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Original Article

Prevalence of modifiable cardiovascular risk factors among undergraduate students in Kano Nigeria: A need for action

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الملخص

أهداف البحث: مرحلة البالغين الشباب هي فترة تتميز بالعديد من خيارات نمط الحياة التي يمكن أن تهيئ للمرض القلبي الوعائي في وقت لاحق من الحياة. ومع ذلك، فإن البيانات المتعلقة بعوامل تأهب الأمراض القلبية الوعائية بين البالغين الشباب في منطقة جنوب الصحراء الأفريقية غير متوفرة. تهدف الدراسة إلى تحديد مدى انتشار عوامل الاختطار للأمراض القلبية الوعائية القابلة للتعديل بين الطلاب الجامعيين في مدينة كانو، نيجيريا.

طرق البحث: شملت هذه الدراسة المستعرضة مائة وخمسين طالبا جامعيا. تم قياس ضغط الدم والوزن ومحيط الخصر ومحيط الورك والطول باستخدام البروتوكولات المعيارية. تم حساب مؤشر كتلة الجسم بقسمة الوزن (كجم) على الطول بالمتر المربع. تم تحديد الكوليسترول الكلي في الدم، والدهون الثلاثية، وكوليسترول البروتين الدهني عالي الكثافة بالطريقة الأنزيمية. تم حساب كوليسترول البروتين الدهني منخفض الكثافة باستخدام معادلة فريدوالد.

النتائج: كان متوسطعمر المشاركين 23.12 ± 2.97 (17 - 31) سنة. كان لدى تسعين في المائة من المشاركين عامل اختطار واحد على الأقل للأمراض القلبية الوعائية، وكان لدى 65% معلم غير طبيعي واحد على الأقل من معالم الدهون في الدم. كان معدل انتشار ارتفاع ضغط الدم الانقباضي، وضغط الدم الانبساطي، والكوليسترول الكلي، والدهون الثلاثية، كوليسترول البروتين الدهني منخفض الكثافة وانخفاض كوليسترول البروتين الدهني عالي الكثافة 7.33٪، 50٪ ، 0.67٪ ، 7.33٪ ، 0.67٪ ، 58.67٪ على التوالي. بلغ معدل انتشار السمنة العامة والجذعية 0.67٪ و 4٪ على التوالي. كانت نسبة انتشار متلازمة التمثيل الغذائي ومرض السكري 4٪ و 0٪ على التوالي.

الاستنتاجات: هناك انتشار مرتفع لعوامل خطر الأمراض القلبية الوعائية القابلة للتعديل بين الطلاب الجامعيين في مدينة كانو، نيجيريا. يجب وضع سياسات مناسبة للفحص والكشف المبكر عن عوامل الاختطار هذه ومعالجتها.

الكلمات المفتاحية: الأمراض القلبية الوعائية؛ عوامل الاختطار القلبية الوعائية؛ الكوليسترول؛ منطقة جنوب الصحراء الأفريقية؛ مرحلة البالغين الشباب؛ السمنة؛ متلازمة التمثيل الغذائي؛ طلاب.

Abstract

Objective: Early adulthood is a period characterised by many lifestyle choices that could predispose an individual to cardiovascular disease (CVD) later in life. However, data on CVD risk factors among young adults in sub-Saharan Africa are lacking. We aim to determine the prevalence of modifiable CVD risk factors among undergraduates in Kano, Nigeria.

Methods: One hundred and fifty undergraduate students were recruited for this descriptive cross-sectional study. Blood pressure, weight, waist circumference, hip circumference, and height were measured using standard protocols. The body mass index was calculated as weight (kg) divided by height in square metre. Serum total cholesterol, triglycerides, and high-density lipoprotein cholesterol (HDL-c) were determined via an enzymatic method. Low-density lipoprotein cholesterol (LDL-c) was calculated using the Friedewald equation.

Results: The mean age of the participants was 23.12 ± 2.97 (17–31) years. Notably, 90% of the participants had at least one CVD risk factor and 65% had at least one abnormal lipid parameter. The prevalence of elevated systolic blood pressure, diastolic blood pressure, total cholesterol, triglycerides, LDL-c, and reduced HDL-c were 7.33%, 50%, 0.67%, 7.33%, 0.67%, and

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58.67%, respectively. Moreover, the prevalence of general and truncal obesity were 0.67% and 4%, respectively, while the prevalence of metabolic syndrome and diabetes were 4% and 0%, respectively.

