



CLUSTERING PATTERN OF CARDIOVASCULAR DISEASES MODIFIABLE RISK FACTORS AND PREDICTORS AMONG MEDICAL STUDENTS IN A TERTIARY INSTITUTION IN SOUTH-SOUTH, NIGRIA

IWASAM ELEMI AGBOR, UGOCHI OGU EYONG, BENSON E. OBU, ENAGU AKWA MPAMA, ANASTASIA IKILISHI ISIKA AND OGBODUM EFFA-OBASI UNO
Email: iwasamelemi1900@gmail.com

(Received 30 May 2025; Revision Accepted 2 July 2025)

ABSTRACT

Background: Cardiovascular diseases (CVDs) remain the leading cause of global mortality, largely driven by modifiable risk factors such as smoking, poor diet, physical inactivity, obesity, and hypertension. These risk factors are increasingly observed among young adults, including medical students.

Objectives: To determine the prevalence and pattern of modifiable cardiovascular risk factors and predictors among University of Calabar (UNICAL) medical students, and to assess associations with sociodemographic characteristics.

Methods: This was a cross-sectional descriptive study. Data on socio-demographic, behavioural risk factors, physical measurements and medical history and risk factor clustering were collected using a semi-structured, interviewer-administered questionnaire adapted from the WHO STEP-wise approach. Data analysis was with SPSS version 25. Significance was at $p < 0.05$ and 95% confidence interval.

Results: A total of 311 medical students participated in the study, comprising 163(52.4%) females and 148(47.6%) males. The majority were aged between 21 and 30 years. The overall prevalence of modifiable cardiovascular risk factors (had at least one risk factor) was 183(58.8%). Overweight and obesity were the most common (49.8%) of respondents, followed by unhealthy dietary habits (42.1%), physical inactivity (13.2%), and alcohol intake (7.1%). Less frequently reported risk factors included cigarette smoking (4.2%) and high blood pressure (3.9%). Statistically significant associations were observed between cardiovascular risk factors and age ($p=0.039$), academic level ($p<0.001$), tribe ($p<0.001$), and religion ($p=0.048$). Multivariate logistic regression analysis identified older age (above 30 years), 5th year of study, and ethnicity as significant independent predictors of cardiovascular risk. Additionally, 43(23.5%) of the respondents exhibited clustering of two or more modifiable risk factors. The most common clustering patterns were unhealthy diet with physical inactivity (39.5%), unhealthy diet with overweight (20.9%), and alcohol use with overweight (11.6%). Notably, 9.3% of participants had all five risk factors simultaneously.

Recommendation/conclusion: The findings of this study points to a growing burden of cardiovascular risk among future healthcare professional, calling for urgent, structured preventive measures. Integrating cardiovascular health promotion into the medical curriculum, establishing regular health screening programs, and supporting behavioral change interventions that promote physical activity, healthy diets, and reduced alcohol intake among students is recommended.

KEYWORDS: Modifiable, cardiovascular risk factors, medical students, clustering, predictors

BACKGROUND TO THE STUDY

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, with an increasing burden in low- and middle-income countries, including Nigeria (Sani et al., 2010).

Iwasam Elemi Agbor, Department of Community Medicine, University of Calabar, Cross River State, Nigeria

Ugochi Ogu Eyong, Department of Community Medicine, University of Calabar, Cross River State, Nigeria

Benson E. Obu, Department of Public Health and Community Medicine, University of Calabar Teaching Hospital, Calabar, Nigeria

Enagu Akwa Mpama, Department of Community Medicine, University of Calabar, Cross River State, Nigeria

Anastasia Ikilishi Isika, Department of Community Medicine, University of Calabar, Cross River State, Nigeria

Ogbodum Effa-Obazi Uno, Department of Community Medicine, University of Calabar, Cross River State, Nigeria

Modifiable risk factors such as physical inactivity, unhealthy diet, tobacco use, and excessive alcohol consumption contribute significantly to the development of CVDs (Mukhtar et al., 2022; Sani et al., 2010), accounting for over 17.9 million deaths yearly, driven in part by lifestyle-related modifiable risk factors (WHO, 2021). In Nigeria, escalating urbanization and lifestyle transition have increased CVD risk across age groups (Mbakwem et al., 2022; WHO AFRO, 2025). Evidence from African university settings shows high prevalence of cardiometabolic risk factors—obesity (0.6–21.7%), hypertension (0.28–26.4%), dyslipidemia up to 57%—often clustered (Enoh et al., 2024). Among Nigerian undergraduates, studies confirm clustering, with first-year University of Ibadan students showing 23.4% clustering ≥ 2 factors including inactivity, unhealthy diet, overweight, alcohol, and smoking (Olufayo et al., 2023). In Kano, dyslipidemia and overweight were prevalent among students (Mukhtar et al., 2022). Research in North-Central Nigeria highlights high knowledge but low preventive practice of CVD risk factors (Artu et al., 2025). Lifestyle behaviors such as smoking, poor diet, salt use, and sedentary behavior cluster among young Nigerian adults (Umuerrri, 2019). The incidence of cardiovascular diseases (CVDs) is rapidly increasing worldwide and is currently considered to be the leading cause of death in both developing and developed countries (Gaziano et al., 2010; Mittal & Singh, 2010). The most important behavioural risk factors of heart disease and stroke are unhealthy diet, physical inactivity, tobacco use and harmful use of alcohol. Amongst environmental risk factors, air pollution is an important factor (WHO, 2021). The effects of behavioural risk factors may show up in individuals as raised blood pressure, raised blood glucose, raised blood lipids, and overweight and obesity. Many cardiovascular risk factors such as tobacco use, unhealthy diet, physical inactivity, obesity, and hypertension are modifiable through lifestyle changes. Increasing evidence suggests that these risk factors are becoming prevalent even among young populations, including university students (Olufayo et al., 2023). The medical student population represents an important subset of the young adult demographic. Ironically, despite their knowledge of health risks, several studies have revealed a concerning prevalence of modifiable cardiovascular risk factors among them (Mukhopadhyay et al., 2021; Mukhtar et al., 2022). However, no published study to date has investigated the prevalence of these modifiable risk factors among medical students in the University of Calabar.

