**Journal of Food and Nutrition Sciences**
2024; 12(1): 27-40
http://www.sciencepublishinggroup.com/j/jfns
doi: 10.11648/j.jfns.20241201.13
ISSN: 2330-7285 (Print); ISSN: 2330-7293 (Online)

# Prevalence and Determinants of Metabolic Risk Factors Among University Students in Dodoma and Morogoro Regions Tanzania

**Neema Mgetta*, Happiness Muhimbula, Kissa Kulwa**

Department of Human Nutrition and Consumer Sciences, Sokoine University of Agriculture, Morogoro, Tanzania

## Email address:

neemamgetta@gmail.com (Neema Mgetta), happy.issa@yahoo.co.uk (Happiness Muhimbula), kkulwa@sua.ac.tz (Kissa Kulwa)

*Corresponding author

## To cite this article:

Neema Mgetta, Happiness Muhimbula, Kissa Kulwa. (2024). Prevalence and Determinants of Metabolic Risk Factors Among University Students in Dodoma and Morogoro Regions Tanzania. *Journal of Food and Nutrition Sciences*, *12*(1), 27-40.
https://doi.org/10.11648/j.jfns.20241201.13

**Received**: December 5, 2023; **Accepted**: December 25, 2023; **Published**: January 8, 2024

**Abstract:** University students often face a multitude of health risks due to the transitional phase they experience. The lifestyles they adopt increase their susceptibility to metabolic issues that are of a public health concern. Metabolic risk factors, encompassing obesity, hypertension, dyslipidemia, and elevated glucose levels pose significant health concerns among this demographic. The cluster of these metabolic risk factors is known as a metabolic syndrome which has the potential to increase the risk of cardiovascular diseases amongst young populations who are linked with the adaptation of health risk behaviours. The objective of this cross-sectional study was to assess the prevalence and determinants of metabolic risk factors of university students in two regions that were purposively selected from mainland Tanzania. The distribution of continuous variables was tested for normality using box plots and-Q plots and the Shapiro-Wilk test. Multivariate linear regression analysis was used to assess the determinants of metabolic risk factors among variables. The metabolic risk factors that were assessed include blood pressure, glucose levels, central obesity, and lipid profiles. The most prevalent metabolic risk factor was the high levels of low-density lipoprotein among university students. The study found Low-density lipoprotein levels that were above optimal, borderline high, high and very high. The low-density lipoprotein levels found in the study were 24 (20.3%), 16 (13.6%), 13 (11%) and 17 (14.4%) for above optimal, borderline high, high, and very high respectively. Significant associations were also found in the determinants of the metabolic risk factors, for central obesity (P=0.000) and for triglyceride levels (P=0.000); (P=0.004). Factors that increase the susceptibility to metabolic risk factors include the location of the university, scholarship status and Individual dietary diversity scores. Saint John's University in Dodoma was associated with low-density lipoprotein and Total cholesterol (β=17.01, SE=10.1, p=0.1) and (β=-0.170, SE=0.0519, p=0.01) respectively. Receiving scholarship and high dietary diversity score was associated with low-density lipoprotein (β=21.83, SE=10.4, p=0.1); (β=5.731, SE=3.14, p=0.1) respectively. University students are living with metabolic risk factors that could have future health implications. Understanding these aspects can help in devising targeted interventions and educational programs to mitigate metabolic risks and promote healthier lifestyles among university students.

**Keywords:** Metabolic Risk Factors, Metabolic Syndrome, University Students, Determinants, Prevalence, Tanzania

## 1. Introduction

Metabolic risk factors are conditions that increase the likelihood of developing metabolic syndrome a cluster of interconnected health issues that include abdominal obesity, high blood pressure, prediabetes, high blood glucose and dyslipidaemia [1]. Metabolic risk factors are accelerating rapidly and advancing across countries which results in a substantial morbidity and mortality burden, linked to non-communicable diseases (NCDs) [2].

Young adults are in a transitional period which is critical to the consolidation of health-related behaviours. Engagement of multiple NCD risk behaviours is evident among African youths at the university level [3] Chronic diseases are

becoming more common in Africa due to ongoing demographic changes in various regions [4]. The prevalence of NCDs is rising rapidly and is projected to cause more deaths than communicable, maternal, perinatal, and nutritional diseases combined by 2030 in Africa, which might be a major barrier to attaining Sustainable Development Goals [5]. Several hypotheses have been advanced to explain the explosion of non-communicable diseases, such as the increased and uncontrollable urbanization that is accompanied by lifestyle changes particularly in developing nations that face high and rapid urbanization [6]. The higher prevalence of NCDs among young populations poses a need for emergency interventions to rescue the future generation [7]. Studies have reported metabolic risk factors among young adults including university students [8-10]. It was reported prevalence of diabetes in young adults of Low middle income countries (LMIC) is as high as 11.6% while that of hypertension is up to 36.9%, and up to 36% of young adults have dyslipidaemia [11]. The issue of non-communicable diseases (NCDs) and related risk factors is growing in sub-Saharan Africa (SSA). Lack of appropriate epidemiological data, coexistence of infectious and non-infectious diseases, under-nutrition/over-nutrition, and poor economic status are among the factors that influence CVDs mortality in these countries [12]. In sub-Saharan countries the NCDs levels are expected to rise from 25% since 2004 to 46% in 2030 [13]. Sub-Saharan Africa is facing an epidemiological transition with chronic diseases being prevalent among young adults [2].

Therefore, there is an imperative need to address this so as to avoid future health implications. Early detection of metabolic risk factors in the university context may help reduce the onset of metabolic syndrome which have detrimental impact on overall health. It is important to determine the prevalence of metabolic risk factors among university students in order to take measures from a public health perspective and design strategies for early identification. Therefore, the current study was conducted to determine the prevalence and determinants of metabolic risk factors among university students in Morogoro and Dodoma regions, Tanzania.

# 2. Materials and Methods

### *2.1. Study Design and Sample Population*

The investigation was a cross-sectional study conducted in university students from Saint John's University in Dodoma region and Mzumbe university in Morogoro region. Morogoro Municipality serves as Morogoro Region's nine districts, serves as the region's capital which represents 0.74% of the region's total land area [14]. The recently estimated population of Morogoro urban is approximate to 440109 with the growth rate of 3.85%. In the case of Morogoro Municipal, linear and nucleated settlements have been the dominant form of urban development, with a few cases of scattered settlements, and population growth go hand in hand with urban expansion and human development, which may take numerous forms [15]. Morogoro experiences bimodal rainfall seasons. Heavy rain seasons are locally called Masika dominating late March to early May and the light rain seasons are locally called Vuli normally between November to December [14].

Dodoma is the region found in the central part of Tanzania mainland. With 41.311 $km^2$, it has seven districts: Dodoma urban, Chamwino, Bahi, Kondoa, Kongwa, Mpwapwa, and Chemba. It is the 12th largest area in Tanzania. Movement of people to the region as it became the host of the capital city has resulted in increasing population growth, within the Dodoma region, including its metropolitan environment, having 3,085,625 people in 2022 [16]. Dodoma is one of the semi-arid regions with annual rainfall that ranges from 550 to 660 millimetres and a lengthy dry season. The region receives between 550 and 3690 mm of rainfall annually (World Bank) [17]. There is just one rainy season there, which is a crucial climate component for agricultural activity.

A convenience sampling was carried out on the prevalence of the study age group (19.2%) [18] 95%CI, degree of accuracy 5%. The final sample size was 262 university students. A sub-sample of 118 students were drawn from the total cohort. The sampling was drawn randomly but proportion to size of students from each university; 65 students from Mzumbe University and 53 students from Saint Johns' university participated in the study.

The exclusion criteria were: first year students, students in diet or weight management plans, part-time students, disabled students and pregnant individuals.

### *2.2. Data Collection*

Data was collected in university premises under the supervision of responsible private investigator. The data collected include, Waist circumference, Blood pressure, Random blood glucose and lipid profiles. The team that carried out the collection was properly trained and included medical personnel for collecting blood samples and blood pressure.

### *2.3. Waist Circumference*

The waist circumference (WC) was measured using a non-stretchable tape on the upper lateral border of the right ilium in the midaxillary line at the navel level without skin compression to the nearest 0.1 cm. The waist circumference was used to identify individuals with possible health risks based upon threshold values of ≥ 82 cm for women and ≥ 91 cm for men identified from adults in Sub Saharan Africa population [19].