Conclusions: There is high prevalence of modifiable CVD risk factors among undergraduates in Kano, Nigeria. Thus, appropriate policies for screening, early detection, and treatment of these risk factors should be developed.

Keywords: Cardiovascular diseases; Cardiovascular risk factors; Cholesterol; Metabolic syndrome; Obesity; Students; Sub-Saharan Africa; Young adult

Introduction

Cardiovascular diseases (CVDs) are a constellation of diseases that primarily affect the heart and blood vessels. Together, they constitute the leading cause of mortality and disability globally, especially in low- and middle-income countries.[1,2] An estimated 17.9 million people have been reported to have died from CVDs in 2019, and this figure represents approximately 32% of all global deaths in that year.[1] Even more alarming was the fact that three quarters of these deaths took place in low- and middle-incoming countries, such as those in sub-Saharan Africa (SSA), which also contributed 80% of the global burden of the disease.[1,3] Not only is the current prevalence, mortality, and disability associated with CVDs high, there is equally an upward trend, thus making projections into the future seem even bleaker than the current situation. In their synthesis of data from the Global Burden of Disease 2019 Study, Roth et al.[2] reported a near doubling of the global prevalence of CVDs from 1990 to 2019. Similarly, there was a near doubling of the number of deaths (from 12.1 million in 1990 to 18.6 million in 2019) and years lived with disability (from 17.7 million in 1990 to 34.4 million in 2019) within the same period.[2]

Sub-Saharan Africa comprises countries that fall under the low- and middle-income categories, and thus, it is at a higher risk of the burden of CVDs. Though the pattern, magnitude, and trends of CVD deaths in SSA are not completely understood,[4] emerging data indicate the rising prevalence and mortality in the region.[5] Nigeria, similar to many other low- and middle-income countries, is also experiencing a similar rising prevalence of CVDs. A systematic review of the literature on the prevalence of CVDs among a group of selected SSA countries, which was dominated by studies from Nigeria, Hamid, Groot, and Pavlova,[5] reported an overall rising prevalence and CVD-related deaths in Nigeria.

Cardiovascular diseases are caused by a multiplicity of factors, among which are behavioural risk factors, such as tobacco use, unhealthy diet and obesity, sedentary lifestyle, and excessive consumption of alcohol.[1] These behavioural risk factors manifest in the form of hypertension, diabetes, obesity, and dyslipidaemia and can therefore be effectively managed if these intermediate risk factors are prevented or identified early and effectively managed. This makes screening for modifiable CVD risk factors an important prevention strategy because of its simplicity and cost effectiveness. However, despite the demonstrated effectiveness of prevention strategies in the global effort towards combating CVDs, there is poor awareness and, in some cases, unavailability, of these services in low- and middle-income countries, especially among young people.[5,6]

Adolescence and early adulthood are periods characterised by many behavioural choices that could predispose an individual to CVD later in life.[7] Thus, young people have increasingly become the targets of many CVD prevention strategies.[1] However, for these strategies to be successful, especially in low- and middle-income countries, including Nigeria, baseline data on the prevalence of modifiable CVD risk factors among young people are needed. While there is an extensive body of literature on modifiable CVD risk factors among various sections of the Nigerian and indeed the SSA population, many have been restricted to single risk factors to the exclusion of others; hospital-based as against the general population; among the middle aged and elderly, while neglecting young people; and, in some cases, focussed on patients who have already developed the disease.[5] In the few studies that have exclusively investigated modifiable CVD risk factors among young adults,[8] some of them suffer from the same limitations of merely considering single risk factors to the exclusion of others and have been predominantly conducted within a single ethnic group. Nigeria's population is ethnically heterogeneous, and with the reported racial differences being one of the major CVD risk factors in young adults with CVD incidents later in life,[9] there is the need for data on the prevalence of multiple modifiable CVD risk factors among young adults with different ethnic backgrounds. A population of undergraduate students in a federal university could provide a representative sample of the Nigerian young adult population. The aim of this study was therefore to determine the prevalence of multiple modifiable CVD risk factors among an ethnically diverse undergraduate student population in Nigeria.

