

Sokoine University of Agriculture



MSc Dissertation

**Nutritional Status and Metabolic
Risk Factors Among University
Students in Morogoro and Dodoma
Regions**

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May 2024**

**NUTRITIONAL STATUS AND METABOLIC RISK FACTORS
AMONG UNIVERSITY STUDENTS IN MOROGORO AND
DODOMA REGIONS**

***Dissertation is Submitted to Sokoine University of Agriculture
in Partial Fulfilment of the Requirements for the Master's
Degree in Human Nutrition***

By

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EXTENDED ABSTRACT

The transition from adolescence to adulthood coupled with the demands of academic life often leads to significant changes in dietary patterns and lifestyle behaviors among university students. These changes can have profound implications for their nutritional status and metabolic health. The lifestyle choices due to independence increases the incidence of chronic illnesses for this sub-population. University is an opportune setting in the transition from youth to adulthood and provides a chance to influence healthy habits and good nutritional status. University students are important group to target in influencing future health-promoting habits, prevention and management of obesity which is associated with the development of non-communicable diseases (NCDs). However, information on the nutritional status and metabolic risk factors of university students is scarce. Therefore, findings from the present study could serve as a stepping stone in enhancing the nutritional and healthy quality of university students. The cross-sectional study was conducted among 247 university students in Mzumbe and Saint John's Universities in Morogoro and Dodoma regions respectively. Two Tanzania Commission for Universities (TCU) accredited universities present based on agro-ecological zones. Data were collected through face-to-face interviews using a pre-tested structured questionnaire that included the socio-demographic characteristics of the population, food-frequency questionnaire and dietary habits. Anthropometric measurements (weight, height and waist circumference) were collected as well as the metabolic risk bio-markers (blood lipid profile, blood pressure and blood glucose) by trained medical personnel. The study commenced after receiving approval from National Health Research Committee of the National Institute for Medical Research. Permission to conduct this study was also sought from each university's authorities. Data were managed and analysed using IBM SPSS Statistics for Windows (Version 26.0. IBM Corp, 2011, Armonk, NY). Descriptive statistics were generated for each variable. The distribution of continuous variables was tested

for normality using box plots and-Q plots and the Shapiro-Wilk test. Multivariate analysis (Multiple linear regression) was used to assess the determinants of metabolic risk factors among variables. A sub-sample of 118 students was drawn from the total study cohort for metabolic risk factors assessment. Students from each university were selected randomly; 65 students from Mzumbe University and 53 students from Saint Johns' university.

The study findings revealed the overall prevalence of overweight (44%) and obesity (11.1%) in the study population. University students with a high dietary diversity score (consumed ≥ 7 food groups) were linked with central obesity ($P=0.04$). The risk of morbidity (central obesity) was significantly associated ($P=0.000$) with being female and age above 25 years ($P=0.001$) in both universities. Students at Saint John's University were significantly at higher risk of being overweight ($P=0.031$) than their counterparts. Findings from the assessed metabolic risk factors namely central obesity, Low-density lipoprotein (LDL), triglycerides (TG) and total cholesterol (TC) revealed that LDL was the most prevalent metabolic risk factor among students in both universities. The LDL levels were (20.3%), (13.6%), (11%) and (14.4%) for above optimal, borderline high, high and very high respectively. Students from Mzumbe University were significantly associated with hypertriglyceridemia ($P=0.000$). The susceptibility to LDL were found among students who were receiving scholarship ($\beta=21.83$, $SE=10.4$, $p=0.1$) and those with high dietary diversity ($\beta=5.731$, $SE=3.14$, $p=0.1$).

In conclusion, findings from this study revealed that university students are at a risk of being overweight, generally obese and centrally obese. This sub-population is also prone to a cluster of metabolic risk factors, which according to the findings include elevated triglyceride levels, elevated low-density lipoprotein levels and central obesity. This indicates the necessity of enhancing the availability of exercise and sports facilities, healthier food outlets and implementing nutrition education intervention to empower students in making healthy life style choices.

IKIRIKISI KUU

Ukuaji kutoka ujana hadi utu uzima pamoja na mahitaji ya maisha ya kitaaluma mara nyingi husababisha mabadiliko makubwa katika mifumo ya chakula na tabia ya maisha kati ya wanafunzi wa vyuo vikuu. Mabadiliko haya yanaweza kuwa na athari kubwa kwa hali yao ya lishe na afya ya kimetaboliki. Utaratibu wa namna ya ulaji na mitindo ya maisha huongeza matukio ya magonjwa sugu kwa wanafunzi hawa. Chuo kikuu kinawakilisha eneo muhimu katika mabadiliko kutoka ujana hadi utu uzima na ni kipindi cha mpito ambacho hutoa fursa ya kuwa na tabia bora za kiafya na hali nzuri ya lishe. Mazingira mapya ya vyuoni hufanya wanafunzi wa vyuo vikuu kuwa kundi kubwa lililo katika hatari ya kuathiriwa na magonjwa ya kimetaboliki. Hii inapelekea kundi hili kuwa la muhimu katika kufanyiwa tafiti zinazolenga kuboresha utaratibu wa ulaji na mitindo ya maisha. Kutokana na uchache wa takwimu kuhusu hali ya lishe na viashiria hatarishi vya kimetaboli ya wanafunzi wa vyuo vikuu, utafiti huu unaweza kutumika kama hatua ya kuimarisha lishe na afya bora kwa wanafunzi wa vyuo vikuu. Utafiti huu ulifanywa kwa wanafunzi 247 toka vyuo vikuu vilivyopo mikoa ya Morogoro na Dodoma vilivyoidhinishwa na Tume ya Vyuo Vikuu Tanzania (TCU). Pia uchaguzi wa vyuo ulizingatia tofauti za ikolojia ya mikoa husika. Chuo Kikuu cha Mzumbe kilichopo Morogoro na Chuo Kikuu cha Saint John's cha Dodoma vilichaguliwa. Takwimu zilikusanywa kupitia mahojiano ya ana kwa ana kwa kutumia dodoso lililofanyiwa majaribio. Dodoso hili lilikusanya taarifa za kidemografia, taarifa za hali ya lishe, makundi ya vyakula na vipimo vya kimetaboli (viwango vya mafuta kwenye damu, shinikizo la damu na kiwango cha sukari kwenye damu). Utafiti huu ulifanyika baada ya kupokea idhini kutoka Taasisi ya Taifa ya Utafiti wa Magonjwa ya Binadamu (NIMR) pamoja na mamlaka ya vyuo vikuu husika. Kati ya wanafunzi 247 waliochaguliwa katika utafiti huu wanafunzi 118 ndio waliofanyiwa utafiti wa viashiria hatarishi vya kimetaboli. Hii ilhusisha wanafunzi 65 kutoka Chuo Kikuu cha Mzumbe na wanafunzi 53 kutoka chuo kikuu cha Saint John's.

Matokeo ya utafiti yalionesha kuenea kwa jumla kwa uzito kupita kiasi (44%) na unene uliozidi (11.1%) miongoni mwa wanafunzi. Pia wanafunzi wa chuo kikuu walioripoti kula zaidi ya makundi saba ya vyakula walihusishwa na unene wa kupindukia ($P=0.04$). Unene uliozidi wa eneo la kati la tumbo ulihusishwa kwa kiasi kikubwa ($P=0.000$) na jinsia ya kike na umri zaidi ya miaka 25 ($P=0.001$). Wanafunzi kutoka chuo kikuu cha Saint John's walikuwa katika hatari kubwa zaidi ya kuwa na uzito uliozidi ($P=0.031$) kuliko wenzao wa chuo kikuu cha Mzumbe. Matokeo ya viashiria hatarishi vya kimetaboli ambavyo ni unene uliozidi wa eneo la kati la tumbo, viwango vya juu vya lehemu mbaya (LDL), viwango vya juu vya mafuta kwenye damu (TG) na lehemu (TC) yalionesha kwamba viwango vya juu vya LDL ndiyo sababu kuu hatarishi ya kimetaboli kwa wanafunzi katika vyuo vikuu vyote viwili. Vilevile wanafunzi kutoka Chuo Kikuu cha Mzumbe walihusishwa kwa kiasi kikubwa na viwango vya juu vya mafuta kwenye damu (hypertriglyceridemia) kwa $P=0.000$. Wanafunzi walioripoti kupokea ufadhili wa masomo ($\beta=21.83$, $SE=10.4$, $p=0.1$) na kula zaidi ya makundi saba ya vyakula ($\beta=5.731$, $SE=3.14$, $p=0.1$) walikua katika hatari kubwa ya kuwa na viwango vya juu vya LDL.