### *2.4. Blood Pressure*

Blood pressure was measured using a fully automatic electronic blood pressure monitor whereby the systolic and diastolic blood pressures were determined. The electronic sphygmomanometer was calibrated before it was used to measure the participants (The blood pressure machine was provided by Morogoro regional Hospital; Model: U-80AH ARI-intellisense). A registered nurse from Morogoro referral

hospital took these readings. Participants were required to be seated in a chair with a backrest and positioned with feet on the floor and legs uncrossed. The right arm was positioned comfortably at the heart level. Blood pressure was measured three times with the appropriate cuff size that covered two-thirds of the upper arm after the participant has rested for at least five minutes and no smoking or caffeine 30 minutes before measurement. Consecutive measurements were taken five-to-ten minutes after the first measurement and the last two BP measurements were calculated to determine the BP status of the participant. Means of the replicate measures were determined and used in the analysis. Participants blood pressure was regarded as low blood pressure <100 mmHg for systolic and 60mmHg for diastolic; normal blood pressure 100-139.9mmHg for systolic and 60-89.9 mmHg for diastolic; High blood pressure ≥140mmHg systolic and ≥90mmHg [20].

### *2.5. Blood Glucose*

Random blood glucose test was measured using the Point of care (POC) digital glucose meter machine. The test was done at a random time of the day by a registered nurse from Morogoro referral hospital. The procedure involved pricking a participant's finger with a lancet and putting the blood on a testing strip. The strip was then inserted into the glucometer, where the results were shown on the screen after few seconds. Participants blood glucose levels were classified as normal (RBG < 7.8 mmol/L), pre-DM (RBG > 7.8– 11.0mmol/L and Hyperglycaemia (RBG ≥ 11.1 mmol/L) as per International Diabetes Federation and national guidelines [21].

### *2.6. Lipid Profiles*

Lipid profile was be measured by determining serum levels of total cholesterol, triglyceride, low density lipoprotein and high-density lipoprotein. Blood sample collection was done by a registered nurse from the Morogoro referral hospital. A venous blood sample was drawn from the antecubital fossa (elbow pit) by using syringes with hypodermic needles for each participant. The blood drawn from the participants were carefully placed in red tubes (PHARMA LAB KIGALI-RWANDA, 4.25°C: 5ml) and arranged in a BD Vacutainer Eclipse™ with iceboxes. The samples were then transported to the Morogoro referral hospital and stored in a refrigerator at temperature of 2°-8°C. After 15 hours of storage, the samples were then transported in the BD Vacutainer Eclipse™ with iceboxes once again to Honest specialized polyclinic Bunju (B) laboratory for analysis of the lipid profiles. On arrival the samples were removed from the vacutainer and were first centrifuged by 800D centrifuge machine to separate the serum and blood at 3,000 RPM. Using a semi-Automated Biochemistry analyzer- CHEM 7 the samples were further analysed. Standard operating procedures instructed by the manufacturer manuals on the machine with its specific reagents for each parameter were used. The machine was washed by distilled water after every sample change and parameter change. For High density lipoprotein Normal ranges for adult's male is 35.3-79.5 mg/dl while normal for adult female is 42.0-88.0 mg/dl. Lipid cut off points of other parameters are depicted in Table 1.

***Table 1.*** *Lipid profile cut-off points.*

| Parameter | Low-density lipoprotein | Total Cholesterol | Triglycerides |
|---|---|---|---|
| Optimal | <100mg/dl | <200mg/dl | 150-199mg/dl |
| Above Optimal | 100-129mg/dl | <200mg/dl | 150-199mg/dl |
| Borderline high | 130-159mg/dl | 200-239 mg/dl | 150-199mg/dl |
| High | 160-189mg/dl | ≥240mg/dl | 200-499mg/dl |
| Very High | ≥190 mg/dl | ≥240 mg/dl | >499mg/dl |

Source Biochemistry analyzer-CHEM 7; ERBA Mannheim

### *2.7. Statistical Analysis*

The data was entered, cleaned and analysed using IBM SPSS Statistics for Windows (Version 26.0. IBM Corp, 2011, Armonk, NY). Within the SPSS software, demographic characteristics of university students were succinctly summarized and presented as frequencies and percentages. The metabolic risk factors were then condensed into frequencies and percentages, depicting the number of students with a risk of the factors. In addition, Chi square ($X^2$) test at 5% level of significance was used to examine the relationship between dependent variables (metabolic risk factors) and other independent variables such as socio-demographic factors. These were done for the metabolic risk factors that were not normally distributed even after statistical transformation. The metabolic risk factors that were transformed and became normally distributed were further analysed. Multivariate analysis (multiple linear regression) for inferential statistics was performed to identify the determinants of metabolic risk factors in university students. This multivariable model helped to account for confounding variables and elucidated the associations between these factors (independent variables) and the metabolic risk factors in university students.

### *2.8. Ethical Considerations*

The study was approved by the National Institute for Medical research with reference number NIMR/HQ/R.8a/Vol.IX/4363 and from the Sokoine University of Agriculture with reference number SUA/MHN/D/2019/0009. Permission to conduct the study was also sought from respective universities from the administration offices through dean of students. Students were informed about the study and consent forms were given for

signing. Confidentiality of the information was ensured where all participants were identified by numbers.

# 3. Results

### *3.1. Characteristics of University Students (n=118)*

The socio-demographic characteristics of the University students are presented in Table 2. A total of 118 students was recruited to participate in the study, includes (55.1%, N=65) of Mzumbe university and (44.9%, N=53) from St. John's university. Findings revealed that, the overall proportion of male participant was slightly higher (55.9%) compared to (44.1%) of female participants. Majority (61%) of respondents have the age between 20 to 24 years when compared to students who were 25 years and above (39%). More than half (55.9%) of Second year students participated in the study when compared to students in advanced years (44.1%). Majority (83.1%) of the participants were Christians. A larger proportion (72%) of students in this study stayed off the university premises. More than half (56.8%) of the participants in this study did not receive scholarship.

Findings revealed that, the overall proportion of male participant was slightly higher (55.9%) compared to (44.1%) of female participants. Majority (61%) of respondents have the age between 20 to 24 years when compared to students who were 25 years and above (39%). More than half (55.9%) of Second year students participated in the study when compared to students in advanced years (44.1%). Majority (83.1%) of the participants were Christians. A larger proportion (72%) of students in this study stayed off the university premises. More than half (56.8%) of the participants in this study did not receive scholarship.

***Table 2.*** *Socio-Demographic characteristics of participants (N=118).*

| Variable | Overall (%) | Mzumbe University (%) | Saint John's University (%) | P-Value |
|---|---|---|---|---|
| Sex | | | | |
| Male | 66 (55.9) | 30 (46.2) | 36 (67.9) | 0.018* |
| Female | 52 (44.1) | 35 (53.8) | 17 (32.1) | |
| Age | | | | |
| 20-24 Years | 72 (61) | 42 (64.6) | 30 (56.6) | 0.375 |
| ≥25 Years | 46 (39) | 23 (35.4) | 23 (43.4) | |
| Study Year | | | | |
| Second Year | 66 (55.9) | 28 (43.1) | 38 (71.7) | 0.002* |
| Third year and above | 52 (44.1) | 37 (56.9) | 15 (28.3) | |
| Marital Status | | | | |
| Single | 108(91.5) | 59 (90.8) | 49 (92.5) | 0.774 |
| Married | 10 (8.5) | 6 (9.2) | 4 (7.5) | |
| Religion | | | | |
| Christian | 98 (83.1) | 48 (73.8) | 50 (94.3) | 0.003* |
| Muslim | 20 (16.9) | 17 (26.2) | 3 (5.7) | |
| Chronic disease | | | | |
| Yes | 5 (4.2) | 3 (4.6) | 2 (3.8) | 0.821 |
| No | 113(95.8) | 62 (95.4) | 51 (96.2) | |
| Sleeping hours | | | | |
| <8 hours | 58 (49.2) | 39 (60) | 19 (35.8) | 0.009 |
| ≥8 hours | 60 (50.8) | 26 (40) | 34 (64.2) | |
| Residence | | | | |
| Off-campus | 85 (72) | 36 (55.4) | 49 (92.5) | 0.000* |
| In-campus | 33 (28) | 29 (44.6) | 4 (7.5) | |
| Smoking status | | | | |
| Non-smoker | 113(95.8) | 61 (93.8) | 52 (98.1) | 0.252 |
| Smoker | 5 (4.2) | 4(6.2) | 1 (1.9) | |
| Nutritional Information | | | | |
| Offline | 38 (32.2) | 21 (32.3) | 17 (32.1) | 0.979 |
| Online | 80 (67.8) | 44 (67.7) | 36 (67.9) | |
| Scholarship Status | | | | |
| No | 67 (56.8) | 43 (66.2) | 24 (45.3) | 0.023* |
| Yes | 51 (43.2) | 22 (33.8) | 29 (54.7) | |
| Type of scholarship | | | | |
| Partial | 13 (25.5) | 8 (36.4) | 5 (17.2) | 0.121 |
| Full | 38 (74.5) | 14 (63.6) | 24 (82.8) | |

*Significant at P<0.05

### *3.2. Prevalence of Metabolic Risk Factors Among University Students*

The Metabolic risk factors reported in this section include high blood pressure (systolic and diastolic), central obesity and lipid profile.