Materials and Methods

Participants' selection and study design

This descriptive cross-sectional study was conducted at the Department of Human Physiology, Bayero University, Kano, Nigeria, in June and July 2021. The study population consisted of all undergraduate students of the Faculty of Basic Medical Sciences of the university. A multistage sampling technique was used to recruit eligible and consenting participants for the study. A comprehensive list of all the faculties in the university was obtained and a simple random sampling technique used to select one faculty. A systematic random sampling technique was then used to select participants to the desired sample size.

All the participants were initially screened for the history of any cardiovascular and other medical conditions through an oral interview. The participants found to be known patients of any of those medical conditions were excluded from the study. Pregnant women and students older than 35 years were also excluded from the study. Only participants who gave written informed consent were included in the study.

Sample size determination

The G*Power computer software[10] was used to calculate the minimum sample size required for the study. An effect size of 0.5, α level of significance of 0.05, and statistical power of 0.80 were used, and these gave a minimum total sample size of 102 (51 males and females each).

Data collection

A data capture form designed for this study was used to obtain the family history of CVD risk factors, smoking and alcohol consumption, and level of physical activity of the participants. The results of clinical and laboratory assessments were also entered into the form.

Measurement of anthropometric indices

Anthropometric indices were measured with the participants wearing light clothing, without shoes or caps, and standing erect with both upper limbs by the side. Weight was measured with an Omron HN286 digital weighing scale (Kyoto, Japan) to the nearest 100 g. Height was measured using a stadiometer with the participants facing forward and upward.[11] Waist and hip circumferences were measured according to the World Health Organization (WHO) STEPwise protocol.[12]

The body mass index (BMI) was calculated as weight in kg divided by height in square metre (kg/m^2), waist–hip ratio (WHR) as waist circumference (WC) divided by hip circumference (HC), and waist–height ratio (WHtR) as WC divided by height.

Measurement of blood pressure and fasting blood glucose

Blood pressure was measured twice within a 5-min interval on the left arm with the participant seated using a mercury sphygmomanometer (Accoson™ Ltd., Ayrshire, UK) and Littmann's stethoscope (3M Littmann®, Minnesota, USA). Systolic blood pressure (SBP) was taken at the first appearance of Korotkoff's sounds, while its disappearance was considered diastolic. Fasting blood glucose (FBG) was measured via a glucose oxidase method following an overnight fast of at least 10 hours.

Determination of serum lipids parameters

Approximately 5 mL of venous blood was collected from each participant at 9–10 am after an over-night fast of at least 10 hours. Serum total cholesterol, triglyceride, and high-density lipoprotein cholesterol (HDL-c) were determined chemically via an enzymatic colorimetric method. The blood sample was first allowed to coagulate and the serum was extracted after centrifugation at 1000*g* for 5 minutes and stored at −20 °C until analysis. The reagents meant for each component of serum lipid from Randox laboratories Ltd. (Randox Laboratories Ltd., Crumlin, County Antrim, UK) were used to obtain a characteristic coloured solution, the absorbance of which was measured using an Ortho clinical Vitros DT60 II autoanalyzer (Diamond Diagnostics Inc., Holliston, Massachusetts, USA) at a wavelength of 560 nm. The concentration of each parameter was calculated from the measured absorbance and concentration of the standard according to the manufacturer's instructions. Serum low-density lipoprotein cholesterol (LDL-c) was calculated indirectly from the concentrations of serum total cholesterol, triglyceride, and HDL-c using the following Friedewald equation:[13]