Matokeo ya utafiti huu yameonesha kwamba wanafunzi wa vyuo vikuu wako katika hatari ya kuwa na uzito uliozidi, unene uliokithiri na unene uliozidi wa eneo la kati la tumbo. Pia wanafunzi hawa wameonekana kukabiliwa na viashiria hatarishi vya kimetaboli ambavyo ni unene uliozidi wa eneo la kati la tumbo, viwango vya juu vya lehemu mbaya (LDL) na viwango vya juu vya mafuta kwenye damu (TG). Matokeo haya yanaonesha umuhimu wa kuimarisha upatikanaji wa vifaa vya mazoezi na michezo, upatikanaji wa vyakula bora katika mazingira ya vyuo na utekelezaji wa afua ya elimu ya lishe ili kuwawezesha wanafunzi kufanya uchaguzi wa namna ya ulaji na mitindo bora ya maisha.

DECLARATION

I, **NEEMA JOHN MGETTA**, do hereby declare to the senate of Sokoine University of Agriculture that this dissertation is my own original work done and that it has neither been submitted nor being concurrently submitted in any other institution.

Neema John Mgetta
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The above declaration is confirmed by;

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LIST OF PUBLISHED PAPERS

- 1: Mgetta, N., & Muhimbula, H. (2024). Dietary diversity and Anthropometric status of students at universities in Dodoma and Morogoro Regions, Tanzania. *Tanzania Journal of Health Research*, 25(2), 871-888. *Tanzania Journal of Health Research*. <https://doi.org/10.4314/thrb.v25i2.14>
- 2: Mgetta, N., Muhimbula, H., & Kulwa, K. (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://www.sciencepg.com/article/10.11648/j.jfns.20241201.13>

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DEDICATION

This work is dedicated to my beloved family, my Father John Samwel Mgetta, my Mother Rose Joseph Mgetta, my late Sister Irene John Mgetta, My Sister Dorice Mgetta and brothers Daniel and David Mgetta.

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LIST OF ABBREVIATIONS AND ACRONYMS

CVD	Cardiovascular diseases
FAO	Food and Agriculture Organization
LMICs	Low- and Middle-Income Countries
NCDs	Non-Communicable Diseases
TAMISEMI	<i>Tawala za Mikoa na Serikali za Mitaa</i>
TDHS	Tanzania Demographic and Health Survey
WHO	World Health Organization

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background Information

The university environment can present challenges that may increase the risk of unhealthy behaviours that potentially impact on overall health. Eating behaviour is a significant aspect of life as they can affect long-term health outcomes because unhealthy eating habits such as consuming nutrient-deficient food, skipping meals, and lack of a timely diet are understood to cause various health problems and nutritional deficiencies (Kabir *et al.*, 2018). The transition to college is associated with significant changes in dietary options among university students. It puts them at risk of making poor dietary choices that can lead to health problems (Mogeni & Ouma, 2022).

The beginning of the university period generally includes the transition period between adolescence and adulthood, a phase that is often characterized as a time of greater autonomy for the student over his/her life due to factors such as the separation from the parental home and the acquisition of new responsibilities (Araujo *et al.*, 2023). Globally, more than 207 million students (majority emerging adults) are enrolled in higher education (Bailey *et al.*, 2020). In general, a substantial proportion of young adults, in particular higher education students, follow unhealthy lifestyles (Telleria-Aramburu & Arroyo-Izaga, 2021). The nutritional status of young adults has a significant impact on their well-being both now and in the future. The overall nutritional status of an individual can be assessed by anthropometry, biochemical tests, and evaluation of dietary intake which establishes normal status or risk of malnutrition (Pimentel *et al.*, 2019).

The evaluation of nutritional status plays an important role as it has an inverse relationship with the incidence of non-communicable

diseases (NCDs), including obesity, type 2 diabetes mellitus (DM2), cardiovascular diseases (CVDs), hypertension, and some cancers (Pimentel *et al.*, 2018). The fundamental elements of anthropometry are height, weight, body circumference (waist, hip, and head), and skinfold thickness (Kayode & Oshineye, 2022). Malnutrition is characterized by the simultaneous presence of undernutrition, overweight, and obesity linked to diet within populations (Bhati *et al.*, 2022). Obesity is a serious public health issue that impacts individuals of all ages and genders in both developed and developing countries. It is also linked to several disorders, including 2 diabetes, metabolic syndrome, cardiovascular disease (CVD), hypertension, dyslipidemia, and premature mortality (Getahun *et al.*, 2023). The risk of developing lifestyle-related disorders like Diabetes Mellitus, myocardial infarction, stroke, hypertension and certain cancers increases with an increase in the prevalence of overweight and obesity. Chronic diseases are becoming more common in Africa due to ongoing changes. 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 (Macicame, 2021). 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 (Tladi *et al.*, 2021).

A considerable number of cases of NCD burden are attributable to behavioral, environmental, dietary, and metabolic risk factors such as hypertension, dyslipidemia, raised blood sugar, overweight, and obesity (Majic *et al.*, 2023). Students at the university level are characterized by independence in choices of various aspects of the university life changes in various regions (Obsa *et al.*, 2022). Global estimates indicate that about a third of the population in every country is affected by Metabolic syndrome with predictions of a

worldwide increase primarily in developing countries (Abagre *et al.*, 2022). Obesity and being overweight continue to be major societal problems which represent a rapidly growing risk to the health of people in several countries (Muhomba *et al.*, 2023). Tanzania is experiencing an epidemic of obesity and disorders that are associated with the risk of non-communicable diseases much like other nations. Recently studies have established that Tanzania like other developing countries is also undergoing a higher burden of cardiovascular risk factors particularly diabetes and hypertension (Munyogwa *et al.*, 2021). Therefore, the essence of determining the anthropometric status, metabolic risk factors and eating behaviours of university students pose a public health significance. Figure 1.1 shows a diagram of the university environment and the eating behavior of the students.

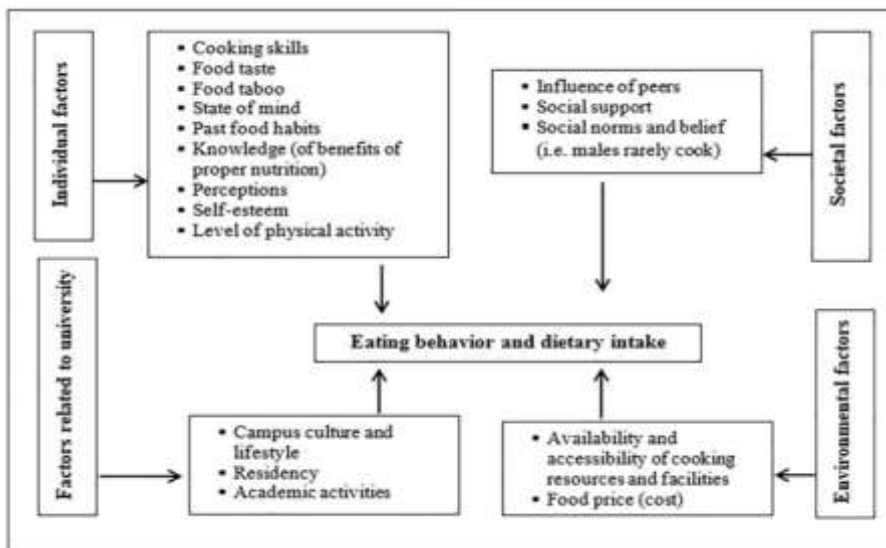


Figure 1.1: Conceptual framework of the university environment and eating behavior amongst university students, Source Kabir *et al.* (2018).

1.2. Problem Statement and Justification of the Study

1.2.1. Problem statement

The global increase in obesity also referred to as 'globesity' represents one of the most significant public health issues facing societies (Koliaki *et al.*, 2023). One of the most significant dietary and health issues affecting young adults in both developed and developing nations is obesity, a multifactorial metabolic disease linked to other comorbidities (Abbasifard *et al.*, 2023). Metabolic conditions and obesity are linked to a number of non-communicable diseases (NCDs), including cancer, type 2 diabetes, and cardiovascular disease (Khamis *et al.*, 2022). Substantial life-changing transitions have been reported to happen when young adults join university and college education and live independently for the first time (Stok *et al.*, 2018). Globally, the literature suggests that during the transitional period from secondary level to graduate level, students often engage in unhealthy dietary habits and poor nutritional intake which have adverse health effects (Kabir *et al.*, 2018). It is critical to develop measures to prevent future health consequences since university students are entering the pool of emerging adults, who are seeing a global rise in obesity and other chronic illnesses.