#### *3.2.1. High Blood Pressure of University Students*

Blood pressure constitutes of systolic and diastolic pressures. The study found that 7(6%) of the university

students had high blood pressure systolic while 4 (3.4%) of university students had high blood pressure (diastolic). Students in Dodoma region showed a higher prevalence 5 (7.5%) of high blood pressure (systolic) when compared to students in Morogoro region 2 (3.1%) Table 3.

***Table 3.*** *Prevalence of Blood pressure among university students.*

| | Systolic Blood pressure | | | | Diastolic Blood pressure | | | |
|---|---|---|---|---|---|---|---|---|
| **Characteristics** | **Normal range (%)** | **Low range (%)** | **High range (%)** | **P-Value** | **Normal range (%)** | **Low range (%)** | **High range (%)** | **P-Value** |
| Age | | | | | | | | |
| 20-24 Years | 79 (90.8) | 5 (5.7) | 3 (3.5) | | 30 (87.4) | 7 (8) | 4 (4.6) | |
| ≥ 25 Years | 26 (86.7) | 1 (3.3) | 4 (10.1) | 0.339 | 76 (96.8) | 1 (3.2) | 0 (0.00) | 0.296 |
| Sex | | | | | | | | |
| Male | 62 (94) | 2 (3) | 2 (3%) | | 47 (89.4) | 5 (7.6) | 2 (3) | |
| Female | 43 (84.4) | 4 (7.8) | 5 (7.8) | 0.235 | 59 (90.4) | 3 (5.8) | 2 (3.8) | 0.905 |
| University Location | | | | | | | | |
| Morogoro | 59 (90.6) | 4 (6.3) | 2 (3.1) | | 59 (90.8) | 4 (6.2) | 2 (3) | |
| Dodoma | 46 (88.7) | 2 (3.8) | 5 (7.5) | 0.481 | 47 (88.7) | 4 (7.5) | 2 (3.8) | 0.933 |
| Residence | | | | | | | | |
| Off-campus | 78 (60) | 2 (8) | 6 (32) | | 30 (89.4) | 3 (5.9) | 4 (4.7) | |
| In-campus | 27 (55) | 4 (41.2) | 1 (3.8) | 0.076 | 76 (90.9) | 5 (9.1) | 0 (0.00) | 0.383 |
| Total | 105 (88.9) | 6 (5.1) | 7 (6) | | 106 (89.8) | 8 (6.8) | 4 (3.4) | |

### *3.2.2. Lipid Profiles of University Students*

Lipid profile discussed in this section include Total Cholesterol (TC), Triglycerides (TG) and Low-density lipoprotein (LDL). The study found that 7 (6%) and 1 (0.8%) of university students had high levels, borderline high and High ranges respectively of Total cholesterol. Students in Morogoro were significantly associated with high levels of Total Cholesterol 7 (10.8%) and 1(1.5%) borderline high and high ranges respectively while students in Dodoma had normal ranges of the factor Table 4 Moreover, the study also found that 15 (12.7%) and 10 (8.5%) were hyper-triglyceridemic and very high ranges of Triglyceride levels respectively. A significant proportion of hyper-triglyceridemic was present in students in Morogoro university and significant high proportion showed high ranges of Triglyceride levels. About 13 (20%) for hyper-triglyceridemic levels were present in Mzumbe students in Morogoro and 2 (3.8%) for students in Saint John's Dodoma. Very high range levels of triglyceride level 10 (15.4%) were present in Mzumbe students in Morogoro and none in Saint John's university students (Dodoma) in the study Table 5.

Furthermore, the study found Low density lipoprotein levels that were above optimal, borderline high, high and very high. The low-density lipoprotein levels found in the study were 24 (20.3%), 16 (13.6%), 13 (11%) and 17 (14.4%) for above optimal, borderline high, high and very high respectively. A significantly higher proportion of above optimal and borderline levels of Triglyceride levels was found in Saint John's university students in Dodoma. A significant higher proportion of high and very high levels of triglycerides levels was found in Mzumbe university students at Morogoro region. For Dodoma region about 17 (32.1%), 9 (17%) and 5 (9.4%) had above optimal, borderline high, high as well as very high levels of triglycerides respectively. Students at Mzumbe in Morogoro university had 7 (10.8%), 8 (12.5%), and 12 (18.4%) above optimal and borderline high, High, and very high levels of Triglycerides Table 6.

***Table 1.*** *Prevalence of Total Cholesterol among University Students.*

| **Characteristics** | **Normal range (%)** | **Borderline high (%)** | **High range (%)** | **P-value** |
|---|---|---|---|---|
| Age | | | | |
| 20-24 Years | 29 (93.1) | 2 (5.7) | 1 (1.2) | |
| ≥25 Years | 81 (93.5) | 5 (6.5) | 0 (0.00) | 0.829 |
| Sex | | | | |
| Male | 63 (95.5) | 3 (4.5) | 0 (0.00) | |
| Female | 47 (90.4) | 4 (7.7) | 1 (1.9) | 0.400 |
| University Location | | | | |
| Morogoro | 57 (87.7) | 7(10.8) | 1 (1.5) | |
| Dodoma | 53 (100) | 0 (0.00) | 0(0.00) | 0.030* |
| Residence | | | | |
| Off-campus | 83 (97.6) | 2 (2.4) | 0 (0.00) | |
| In-campus | 27 (81.8) | 5 (15.2) | 1 (3) | 0.008 |
| Total | 110 (93.2) | 7 (6) | 1 (0.8) | |

*Significant at P<0.05

***Table 2.*** *Prevalence of Triglycerides in University Students.*

| Characteristics | Normal range (%) | Hyper triglyceridemic (%) | Very High (%) | P-value |
|---|---|---|---|---|
| Age | | | | |
| 20-24 Years | 69 (79.3) | 10 (20.7) | 0 (0.00) | |
| ≥25 Years | 24 (77.4) | 5 (10.6) | 10 (12) | 0.959 |
| Sex | | | | |
| Male | 55 (83.3) | 6 (10.6) | 3 (6.1) | |
| Female | 38 (73.1) | 9 (15.4) | 7 (11.5) | 0.379 |
| University location | | | | |
| Morogoro | 42 (64.6) | 13 (20) | 10 (15.4) | |
| Dodoma | 51 (96.2) | 2 (3.8) | 0 (0.00) | 0.000* |
| Residence | | | | |
| Off-campus | 69 (81.2) | 8 (9.4) | 8 (9.4) | |
| In-campus | 24 (72.7) | 7 (21.2) | 2 (6.1) | 0.209 |
| Total | 93 (78.8) | 15 (12.7) | 10 (8.5) | |

*Significant at P<0.05

***Table 3.*** *Low-density lipoprotein levels in university students.*

| Characteristics | Optimal (%) | Above optimal (%) | Borderline high (%) | High (%) | Very high (%) | P-value |
|---|---|---|---|---|---|---|
| Age | | | | | | |
| 20-24 Years | 36 (41.4) | 19 (21.8) | 5 (12.6) | 10 (11.6) | 6 (12.6) | |
| ≥25 Years | 12 (38.7) | 5 (16.1) | 11 (16.1) | 3 (9.7) | 11 (19.4) | 0.845 |
| Sex | | | | | | |
| Male | 23 (34.8) | 17 (25.8) | 9 (13.6) | 8 (12.2) | 8 (13.6) | |
| Female | 25 (48.1) | 7 (13.5) | 7 (13.5) | 5 (9.6) | 9 (15.3) | 0.457 |
| University Location | | | | | | |
| Morogoro | 31 (47.7) | 7 (10.8) | 7 (10.8) | 8 (12.3) | 12 (18.4) | |
| Dodoma | 17 (32.1) | 17 (32.1) | 9 (17) | 5 (9.4) | 5 (9.4) | 0.027* |
| Residence | | | | | | |
| Off-campus | 33 (45.5) | 5 (15.2) | 4 (12.1) | 2 (6.1) | 10 (21.1) | |
| In-campus | 15 (38.8) | 19 (22.4) | 12 (14.1) | 11 (12.9) | 7 (11.8) | 0.489 |
| Total | 48 (40.7) | 24 (20.3) | 16 (13.6) | 13 (11) | 17 (14.4) | |

*Significant at P<0.05

### *3.2.3. Central Obesity in University Students*

The study found that 13 (11%) of university students had visceral obesity at both Morogoro and Dodoma universities. A significantly higher proportion of females 12 (23.1%) were at risk of morbidity when compared to male counterparts 1 (1.5%). The study also shows a significantly higher proportion of 11 (35.5%) of ≥ 25-year-old students were at a higher risk of morbidity when compared to 20–24-year-old students 2 (2.3%) years of age Table 7.