$$LDL\text{-}c = (Total\ cholesterol - HDL\ cholesterol - Triglyceride)/5$$

Definitions of cardiovascular risk factors

Dyslipidaemia was defined based on the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) as the presence of any of the following abnormalities of serum lipid parameters[14]: total cholesterol >200 mg/dL; triglyceride >150 mg/dL; LDL-c > 130 mg/dL; HDL-c < 40 mg/dL in males and <50 mg/dL in females. The BMI was categorised according to the WHO classification as follows: underweight (less than 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (30 kg/m^2 and above).[15] Waist circumference and WHR were defined according to the International Diabetic Federation's consensus worldwide definition of the metabolic syndrome.[16] Waist circumferences of <94 cm in males and <80 cm in females were considered normal, while ≥94 cm in males or ≥ 80 cm in females were considered obesity.[16] Waist–hip ratios of ≥0.90 in males and ≥0.85 in females were also considered obesity.[16] A participant is said to have metabolic syndrome if he/she has three of the following: blood pressure ≥130/85 mmHg; WC ≥ 0.94 m or ≥ 0.80 m in males and females, respectively; triglycerides ≥150 mg/dL; HDL-c < 40 mg/dL in males or < 50 mg/dL in females; and FBG ≥100 mg/dL. A WHtR of ≥0.5 in both sexes was considered obesity.[17] The atherogenic index (AI) was calculated as the log-transformed ratio of triglycerides to HDL-c and classified into three categories according to the European Atherosclerosis Guidelines as low risk <0.18, average risk 0.18–0.4, and high risk >0.4.[18] Hypertension was defined as SBP ≥130 mmHg and/or DBP ≥85 mmHg (International Diabetes Federation, 2006), while FBG of <100 mg/dL, 100–125 mg/dL, and ≥126 mg/dL were considered normal, prediabetes, and diabetes, respectively.[16]

Statistical analysis

Data were analysed using Statistical Package for Social Sciences (SPSS) version 23.0. Independent t test was used to compare mean values between the male and female participants, while the chi-squared test of association was used to compare the categorical variables. Pearson's correlation was used to determine the relationship between the atherogenic

index and other cardiovascular risk factors. A p-value of ≤ 0.05 was considered to be statistically significant.

Results

One hundred and fifty participants were randomly recruited for the study. The mean age of the participants was 23.12 ± 2.97 years (17–31 years). The male participants were significantly older (24.15 ± 2.60 years) than the female (21.48 ± 2.79 years) participants ($p = 0.001$). Approximately 3% of the participants, all of whom were males, had a history of cigarette smoking, while none of the participants consumed alcohol. Similarly, approximately 32% of the participants (males = 40%, females = 19%, $p = 0.032$) were physically inactive. Equally, 22% (males = 20%, females = 26%, $p = 0.365$) and about 18% (males = 14%, females = 24%, $p = 0.120$) of the participants had maternal and paternal history of CVDs, respectively (Table 1). Even though majority of the study participants were of the Hausa ethnic group (63.3%), the overall composition had representations of the major Nigerian ethnicities (Yoruba = 10%, Fulani = 8.7%, Igbo = 6%, other minority ethnicities = 12%).

Majority of the mean values of the clinical and laboratory parameters of the participants were within normal limits. However, there were evident sex-specific differences. The male participants had significantly higher SBP, DBP, MAP, weight, height, WC, and WHR. However, the mean serum lipid parameters, FBG, and AI were not significantly affected by sex (Table 2).

Table 3 shows the prevalence of the various CVD risk factors of the participants. While only 7% of the participants (males = 10%, females = 3%, $p = 0.147$) had elevated SBP, a staggering 50% (males = 50%, females = 43%, $p = 0.180$) had elevated DBP, thus making the prevalence of hypertension to be approximately 51% (males = 54%, females = 45%, $p = 0.256$). However, none of the participants had elevated FBG to a diabetic range; the prevalence of prediabetes was 3% with female participants, accounting for three fifths of that (males = 2%, females = 5%, $p = 0.130$). The prevalence of general obesity among the participants was very low, 0.67%, all of whom were females (males = 00%, females = 1.72%, $p = 0.606$). The prevalence of truncal obesity was however varied depending on which index was considered. It was 4% (males = 1%, females = 9%, $p = 0.064$), 37% (males = 37%, females = 38%, $p = 0.904$), and 6% (males = 4%, females = 9%, $p = 0.283$) when WC, WHR, and WHtR were used, respectively. A staggering 65% (males = 61%, females = 71%, $p = 0.220$) of the participants had at least one abnormal serum lipid parameter. The most common forms of dyslipidaemia among the participants were depressed HDL-c, 59% (males = 55%, females = 64%, $p = 0.311$), and hypertriglyceridemia, 7% (males = 5%, females = 10%, $p = 0.261$). The prevalence of metabolic syndrome among the participants was 5%, majority of whom were females (males = 2%, females = 9%, $p = 0.068$). When the AI was used to classify the participants into three CVD risk categories, only 4% (males = 4%, females = 3%, $p = 0.186$) were in the high risk category. Overall, 90% (males = 89%, females = 91%, $p = 0.655$) of the participants had at least one major CVD risk factor. This suggests a very high prevalence of CVD risk factors among the participants.