Problem statement

Cardiovascular diseases (CVDs) remain the leading cause of death globally, responsible for approximately 17.9 million deaths annually (WHO, 2021). In recent years, a significant shift has been observed in the burden of CVDs toward low- and middle-income countries, including Nigeria (Mensah et al., 2019).

Modifiable risk factors—such as unhealthy diet, tobacco use, physical inactivity, alcohol consumption, obesity, and hypertension—are increasingly common among young adults (Ribeiro et al., 2018; Yusuf et al., 2020). University students, particularly those studying medicine, may be especially vulnerable due to academic stress, irregular sleep patterns, and time constraints that compromise their ability to maintain healthy lifestyles (Al-Drees et al., 2016). Paradoxically, even though medical students are expected to possess knowledge of preventive health, studies suggest they frequently engage in behaviors that predispose them to CVDs (Mukhopadhyay et al., 2021). In Nigeria, limited data exists on the cardiovascular risk profile of medical students, particularly in south-south institutions such as the University of Calabar. Without reliable local data, efforts to promote heart-healthy behaviors and preventive education may be poorly focused or insufficient. This underscores the need for a focused study to assess the prevalence of modifiable cardiovascular risk factors among this group of future healthcare providers.

Justification: Studies in some part of Nigeria have revealed a high prevalence of modifiable CVD risk factors among university students. For instance, a study among undergraduates in Kano reported that 90% had at least one CVD risk factor, with 65% exhibiting abnormal lipid profiles (Mukhtar et al., 2022). Similarly, research among first-year students at the University of Ibadan found that 94.5% were physically inactive, and 85.3% had unhealthy diets (Olufayo et al., 2023). However, there is a paucity of data specifically focusing on medical students in the University of Calabar. This proposed research therefore seeks to fill the gap by assessing the prevalence and pattern of modifiable cardiovascular risk factors in this population. The findings could inform targeted preventive strategies and promote healthier behaviors among these future healthcare providers.

Specific Objectives: The specific objectives of the study are:

1. To determine the prevalence of modifiable cardiovascular risk factors (obesity, physical inactivity, smoking, and poor diet) among medical students at the University of Calabar.
2. To assess the factors (sociodemographic characteristics (age, sex, and academic level) associated with prevalence of modifiable cardiovascular risk factors.
3. To determine the proportion of medical students with clustering (co-occurrence) of two or more modifiable cardiovascular risk factors.

METHODOLOGY

Study Area: This study was conducted in Calabar, the capital of Cross River State, located in the South-South region of Nigeria.

Calabar is a coastal city known for its educational institutions, cultural heritage, and healthcare infrastructure. It hosts the University of Calabar, a federal tertiary institution offering diverse academic programs, including medicine. The University of Calabar is one of Nigeria's prominent universities, with an established College of Medical Sciences offering the MBBCh program. Clinical training for medical students (Years 4 to 6) takes place at the University of Calabar Teaching Hospital, a tertiary healthcare facility affiliated with the university. The hospital provides practical exposure to clinical environments, which is essential for the professional development of medical students.

Study Population: The target population for this study comprised undergraduate clinical medical students in Years 4, 5, and 6 at the University of Calabar. These students have progressed beyond the basic sciences and are currently undergoing clinical training. Students in Years 4 to 6 are selected for this study because they are engaged in rigorous clinical rotations and have more exposure to health education, risk behavior awareness, and patient care responsibilities. Additionally, by the fourth year of study, medical students are typically 18 years and above, meeting the age criterion for adult research participants. This group is also more likely to provide reliable self-reported data related to health behaviors and have the maturity to understand and consent to participate in research of this nature.

Study Design/duration: The study was a descriptive cross-sectional study aimed at assessing the prevalence of modifiable cardiovascular risk factors among medical students. The study was carried out over a period of five months.

Inclusion Criteria: Registered medical students from years 4 to 6 aged 18 years and above who consent to participate.

Exclusion Criteria: Students with known cardiovascular conditions under medical management.

Pregnant students (due to possible confounding influence on risk indicators).