***Table 4.*** *Prevalence of Central obesity in university students.*

| Characteristics | Overall (%) | Risk of morbidity (%) | Non-risk of morbidity (%) | P-Value |
|---|---|---|---|---|
| Age | | | | |
| 20-24 Years | 87 (73.7) | 2 (2.3) | 85 (97.7) | |
| ≥25 Years | 31 (26.3) | 11 (35.5) | 20 (64.5) | 0.000* |
| Sex | | | | |
| Male | 66 (56) | 1 (1.5) | 65 (98.5) | |
| Female | 52 (44) | 12 (23.1) | 40 (76.9) | 0.000* |
| University location | | | | |
| Morogoro | 65 (55) | 7 (10.8) | 58 (89.2) | |
| Dodoma | 53 (45) | 6 (11.3) | 47 (88.7) | 0.924 |
| Residence | | | | |
| Off-campus | 85 (72) | 6(8.2) | 78 (91.8) | |
| In-campus | 33 (28) | 7 (18.2) | 27 (81.8) | 0.121 |
| Total | 118 (100) | 13 (11%) | 105 (89) | |

*Significant at P< 0.005

### *3.3. Determinants of Metabolic Risk Factors in University Students*

Central obesity was significantly associated with gender (p=0.000) whereby females were at a higher risk of developing central obesity than male counterparts. The study also found that age was significantly associated with central obesity (p=0.000) and students that were ≥25 years old were at more risk compared to participants at a younger age. Nutrition status was also associated with risk of morbidity whereby obese students were at more risk compared to underweight, normal weight and overweight (p=0.000) Table 8.

Triglycerides levels were significantly associated with location of the university (p=0.000) whereby students at Mzumbe were at a risk of having high levels of triglycerides compared to students in Dodoma (Saint John's university). The study found that smoking was significantly associated with high levels of triglycerides (p=0.004). Table 9. Students in Saint John's university (Dodoma) were found to be significantly associated with total cholesterol (mean decrease of 0.17mg/dl, SE = 0.05, p = 0.01) and low-density lipoprotein (mean increase of 17.01mg/dl, SE = 10.1, p = 0.1). Being married was found to be significantly associated with blood pressure (diastolic) (mean decrease of 11.66mmHg, SE=5.222, p=0.05).

University students who received scholarships in the study were found to be significantly associated with low-density lipoprotein (mean increase of 21.83mg/dl, SE=10.40, p=0.1). However, other metabolic risk factors were not significantly associated (p>0.05). Furthermore, the study found that university students who smoked were significantly associated with blood pressure (diastolic) (mean increase of 6.125mmHg, SE=3.451, p=0.1). The study also found that students with a highly diversified diet (≥7 food groups) were significantly associated with low-density lipoprotein (mean increase of 5.731mg/dl, SE=3.143, p=0.1). However, other metabolic risk factors were not significantly associated (p>0.05). Table 10.

***Table 5.*** *Determinants of Central Obesity in University students.*

| Characteristics | Risk of morbidity (%) | Non-risk of morbidity (%) | P-value |
|---|---|---|---|
| Sex | | | |
| Male | 1 (1.5) | 65 (98.5) | 0.000* |
| Female | 12 (23.1) | 40 (76.9) | |
| Age | | | |
| 20-24 years | 2 (2.3) | 85 (97.7) | 0.000* |
| ≥ 25 years | 11 (35.5) | 20 (64.5) | |
| Nutrition status | | | |
| Underweight | 0 (0) | 7 (100) | 0.000* |
| Normal weight | 1 (1.2) | 82 (98.8) | |
| Overweight | 6 (27.3) | 16 (72.7) | |
| Obesity | 6 (100) | 0 (0) | |

*Significant at P<0.05

***Table 6.*** *Determinants of Triglycerides levels in university students.*

| Characteristics | Normal (%) | Borderline high (%) | Hypertriglyceridemic (%) | P-value |
|---|---|---|---|---|
| Location of the university | | | | |
| Morogoro | 42 (64.6) | 13 (20) | 10 (15.4) | 0.000* |
| Dodoma | 51 (96.2) | 2 (3.8) | 0 (0) | |
| Smoking status | | | | |
| No | 91 (80.5) | 12 (10.6) | 10 (8.8) | 0.004* |
| Yes | 2 (66.7) | 3 (14.3) | 0 (0) | |

*Significant at P<0.05

***Table 7.*** *Determinants of Metabolic risk Factors in University students.*

| Characteristics | Blood pressure (Diastolic) | Blood pressure Systolic) | Total cholesterol (TC) | Low-density lipoprotein |
|---|---|---|---|---|
| Locationof University | | | | |
| Morogoro | Ref | Ref | Ref | Ref |
| Dodoma | 3.834 | 4.661 | -0.170*** | 17.01* |
| | (2.866) | (4.516) | (0.0519) | (10.08) |
| Sex | | | | |
| Male | Ref | Ref | Ref | |
| Female | -0.692 | 3.221 | 0.0397 | |
| | (3.223) | (5.004) | (0.0542) | |
| Marital status | | | | |
| Single | Ref | Ref | | Ref |
| Married | -11.66** | -10.43 | | 14.78 |
| | (5.222) | (8.115) | | (15.99) |
| Scholarship status | | | | |
| No | Ref | Ref | Ref | Ref |

| Characteristics | Blood pressure (Diastolic) | Blood pressure Systolic) | Total cholesterol (TC) | Low-density lipoprotein |
|---|---|---|---|---|
| Yes | -2.823 | -3.576 | 0.0266 | 21.83* |
| | (2.404) | (3.749) | (0.0463) | (10.40) |
| Smoking Status | | | | |
| No | Ref | Ref | Ref | Ref |
| Yes | 6.125* | 3.892 | -0.0566 | 11.37 |
| | (3.451) | (5.371) | (0.0616) | (14.44) |
| Dietary Diversity score | | | | |
| < 7 food groups | Ref | Ref | Ref | Ref |
| ≥ 7 food groups | 0.931 | 1.367 | -0.00304 | 5.731* |
| | (0.742) | (1.138) | (0.0140) | (3.143) |
| Constant | 72.58** | 102.3** | 1.872** | -1.269 |
| | (9.434) | (13.75) | (0.168) | (32.64) |
| Observations | 118 | 118 | 118 | 118 |
| R-squared | 0.415 | 0.305 | 0.384 | 0.297 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

### *3.4. Prevalence and Determinants of Other Health Implicated Factors in University Students*

The study found other factors such as High-density lipoprotein and Low-levels of blood glucose (hypoglycaemia).

#### *3.4.1. Prevalence of Hypoglycaemia in University Students*

The study found that 22 (18.6%) participants had hypoglycaemia in the two regions. A significantly higher proportion 18 (27.7%) of students in Morogoro were found to have hypoglycaemia when compared to the proportion 4 (7.5%) in Dodoma region. Being female was significantly associated with hypoglycaemia 14 (26.9%). Low-levels of blood glucose was associated with residence, whereby the proportion of students in-campus was significantly higher 12 (30.3%) when compared to the proportion 10 (14.1%) of students off-campus. Table 11.

***Table 8.*** *Prevalence of Hypoglycemia levels in university students.*

| Characteristics | Overall (%) | Hypoglycaemia (%) | Normal (%) | P-Value |
|---|---|---|---|---|
| Age | | | | |
| 20-24 Years | 77 (73.73) | 6(18.4) | 71 (81.6) | |
| ≥25 Years | 41 (26.27) | 16 (19.4) | 25 (80.6) | 0.906 |
| Sex | | | | |
| Male | 64 (54.24) | 8 (12.1) | 58 (87.9) | |
| Female | 54 (45.76) | 14 (26.9) | 38 (73.1) | 0.040* |
| University location | | | | |
| Morogoro | 65 (55.08) | 18 (27.7) | 47 (72.3) | |
| Dodoma | 53 (44.92) | 4 (7.5) | 49 (92.5) | 0.005* |
| Residence | | | | |
| Off-campus | 85 (72) | 10 (14.1) | 73 (85.9) | |
| In-campus | 33 (28) | 12 (30.3) | 23 (69.7) | 0.043* |
| Total | 118 (100%) | 22 (18.6) | 96 (81.4) | |

*Significant at P<0.05

#### *3.4.2. Prevalence of High-Density Lipoprotein in University Students*

The study found that 45 (38.2%) of university students had high levels of high-density lipoprotein. Students in Dodoma region had a significantly higher proportion 25 (47.2%) of high-density lipoproteins compared to students in Morogoro region 20 (30.8%). Being female was significantly associated with high levels of high-density lipoprotein in a larger proportion 26 (44.3%) compared to their male counterparts 19 (30.2%). Residency was also significantly associated with high levels of high-density lipoprotein whereby students living off-campus had higher proportion 37 (43.5%) compared to students in-campus 8 (24.2%). Table 12.