All the serum lipid parameters were significantly correlated with the AI, irrespective of sex, except for total cholesterol, which was not significantly correlated among male participants. However, there was no significant correlation between the AI and other parameters, except for FBG

Table 1: Family history of cardiovascular risk factors and other related social information of the participants.

Variable	Variable	Total	Male	Female	X^2	P
		N (%)	N (%)	N (%)	statistic	value
Maternal history of CVD						
Yes		33 (22)	18 (19.86)	15 (25.86)	0.822	0.365
No		117 (78)	74 (80.43)	43 (74.14)		
Paternal history of CVD						
Yes		27 (18)	13 (14.13)	14 (24.14)	2.414	0.120
No		123 (82)	79 (85.87)	44 (75.86)		
Smoking (participants)						
Yes		5 (3.33)	5 (5.43)	0 (00)	3.261	0.071
No		145 (96.67)	87 (94.57)	58 (100)		
Exercise (participants)						
Once a wk		48 (32)	37 (40.22)	11 (18.97)	8.839	0.032[a]
2–3 a wk		79 (52.67)	45 (48.91)	34 (58.62)		
4–5 a wk		10 (6.67)	4 (4.34)	6 (10.34)		
≥5 a wk		13 (8.67)	6 (6.52)	7 (12.07)		
Ethnicity						
Hausa		95 (63.3)	–	–	–	–
Yoruba		15 (10)	–	–		
Fulani		13 (8.7)	–	–		
Igbo		9 (6)	–	–		
Others		18 (12)	–	–		

CVD = cardiovascular disease, wk = number of physical exercises in a week.
[a] Statistically significant variable.

Table 2: Mean clinical and laboratory parameters of the participants.

Variable	Total	Male	Female	T	p
	Mean ± SD	Mean ± SD	Mean ± SD	Statistic	Value
Ag (Years)	23.12 ± 2.97	24.15 ± 2.60	21.48 ± 2.79	5.96	0.001[a]
SBP (mmHg)	114.23 ± 11.77	116.66 ± 11.26	110.38 ± 11.61	3.29	0.001[a]
DBP (mmHg)	82.59 ± 12.37	84.02 ± 11.31	80.31 ± 13.68	1.80	0.073
MAP (mmHg)	93.14 ± 11.03	94.90 ± 10.17	90.33 ± 11.82	2.52	0.007[a]
Weight (Kg)	57.62 ± 9.25	59.22 ± 8.93	55.09 ± 9.26	2.72	0.007[a]
Height (m)	1.68 ± 0.008	1.71 ± 0.09	1.64 ± 0.05	5.58	0.001[a]
BMI (Kg/m^2)	20.38 ± 3.13	20.29 ± 2.90	20.54 ± 3.48	−0.48	0.636
WC (m)	0.69 ± 0.11	0.71 ± 0.10	0.67 ± 0.12	2.46	0.015[a]
HC (m)	0.80 ± 0.13	0.80 ± 0.13	0.80 ± 0.12	0.08	0.940
WHR	0.87 ± 0.09	0.89 ± 0.09	0.83 ± 0.07	4.16	0.001[a]
WHtR	0.41 ± 0.07	0.42 ± 0.006	0.41 ± 0.08	0.77	0.444
FBG (mmol/L)	3.54 ± 0.99	3.55 ± 1.01	3.53 ± 0.95	0.155	0.877
Tchol. (mg/dL)	84.97 ± 26.82	83.53 ± 23.96	87.24 ± 30.91	−0.820	0.412
Trigly. (mg/dL)	92.16 ± 39.24	91.75 ± 35.31	92.80 ± 45.10	−0.160	0.873
LDL (mg/dL)	33.30 ± 17.25	31.57 ± 12.85	36.05 ± 22.40	−1.560	0.121
HDL (mg/dL)	33.24 ± 10.72	33.62 ± 10.71	32.63 ± 10.80	0.550	0.582
AI	0.40 ± 0.11	0.41 ± 0.12	0.39 ± 0.12	0.960	0.339

SBP = systolic blood pressure, DBP = diastolic blood pressure, MAP = mean arterial blood pressure, BMI = body mass index, WC = waist circumference, HC = hip circumference, WHR = waist-hip-ratio, WHtR = waist-height-ratio, FBG = fasting blood glucose, Tchol. = total cholesterol, Trigly. = triglycerides, LDL = low density lipoprotein, HDL = high density lipoprotein, and AI = atherogenic index.
[a] Statistically significant variable.