Students' college time is unique and a critical developmental stage for establishing health-related behavioural patterns, as they gain new experiences and transition from adolescence to adulthood, and increase independence and personal freedom (Nawsherwan *et al.*, 2021). Adolescence is a period of change in which numerous health risk behaviors such as tobacco use and unhealthy dietary behaviors are initiated which are commonly associated with premature morbidity and mortality in a young age (Cherry, 2020). Studies indicate that the college lifestyle is often characterized by practices harmful to health, such as consumption of high energy density diet, sedentarism, frequent consumption of alcoholic beverages and meal skipping; these are risk factors for the

development of Chronic Non-communicable Diseases (Sprake *et al.*, 2018; Whatnall *et al.*, 2021; Rodemann & Arigo, 2018). The transition from adolescence to adulthood is important for establishing interventions that affect long-term health and chronic disease risk (Olatona *et al.*, 2023). The transitional phase experienced by university students and its corresponding traits bring up a significant issue of public health importance.

Behaviours that negatively affect health, such as insufficient food intake and physical inactivity, are frequently observed in university students (Icen & Gunes, 2021). They are considered to be in the risk group of nutritional deficiency due to these unhealthy eating behaviours. Studies among university students in Sub-Saharan African (SSA) countries have shown a high prevalence of obesity which is associated with comorbidities. For-instance a high prevalence of 25.3% - 59.4% has been reported among university students. In Botswana 36.8% of university students were reported to be obese while in South Africa 10.8% - 24% of students were obese, 10% in Nigeria and 19.6%- 28% in Kenya (Rotich *et al.*, 2023). Tanzania among many other developing countries in Sub-Saharan Africa is facing nutritional problems by which obesity and overweight rates are between 24.1-34.5% and 19.2-23.4% respectively (Pallangyo *et al.*, 2020). A survey on the burden of NCD risk factors in Tanzania showed that the burden of diabetes and cardiovascular diseases was high, with the prevalence of hypertension estimated to be around 26% (Maluka & Sangeti, 2022).

Tanzania has experienced an increase of obesity and other metabolic conditions in the past decade (Khamis *et al.*, 2022). NCDs are most prevalent in low- and middle-income countries (LMICs), and the age-adjusted death rates from NCDs are nearly twice as high in LMICs as in high-income countries (Maluka & Sangeti, 2022). The increasing burden of NCDs in LMICs is fuelled by risky

behaviours such as unhealthy dietary habits, smoking and consumption of energy-dense foods (Malindisa *et al.*, 2022).

1.2.2. Justification of the study

The transitioning from adolescent to adulthood and acquiring independence and new experiences, university students play a crucial role in the establishment of health-related behavioural pattern. Researchers have investigated the link between the dietary habits of students and their nutritional status in different contexts. Studies, revealed that improper dietary habits such as the high intake of sweetened drinks and high-fat food consumption have a positive association with overweight and obese (Oti & Eshun, 2020). Studies have specifically focused on more specific types of NCDs such as hypertension and diabetes (Ibrahim *et al.*, 2016; Abdul-Razak *et al.*, 2016; Bashaar *et al.*, 2019; Mwimo *et al.*, 2021).

The consequences of unhealthy behaviours among university students increases the risk of chronic non-communicable diseases and the associated economic burden on individuals and society. Even though the magnitude of obesity and metabolic conditions are increasing globally and in Tanzania there is limited information on the nutrition status and metabolic risk factors in university students. University students represent a transitional period in life where individuals often establish lifelong behaviours and habits which will help to obtain insights in the adaptation of change and new environments.

There is scant data on the nutritional status and metabolic risk factors among university students of Morogoro and Dodoma regions. Findings from this study will contribute to the limited information which will in turn strengthen existing policies and develop strategies as well as tailored interventions with a public health significance. The study findings will enable nutritionists, public health specialists and policy makers to develop comprehensive policies and

prevention strategies for risk behaviours that have health implication amongst this population. Therefore, it will serve as useful information to attain sustainable development goals in particular number 3 which states that “Ensure healthy lives and promote well-being which is in alignment with the national development 2025.

1.3. Study Objectives

1.3.1. General objective

To determine the nutrition status and metabolic risk factors among university students in Morogoro and Dodoma regions.

1.3.2. Specific objectives

- i. To assess the anthropometric status among university students.
- ii. To determine the prevalence and determinants of metabolic risk factors among university students.
- iii. To assess the dietary diversity among university students in Morogoro and Dodoma regions.

1.4. Research Methodology

1.4.1. Description of the Study Area

The study was at Mzumbe University Morogoro and Saint John's University in Dodoma Regions. Morogoro region is located in the eastern zone of Tanzania. The recently estimated population of Morogoro is approximate to 44,0109 with a growth rate of 3.85%. Morogoro has a 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 (Sumari *et al.*, 2020). 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 (Pori *et al.*, 2022).

Dodoma is the region found in the central part of Tanzania mainland with 41,311 km². 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 (NBS, 2022). Dodoma is one of the semi-arid regions with an 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, 2022). There is just one rainy season there, which is a crucial climate component for agricultural activity.

1.4.2. Study design

A cross-sectional design was used for this study whereby data were collected once among university students. This design was employed so that it could allow the collection of data from a large sample of individuals at a single point in time. Additionally, cross-sectional designs are relatively quick and cost-effective, which can be important considerations in studies of university students who may be difficult to access especially when universities are closed and during tight schedules.

1.4.3. Study population (Inclusion and exclusion criteria)

This study was conducted among university students who were full-time in the selected universities (Mzumbe University and Saint John's University) and who signed consent forms. Additionally, students who were pregnant, individuals with disabilities and first-year students, diet/weight management programs were excluded from the study.

1.4.4. Sampling procedure and sample determination

1.4.4.1 Sampling procedure

Two regions, Morogoro and Dodoma were purposively selected as they represent different food systems, diverse environmental and socio-economic conditions and have a fairly large population of

university students for investigating dietary patterns. These regions are fast-growing metropolitans with rapidly changing lifestyles, modernization, and socio-economic transitions. Furthermore, the regions experience a high influx of university students due to increasing numbers of universities and colleges, thus expected to have a diverse population of young adults. Selection of Universities considered ecological zones and public as well as private institutions. Purposive sampling was used to select one public in Morogoro university and one private university in the Dodoma region. Simple Random sampling but proportion to size was used to select students in the university environment. Furthermore, Convenience sampling was used to select students for assessing the metabolic risk profiles from the randomized cohort.

1.4.4.2. Sample size determination

The total number of university students was computed, and a formula by Kothari (2004) was used to calculate the sample size.

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

Whereby;

n = desired sample size

z = standard normal deviation, set at 1.96 corresponding to a 95 % confidence interval

P = proportion in the intended population estimated to have a particular characteristic (0.192) among university students. The prevalence of obesity in community studies in urban Tanzania revealed obesity rate to be 19.2% (Pallangyo *et al.*, 2020)

q = (1-p) proportion of the population who are estimated to not have the particular characteristics (0.192)

d = degree of accuracy desired (0.05)

therefore

$$n = (1.96)^2 \times 0.192 (1-0.192)/0.05^2$$

$$n = 238$$

Allowance for attrition/non-response which is 10% was added, henceforth:

$$10\% \text{ of } 238 = 23.8$$

$$23.8 + 238 = 262$$

The sample size is 262 students.

1.5. Data Collection

Data were obtained from university students through a structured questionnaire. The questionnaire was divided into sections based on objectives. The sections included (i) socio-demographic information; (ii) information on the eating behaviour of the university students which included a food frequency questionnaire, access to meals and consumption of breakfast, lunch and supper with a 7-day inference period; and (iii) nutritional status information of the university students (Height, weight, waist circumference, blood pressure, blood glucose). The interviews were conducted in English and Swahili language to ensure effective communication with the participants. The measurements were taken by phlebotomist (blood samples) and trained enumerators. Data were collected using a pretested questionnaire (Appendix 2).

1.5.1 Data management and statistical analysis

Data was compiled and imported into IBM SPSS Statistics for Windows (Version 26.0. IBM Corp, 2011, Armonk, NY) for analysis. The distribution of continuous variables was tested for normality using box plots and-Q plots and the Shapiro-Wilk test. Continuous variables that were normally distributed were described using mean and standard deviation (SD), frequencies and percentages to describe the characteristics of the study population. The non-normally distributed variables were log-transformed for multivariate analysis to identify the determinants of metabolic risk factors and to check for confounders. Statistical analyses were performed at a significance level of 5% ($p < 0.05$).