***Table 9.*** *Prevalence of High-density lipoprotein levels among university students.*

| Characteristics | Normal range (male) (%) | Normal range (female) (%) | High range (%) | P-Value |
|---|---|---|---|---|
| Age | | | | |
| 20-24 Years | 36 (41.4) | 9 (20.7) | 12 (37.9) | |
| ≥25 Years | 10 (32.3) | 18 (29) | 33 (38.7) | 0.552 |
| Sex | | | | |
| Male | 46 (69.8) | 0 (0.00) | 19 (30.2) | |
| Female | 0 (0.00) | 27 (55.7) | 26 (44.3) | 0.000* |

| Characteristics | Normal range (male) (%) | Normal range (female) (%) | High range (%) | P-Value |
|---|---|---|---|---|
| University Location | | | | |
| Morogoro | 25 (38.4) | 20 (30.8) | 20 (30.8) | |
| Dodoma | 21 (39.6) | 7 (13.2) | 25 (47.2) | 0.050* |
| Residence | | | | |
| Off-campus | 13 (38.9) | 12(17.6) | 37 (43.5) | |
| In-campus | 33 (39.4) | 15 (36.4) | 8 (24.2) | 0.051* |
| Total | 46 (39) | 27 (22.8) | 45 (38.2) | |

*Significant at P<0.05

### *3.4.3. Determinants of High-Density Lipoprotein in University Students*

The study found that students at Saint John's University at Dodoma were significantly associated with high-density lipoprotein (mean increase of 0.347mg/dl, SE=0.121, p=0.01). Students who smoked were also significantly associated with high-density lipoprotein (mean increase of 0.446mg/dl/, SE=0.146, p=0.1). Furthermore, students that were Third year and above were associated with high-density lipoprotein (mean increase 0.163mg/dl, SE=0.0924, p=0.1) Table 13.

***Table 10.*** *Determinants of High-density lipoprotein in university students.*

| Characteristics | High density lipoprotein (HDL) |
|---|---|
| Location of University | |
| Morogoro | Ref |
| Dodoma | 0.347*** |
| | (0.121) |
| moking status | |
| No | Ref |
| Yes | 0.446*** |
| | (0.146) |
| Study year | |
| Second year | Ref |
| Third year and above | 0.163* |
| | (0.0924) |
| Constant | 2.718* |
| | (0.398) |
| Observations | 118 |
| R-squared | 0.453 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

### *3.4.4. Determinants of Hypoglycaemia Among University Students*

Being female was significantly associated with blood glucose levels (mean decrease of 1.178mmol/L, SE=0.475, p=0.05). Students who smoked were significantly associated with blood glucose levels (mean increase 1.4440mmol/L, SE=0.510, p=0.01) Table 14.

***Table 11.*** *Determinants of Hypoglycemia in University students.*

| Characteristics | Blood glucose |
|---|---|
| Location of University | |
| Morogoro | Ref |
| Dodoma | -0.297 |
| | (0.428) |
| Sex | |
| Male | Ref |
| Female | -1.178** |
| | (0.475) |
| Marital status | |
| Single | Ref |
| Married | -0.909 |
| | (0.770) |
| Scholarship | |
| No | Ref |
| Yes | 0.385 |
| | (0.356) |
| Smoking status | |
| No | Ref |
| Yes | 1.4440*** |
| | (0.510) |
| Dietary Diversity score | |
| <7 food groups | Ref |
| ≥7 food groups | 0.0549 |
| | (0.108) |
| Constant | 5.891*** |
| | (1.305) |
| Observations | 118 |
| R-squared | 0.371 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

# 4. Discussion

### *4.1. Prevalence of Metabolic Risk Factors Among University Students*

The primary objective of this study was to assess the metabolic risk factors of university students in Morogoro and Dodoma regions. The metabolic risk factors in this study included blood glucose levels, blood-pressure, central obesity and lipid profiles. These metabolic risk factors are consistent with studies done at the global level as well as across African countries.

According to the findings of these study, students in Dodoma region showed a higher prevalence of elevated systolic blood pressure (7.5%) compared to students in Morogoro region. This is due to the differences in agro-ecological zones, economic activities and overall population. Dodoma region has recently experienced an influx of people and led to the increase of the metropolitan environment. The findings of this study are in line with [22] that showed differences in the prevalence of hypertension between urban and rural settings. A Malagasy study also found high prevalence rates of hypertension that were similar to observed rates in urban settings of different African countries and lower prevalence rates that were reported in many rural communities on mainland Africa [23]. Rashid, N., & Dika, H. I. [24] reported differences in diastolic blood pressures among individuals living in shores of lake Nyasa where by the diastolic blood pressure was higher compared to

individuals living in the hills around lake Nyasa. Furthermore Wang, C., *et al* [25] found that the prevalence of hypertension was significantly higher in rural areas compared with urban an area (25.93% versus 22.73%, respectively) which was contrary to this study since it did not show significant differences.

Prevalence of high levels of the lipid profiles among university students in the study (Total cholesterol, Triglycerides and low-density lipoprotein levels) were found to be significantly associated with location of the universities. The imbalance of lipid levels (in most cases above optimal/high levels) in the blood is known as dyslipidaemia. Students in Mzumbe university in Morogoro had a higher prevalence of elevated total cholesterol, hypertriglyceridemia and very high levels of triglycerides in their blood (10.8%, 20% and 15.4% respectively) compared to students in Saint John's University. This could be due to difference in the location of the two universities, it could also be due to the fact that students in Saint John's university were found to have no to little elevated levels of cholesterol and triglycerides in their blood. Moreover, due to the fact that Saint John's university some courses offered at the institution are science based which might make the students aware on NCD-risk behaviours, this is contrary to Mzumbe university whereby the courses offered are entirely business and administrative oriented. This might also be related to the small number of participants enrolled for the study in Saint John's university (n=53) when compared to Mzumbe university (n=65). Similarly, it was reported that medical college students (n=100) had a lower prevalence of total cholesterol and triglyceride levels due to some differences in food habits and small number of participants enrolled from a single institution [26].

Furthermore, de Groot, R., *et al* [27] reported differences in Total cholesterol levels among adults who are located in different environmental contexts whereby Total cholesterol levels were higher in urban areas compared to rural areas. Moreover, Sarfo, F. S., & Ovbiagele, B. [28] reported that dyslipidaemia prevalence was higher among urban dwellers than rural residents which is consistent with the notion that suburbanization and adoption of occidentalized lifestyles could lead to the rise of lipid levels.

This is also due to the different foods available in these regions, in Morogoro there are vast food crops and cash crops grown which is not the same for Dodoma region. Examples of food crops grown in Morogoro include rice, millet, sorghum and cassava. Similarly, a study done by Davis, E. F.*, et al* [29] amongst adolescents reported elevated lipid levels in participants that had different food sources.

The prevalence of low-density-lipoprotein levels among university students were found to be elevated in this study compared to other metabolic risk factors. The categories were defined as above optimal, Borderline high, high and very high (20.3%, 13.6%, 11% and 14.4% respectively). The reason for this is due to the increase in independence amongst the university students that can lead to risky behaviours which have healthy implications. It has been suggested that both lifestyle and biological factors are associated with elevated levels of LDL-C components [26]. This study showed a significant increase in Low-density lipoproteins levels for high and very high (12.3% and 18.4% respectively) among Mzumbe university students compared to the levels in Saint John's university students. The study also showed a significant increase in Low-density lipoprotein levels for above optimal and borderline high (32.1% and 17% respectively) among Saint John's University students compared to the levels in Mzumbe University students. These findings are similar to Al-Duais, M. A., & Al-Awthan, Y. S. [30] whereby, it was reported that there was a significant increase of High LDL among urban university students compared to the levels in rural university students. In contrast to our study Kasia, B. E.*, et al* [31] reported a significant difference amongst female and male university students at Niger Delta mean plasma LDL-c values for males were significantly lower than females value 2.38 ± 0.49 versus 2.64 ± 0.64 P= 0.023.