Table 3: Prevalence of cardiovascular disease risk factors among the participants.

Variable	Total (150)	Male	Female	X^2	p
	N (%)	N (%)	N (%)	Statistic	Value
SBP (mmHg)					
Normal	139 (92.67)	83 (90.22)	56 (96.55)	2.100	0.147
Elevated	11 (7.33)	9 (9.78)	2 (3.45)		
DBP (mmHg)					
Normal	75 (50)	42 (45.65)	33 (56.90)	1.80	0.180
Elevated	75 (50)	50 (50.35)	25 (43.10)		
Prevalence of HTN					
Normal	74 (49.33)	42 (45.65)	32 (55.17)	1.290	0.256
Hypertension	76 (50.67)	50 (54.35)	26 (44.83)		
BMI (Kg/m^2)					
Underwt.	40 (26.67)	26 (28.26)	14 (24.14)	1.84	0.606
Normal	104 (69.33)	63 (68.48)	41 (70.69)		
Overwt.	5 (3.33)	3 (3.26)	2 (3.45)		
Obesity	1 (0.67)	0 (00)	1 (1.72)		
WC (m)					
Normal	144 (96)	91 (98.91)	53 (91.38)	5.258	0.022
Obese	6 (4)	1 (1.09)	5 (8.62)		
WHR					
Normal	94 (62.67)	58 (63.04)	36 (62.07)	0.014	0.904
Obesity	56 (37.33)	34 (36.96)	22 (37.93)		
WHtR					
Normal	144 (96)	88 (95.62)	53 (91.38)	1.150	0.283
Obesity	9 (6)	4 (4.35)	5 (8.62)		
FBG (mmol/L)					
Normal	145 (96.67)	90 (97.83)	55 (94.83)	0.993	0.319
Prediabetic	5 (3.33)	2 (2.17)	3 (5.17)		
Tchol. (mg/dL)					
Normal	149 (99.33)	92 (100)	57 (98.28)	1.597	0.206
Elevated	1 (0.67)	0 (00)	1 (1.72)		
Trig. (mg/dL)					
Normal	139 (92.67)	87 (94.57)	52 (89.66)	1.262	0.261
Elevated	11 (7.33)	5 (5.43)	6 (10.34)		

Table 3 (*continued*)

Variable	Total (150)	Male	Female	X^2	p
	N (%)	N (%)	N (%)	Statistic	Value
LDL (mg/dL)					
Normal	149 (99.33)	92 (100)	57 (98.28)	1.597	0.206
Elevated	1 (0.67)	0 (00)	1 (1.72)		
HDL (mg/dL)					
Normal	62 (41.33)	41 (44.57)	21 (36.21)	1.025	0.311
Elevated	88 (58.67)	51 (55.43)	37 (63.79)		
Dyslipidaemia					
Normal	53 (35.33)	36 (39.13)	17 (29.31)	1.501	0.220
≥1 abnormal	97 (64.67)	56 (60.87)	41 (70.69)		
AI					
High risk	6 (4)	4 (4,34)	2 (3.45)	3.369	0.186
Average risk	76 (52.67)	43 (46.74)	36 (62.07)		
Low risk	65 (43.33)	45 (48.91)	20 (34.48)		
Metab.Syndrome					
No	143 (95.33)	90 (97.83)	53 (91.38)	3.323	0.068
Yes	(4.67)	2 (2.17)	5 (8.62)		
No. of CVDRF					
None	15 (10)	10 (10.87)	5 (8.62)	0.200	0.655
At least one	135 (90)	82 (89.13)	53 (91.38)		

SBP = systolic blood pressure, DBP = diastolic blood pressure, MAP = mean arterial blood pressure, BMI = body mass index, Overwt. = overweight, underwt. = underweight, WC = waist circumference, WHR = waist-hip-ratio, WHtR = waist-height-ratio, FBG = fasting blood glucose, Tchol. = total cholesterol, Trigly. = triglycerides, LDL = low density lipoprotein, HDL = high density lipoprotein, and AI = atherogenic index, Metab.Syndrome = metabolic syndrome, CVDRF = cardiovascular risk factor, "≥ 1 abnormal" = at least one abnormal serum lipid parameter.