1.5.2 Anthropometric assessment

Weight, height and waist circumference were measured to determine the anthropometric status of the students. Weight was measured using a standard weighing scale (digital electronic SECA scale; (Model 8811021659, Germany) that was kept on a firm horizontal surface. The participant was measured without shoes and with light clothing by ensuring the removal of heavy-worn clothing such as coats and scarves as well as personal items such as wallets, phones and watches. Weight was then recorded to the nearest 0.1kg. The scale reading was always allowed to return to zero before the subject was asked to stand on it. Height was measured using a stadiometer (Model No PE-AIM-101-USA) and recorded to the nearest 0.1 cm. Participants were requested to stand upright without shoes on with their back kept against the wall and heels put together in a V-shape while looking forward.

The body mass index (BMI) was calculated by dividing weight (in kilograms) by their height (in meters square). Nutritional status was classified according to the WHO classification of Body mass index. Students were classified as underweight, normal, overweight and obese if they had a Body mass index of below 18.5 (underweight), 18.5-24.9 (normal weight), 25.0-29.9 (overweight) and ≥ 30.0 above (obese) (Weir and Jan, 2022). 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 (Tladi et al., 2020)

1.5.3. Assessing food consumption pattern

Individual dietary diversity was collected by using a dietary diversity score questionnaire. Participants were asked whether or not certain

food groups were consumed during the past 7-days prior to the survey to assess their variety in diets on the food groups consumed (Kolliessuah *et al.*, 2023) reported the 7-day reference period presents a better understanding on nutrient adequacy which is a proxy measure of nutritional status. The individual dietary diversity was adapted from United Nations' Food and Agriculture Organization (FAO, 2010) and modified to include foods present in the Tanzanian setting. To calculate the Dietary diversity score (DDS), reported food items were categorized into 16 food groups which are (i) cereals (ii) Vitamin A-rich vegetables and tubers (iii) Other roots and tubers (iv) Green leafy vegetables (v) Vitamin A-rich fruits (vi) Other vegetables and fruits (vii) Legumes (viii) Nuts and oil seeds (ix) Animal milk and milk products (x) Eggs (xi) Organ meats (xii) flesh meats (xiii) fish, sardines and other sea foods (xiv) Oil, fat, ghee and butter used for cooking (xv) Sugars, honey, sugary products, sweetened sodas (xvi) spices, condiments, beverages.

Consumption of each food group was transformed into binary variables (1=yes, 0=No) to indicate whether food items from a particular group were eaten or not. A total score was the sum scores of the sixteen food groups and the maximum score was 16. The sixteen (16) food groups were then aggregated into nine (9) food groups adapted from (FAO, 2010).

Individual Dietary Diversity Score (IDDS) was determined by aggregating the sixteen (16) food groups into nine (9) food groups present in the Women's Dietary Diversity questionnaire. Women's dietary diversity questionnaire can be used to assess dietary diversity at an individual level on individuals in other age/sex groups (FAO, 2010). The food groups aggregated include (i) Starch staples (ii) Dark green leafy vegetables (iii) Other vitamin A rich fruits and vegetables (iv) Other fruits and Vegetables (v) Organ meats (vi) Meat and Fish (vii) Eggs (viii) Legumes, nuts and seeds (ix) Milk and Milk products. Cut off values were established by determining the

distribution of the dietary diversity scores by measuring of the central tendencies (Median) of the participants. The points were then summed to generate a DDS for each participant. A dietary diversity scored <7 was regarded as inadequate dietary diversity and ≥ 7 was regarded as adequate dietary diversity.

1.5.4 Determinants of Metabolic Risk Factors

Comparative Chi-square analysis was used to determine the prevalence of the metabolic risk factors among students in the two universities. Metabolic risk factors assessed in this study were blood pressure, blood glucose levels, central obesity and lipid profile. Comparative Chi-square analysis was also used to identify the determinants of metabolic risk factors for non-normally distributed factors even after transformation. The transformed variables were then analysed by multivariate analysis after controlling for confounders.

1.6 Ethical Consideration

All the required ethical procedures were followed including getting approval from Sokoine University of Agriculture to carry out the research. The study permission was sought from the National Institute of Medical Research (NIMR) - NIMR/HQ/R.8a/Vol.IX/4363. Other permissions were obtained from university administrations through the dean of students. Each university student had a written consent to participate in the study.

1.7. Study Limitations

The study involved a single cross-sectional design and a small sample size therefore casual inference might not be strong. Recall and reporting bias might also affect dietary data collection using a food frequency questionnaire. Consequently, the cut-off points for metabolic risk factors vary in ethnic groups; hence the findings may not be applicable to another ethnicity. However, the study did not assess physical activity level which is among the important

determinants of metabolic risk factors. Therefore, further studies should combine qualitative and quantitative approaches which might be a comprehensive approach for better understanding of nutritional status and factors associated among university communities.

1.8. Structure of the Dissertation

There are five chapters in this dissertation. Two chapters (chapters two and three) are published papers. Chapter One covers the general introduction of the study which gives context and provides justification for conducting the study. Chapter two presents the first paper that addressed the first and third specific objectives on “Dietary diversity and Anthropometric status of students at Universities in Dodoma and Morogoro regions”. In chapter three, the second paper addressed the second specific objective that determined the “Prevalence and determinants of Metabolic risk factors among University students in Dodoma and Morogoro regions”. Chapter four has the general discussion synthesized from all findings of the study. Chapter Five gives conclusions and recommendations based on the research findings.

CHAPTER TWO

Paper one

Dietary Diversity and Anthropometric status of students at Universities in Dodoma and Morogoro regions

Dietary diversity and Anthropometric status of students at universities in Dodoma and Morogoro Regions, Tanzania

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Abstract

Background: Young adulthood is a transitional period that provides an opportunity to influence immediate and future eating behavior and good nutritional status. As diets evolve during young adulthood due to changes in circumstances and the introduction of new influences, young adults are a significant population group that influences future eating behaviours and prevents the development of NCDs. There is scanty information on the relationship between dietary diversity and the nutritional status of university students in Tanzania. This study aimed to find the synergy between university students' anthropometric status and dietary diversity in Morogoro and Dodoma regions of Tanzania.

Methods: This cross-sectional study involved 247 University students in Morogoro and Dodoma regions (130 from Mzumbe University and 117 from Saint John's University) respectively. The two Universities were purposively selected from each region. Data on Dietary diversity was collected using food groups from DDS to obtain the dietary score of each student. Anthropometric measures such as weight, height and waist circumference were done to obtain the anthropometric status of the University students.

Results: The descriptive cross-sectional study involved 247 University students. In comparative chi-square analysis, the association was found among different socio-demographic characteristics of the University students. The p-value < 0.05 was used to determine the association among the variables.

Conclusion: In conclusion, university students are a vulnerable group in developing obesity/overweight due to the transitional stage. Being overweight and obese was associated with being female, increased age and being married. High dietary diversity was also linked with abdominal obesity. Factors that can help describe and understand the anthropometric status of university students have also been identified. These include years of study, religion, and university location. Therefore, efforts to adopt good lifestyle behaviours should be sensitized amongst this sub-population to reduce the risk of developing chronic diseases in the long run.

Keywords: dietary diversity, anthropometric status, university students

Introduction

Nearly a third of the world's population is affected by the incidence of overweight and obesity, which has doubled since 1980 whereby it is becoming more of a public health concern, especially among university students in developing nations (Quiliche

Castañeda et al., 2021). According to (2018), university represents a fundamental transition into adulthood whereby concerns about lifestyle changes, such as selecting poor-quality diets, have potential implications for body weight and long-term health.

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The overall nutritional status of an individual can be assessed by anthropometry, biochemical tests and evaluation of dietary intake which establishes normal status or risk of malnutrition (Pimentel et al., 2019). The fundamental elements of anthropometry are height, weight, body circumference (waist, hip, and head), and skinfold thickness (Kayode & Oshineye, 2022). Malnutrition is characterized by the simultaneous presence of undernutrition, overweight, and obesity linked to diet within populations (Bhati et al., 2022).

The Food and Agriculture organization defines dietary diversity as a measure of the number of individual foods or food groups consumed in a given period of time (Ansari et al., 2020). Food diversity has long been recognized as a key element of high-quality diet, based on the principle that no single food can provide the right amount of nutrients necessary to maintain optimal health (Verger et al., 2021).

