PF	1(14.PF	

Key: WC – Waist circumference, SD – standard deviation, SBP – systolic blood pressure, DBP – diastolic blood pressure, FPG – fasting plasma glucose, TG – triglyceride, HDL-C – high density lipoprotein cholesterol

Table 5. Comparison of present study with some published studies

Variables	Yen et al[16](n=8226)		Morell et al[10] (n=2103)		Topé and Rogers[12] n=376		Huang et al [13] n=300		Fernandes et al[11] n=189		Present study n=173	
Study Setting	Taiwan		United States of America		United States of America		United States of America		United States of America		Nigeria	
Gender	Male n=4475	Female n=3751	Male n=575	Female, n=1528	Male n=158	Female n=218	Male n=102	Female n=198	Male n=61	Female n=128	Male n=64	Female n=109
Low HDL-C	25.4	43.7	30.6	23.7	13.6	23.7	22.5	25.3	3.2	16.9	28.1	56.9
High TG	6.0	1.8	12.2	18.3	6.1	5.1	15.7	5.6	3.7	13.8	0.0	0.0
High FPG	14.2	6.6	13.7	6.4	11.7	10.4	13.7	6.6	2.1	5.3	25.0	9.2
Central obesity	10.2	5.9	5.2	4.2	5.3	16.0	2.9	2.5	1.1	6.3	1.6	6.4
High BP	6.0	1.8	62.1	21.2	14.9	6.6	9.8	0.5	2.1	0.0	23.4	7.3
MetS	6.4	2.4	9.9	3.0	12.7	11.5	0.98	1.5	1.6	4.7	7.8	1.8
Number of embolic syndrome criteria												
0	NA	NA	22.6	46.2	30.4	39.9	NA	NA	73.8	54.7	48.4	35.8
1	NA	NA	33.6	34.4	35.4	28.4	NA	NA	18.0	32.8	34.4	50.5
2	NA	NA	24.0	13.4	21.5	20.2	NA	NA	6.6	7.8	9.4	11.9
≥3	6.4	2.4	9.9	3.0	12.7	11.5	NA	NA	1.6	4.7	7.8	1.8

Key: HDL-C – low density lipoprotein cholesterol, TG – triglyceride, FPG – fasting plasma glucose, BP – blood pressure, MetS – metabolic syndrome, NA – not available