Table 4: Correlation of the atherogenic index with some cardiovascular risk factors.

Variable	Total		Male		Female	
	R	P	r	p	r	p
Tchol (mg/dL)	−0.268	0.001[a]	−0.168	0.110	−0.377	0.040[a]
Trig (mg/dL)	−0.283	0.001[a]	−0.250	0.016[a]	−0.322	0.014[a]
LDL (mg/dL)	−0.628	0.001[a]	−0.619	0.001[a]	−0.663	0.001[a]
HDL (mg/dL)	0.547	0.001[a]	0.532	0.001[a]	0.567	0.001[a]
FBG (mmol/)	−0.105	0.200	0.005	0.959	−0.281	0.032[a]
HC (m)	−0.150	0.068	−0.215	0.039[a]	−0.053	0.690
WHR	0.174	0.033[a]	0.138	0.190	0.199	0.135

HC = hip circumference, WHR = waist-hip-ratio, FBG = fasting blood glucose, Tchol. = total cholesterol, Trigly. = triglycerides, LDL = low density lipoprotein, HDL = high density lipoprotein.
[a] Statistically significant variable.

in the female participants (r = −0.282, p = 0.032), HC in the male participants (r = −0.215, p = 0.039), and WHR among all the participants (r = 0.174, p = 0.033) (Table 4).

Discussion

This study focussed on the prevalence of multiple CVD risk factors among ethnically diverse Nigerian undergraduate students. We found a very high prevalence of CVD risk factors among the students. About nine out of ten students had at least one CVD risk factor. Studies on CVD risk factors among Nigerian undergraduate students are generally lacking. The first, and probably the only study so far, to investigate CVD risk factors among Nigerian undergraduate students is that by Adams−Campbell et al.[19] The study was not focussed on the prevalence of risk factors among the students, rather it was vis-à-vis comparison with African Americans. However, a finding similar to that of ours was reported by Onyemelukwe et al.[20] among general adult outpatients at a tertiary hospital in Abuja, Nigeria. They found that over 90% of their study participants had at least one major CVD risk factor. Even though their participants were adults with a mean age of 42.7 years, more than 50% were below the age of 45 years and can therefore be compared with the participants of our study. Similarly, Ofori et al.[21] reported a high prevalence of various CVD risk factors among undergraduate students of University of Ghana. Findings similar to ours have also been reported among young adults in Chile,[22] young adult Nigerians with hyperglycemia,[23] and Nigerian secondary school adolescents.[8,24] There seems to be a general consensus that the prevalence of CVD risk factors among adolescents and young adults is rising largely due to changing lifestyle patterns and poor perception and awareness of the dangers such risk factors may pose in the

future. Unhealthy dietary habits coupled with sedentary lifestyle among young adults have led to the rising local,[25] regional,[26] and global[27] prevalence of overweight and obesity with attendant consequences on other major CVD risk factors. This calls for the formulation of policies and guidelines for effective screening, early detection, and proper treatment of major CVD risk factors among university students, and indeed young adults generally, who are now being considered as a high-risk population,[28] if the new initiative for prevention of CVD risk factors by the WHO is to be successful. Massive health education concerning the implications of some lifestyle choices of young adults should be encouraged to bridge the identified gap in awareness[6,29] among this demographic.

Dyslipidaemia was the commonest CVD risk factor found in this study. Approximately 65% of the participants had at least one abnormal serum lipid parameter. Depressed HDL-c was the most frequent serum lipid abnormality followed by hypertriglyceridaemia. The participants had generally low serum total cholesterol and LDL-c. This is similar to the report by Onyemelukwe et al.,[20] who detail the prevalence of dyslipidaemia of 68% among adult outpatients in a tertiary hospital in Abuja, Nigeria. A similarly high prevalence of dyslipidaemia with a disproportionately high frequency of depressed HDL-c was also reported by Ofori et al.[21] among undergraduate students of University of Ghana. The low prevalence of serum total cholesterol and LDL-c found in this study is unsurprising. In their assessment of 65 Nigerian medical students, Adams–Campbell et al.[19] reported that Nigerian students had lower serum total cholesterol and triglycerides compared to African Americans. They attributed this finding to lower BMI and high rate of infectious diseases among the Nigerian students. While we did not study prevalence of infectious diseases among our participants, it could be fair to say that the prevalence of infectious diseases in Nigeria today will not be as it was in 1988 and could therefore not reasonably be responsible reason for the lower serum total cholesterol and LDL-c in our participants. However, we found relatively low prevalence of both general and truncal obesity among our participants that could partly explain the low prevalence of total cholesterol and LDL-c. Additionally, traditional northern Nigerian diets are not rich in fats; they are mainly made up of carbohydrates.[30] The high rate of physical activity and the low prevalence of smoking could also explain the low total cholesterol and LDL-c among our participants. More than 50% of the participants exercise at least twice a week, while only 3% either smoked or are active smokers with none engaging in the consumption of alcohol. These lifestyle choices need to be encouraged and reinforced.