Unhealthy dietary habits are common among university students and are associated with increased incidence of lifestyle and chronic illnesses. Studies have reported poor dietary practices among university students for example Tok et al., (2018) reported consumption of less than 3 meals per day among (33.3%) of university students. Globally, the literature suggests that during the transitional period from secondary level to graduate level, students often engage in unhealthy dietary habits and poor nutritional intake (Kabir et al., 2018). For this reason, University years are also a potential period of intervention.

The central cause of overweight and obesity is imbalance between energy consumed and calories expended, and reports show a global increase in intake of energy dense-foods that are high in fat (Munyogwa & Mtumwa, 2018). The World Health Organization has linked overweight and obesity to more death worldwide

whereby more people are obese in parts of sub-Saharan Africa (WHO, 2020).

Tanzania is one of the sub-Saharan African (SSA) countries facing both undernutrition and obesity problems, where limited dietary diversity is a major challenge (Minja et al., 2021). The recent national nutrition survey reported that the prevalence of overweight or obesity among adult females has nearly tripled from 11.3% in 1991 to 31.7% in 2018 (TNNS, 2018). They are characterized by abnormal eating behaviors, a preoccupation with food and an obsession with weight and body shape.

Studies in Tanzania have shown the association of obesity and dietary diversity in other populations such as women, children, and pastoralist societies. Although there is extensive literature on the association between dietary diversity and anthropometric status of university students in developed countries, there appears to be a scarcity of research on university students in Tanzania.

Due to the rapid global nutrition shift and growing number of people who are directly affected by the double burden of malnutrition and their exposure to various forms of malnutrition throughout their lives (Wells et al., 2020) it is important to know what factors are associated with these risks. The need to focus on this subpopulation is due to the healthy risky behaviors that start in young people.

Considering the scant information this study aims to understand the synergy between dietary diversity and anthropometric status in university students in Tanzanian regions that have contrasting characteristics.

Findings from this study will therefore be important to public health experts in Tanzania and help to work towards the Sustainable Development Goal-3 (SDG-3), which aims to ensure healthy lives and promote wellbeing for all at all ages (United Nations, 2015).

Methodology

Study design.

The study used a cross sectional research design, which is appropriate for descriptive research and was chosen because of the nature of the investigation, which included collecting and analyzing data from a sample of a large population at a specific point in time.

Description of the study area

The study was conducted in universities located in Morogoro and Dodoma Regions. Morogoro region is in the eastern zone of Tanzania. With 29 wards and 260 square miles of land, Morogoro Municipality, one of Morogoro Region's nine districts, serves as the region's capital which represents 0.74% of the region's total land area. (Pori et al., 2022). 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. (Sumari et al., 2020). 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 (Pori et al., 2022).

Dodoma is the region found in the central part of Tanzania mainland. With 41,311 km², 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 (NBS, 2022). 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, 2022). There is just one rainy season there, which is a crucial climate component for agricultural activity.

Description of the study population

The cross-sectional study included full-time registered students who gave consent in the selected universities in Morogoro and Dodoma region which were Mzumbe University and Saint John's University respectively. Students who were on diet or weight management programs, those pregnant and those having physical limitations were excluded from the study.

Sample size and sampling procedure.

Students were randomly selected into the sample to ensure fairness, males and females were given an equal opportunity to be included in the sample.

Morogoro and Dodoma regions were purposively selected due to differences in climatic conditions, food systems, agro-

ecological zones, and having a large population of university students.

Purposive sampling was also used to select one public university in Morogoro and one private University in the Dodoma region (Mzumbe university and Saint John's university respectively).

The total number of university students who participated in the study was determined by using the formula by Kothari (2004) which is used to calculate sample size.

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

whereby,

n = desired sample size

z = standard normal deviation, set at 1.96 corresponding to 95 % confidence interval

P = proportion in the intended population estimated to have a particular characteristic (0.192) among university students.

Prevalence of obesity in community studies in urban Tanzania revealed obesity rate to be 19.2% (Pallangyo et al., 2020).

$Q = (1-p)$ proportion of the population who are estimated to not have the characteristics (0.192) $d =$ degree of accuracy desired (0.05) therefore

$$n = (1.96)^2 \cdot 0.192(1-0.192)/0.05^2$$

$$n = 238$$

Allowance for attrition/non-response, which is 10% will be added,

$$\text{Therefore } 10\% \text{ of } 238 = 23.8$$

$$23.8 + 238 = 262$$

The sample size is approximately 262 students. A total of 247 university students participated in this study. 130 students from Mzumbe University participated in the study 117 students from Saint John's participated in the study.

Data Collection

Pre-testing was carried out in one university in Morogoro region (Sokoine University of Agriculture) and another University in Dodoma (University of Dodoma) region after the completion of formal training of research assistants. Data was then collected by the help of research assistants at Mzumbe and Saint John's University in Morogoro and Dodoma regions respectively.

Information on socio-demographics

Age of university students, gender, degree type, year of study, marital status, religion, living arrangements, chronic disease situation, smoking status, primary source of nutritional information, total hours spent for sleeping, scholarship status were collected using pretested questionnaire with structured questions which was administered to the students by trained research assistants in the selected Universities in Morogoro and Dodoma regions (Mzumbe and Saint John's respectively).

Anthropometry Measurements

Weight, height, and waist circumference were measured to determine the anthropometric status of the students.

Weight was measured using a standard weighing scale (digital electronic SECA scale; (Model 881021659, Germany) that was kept on a firm horizontal surface. The participant was measured without shoes and with light clothing by ensuring the removal of heavy-worn clothing such as coats and scarfs as well as personal items such as wallets, phones, and watches. Weight was then recorded to the nearest 0.1kg. The scale reading was always allowed to return to zero before the subject was asked to stand on it. Height was measured using a stadiometer (Model No PE-AIM-101-USA) and recorded to the nearest 0.1 cm. Participants were requested to stand upright without shoes on with their back kept against the wall and heels put together in a V-shape while looking forward.

The body mass index (BMI) was calculated by dividing weight (in kilograms) over their height (in meters square). Nutritional status was classified according to the WHO classification of Body mass index. Students were classified as underweight, normal, overweight and obese if they have a Body mass index of below 18.5 (underweight), 18.5-24.9 (normal weight), 25.0-29.9 (overweight) and ≥ 30.0 above (obese) (Weir and Jan 2022).

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 ≥ 94 cm for men identified from adults in Sub-Saharan Africa population (Tiadi et al., 2020).

Dietary Consumption.

Participants were required to recall food groups, number of meals per day during the past 7-days prior to survey. They were also asked on how they accessed their diets during different mealtimes.

Dietary Diversity

Individual dietary diversity was collected by using a dietary diversity score questionnaire. Participants were asked on whether or not certain food groups were consumed during the past 7-days prior to survey to assess their variety in diets on the food groups consumed. (Kollesuah et al., (2023) reported the 7-day reference period presents a better understanding on nutrient adequacy which is a proxy measure of nutritional status.

The individual dietary diversity was adapted from United Nations' Food and Agriculture Organization (FAO, 2010) and modified to include foods present in Tanzanian setting.

To calculate the Dietary diversity score (DDS), reported food items were categorized into 16 food groups which are (i) cereals (ii) Vitamin A-rich vegetables and tubers (iii) Other roots and tubers (iv) Green leafy vegetables (v) Vitamin A-rich fruits (vi) Other vegetables and fruits (vii) Legumes (viii) Nuts and oil seeds (ix) Animal milk and milk products (x) Eggs (xi) Organ meats (xii) flesh meats (xiii) fish, sardines and other sea foods (xiv) Oil, fat, ghee and butter used for cooking (xv) Sugars, honey, sugary products, sweetened sodas (xvi) spices, condiments, beverages.

Consumption of each food group was transformed into binary variables (1=yes, 0=No) to indicate whether food items from a particular group was eaten or not. Total score was the sum scores of the sixteen food groups and the maximum score was 16.

The sixteen (16) food groups were then aggregated into nine (9) food groups adapted from (FAO,2010). Individual dietary diversity was determined by aggregating the sixteen (16) food groups into nine (9) food groups present in the Women's dietary diversity questionnaire. Women's dietary diversity questionnaire can be used to assess dietary diversity at individual level on individuals in other age/sex groups (FAO,2010). The food groups aggregated include (i) Starch staples (ii) Dark green leafy vegetables (iii) Other vitamin A rich fruits and vegetables (iv) Other fruits and Vegetables (v) Organ meats (vi) Meat and Fish (vii) Eggs (viii) Legumes, nuts and seeds (ix) Milk and Milk products. Cut off values were established by determining the distribution

of the dietary diversity scores by measures of central tendencies (mean and median) of the participants. The points were then summed to generate a DDS for each participant. A dietary diversity scored <7 was regarded as inadequate dietary diversity and a 7 was regarded as adequate dietary diversity.