Sample Size Calculation: Using the Cochran formula for prevalence studies:

$$n = \frac{Z^2 X p (1-p)}{d^2}$$

Where: $Z = 1.96$ (standard normal deviate for 95% confidence), $p = 23.4\%$ as prevalence of students with clustering of ≥ 2 risk factors of cardiovascular risk factors reported from a previous studies in Ibadan (Olufayo et al., 2023).

$$n = \frac{1.96^2 \times 0.234(1-0.234)}{0.05^2} = 275 \text{ participants. Adding } 10\%$$

$$\text{for non-response} = \frac{\text{Calculated sample size}}{1 - \text{non-response rate}} = \frac{275}{1 - 10\%} = \frac{275}{0.9} = 306 \text{ participants}$$

Sampling method: A stratified random sampling method was used. The study population were stratified by academic level across years 4 to 6, and

participants randomly selected proportionately from each stratum.

Study Tools: A semi-structured, interviewer-administered questionnaire (adapted from WHO STEPS instrument).

Variables measured were sociodemographic (age, sex, academic level, residence, behavioral risk factors (tobacco use, alcohol intake, physical activity, diet (WHO, 2005), and physical/biological measurements (body Mass Index (BMI): weight (kg)/height (m²), and blood pressure.

Data Analysis plan: Data collected was entered and cleaned using SPSS version 25. Descriptive statistics was used to summarize the sociodemographic variables and the prevalence of each modifiable cardiovascular risk factor. Categorical variables such as gender, academic level, smoking status, and physical activity levels was presented as frequencies and percentages. Kolmogorov test of normality was used to ascertain that the continuous variables like age and body mass index were normally distributed and therefore expressed as means and standard deviations where appropriate. The prevalence of each cardiovascular risk factor (obesity, hypertension, physical inactivity, smoking, poor diet) was computed and presented using frequency tables and pie/bar charts as needed. Bivariate analysis was conducted using the Chi-square test to examine associations between sociodemographic variables and overall prevalence of modifiable risk factors. Multivariate binary logistic regression analysis was performed on variables that were significant at bivariate analysis to identify independent predictors of the presence of at least one modifiable cardiovascular risk factor. Clustering of risk factors was assessed by identifying individuals with two or more of the defined risk factors. The proportion of participants meeting this criterion was identified. Descriptive statistics will be used to present the distribution of clustering and presented as figures. All tests was two-tailed, and statistical significance was set at $p < 0.05$ and 95% confidence Interval.

Ethical Considerations: Full ethical approval was obtained from the Cross River State Health Research Ethics Committee (CRS-HREC) with REC. No. CRS/MH/HREC/2025/VOL.V2/1126 prior to commencement of the study. Informed consent was also obtained from each participant before enrolment.

RESULTS

Socio-demographic characteristics of medical students in the University of Calabar

The socio-demographic characteristics of the 311 clinical medical students surveyed at the University of Calabar are shown in Table 1. The majority were female, with 163 (52.4%) participants, while males accounted for 148 (47.6%). Most of the respondents were within the age group of 21–30 years, 233 (74.9%), followed by those aged below 21 years, 38 (12.2%).

A smaller proportion were aged 31–40 years, 28 (9.0%), and 41 years and above, 12 (3.9%). Regarding their year of study, 138 (44.4%) were in their 5th year, 94 (30.2%) in 4th year, and 79 (25.4%) in 6th year. A vast majority were single, 282 (90.7%), while 29 (9.3%) were married. In terms of residential status, 137 (44.1%) lived on-campus, 126 (40.5%) off-

campus, 35 (10.9%) lived alone, and 13 (4.2%) lived with parents or guardians. The ethnic composition showed that 43 (11.3%) were Efik, 17 (5.5%) Ekoi, 31 (10.0%) Ibibio, 22 (7.1%) Annang, 13 (4.2%) Yoruba, while the majority belonged to other ethnic groups, 185 (59.5%). With regard to religion, most of the respondents were Christians, 301 (96.8%), while both Islam and Traditional religion had 5 (1.6%) respondents each.

Table 1: Socio-demographic characteristics of medical students in the University of Calabar (N=311)

Variable	Frequency	Percentage
Sex		
Male	148	47.6
Female	163	52.4
Age group/years		
<21	38	12.2
21-30	233	74.9
31-40	28	9.0
41 and above	12	3.9
Year of study		
4 th year	94	30.2
5 th year	138	44.4
6 th year	79	25.4
Marital status		
Single	282	90.7
Married	29	9.3
Residential		
On-campus	137	44.1
Off-campus	126	40.5
Living with parent/guardians	13	4.2
Living alone	35	10.9
Tribe		
Efik	43	11.3
Ekoi	17	5.5
Ibibio	31	10.0
Annang	22	7.1
Yoruba	13	4.2
Others	185	59.5
Religion		
Christianity	301	96.8
Islam	5	1.6
Traditional	5	1.6

Proportion of medical students with clustering (co-occurrence) of two or more modifiable cardiovascular risk factors.

As shown in Figure 1, the prevalence of clustering of two or more modifiable cardiovascular risk factors among medical students was 43(23.5%).