Elevated blood pressure was the second most prevalent CVD risk factor among our participants. Approximately 51% of the participants had elevated SBP, DBP, or both. While the prevalence of SBP was low, about 50% of the participants had DBP above the normal limit, with the males contributing more compared to the females. This implies a high prevalence of isolated diastolic hypertension among the participants. Indeed, Adams–Campbell et al.[19] reported high blood pressure among Nigerian undergraduate students in the University of Benin, with men having higher mean values than women. They equally reported that Nigerian men had higher DBP compared to African American men. However, albeit Ofori et al.[21] reported an overall high prevalence of elevated blood pressure among undergraduate students of the University of Ghana, there was a disproportionately higher prevalence of elevated SBP as against the finding of this study wherein the prevalence of DBP was notable. There should be concerted efforts aimed at routine screening and management of young adults with isolated diastolic hypertension and hypertension in general. Lifestyle practices that promote better and healthy blood pressure should be developed and, where they exist, reinforced and strengthened.

The prevalence of type 2 diabetes among our participants was very low; none of the participants had FBG in the diabetic range. However, approximately 3%, majority of whom were females, had prediabetes. Similarly, the prevalence of metabolic syndrome was low at 5% (majority of whom were females).

The presence of multiple CVD risk factors among Nigerian undergraduate students or young adults requires serious attention. Various studies have linked the exposure to CVD risk factors early in life to the development of CVDs later in life.[7,31] The Framingham Offspring Study has demonstrated that early exposure to SBP, DBP, LDL-c, and HDL-c leads to the development of coronary heart disease (one of the CVDs) later in life.[32] In particular, they found early exposure to elevated DBP (found to be very prevalent in this study) and LDL-c to be linked to the development of coronary heart diseases independent of subsequent later life exposure. Similarly, an autopsy study of 204 young adults has demonstrated a correlation between the presence of fatty streaks and fibrous plagues in the aorta and coronary arteries with BMI, SBP, DBP, total cholesterol, triglycerides, LDL-c, and HDL-c as a group.[33] This clearly shows the summative effect of the presence of multiple CVD risk factors on the extent of the development of atherosclerotic streaks among young adults. There is thus the need for formulation of policies and guidelines for comprehensive screening, treatment, and follow-up programmes for young adults with exposure to multiple CVD risk factors.

Notwithstanding the small sample size of this study and its restricted ethnic and regional representation, it does provide an insight into the prevalence of modifiable CVD risk factors among young adults in this environment.

Conclusion and recommendations

This study has demonstrated the high prevalence of modifiable CVD risk factors among undergraduate students in Kano, Nigeria, with dyslipidaemia and elevated blood pressure being the commonest. This calls for the development of comprehensive screening, identification, and treatment protocols and guidelines for university students and the young adult population in general. Similarly, future studies in this area should focus on larger sample sizes and multiple centres to have better ethnic and regional representations in the sample.

Abbreviations: CVD, Cardiovascular disease; SSA, Sub-Saharan Africa; WHO, World Health Organization.

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Conflict of interest

The authors have no conflicts of interest to declare.

Ethical approval

The study was approved by the Research Ethics Committee of Kano State Ministry of Health NHREC/17/03/2018 on June 24, 2021, SHREC/2021/2595.

Authors contributions

The study was conceived by MIG and SNH. MIG designed the study, while AAT, SNH, and MSM collected data and funded the study. MIG analysed and interpreted the data and wrote the initial manuscript. SAI and AAT conducted literature search and critically reviewed the initial draft. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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