Dietary habits

Participants were required to recall the number of meals consumed per day i.e. Breakfast Lunch and dinner and how often they consumed these meals during the past 7-days prior to the survey. They were also asked if they skipped meals (yes/no) and reasons for meal skipping.

Dietary access during various mealtimes

Participants were asked on how they access their diets throughout their day. The questionnaire included four options adapted for university settings (i) Purchasing cooked meals at university canteens (ii) Purchasing food out of university (iii) Self-cooking (iv) Group cooking.

Data Analysis

The data was entered, cleaned and analyzed using Statistical Package for Social Sciences (SPSS[®]) version 26 software. Descriptive statistical measures such as percentage and frequencies of variables were computed to summarize the data. Chi square (χ^2) test at 5% level of significance was used to examine the relationship between dependent variables (Anthropometric status) and other independent variables such as socio-demographic factors.

Ethical Considerations

The study was approved by the National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/4363) and Sokoine University of Agriculture (SUA/MHN/D/2019/0009). Permission to conduct the study was also sought from respective universities from the administration offices through the 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.

Results

Socio-demographic characteristics of University Students

The socio-demographic characteristics of the University students are presented in Table 2.1. A total of 247 university students participated in this study whereby about half 131 (53%) were males and 116 (47%) were females. More than half females at Mzumbe University participated in the study 70 (53.8%) when compared to Saint John's 46 (39.3%).

More than half of the males at Saint John's University participated in the study 71 (60.7%) when compared to Mzumbe University 60 (46.2%).

More than half of the participants 155 (62.8%) were between 20-24 years old. About half 137 (55%) of the participants in this study were on their second year of university. Most of the study participants were single 230 (93.1%). Majority 201 (81.4%) of the university students were Christians. There was a significant difference in gender, years of study, religion and place of residence between the University students in Mzumbe and Saint John's University.

Table 2.1: Demographic characteristics of study population (n=247)

Characteristics	Overall	Mzumbe University	St. John's University	P-Value
Sex				0.022*
Female	116 (47%)	70 (53.8%)	46 (39.3%)	
Male	131 (53%)	60 (46.2%)	71 (60.7%)	
Age				0.221
20-24 Years	155 (62.8%)	85 (65.4%)	70 (59.8%)	
>25 Years	92 (37.2%)	45 (34.6%)	47 (40.2%)	
Study Year				0.045*
Second Year	137 (55.5%)	65 (50%)	72 (61.5%)	
>Second Year	110 (44.5%)	65 (50%)	45 (38.5%)	
Marital Status				0.301
Single	230 (93.1%)	119 (91.5%)	111 (94.9%)	
Married	17 (6.9%)	11 (8.5%)	6 (5.1%)	
Religion				0.001*
Christian	201 (81.4%)	96 (73.8%)	105 (89.7%)	
Muslim	46 (18.6%)	34 (26.2%)	12 (10.3%)	
Presence of Chronic diseases				0.858
Yes	9 (3.6%)	5 (3.8%)	4 (3.4%)	
No	238 (96.4%)	125 (96.2%)	113 (96.6%)	
Sleeping hours				0.373
<8 hours	124 (50.2%)	69 (53.1%)	55 (47%)	
≥ 8 hours	123 (49.8%)	61 (46.9%)	62 (53%)	
Place of residence				0.000*
Off campus	190 (77.7%)	85 (65.4%)	107 (91.5%)	
In campus	55 (22.3%)	45 (34.6%)	10 (8.5%)	
Smoking status				0.079
Non-smoker	240 (97.1%)	124 (95.4%)	116 (99.1%)	
Smoker	7 (2.8%)	6 (4.6%)	1 (0.9%)	
Primary source of nutritional information				0.893
Offline	83 (33.6%)	43 (33.1%)	40 (34.2%)	
Online	164 (66.4%)	87 (66.9%)	77 (65.8%)	
Scholarship status				0.006
No	124 (50.2%)	76 (58.5%)	48 (41%)	
Yes	123 (49.8%)	54 (41.5%)	69 (59%)	
Type of scholarship				0.087
Partial	25 (10.1%)	9 (6.9%)	16 (13.7%)	

Full	98 (79.7%)	45 (83.3%)	53 (76.8%)
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*Significant at $P < 0.05$ **Food access during various meal times**

Majority 100 (79.9%) of the participants eat breakfast and purchase them at University Canteens. The proportion of students that purchase breakfast at university canteens in Mzumbe university is slightly higher 65 (50%) than Saint John's University 35 (29.9%). More than half 89 (72%) of the university students purchase their lunch out of the University premises. The proportion of students that purchase lunch out of the university premises

in Mzumbe university is slightly higher 48 (37%) than Saint John's University 41 (35%). A large proportion 91 (76%) of participants in this study cook their dinner. More than half 70 (59.8%) of Saint John's students cook their dinner compared to Mzumbe university students 21 (16.2%). There was a significant difference in ways of accessing food during all the mealtimes.

Dietary habits of University Students

The dietary habits of the University Students are as shown in Table 2.3. Majority 167 (67.6%) of the study participants ate two meals per day. The proportion of students who ate two meals per day was slightly higher 88 (67.7%) in Mzumbe university when compared to Saint John's University 79 (67.5%). Skipping of

meals due to being busy with studies was common 144 (58.3%) and was significantly higher in Mzumbe University 87 (66.9%) than Saint John's University 57 (48.7%). There was a significant difference in reasons for meal skipping in Mzumbe and Saint John's university.

Table 2.3 Dietary habits of University Students

VARIABLES	OVERALL	MZUMBE UNIVERSITY	ST JOHNS' UNIVERSITY	P-VALUE
Number of meals per day				
One meal	17 (6.9)	9(6.9)	8(6.8)	0.999
Two meals	167 (67.6)	88(67.7)	79(67.5)	
Three meals	63 (25.5)	33(25.4)	30(25.7)	
Meal Skipping				
No	63 (25.5)	33(25.4)	30(25.6)	0.963
Yes	184 (74.5)	97(74.6)	87(74.4)	
Reasons for meal skipping				
Busy with studies	144 (58.3)	87(66.9)	57(48.7)	0.001*
Financial constraints	20 (8.1)	4(3.1)	16(13.7)	
Less priority	12 (4.9)	3(2.3)	9(7.7)	
Not applicable	71 (28.7)	36(27.7)	35(29.9)	0.779
Often take breakfast				
No	176 (71.3)	94(72.3)	82(70.1)	0.779
Yes	71 (28.7)	36(27.7)	35(29.9)	
Often take Lunch				
No	66 (26.7)	41(31.5)	25(21.4)	0.071
Yes	181(73.3)	89(68.5)	92(78.6)	
Often take dinner				
No	37(15)	24(18.5)	13(11.1)	0.106
Yes	210 (85)	106(81.5)	104(88.9)	

*Significant at $P < 0.05$

Association between Dietary diversity score and Anthropometric status

The association between dietary diversity score and Anthropometric status of university students are as shown in Table 2.4. The proportion of Mzumbe university students in consuming a diverse diet was

slightly higher 79 (60.8%) than students in Saint John's University 75 (64.1%). The study revealed that more than half 119 (59.2%) of the Christian students had a diversified diet. There was a significant difference in Religion and waist circumferences in the dietary diversity of the university students.