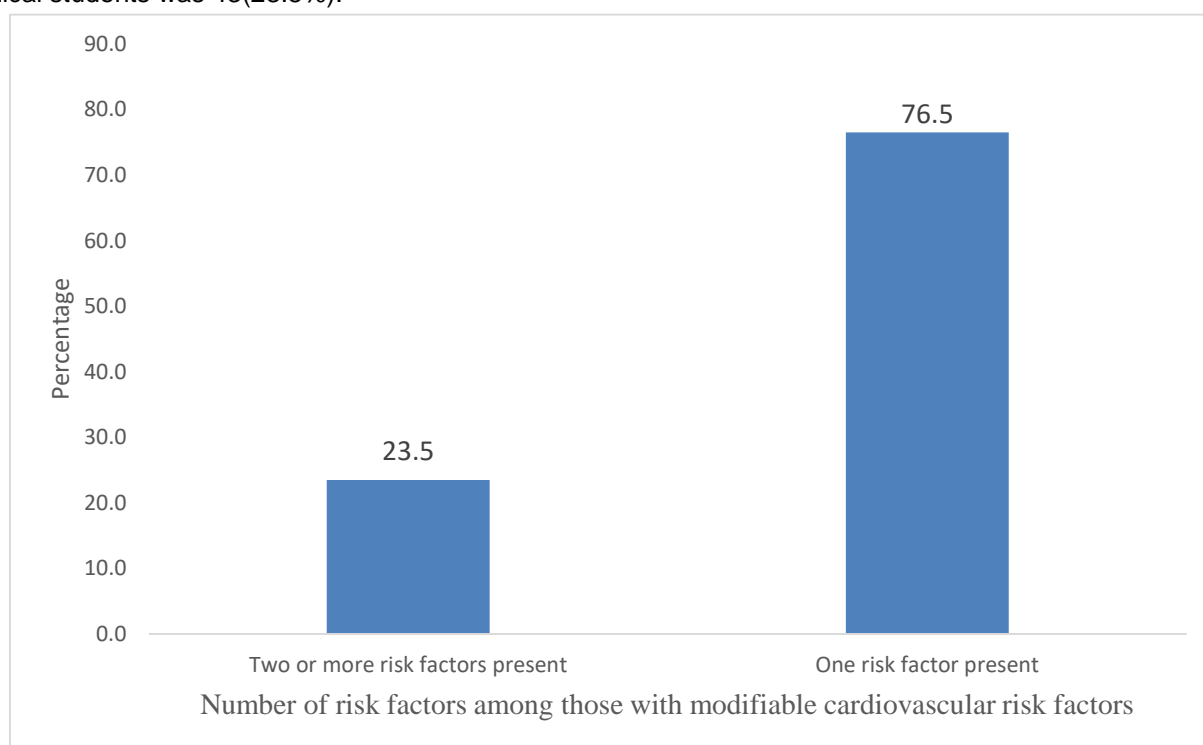


Figure 1: proportion of clustering (co-occurrence) of two or more modifiable cardiovascular risk factors among medical students

Clustering pattern of modifiable cardiovascular risk factors among medical students

As shown in Figure 2, a total of 43 study participants showed clustering patterns, and the most common clustering pattern was unhealthy food/physical inactivity (39.5%), followed by unhealthy

food/overweight (20.9%), then alcohol/overweight (11.6%). Furthermore, 9.3% had all of obesity, hypertension, physical inactivity, smoking and poor diet. Other clustering pattern are as shown in Figure 2.