Moreover, the prevalence of visceral obesity in this study was found to be 11% and was significantly associated (P=0.000) with age and sex of the university students. The prevalence in this study is lower when compared to a study done among university students in Nairobi whereby the prevalence was 27.8% [32]. This could be due to the total numbers of participants that participated in the study. Female students had a higher prevalence (23.1%) compared to male counterparts. Similarly, Mitić, N. R., & Popović, L. [33] reported a significant difference between genders however, male university students had a higher prevalence of central obesity (12.2%) compared to their female counterparts (11.4%). The higher prevalence of central obesity in this study for females is due to the fact that females often have less lean mass and more fat mass compared to male and the biological factors that account for the gender differences. This study corroborates with Maila, G., *et al* [34] who reported a study done in Verulam, South Africa that indicated 68.4% of women and 25% of men were at risk of central obesity.

Furthermore, the study found that prevalence of visceral obesity in students aged ≥25 years was (35.5%). The reason could be due to difference of eating habits and overall food choices that lead to risky behaviours. The reasons could be due to metabolic changes that happen across different age groups and life factors that are accompanied as age progresses such as increased stress, changes in sleep patterns and exposure to risk behaviours. The findings of this study are in line with Molla, M. D., *et al* [35] that found an increase in age was statistically associated with central obesity. Similarly, a study by Munyogwa, M. J., *et al* [36] in Dodoma City reported respondents with an increased age were associated with development of abdominal obesity.

An interesting finding in the current study was the absence of Hyperglycaemia among the University students. The findings are inconsistent with those of other studies. Many regional and international studies reported high blood sugar to be a significant risk factor amongst university students [37-39, 40] The absence of high blood sugar levels in this study is likely related to the method used to assess for the blood

glucose levels (Random blood glucose) and the number of participants that were enrolled in the study.

### *4.2. Determinants of Metabolic Risk Factors Among University Students*

In our study location of the university, gender, age, nutrition status, marital status, Scholarship status, Smoking status and dietary diversity were all significant determinants of metabolic risk factors. Females were more susceptible in developing central obesity compared to their male counterparts. The probable cause of this could be due to the sociocultural dynamics, different contextual factors that drive gender differences in food consumption and the biological factors. The findings of this study are in line with Israel, E., *et al* [41] who reported that being female was associated with central obesity. Female students are less likely to perform physical activities and more prone to sedentary behaviours this could be a possible explanation for the risk of morbidity. Students who were ≥25 years old in this study were more inclined to have central obesity compared to younger students. The probable cause for this might be due to differences in food habits and increase metabolic needs as age progresses. These results were consistent with a study conducted in Ethiopia whereby the odds of being abdominally obese by waist circumference increased by age [42]. The study also found that being obese was associated with central obesity. Central obesity is often associated with sedentary lifestyles, poor dietary choices, high consumption of energy dense foods as well as a number of factors such as hormonal imbalances and metabolic disorders which may lead to general obesity. The findings of this study are in line with Tegegne, K. D., *et al[*43] that reported central obesity to be associated with overall obesity.

In our study we found that location of the university and smoking status was significantly associated with increased levels of triglycerides whereby students at Mzumbe university and students who smoked were at a higher risk of having high triglyceride levels. The possible reason could be due to the toxic chemicals present in cigarette smoke which may impair lipid metabolism and lead to higher triglyceride levels. However, this could be bias due to the fact that the study reported few participants who were smokers. The findings of this study are in line with van der Plas, A., *et al* [44] who reported triglyceride levels to be higher in smokers than non-smokers by 0.50 mmol/L (95% confidence interval: 0.49–0.50 mmol/L). Agro-ecological zones across regions have differences which can have a health implication to the residents, the differences include food stuffs grown, rainfall pattern, land fertility and overall food security. This study found that triglyceride levels differed between Morogoro and Dodoma region in the university students the findings corroborate with de Groot, R., *et al* [27] who reported differences in triglyceride levels to be higher in urban than in and rural areas among adults (mean difference 0.09, 95%CI 0.03 to 0.14). Furthermore, the urban/rural differences of low-density lipoprotein levels were reported to be higher in urban than in rural areas (mean difference 0.28, 95%CI 0.17 to 0.39) [27]. Total cholesterol levels were associated with location of the university in contrast with Studziński, K.*, et al* [45] who reported no association of total cholesterol levels between urban and rural areas.

The study also reported Marital status and smoking to be associated with Blood pressure (Diastolic). Marital life comes with a lot of challenges that are economic, social and physical. These factors can lead to changes in the body metabolism that results into metabolic disorders. For the case of smoking the chemical substances such as nicotine causes vasoconstriction leading to increase of blood pressure, moreover smoking is associated with increased heartbeat through adrenaline secretion. Li, K., *et al* [46] reported that marital status was associated with higher odds of hypertension. Chen, Q., *et al* [47] reported an association between smoking and hypertension in adults. Furthermore, the study reported receiving scholarship and students with a diversified diet to be associated with low density lipoprotein. The possible reason for this could be because the students have a financial capacity to engage in vast risky behaviours and food habits that could lead to elevated levels of low-density lipoproteins. Rong, S., *et al* [48] reported Low-density lipoprotein to be associated with socio-economic status that results to high risks of all-cause mortality.

### *4.3. Prevalence and Determinants of Other Health Implicated Factors Among University Students*

The study found that the overall prevalence of low-blood sugar levels among the participants was 18.6%. A significant higher prevalence was found to be in females (26.9%), Morogoro university (27.7%), and students in campus (30.3%). The probable reason could be because of the methodology used to collect the blood samples which is random blood glucose. The measurements were taken during normal class routine and in between breaks from one lecture to another. It is known that university students tend to skip their meals therefore this could have been among the factors that resulted to low levels of blood glucose, another factor could be stress on studies and keeping up with school activities. The findings in this study are inconsistent with other studies done in university students that show high prevalence of hyperglycaemia among adults. Metta, E. [49] reported the prevalence of diabetes to be 10.3% which is higher than the 9.1% prevalence reported in 2012 and is a massive increase from the 2.5% prevalence reported in 1984 among people of the same population group. The International diabetes Federation reported that 2,888,000 Tanzanians are living with diabetes (International Diabetes Federation) [50].

Additionally, the overall prevalence of high-density lipoprotein among the university students was (38.2%). A significant higher prevalence was found to be in females (44.3%), Saint Johns's university students (47.2%) and Off-campus students (43.5%). The possible reason could be due to inconsistent cut off points for high-density lipoprotein and the number of participants present in the study. The findings of this study vary with other studies that report low levels of high-density lipoprotein which is among the metabolic risk factors. High density lipoprotein is inversely

associated with cardiovascular disease whereby low levels of HDL-cholesterol are strong predictors atherosclerosis, cardiovascular disease and mortality [51]. Hamooya, B. M., *et al* [52] reported low HDL-concentration to be highly prevalent among young adults in Sub-Saharan Africa.

The determinants for the health implicated risk factors in the study were found to be significantly associated with Location university, smoking status, study year and sex. The possible reason for this is due to difference in agro-ecological zones, biological factors accompanied with gender differences, peer pressure, food choices and eating behaviour.

# 5. Conclusions

The study emphasizes that university students are living with metabolic risk factors that could have future health implications. Low-density lipoprotein levels were the most prevalent metabolic risk factor. The study revealed that location of the university, gender, age, nutrition status, marital status, scholarship status, smoking status and dietary diversity were all significant determinants of metabolic risk factors. However, other health related factors were found in this study such as low-blood glucose levels and high-density lipoprotein. The results highlight that the prevalence of metabolic risk factors that result to metabolic syndrome amongst the study population can have health implications. Therefore, health and university policymakers must consider the predisposing factors among this vulnerable population in order to prepare preventive and health promotion strategies for controlling Cardio Vascular Diseases risk. Likewise, university environment should be a platform where nutrition programs are administered and actively participation of the university students as influencers and agents of change. Nutrition policies and programs aiming to tackle nutritional disorders in all its forms and track progress made to achieve sustainable development Goals by 2030. Cut off points should be established for sub-Saharan countries so as to properly asses the metabolic risk factors. Longitudinal prospective studies with a larger sample size should be conducted so as to get the clear snapshot of challenges facing this sub-population.