Table 2.4 Association between Dietary Diversity Score and Anthropometric status

VARIABLES	Less than 7 food groups	At least 7 food groups	P-Value
Tanzania Journal of Health Research VOLUME 35: Number 2, April 2024 https://dx.doi.org/10.4314/tjhr.v35i2.19			
Name of university	51 (39.2)	79 (60.8)	
St. John's University	42 (35.9)	75 (64.1)	0.602
Sex of respondents			
Female	39 (33.6)	77 (66.4)	0.219
Male	54 (41.2)	77 (58.8)	
Age categories			
20 to 24 years old	58(37.4)	97 (62.6)	0.922
≥25 years old	35(38)	57 (62)	
Marital status of respondents			
Single	88 (38.3)	142 (61.7)	0.467
Married	5 (29.4)	12 (70.6)	
Religion			
Muslim	11 (23.9)	35 (76.1)	0.033*
Christian	82 (40.8)	119 (59.2)	
Place of residence			
Off-campus	74 (38.5)	118 (61.5)	0.59
Within students' residence	19 (34.5)	36 (65.5)	
Scholarship Status			
No	43 (34.7)	84 (65.3)	0.333
Yes	50 (40.2)	73 (59.3)	
Scholarship Type			
Partial	54 (36.2)	95 (63.8)	0.573
Full	39 (39.8)	59 (60.2)	
Anthropometric profile			
Underweight (BMI < 18.5)	9 (50)	9 (50)	
Normal weight (18.5≤BMI<25)	65 (40.4)	96 (59.6)	
Overweight (25≤BMI<30)	15 (17.8)	39 (72.2)	
Obesity (BMI ≥ 30)	4 (28.6)	10 (71.4)	0.22
WAIST CIRCUMFERENCE			
Risk of morbidity (≥91 cm male ≥82cm female)	7 (21.9)	25 (78.1)	
None risk of morbidity (Normal fat distribution)	86 (40)	129 (60)	0.048*
Suffering from of chronic disease			
No	93(38.2)	147 (61.8)	
Yes	2 (22.2)	7 (77.8)	0.33
Total number of hours spent for sleeping per night			
Less than 8 hours	49 (39.8)	74 (60.2)	
8 hours and above	44(35.5)	80 (64.5)	0.48
Currently smoking status			
Non-smoker	89 (37.1)	151(62.9)	
Ex-smoker/smoker	89 (57.1)	151(62.9)	0.28
Source of nutrition information			
Offline (family, friends and others)	32(38.6)	51(61.4)	
Online (TV, internet, news)	61(37.2)	103 (62.8)	0.835

*Significant at P<0.05

Anthropometric status of university students

Body mass index (BMI) and Waist circumference (WC) were used to assess the anthropometric status of the University students. Body mass index was used to identify general obesity while waist circumference was used to identify central obesity.

Waist Circumference

The waist circumference of study respondents is as shown in Tables 2.5. The study revealed that a larger proportion (95.4%) of male participants not in a risk of morbidity when compared to female participants 90 (77.6%). There was a significant difference on Sex, Age and Marital status.

Table 2.5 Socio- demographic characteristics and Waist Circumference

VARIABLES	Risk of morbidity (≥91 cm male ≥82cm female)	None risk of morbidity (Normal fat distribution)	P-VALUE
Name of university			
Mzumbe	18(13.8)	112(86.2)	0.707
St. John's	14 (12)	103(88)	
Sex			
Female	26 (22.4)	90 (77.6)	0.000*
Male	6(4.6)	125 (95.4)	
Age categories			
20 to 24 years old	11 (7.1)	144 (92.9)	0.001*
≥25 years old	21 (22.8)	71 (77.2)	
Years study			
Second year	18 (13.1)	119 (86.9)	0.924
>Second year	14 (12.7)	96 (87.3)	
Marital status			
Single	22 (9.6)	108 (90.4)	0.000*
Married	10 (58.8)	7 (41.2)	
Religion			
Muslim	7 (15.2)	39 (84.8)	0.613
Christian	25 (12.4)	176 (87.6)	
Place of residence			
Off campus	23 (12)	169 (88)	0.393
Within students' residence	9 (16.4)	46 (83.6)	
Presence of Chronic disease			
No	32 (13.4)	206 (86.6)	0.238
Yes	0	9 (100)	
Hours spent for sleeping			
Less than 8hours	18 (14.6)	105 (85.4)	0.434

More than 8 hours	14 (11.3)	110 (88.7)	
Smoking status			
Non-smoker	31 (12.9)	109 (87.1)	0.915
Smoker	1 (14.3)	6 (85.7)	
Source of nutrition information			
Offline (family, friends and others)	15 (18.1)	68 (81.9)	0.088
Online (TV, internet, news)	17 (10.4)	147 (89.6)	
Scholarship status			
No	19 (15.3)	105 (84.7)	0.266
Yes	13 (10.6)	110 (89.4)	
Type of scholarship			
Partial	21 (14.1)	128 (85.9)	0.511
Full	11 (11.2)	87 (88.8)	

*Significant at $P < 0.05$ **Body Mass Index**

The body mass index of study respondents is as shown in Tables 2.6. This study shows that Saint John's University students had a slightly higher proportion 33 (28.2%) of overweight when compared to Mzumbe University students 21 (16.2%). The study revealed that the proportion of overweight and obesity 37 (31.9%) ;12 (10.3%) respectively in female university students was slightly higher when compared to male university students 17 (13%) for overweight and 2 (1.5%) for obesity.

Overweight in students from third year and above was slightly higher 31 (28.2%) when compared to students in the second year 23 (16.8%). This study also showed that Students who were enrolled in their second year had higher proportion 11 (8%) of obesity than students in higher years of enrolment 3 (2.7%). There was a significant difference on university type Sex, Age, year of study and marital status.

Table 2.6 Socio- demographic characteristics and Body Mass Index (BMI)

VARIABLES	Underweight (BMI < 18.5)	Normal weight (18.5≤BMI<25)	Overweight (25≤BMI<30)	Obesity (BMI ≥ 30)	P-VALUE
Name of university					
Mzumbe	13 (10)	86 (68.2)	21 (16.2)	10 (7.7)	0.031*
St. John's	5 (4.3)	75 (64.1)	33 (28.2)	4 (3.4)	
Sex					
Female	4 (3.4)	63 (54.3)	37 (31.9)	12 (10.3)	0.000*
Male	14 (10.7)	98 (74.8)	17 (13)	2 (1.5)	
Age categories					
20 to 24 years old	15 (9.7)	106 (68.4)	30 (19.4)	4 (2.6)	0.007
≥25 years old	3 (3.3)	55 (59.8)	24 (26.1)	10 (10.9)	
Years study					
Second year	8 (5.8)	95 (69.3)	23 (16.8)	11 (8)	0.039*
>Second year	10 (9.1)	66 (60.0)	31 (28.2)	3 (2.7)	
Marital status					

Single	17 (7.4)	156 (67.8)	47 (20.4)	10 (4.3)	0.001*
Married	1 (5.9)	5 (29.4)	7 (41.2)	4 (23.5)	
Religion					
Muslim	3 (6.5)	28 (60.9)	11 (23.9)	4 (8.7)	0.746
Christian	15 (7.5)	133 (66.2)	43 (21.4)	10 (5)	
Place of residence					
Off campus	14 (7.3)	123 (64.1)	46 (24)	9 (4.7)	0.339
Within students' residence	4 (7.3)	38 (69.1)	8 (14.5)	5 (9.1)	
Presence of chronic diseases					
No	17 (7.1)	154 (64.7)	53 (22.3)	14 (5.9)	0.697
Yes	1 (11.1)	7 (77.8)	1 (11.1)	0	
Total number of hours spent for sleeping per night					
Less than 8 hours	11 (8.9)	81 (65.9)	23 (18.7)	8 (6.5)	0.501
More than 8 hours	7 (5.6)	80 (64.5)	31 (25)	6 (4.8)	
Smoking status					
Non-smoker	16 (6.7)	158 (65.8)	52 (21.7)	14 (5.8)	0.134
Smoker	2 (28.6)	3 (42.9)	2 (28.6)		
Source of nutrition information					
Offline (family, friends and others)	7 (8.4)	56 (67.5)	16 (19.3)	4 (4.8)	0.833
Online (TV, internet, news)	11 (6.7)	105 (64)	38 (23.2)	10 (6.1)	
Scholarship status					
No	5 (4)	82 (66.1)	29 (23.4)	8 (6.5)	0.242
Yes	13 (10.6)	79 (64.2)	25 (20.3)	6 (4.9)	
Type of Scholarship					
Partial	7 (4.7)	95 (63.8)	38 (25.5)	9 (6)	0.115
Full	11 (11.2)	66 (67.3)	16 (16.3)	5 (5.1)	
*Significant at P	<0.05				

Discussions**Dietary diversity and anthropometric status of university students.**

This study reports the association between dietary diversity scores and characteristics of university students as well as their Anthropometric status. Generally, high levels of dietary diversity are frequently linked to better nutritional status, whereas low levels are strongly thought to contribute to inadequate nutrient intake.