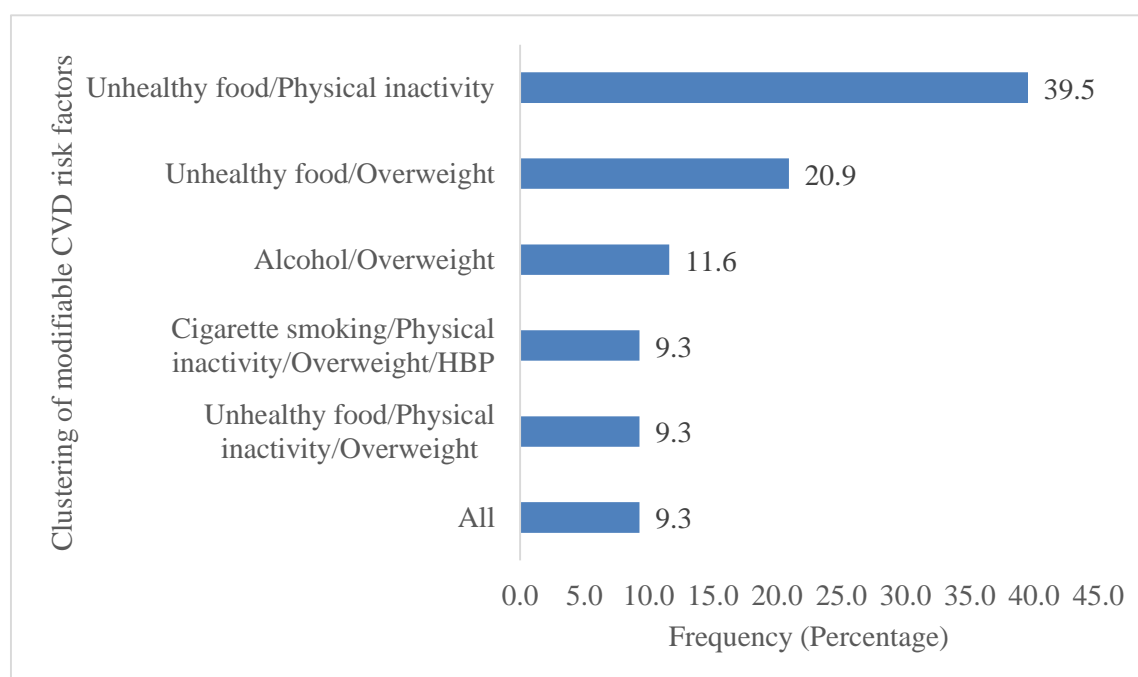


Figure 2: Clustering pattern of modifiable cardiovascular risk factors among medical students
(All* =obesity + hypertension + physical inactivity + smoking + poor diet)

Socio-demographic factors associated with clustering of modifiable CVD risk factors among medical students with risk factors

Table 2 presents findings on how various socio-demographic factors are associated with the clustering of modifiable cardiovascular disease (CVD) risk factors among 183 medical students who have at least one risk factor. Out of this group, 43 students had clustering (i.e., more than one CVD risk factor), while 140 had only one. The results indicate that sex, year of study, residential status, and marital status were significantly associated with clustering of modifiable CVD risk factors among medical students, while age and religion were not. Sex was significantly associated with clustering, with a higher proportion of females (30.7%) having clustering compared to males (16.8%). This difference was statistically significant ($p = 0.036$). Age showed an increasing trend in clustering with advancing age, from 18.9% in the 21–30-year

age group to 50% among students aged 41 and above. However, this trend was not statistically significant ($p = 0.108$). There was a strong and statistically significant association between the year of study and clustering of risk factors ($p < 0.001$). Sixth-year students had the highest proportion with clustering (46.3%), compared to 21.6% in fourth-year and 10.9% in fifth-year students. Living arrangement was another factor significantly associated with clustering ($p < 0.001$). Students living alone had the highest clustering (55.6%), followed by those living with parents or guardians (50%), while those living on-campus had the lowest (9.9%). The association between religion and clustering was not statistically significant ($p = 0.265$). Marital status showed a significant association with clustering ($p = 0.022$). Married students had a much higher proportion with clustering (47.1%) compared to single students (21.1%).

Table 2: Socio-demographic factors associated with clustering of modifiable CVD risk factors among medical students with risk factors (n=183)

Variable	Clustering of modifiable CVD risk factors			Chi square test	p-value
	Present n=43	Absent n=140	Total N=183		
Sex					
Male	16(16.8)	79(83.2)	95(100.0)	4.868	0.036*
Female	27(30.7)	61(69.3)	88(100.0)		
Age group/years					
<21	6(31.6)	13(68.4)	19(100.0)	6.633	0.108
21-30	25(18.9)	107(81.1)	132(100.0)		
31-40	8(33.3)	16(66.7)	24(100.0)		
41 and above	4(50.0)	4(50.0)	8(100.0)		
Year of study					
4 th year	8(21.6)	29(78.4)	37(100.0)	23.848	<0.001*
5 th year	10(10.9)	82(89.1)	92(100.0)		
6 th year	25(46.3)	29(53.7)	54(100.0)		
Residential					
On-campus	9(9.9)	82(90.1)	91(100.0)	24.491	<0.001*
Off-campus	20(30.3)	46(69.7)	66(100.0)		
Living with parents/guardians	4(50.0)	4(50.0)	8(100.0)		
Living alone	10(55.6)	8(44.4)	18(100.0)		
Religion					
Christianity	43(24.9)	130(75.1)	173(100.0)	3.249	0.265
Islam	0(0.00)	5(100.0)	5(100.0)		
Traditional	0(0.00)	5(100.0)	5(100.0)		
Marital status					
Single	35(21.1)	131(78.9)	166(100.0)	5.788	0.022*
Married	8(47.1)	9(52.9)	17(100.0)		

*=statistically significant

Multivariate binary logistic regression of clustering of CVD risk factors among medical students with risk factors

Table 3 is multivariate binary logistic regression analysis of independent socio-demographic predictors of clustering of modifiable cardiovascular disease risk factors among medical students who already had at least one risk factor. Sex was significantly associated with clustering. Female students were significantly less likely to have clustering of CVD risk factors compared to their male counterparts (OR: 0.238; 95% CI: 0.091–0.624; p-value of 0.004). Year of study also showed a significant association overall (p = 0.000). Specifically, fifth-year students were over seven times more likely to experience clustering of CVD risk factors compared to fourth-year students (OR = 7.182;

95% CI: 1.887–27.338; p = 0.004). However, sixth-year students did not show a statistically significant difference compared to fourth years (OR = 0.584, 95% CI: 0.195–1.751, p = 0.337). Residential status was another significant predictor (overall p = 0.000). Students living off-campus were significantly less likely to have clustering of risk factors compared to those living on-campus (OR = 0.157; 95% CI: 0.052–0.468; p = 0.001). Similarly, those living alone had an even lower likelihood of clustering (OR = 0.061; 95% CI: 0.015–0.242; p = 0.000). However, living with parents or guardians was not statistically significant (OR = 0.254; 95% CI: 0.035–1.856; p = 0.177). Marital status did not emerge as a significant predictor of clustering in this model. Married students had lower odds of clustering compared to single students (OR = 0.475; 95% CI: 0.122–1.842), but the association was not statistically significant (p = 0.282).