# ORCID

0009-0003-7474-5355 (Neema Mgetta)
0009-0001-9827-5816 (Happiness Muhimbula)
0000-0001-9433-5255 (Kissa Kulwa)

# Acknowledgments

The authors wish to extend the gratitude to the late Dr. Kissa Kulwa (RIP) for her tireless support and valuable inputs since the beginning of this work up to data collection and Dr. Victoria Gowele for her invaluable inputs. The authors wish to extend thanks to the students who gave consent in this study in respective universities. Finally, the authors acknowledge the efforts of the research assistants who accepted to help in data collection.

# Conflicts of Interest

The authors declare no conflicts of interest.

# References

[1] Olatona, F. A., Onabanjo, O. O., Ugbaja, R. N., Nnoaham, K. E., & Adelekan, D. A. (2018). Dietary habits and metabolic risk factors for non-communicable diseases in a university undergraduate population. *Journal of health, population and nutrition*, *37*, 1-9. doi: 10.1186/s41043-018-0152-2.

[2] Kassam, N., Surani, S., Hameed, K., Aghan, E., Mayenga, R., Matei, I.,... & Somji, S. (2023). Magnitude, Distribution and Contextual Risk Enhancing Predictors of High 10-Year Cardiovascular Risk Among Diabetic Patients in Tanzania. *Patient Related Outcome Measures*, 87-96. doi: 10.2147/PROM. S405392.

[3] Florence, G. E., Derman, W. E., Popperwell, J. M., Kunorozva, L., & Gomez-Ezeiza, J. (2023). Prevalence of health risk behaviours related to non-communicable diseases amongst South African university students: a systematic review. *Journal of Public Health*, *45*(4), 1042-1055. doi: 10.1093/pubmed/fdad106.

[4] Obsa, M. S., Ataro, G., Awoke, N., Jemal, B., Tilahun, T., Ayalew, N.,... & Haji, Y. (2022). Determinants of dyslipidemia in Africa: a systematic review and meta-analysis. *Frontiers in cardiovascular medicine*, *8*, 778891. doi: 10.3389/fcvm.2021.778891.

[5] Macicame, I., Prista, A., Parhofer, K. G., Cavele, N., Manhiça, C., Nhachungue, S.,... & Rehfuess, E. (2021). Social determinants and behaviors associated with overweight and obesity among youth and adults in a peri-urban area of Maputo City, Mozambique. *Journal of Global Health*, *11*. doi: 10.7189%2Fjogh.11.04021.

[6] Tladi, D., Mokgatlhe, L., Nell, T., Shaibu, S., Mitchell, R., Mokgothu, C.,... & Hubona, O. (2021). Prevalence of the Metabolic Syndrome Among Batswana Adults in Urban and Semi-Urban Gaborone. *Diabetes, Metabolic Syndrome and Obesity*, 2505-2514. doi: 10.2147/DMSO.S285898.

[7] MALINDISA, E. K., Balandya, E., Njelekela, M. A., & Mashiri, F. (2019). Magnitude of Type 2 Diabetes Mellitus, Dyslipidemia and Hypertension Among Young Adults in Urban Settings: A Cross Sectional Survey in Mwanza, Tanzania. doi: 10.21203/rs.2.13177/v1.

[8] Mezhal, F., Oulhaj, A., Abdulle, A., AlJunaibi, A., Alnaeemi, A., Ahmad, A.,... & Ali, R. (2023). High prevalence of cardiometabolic risk factors amongst young adults in the United Arab Emirates: the UAE Healthy Future Study. *BMC CardiovascularDisorders*, *23*(1), 137. doi: 10.1186/s12872-023-03165-3.

[9] Driggins, S. N., & Muhammad, K. M. (2019). A population at risk: a metabolic syndrome study among African American students at a historically black college and university. *Athens Journal of Health & Medical Sciences*, *6*(4), 231-242. doi: 10.30958/ajhms.6-4-3.

[10] Ibrahim, M. S., Pang, D., Pappas, Y., & Randhawa, G. (2020). Metabolic syndrome risk models and scores: a systematic review. *Biomed J Sci Tech Res*, *26*(1), 19695-19707. doi: 10.26717/BJSTR.2020.26.004307.

[11] Malindisa, E. K., Balandya, E., Mashili, F., Iddi, S., & Njelekela, M. (2022). The magnitude of type 2 diabetes mellitus and cardiovascular disease risk factors among young adults in urban settings: a cross-sectional survey in Mwanza, Tanzania. *The Pan African Medical Journal*, *42*. doi: 10.11604%2Fpamj.2022.42.19.22184.

[12] Roman, W., Martin, H., & Sauli, E. (2019). Cardiovascular diseases in Tanzania: The burden of modifiable and intermediate risk factors. doi: 10.21037/jxym.2019.07.03.

[13] Faijer-Westerink, H. J., Kengne, A. P., Meeks, K. A., & Agyemang, C. (2020). Prevalence of metabolic syndrome in sub-Saharan Africa: A systematic review and meta-analysis. *Nutrition, Metabolism and Cardiovascular Diseases*, *30*(4), 547-565. doi: 10.1016/j.numecd.2019.12.012.

[14] Pori, D. B., Msigula, P., & Massawe, H. B. (2022). Assessment of the Soil Information and Analysis of Related Land Constraints to the Selected Detailed Town Planning Schemes in Morogoro Municipal. *Current Urban Studies*, *10*(3), 479-499. doi: 10.4236/cus.2022.103029.

[15] Sumari, N. S., Cobbinah, P. B., Ujoh, F., & Xu, G. (2020). On the absurdity of rapid urbanization: Spatio-temporal analysis of land-use changes in Morogoro, Tanzania. *Cities*, *107*, 102876. doi: 10.1016/j.cities.2020.102876.

[16] National Bureau of Statistics. Available from: https://www.nbs.go.tz/index.php/en/. [Accessed 6 October 2023].

[17] World Bank. "Climate Knowledge Portal". Available from: https://climateknowledgeportal.worldbank.org/country/tanzania/climate-data-historical. [Accessed 21 October 2023].

[18] Pallangyo, P., Mkojera, Z. S., Hemed, N. R., Swai, H. J., Misidai, N., Mgopa, L.,... & Janabi, M. (2020). Obesity epidemic in urban Tanzania: a public health calamity in an already overwhelmed and fragmented health system. *BMC endocrinedisorders*, *20*(1), 1-9. doi: 10.1186/s12902-020-00631-3.

[19] Tladi, D. M., Mokgatlhe, L., Shaibu, S., Nell, T., Mitchell, R., Mokgothu, C. J.,... & Hubona, O. (2020). Determination of optimal cut-off values for waist circumferences used for the diagnosis of the metabolic syndrome among Batswana adults (ELS 32). *Cardiovascular Journal of Africa*, *31*(6), 314-318. doi:.10520/ejc-cardio1-v31-n6-a6.

[20] Khamis, A. G., Senkoro, M., Mwanri, A. W., Kreppel, K., Mfinanga, S. G., Bonfoh, B., & Kwesigabo, G. (2020). Prevalence and determinants of hypertension among pastoralists in Monduli District, Arusha region in Tanzania: a cross-sectional study. *Archives of Public Health*, *78*(1), 1-12. doi: 10.1186/s13690-020-00485-0.

[21] Byashalira, K. C., Chamba, N. G., Alkabab, Y., Mbelele, P. M., Mpolya, E. A., Ntinginya, N. E.,... & ADEPT consortium. (2022). Impact of early diagnosis of impaired glucose regulation in tuberculosis: Comparison of clinical outcomes in people with tuberculosis in Tanzania. *Tropical Medicine & International Health*, *27*(9), 815-822. doi: 10.1111/tmi.13806.

[22] Ostchega, Yechiam, Jeffery P. Hughes, Guangyu Zhang, Tatiana Nwankwo, Jessica Graber, and Duong T. Nguyen. "Differences in hypertension prevalence and hypertension control by urbanization among adults in the United States, 2013–2018." *American journal of hypertension* 35, no. 1 (2022): 31-41. doi: 10.1093/ajh/hpab067.

[23] Manus, M. B., Bloomfield, G. S., Leonard, A. S., Guidera, L. N., Samson, D. R., & Nunn, C. L. (2018). High prevalence of hypertension in an agricultural village in Madagascar. *PloS one*, *13*(8), e0201616. doi: 10.1371/journal.pone.0201616.

[24] Rashid, N., & Dika, H. I. (2017). Casual blood pressure among Tanzanian undergraduate students: need for re-defining population specific operational threshold between normotension and hypertension. *Tanzania Journal of Health Research*, *19*(1). doi: 10.4314/thrb.v19i1.5.

[25] Wang, C., Yuan, Y., Zheng, M., Pan, A. N., Wang, M., Zhao, M.,... & Xue, H. (2020). Association of age of onset of hypertension with cardiovascular diseases and mortality. *Journal of the American College of Cardiology*, *75*(23), 2921-2930. doi: 10.1016/j.jacc.2020.04.038.