Table 3: Multivariate binary logistic regression of clustering of CVD risk factors among medical students with risk factors

Variable	Odd ratio	95% Confidence Interval		p-value
		Lower	Upper	
Sex				
Male				
Female	0.238	0.091	0.624	0.004*
Year of study				
4 th year	Reference category			
5 th year	7.182	1.887	27.338	0.004*
6 th year	0.584	0.195	1.751	0.337
Residential				
On-campus	Reference category			
Off-campus	0.157	0.052	0.468	0.001*
Living with parents/guardians	0.254	0.035	1.856	0.177
Living alone	0.061	0.015	0.242	0.000*
Marital status				
Single	Reference category			
Married	0.475	0.122	1.842	0.282

*=significant predictors of clustering of CVD risk factors among medical students;
CVD=cardiovascular diseases

DISCUSSION

The current study sought to determine the prevalence of modifiable cardiovascular risk factors, examine the proportion of medical students with clustering (co-occurrence) of two or more modifiable cardiovascular risk factors among students at the University of Calabar. Given the increasing global burden of cardiovascular diseases, particularly in low- and middle-income countries, the early identification and understanding of CVD risk profiles among young adults—especially future healthcare providers—is essential for prevention and effective intervention strategies. This study found that 23.5% of medical students had clustering of two or more modifiable cardiovascular risk factors, highlighting a significant subset of students exposed to compounded risks for future cardiovascular diseases. The most common clustering pattern observed was unhealthy food intake combined with physical inactivity (39.5%), followed by unhealthy food and overweight/obesity (20.9%), and alcohol intake with overweight/obesity (11.6%). Notably, 9.3% of students had the co-occurrence of all five major risk factors: obesity, hypertension, physical inactivity, smoking, and poor diet. This prevalence is nearly identical to the 23.4% clustering reported among medical students at the University of Ibadan (Olufayo et al., 2023), reinforcing the notion that nearly one-quarter of Nigerian medical students are exposed to multiple overlapping behavioral and biological cardiovascular risks. However, the proportion in the present study is markedly lower than that observed in a broader study of adolescents in southwest Nigeria, where 97.2% had two or more risk factors, particularly sedentary lifestyle (94.2%) and unhealthy diet (92.4%) (Sodipo et al., 2024). The substantially higher rates in that adolescent cohort may be due to methodological differences, broader age inclusion, and less focus on a medically informed population. Comparatively, Cissé and colleagues reported a 46.4% clustering rate among adults in Burkina Faso (Cissé et al., 2022), suggesting that clustering becomes more prominent with age and possibly with cumulative lifestyle exposures. The clustering burden among young adults and students across Sub-Saharan Africa remains a pressing concern for cardiovascular disease prevention. In the present study, several socio-demographic variables were found to be significantly associated with clustering. Notably, sex was a significant predictor: female students were significantly less likely to exhibit clustering compared to their male counterparts (OR: 0.238; 95% CI: 0.091–0.624; $p = 0.004$). This contrasts with findings by Olufayo and colleagues, who found that clustering was significantly higher among female students in bivariate analysis, although the association did not remain significant in multivariate models (Olufayo et al., 2023). El Ansari and colleagues also reported that co-occurrence of unhealthy behaviors was more

frequent among females and those in higher academic levels (El Ansari et al., 2018), while Lawlor et al. and colleagues associated clustering with females and students from lower-income families (Lawlor et al., 2005). These inconsistencies highlight the context-specific influence of gender on health risk behaviors, possibly shaped by cultural norms, academic stress levels, and coping mechanisms. The year of study also significantly influenced clustering: fifth-year students were over seven times more likely to experience clustering than fourth-year students (OR = 7.182; $p = 0.004$), while sixth-year students did not show a statistically significant difference. This trend may reflect the accumulation of stress, declining physical activity, and worsening dietary practices as students' progress through medical training. Similar trends were noted in a previous study which reported higher co-occurrence of risk behaviors among students in later academic years (El Ansari et al., 2018). Residential status was another strong predictor of clustering. Students living off-campus were significantly less likely to experience clustering compared to those living on-campus (OR = 0.157; $p = 0.001$), and those living alone had an even lower likelihood (OR = 0.061; $p < 0.001$). These findings contrast with those of a previous study who reported limited variation in residence patterns (93% lived in dormitories) (Olufayo et al., 2023), precluding an in-depth analysis of this factor. However, findings from another previous study suggest that living with parents was protective against clustering (Idowu et al., 2018), consistent with the current study's finding that off-campus and independent living may support healthier behavior in some contexts, possibly due to increased autonomy in food and activity choices. While marital status in the current study showed significant association in bivariate analysis, it was not statistically significant in the multivariate model (OR = 0.475; $p = 0.282$). This aligns with findings from a study, where factors such as marital status, age group, religion, and financial upkeep allowance level were not significant predictors of clustering in multivariate analysis (Olufayo et al., 2023). The observed clustering patterns in the current study—particularly combinations of poor diet with either inactivity or obesity—mirror patterns seen in previous studies. For example, Odunaiya and co-authors reported that 19.6% of clustering combinations among students involved high animal lipid and salt intake (Odunaiya et al., 2015). Similarly, a global review of SNAP behaviors by Noble et al. found that clustering of smoking with alcohol consumption was most commonly reported, with many studies also identifying co-occurrence of all four SNAP risks (smoking, poor nutrition, excess alcohol, and physical inactivity) (Noble et al., 2015). Another study further emphasized that occupational and social determinants—such as student status—strongly influence the co-occurrence of behavioral risk factors (Meader et al., 2016).