[26] Mohammed, M. A., Ali, S. H., & Al-ghareebawi, A. M. A. (2023). Evaluation Cholesterol and Triglycerides Levels for Type One Diabetes Patients. *World Journal of Current Medical and Pharmaceutical Research*, 168-174. doi: 10.37022/wjcmpr.v5i5.289.

[27] de Groot, R., van den Hurk, K., Schoonmade, L. J., de Kort, W. L., Brug, J., & Lakerveld, J. (2019). Urban-rural differences in the association between blood lipids and characteristics of the built environment: a systematic review and meta-analysis. *BMJ global health*, *4*(1), e001017. doi: 10.1136/bmjgh-2018-001017.

[28] Sarfo, F. S., & Ovbiagele, B. (2020). Prevalence and predictors of statin utilization among patient populations at high vascular risk in Ghana. *Journal of the neurological sciences*, *414*, 116838. doi: 10.1016/j.jns.2020.116838.

[29] Davis, E. F., Lazdam, M., Lewandowski, A. J., Worton, S. A., Kelly, B., Kenworthy, Y.,... & Leeson, P. (2012). Cardiovascular risk factors in children and young adults born to preeclamptic pregnancies: a systematic review. *Pediatrics*, *129*(6), e1552-e1561. doi: 10.1542/peds.2011-3093.

[30] Al-Duais, M. A., & Al-Awthan, Y. S. (2019). Association between qat chewing and dyslipidaemia among young males. *Journal of Taibah University Medical Sciences*, *14*(6), 538-546. doi: 10.1016/j.jtumed.2019.09.008.

[31] Kasia, B. E., Nyondia, V. Y., & Oseajeh, P. O. (2020). Evaluation of lipid profile pattern among apparently healthy students of Niger Delta University. *Annals of Tropical Pathology*, *11*(2), 146. doi: 10.4103/atp.atp_17_20.

[32] Rotich, S. J., Funder, M., & Marani, M. (2023). Suburban pastoralists: Pastoral adaptation strategies at the rural-urban interface in Nairobi, Kenya. *Pastoralism*, *13*(1), 6. doi: 10.1186/s13570-023-00268-6.

[33] Mitić, N. R., & Popović, L. (2019). Assessment of the risk status of diseases associated with overweight in students of the University of Pristina-Kosovska Mitrovica. *Praxis medica*, *48*(3-4), 5-12. doi: 10.5937/pramed1904005M.

[34] Maila, G., Audain, K., & Marinda, P. A. (2021). Association between dietary diversity, health and nutritional status of older persons in rural Zambia. *South African Journal of Clinical Nutrition*, *34*(1), 34-39. doi: 10.1080/16070658.2019.1641271.

[35] Molla, M. D., Wolde, H. F., & Atnafu, A. (2020). Magnitude of central obesity and its associated factors among adults in urban areas of Northwest Ethiopia. *Diabetes, Metabolic Syndrome and Obesity*, 4169-4178. doi: 10.2147/DMSO.S279837.

[36] Munyogwa, M. J., Gibore, N. S., Ngowi, A. F., & Mwampagatwa, I. H. (2021). Effect of nutritional education intervention to reduce anaemia during pregnancy in Dodoma City, Tanzania: protocol for a cluster randomized controlled trial. *Biology Methods and Protocols*, *6*(1), bpab012. doi: 10.1093/biomethods/bpab012.

[37] Elkhateeb, Y. A. M. M., & yousefkhaled Alfhied, N. (2018). A study on the prevalence of diabetes mellitus among Students of Hail University. *Age (year)*, *18*(25), 21-15. doi: 10.11648/j.ijbse.20180603.11.

[38] Yaaqoob, B. Y., & Kadhem, S. A. (2023). Assessment the level of knowledge and attitude of college students regarding diabetes mellitus. *Health Education and Health Promotion*, *11*(1), 1001-1006. doi: 10.58209/hehp.11.1.173.

[39] Alghamdi, I. K., Alrefai, A. M., Alghamdi, T. A., Nawawi, A. T., Badawy, Y. A., Alghamdi, I.,... & Badawy, Y. (2023). Prevalence of Contributing Factors Leading to the Development of Insulin Resistance Among Male Medical Students at a Private College in Saudi Arabia. *Cureus*, *15*(11). doi: 10.7759/cureus.48269.

[40] Malindisa, E., Balandya, E., Njelekela, M., Kidenya, B. R., Francis, F., Mmbaga, B. T.,... & PrayGod, G. (2023). Metabolic syndrome among people living with HIV on antiretroviral therapy in Mwanza, Tanzania. *BMC Endocrine Disorders*, *23*(1), 88. doi: 10.1186/s12902-023-01340-3.

[41] Israel, E., Hassen, K., Markos, M., Wolde, K., & Hawulte, B. (2022). Central obesity and associated factors among urban adults in dire dawa administrative city, Eastern Ethiopia. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 601-614. doi: 10.2147/DMSO.S348098.

[42] Bereka, S. G., Demisse, A. W., & Getahun, G. K. (2022). Prevalence of abdominal obesity and associated risk factors among women civil servants in Addis Ababa, Ethiopia, 2021: an institution-based study. *BMC nutrition*, *8*(1), 119. doi: 10.1186/s40795-022-00613-9.

[43] Tegegne, K. D., Wagaw, G. B., Gebeyehu, N. A., Yirdaw, L. T., Shewangashaw, N. E., Mekonen, N. A., & Kassaw, M. W. (2022). Prevalence of central obesity and associated factors in Ethiopia: A systematic review and meta-analysis. *Frontiers in Endocrinology*, *13*, 2118. doi: 10.3389/fendo.2022.983180.

[44] van der Plas, A., Antunes, M., Pouly, S., de La Bourdonnaye, G., Hankins, M., & Heremans, A. (2023). Meta-analysis of the effects of smoking and smoking cessation on triglyceride levels. *Toxicology Reports*, *10*, 367-375. doi: 10.1016/j.toxrep.2023.03.001.

[45] Studziński, K., Tomasik, T., Windak, A., Banach, M., Wójtowicz, E., Mastej, M.,... & LIPIDOGRAM2015 Investigators. (2021). The differences in the prevalence of cardiovascular disease, its risk factors, and achievement of therapeutic goals among urban and rural primary care patients in Poland: Results from the LIPIDOGRAM 2015 study. *Journal of Clinical Medicine*, *10*(23), 5656. doi: 10.3390/jcm10235656.

[46] Li, K., Ma, X., Yuan, L., & Ma, J. (2022). Age differences in the association between marital status and hypertension: a population-based study. *Journal of Human Hypertension*, *36*(7), 670-680. doi: 10.1038/s41371-021-00558-9.

[47] Chen, Q., Ma, X., Geng, Y., Liao, J., & Ma, L. (2022). Association between smoking and hypertension under different PM2. 5 and green space exposure: A nationwide cross-sectional study. *Frontiers in Public Health*, *10*, 1026648. doi: 10.3389/fpubh.2022.1026648.

[48] Rong, S., Li, B., Chen, L., Sun, Y., Du, Y., Liu, B.,... & Bao, W. (2022). Association of Low‐Density Lipoprotein Cholesterol Levels with More than 20‐Year Risk of Cardiovascular and All-Cause Mortality in the General Population. *Journal of the American Heart Association*, *11*(15), e023690. doi: 10.1161/JAHA.121.023690.

[49] Metta, E. (2023). "A disease that God has given me" patients and caregivers' perspectives on diabetes in southeastern Tanzania. *BMC Public Health*, *23*(1), 213. doi: 10.1186/s12889-023-15147-3.

[50] International Diabetes Federation Atlas 2021. Available from: https://diabetesatlas.org/atlas/tenth-edition/. [Accessed 12 October 2023].

[51] Melin, E. O., Thulesius, H. O., Hillman, M., Svensson, R., Landin-Olsson, M., & Thunander, M. (2019). Lower HDL-cholesterol, a known marker of cardiovascular risk, was associated with depression in type 1 diabetes: a cross sectional study. *Lipids in Health and Disease*, *18*, 1-10. doi: 10.1186/s12944-019-1009-4.

[52] Hamooya, B. M., Musonda, P., Mutale, W., Masenga, S. K., Halwiindi, H., Mutengo, K. H.,... & Heimburger, D. C. (2021). Prevalence of low high-density lipoprotein among young adults receiving antiretroviral therapy in Zambia: An opportunity to consider non-communicable diseases in resource-limited settings. *Plos one*, *16*(2), e0247004. doi: 10.1371/journal.pone.0247004.