The current study reveals that nearly one in four medical students experience clustering of modifiable cardiovascular risk factors, with combinations involving poor diet, inactivity, and obesity being most common. Key determinants of clustering in this population included sex, academic level, and residence status, highlighting potential targets for intervention. These findings are consistent with the broader literature and underscore the need for integrated prevention strategies within medical training institutions that address not only individual behaviors but also structural and environmental factors that foster clustering of cardiovascular risk.

CONCLUSION

This study revealed a high burden of modifiable cardiovascular disease (CVD) risk factors among medical students, with an overall prevalence of 58.8%. Overweight/obesity and unhealthy dietary habits were the most common individual risk factors. A significant proportion (23.5%) of students had clustering of two or more modifiable risk factors, further increasing their potential long-term risk for cardiovascular morbidity and mortality.

Socio-demographic factors such as age, academic level, tribe, and religion showed significant associations with the presence of modifiable CVD risk factors. The early onset and aggregation of CVD risk factors in this group call for urgent institutional and policy-level interventions focused on health promotion and behavioral change.

Conflict of Interest: The authors declare that there is no conflict of interest

Funding: The research was self-funded.

REFERENCES

- Al-Drees, A., Abdulghani, H., Irshad, M., Baqays, A. A., Al-Zhrani, A. A., Alshammari, S. A., and Alturki, N. I., 2016. Physical activity and academic achievement among the medical students: A cross-sectional study. *Medical Teacher*, 38(sup1), S66–S72. <https://doi.org/10.3109/0142159X.2016.1142516>
- Al-Drees, A., Abdulghani, H., Irshad, M., Baqays, A. A., Al-Zhrani, A. A., Alshammari, S. A., and Alturki, N. I. (2016). Physical activity and academic achievement among the medical students: A cross-sectional study. *Medical Teacher*, 38(sup1), S66–S72. <https://doi.org/10.3109/0142159X.2016.1142516>
- Artu, I., Akafa, T., Oladele, G., and Iyoko, K., 2025. From knowledge to action: Understanding cardiovascular risk factors among university students in North-Central Nigeria. 2(1), 128–142.
- Cissé, K., Samadoulougou, S., Coppieters, Y., Bonnechère, B., Zabsonré, P., Kirakoya-Samadoulougou, F., and Kouanda, S., 2022. First Report on the Co-Occurrence and Clustering Profiles of Cardiovascular Lifestyle Risk Factors among Adults in Burkina Faso. *International Journal of Environmental Research and Public Health*, 19(14), 8225. <https://doi.org/10.3390/ijerph19148225>
- El Ansari, W., A Khalil, K., Ssewanyana, D., Stock, C., 1 Department of Surgery, Hamad General Hospital, Hamad Medical Corporation, Doha, State of Qatar, 2 College of Medicine, Qatar University, Doha, State of Qatar, 3 School of Health and Education, University of Skövde, Skövde, Sweden, 4 Faculty of Applied Sciences, University of Gloucestershire, Gloucester GL2 9HW, UK#, 5 Faculty of Medical Technology, Misrata, Libya, 6 Utrecht Centre for Child and Adolescent Studies, Utrecht University, Netherlands, & 7 Unit for Health Promotion Research, Institute of Public Health, University of Southern Denmark, Niels Bohrs Vej 9-10, 6700 Esbjerg, Denmark. (2018). Behavioral risk factor clusters among university students at nine universities in Libya. *AIMS Public Health*, 5(3), 296–311. <https://doi.org/10.3934/publichealth.2018.3.296>
- Enoh, J. E., Akah, R. T., and Nkeh-Chungag, B., 2024. Cardiometabolic Risk Factors Among African University Students: A Systematic Review. *BioMed*, 5(1), 1. <https://doi.org/10.3390/biomed5010001>
- Gaziano, T. A., Bitton, A., Anand, S., Abrahams-Gessel, S., and Murphy, A., 2010. Growing Epidemic of Coronary Heart Disease in Low- and Middle-Income Countries. *Current Problems in Cardiology*, 35(2), 72–115. <https://doi.org/10.1016/j.cpcardiol.2009.10.002>

- Idowu, A., Fatusi, A. O., Olajide, F. O., 2018. Clustering of behavioural risk factors for non-communicable diseases (NCDs) among rural-based adolescents in south-west Nigeria. *International Journal of Adolescent Medicine and Health*, 30(1), 20160008. <https://doi.org/10.1515/ijamh-2016-0008>
- Lawlor, D. A., O'Callaghan, M. J., Mamun, A. A., Williams, G. M., Bor, W., and Najman, J. M., 2005. Socioeconomic Position, Cognitive Function, and Clustering of Cardiovascular Risk Factors in Adolescence: Findings From the Mater University Study of Pregnancy and Its Outcomes: *Psychosomatic Medicine*, 67(6), 862–868. <https://doi.org/10.1097/01.psy.0000188576.54698.36>
- Meador, N., King, K., Moe-Byrne, T., Wright, K., Graham, H., Petticrew, M., Power, C., White, M., and Sowden, A. J., 2016. A systematic review on the clustering and co-occurrence of multiple risk behaviours. *BMC Public Health*, 16(1), 657. <https://doi.org/10.1186/s12889-016-3373-6>
- Mensah, G. A., Roth, G. A., and Fuster, V., 2019. The Global Burden of Cardiovascular Diseases and Risk Factors. *Journal of the American College of Cardiology*, 74(20), 2529–2532. <https://doi.org/10.1016/j.jacc.2019.10.009>
- Mittal, B. V., and Singh, A. K., 2010. Hypertension in the Developing World: Challenges and Opportunities. *American Journal of Kidney Diseases*, 55(3), 590–598. <https://doi.org/10.1053/j.ajkd.2009.06.044>
- Mukhopadhyay, S., Mukherjee, A., Khanra, D., Samanta, B., Karak, A., and Guha, S., 2021. Cardiovascular disease risk factors among undergraduate medical students in a tertiary care centre of eastern India: A pilot study. *The Egyptian Heart Journal*, 73(1), 94. <https://doi.org/10.1186/s43044-021-00219-9>
- Mukhtar, I. G., Abdullahi, A. T., Muhammad, S. M., Sabiu, N. H., and Salisu, A. I., 2022. Prevalence of modifiable cardiovascular risk factors among undergraduate students in Kano Nigeria: A need for action. *Journal of Taibah University Medical Sciences*, 17(4), 578–586. <https://doi.org/10.1016/j.jtumed.2021.10.013>
- Noble, N., Paul, C., Turon, H., and Oldmeadow, C., 2015. Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors. *Preventive Medicine*, 81, 16–41. <https://doi.org/10.1016/j.ypmed.2015.07.003>
- Odunaiya, N. A., Grimmer, K., and Louw, Q. A., 2015. High prevalence and clustering of modifiable CVD risk factors among rural adolescents in southwest Nigeria: Implication for grass root prevention. *BMC Public Health*, 15(1), 661. <https://doi.org/10.1186/s12889-015-2028-3>
- Olufayo, O. E., Ajayi, I. O., and Ngene, S. O., 2023. Clustering of cardiovascular disease risk factors among first-year students at the University of Ibadan, Nigeria: A cross-sectional study. *Sao Paulo Medical Journal*, 141(2), 98–106. <https://doi.org/10.1590/1516-3180.2021.0998.11052022>
- Ribeiro, Í. J. S., Pereira, R., Freire, I. V., De Oliveira, B. G., Casotti, C. A., and Boery, E. N., 2018. Stress and Quality of Life Among University Students: A Systematic Literature Review. *Health Professions Education*, 4(2), 70–77. <https://doi.org/10.1016/j.hpe.2017.03.002>
- Sani, M. U., Wahab, K. W., Yusuf, B. O., Gbadamosi, M., Johnson, O. V., and Gbadamosi, A., 2010. Modifiable cardiovascular risk factors among apparently healthy adult Nigerian population—A cross sectional study. *BMC Research Notes*, 3(1), 11. <https://doi.org/10.1186/1756-0500-3-11>
- Sodipo, O. Y., Afolaranmi, T. O., Agbo, H. A., Envuladu, E. A., Lar, L. A., Udofia, E. A., and Zoakah, A. I., 2024. Co-occurrence of non-communicable disease risk factors among adolescents in Jos, Nigeria. *African Journal of Primary Health Care & Family Medicine*, 16(1). <https://doi.org/10.4102/phcfm.v16i1.4342>
- Umuerri, E., 2019. Heart disease: Lifestyle, knowledge, and perception among young Nigerian adults. *International Journal of the Cardiovascular Academy*, 5(4), 134. https://doi.org/10.4103/IJCA.IJCA_28_19
- WHO., 2021. World Health Organization. Cardiovascular diseases (CVDs). [https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-\(cvds\)](https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds))

Yusuf, S., Joseph, P., Rangarajan, S., Islam, S., Mente, A., Hystad, P., Brauer, M., Kutty, V. R., Gupta, R., Wielgosz, A., AlHabib, K. F., Dans, A., Lopez-Jaramillo, P., Avezum, A., Lanas, F., Oguz, A., Kruger, I. M., Diaz, R.,

Yusoff, K., ... Dagenais, G., 2020. Modifiable risk factors, cardiovascular disease, and mortality in 155 722 individuals from 21 high-income, middle-income, and low-income countries (PURE): A prospective cohort study. *The Lancet*, 395(10226), 795–808. [https://doi.org/10.1016/S0140-6736\(19\)32008-2](https://doi.org/10.1016/S0140-6736(19)32008-2)