In this study the religion of the university students was associated significantly with dietary diversity scores. Whereby Muslim students had a high dietary diversity (76.1%) when compared to Christian students. This means that the intake of a diverse diet may be attributed with religion in university students. The possible explanation could be the difference in the agro-ecological zones. However, this could perhaps be due to the fact that majority of respondents in this study were Christians. According to a study

conducted in Ethiopia the odds of having inadequate dietary diversity were 70% lower among Muslim adolescents when compared to Christians due to difference in residence (Gonete et al., 2020). Furthermore, a study done in Tanzania suggested that dietary diversity can also be attributed by agriculture, agrobiodiversity, landscape heterogeneity personality and family traditions (Powell et al., 2017).

The findings of the current study showed that there was a significant difference between waist circumference and dietary diversity. According to this study high dietary diversity is linked with increased risk

of central obesity in university students due to excessive consumption of selected food groups which are mostly energy dense. Respondents that had low dietary diversity were at a low risk of developing central obesity. This study corroborates with similar study done in the southwest of China which showed adults with medium and high Dietary diversity score were at higher risk of central obesity (Zhang et al., 2017). However, using waist circumference, a study of pastoralists in Tanzania revealed no connection between dietary diversification and central obesity for both male and female (Khamis et al., 2021).

Anthropometric status of university students.

Central Obesity among University students.

The study reported that risk of morbidity was associated with sex of the respondents. The finding shows that female university students were at a higher risk of developing central obesity compared to their male counterparts. The possible explanation for this could be due to high dietary diversity in the female students; selection of meals compared to their male counterparts. These findings are in line with the study done by (Mogeni & Ouma, 2022) who reported females embraced greater dietary diversity in their eating habits compared to males.

The possible variations in the obesity prevalence could be justified by the use of different cutoff values for waist circumference (Tekalegn et al., 2022).

Moreover, the findings of this study corroborate with (Molla et al., 2020) the odds of being centrally obese was 9.62 times higher among female study participants compared to their counterparts. Furthermore, Maila et al., (2021) reported a study done in Verulam, South Africa that indicated 68.4% of women and 25% of men were at risk of central obesity.

The study also found that age was associated with risk of abdominal obesity, whereby participants aged twenty-five and above (≥25 years of age) were at a higher risk of morbidity compared to participants aged between 20-24 years. The possible

reasons are higher dietary diversity of individuals aged 20-24 when compared to individuals of ≥25 years of age. The findings of this study are in line with Molla et al., (2020) that found an increase in age was statistically associated with central obesity. Tekalegn et al., (2022) also revealed that the odds of central obesity tend to increase as age increases. Similarly, a study by (Munyogwa et al., 2021) in Dodoma City reported respondents with an increased age were associated with development of abdominal obesity.

Furthermore, in this study married people were reported to have a risk of morbidity compared to Single people. This could be due to the difference in dietary diversity where married people have a higher dietary diversity which is believed to be linked with higher intake of energy dense foods. However, this could perhaps be due to the fact that majority of respondents in this study were single. The findings of this study go in line with a study done by (Ntimana & Choma, 2023) whereby Bivariate correlation analysis showed that married participants correlated positively and significantly with central obesity. Similarly, a study Bakir et al., (2017) reported that the mean Body mass indexes and other anthropometric measurements such as Waist circumference were significantly higher in married women. Furthermore, Cisse et al., (2021) reported that main predictors of abdominal obesity were associated with being married.

Overweight and Obesity among University students.

The findings showed that students in Saint John's University were overweight when compared to Students in Mzumbe University. The possible reason for this could be due to difference of agro-ecological zones, since Saint John's is located in Dodoma a semi-arid area and Mzumbe University is located in Morogoro characterized by bi-modal rainfall patterns. The increase in urbanization in Dodoma could also justify the prevalence of overweight in the region. (Munyogwa & Mtumwa, 2018) reported prevalence of overweight to be higher in urban areas in Tanzania and other countries worldwide. A study revealed that Overweight and obesity are common in private schools and urban settings (Mosha et al., 2021).

It is important to take into consideration difference in agro-ecological zones since they differ in climate soil as well as economic activities, all this can have influence in the overall nutritional status of an individual. A study reported that household dietary diversity differed from different regions in rural and urban Tanzania, regions such as Morogoro contributes to high diversity due to food availability while regions like Dodoma import most foods due to experiencing one season rainfall per annum (Borrego, 2021). Bailey et al., (2022) reported that students in the Midwest had higher BMIS compared to students in the Northeast.

This study reports that female University students were more likely to be Overweight and Obese when compared to their male counterparts. This could be influenced with the differences between the dietary diversity among the genders. Because females often have less lean mass and more fat mass, biological factors may account for the gender differences in overweight or obesity.

Dietary diversity has been reported to positively affect obesity through higher energy intake. A study reported that the probability of overweight/obesity was increased as tertiles of dietary diversity score

increased (Golpour-Hamedani et al., 2020). In contrast to these findings Tok et al., (2018) reported the prevalence of overweight/obesity was similar among male and female students with a difference of only 0.3%.

In our study students that were ≥ 25 years of age were more susceptible to Overweight and obesity when compared to students that were 20-24 years of age. It was noted that individuals that were ≥ 25 years of age had a lower dietary diversity which can affect the overall nutritional status due to lack of diversified foods that complement each other. The study is in line with Al-Ghamdi et al., (2018) who reported that there was a linear positive association (trend) of increasing BMI with older age groups. In the same context a study done in Tanzania reported that older women (35-49 vs 15-24 years) of a reproductive age where at a higher risk to develop obesity/overweight (Mosha et al., 2021). Quiliche Castañeda et al., (2021) reported that being older than 27 years old significantly predicted overweight/obesity ($OR_{95\%} = 1.07; 95\% \text{ CI} = 1.19-3.6$).

The current study reported that years of studies was associated with Overweight and Obesity. Whereby Students that were in their 3rd year and above were associated with Overweight when compared to second year students. The possible explanation for this could be the difference in dietary diversity and selection of food among the second-year students and students that are in their 3rd year and above. These findings are in line with Ahmed et al., (2015) who reported a significant association between students of their first year of study and second year of study. In contrast Bailey et al., (2022) reported that being a second-year student had higher BMIs compared to four-year students.

In our study we also found that Married people were Overweight when compared to single people. This study revealed that married individuals had a high dietary diversity when compared to single individuals which could lead to the

consumption of high energy foods and affect the overall nutritional status. However, we noted that majority of the study participants were single this could also be a possible explanation. These findings are similar with (Liu et al., (2021) who reported that married individuals were at a higher risk of being overweight/obese than never-married

individuals. In the same context being married was a significant predictor of overweight/obesity whereby it was suggested that companionship after marriage may encourage an individual to avoid obesity or even contribute towards it (Al-Ghamdi et al., 2018).

Conclusions and Recommendations

The study concludes that University students are at a risk of general obesity and central obesity which could be a baseline for developing chronic illnesses in the long run. The study also shows that University students have different access to meals in and out of the University campus and tend to skip meals due to being busy with studies. This study suggests that female university students, Increased age and Married individuals are at a higher risk of developing central and general obesity. The study also implicates that high dietary diversity is linked with central obesity. This study builds insight on dietary diversity and anthropometric status on university students. It shows that Body mass index in itself is not sufficient to evaluate the overall nutritional status. Dietary diversity can be associated with factors like Religion and waist circumference which is an indicator of abdominal obesity. Factors that can help describe and understand the Anthropometric status of university students have also been identified these include; gender, year of study, marital status, age, location of university.

Recommendation

Due to the risks that University students face due to their newly adapted independency, there is a need for sustained health and nutrition education initiatives to help them adjust to lifestyle changes that affects their overall health. There should be educational initiatives promoting healthier diets, lifestyles, and weight control which may have a positive impact on university student's health.

Competing Interests

The authors declare that they have no competing interests

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CHAPTER THREE

Paper Two

Prevalence and determinants of Metabolic risk factors among university students in Dodoma and Morogoro regions

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

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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-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 ($\beta=17.01$, $SE=10.1$, $p=0.1$) and ($\beta=-0.170$, $SE=0.0519$, $p=0.01$) respectively. Receiving scholarship and high dietary diversity score was associated with low-density lipoprotein ($\beta=21.83$, $SE=10.4$, $p=0.1$); ($\beta=5.731$, $SE=3.14$, $p=0.1$) 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 dyslipidemia [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 unselected 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 km², it has seven districts: Dodoma urban, Chamwino, Bahi, Kondoa, Kongwa, Mpwapwa, and Chamba. 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 John's 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 ≥ 94 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-50AH ARJ-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 ≥ 140 mmHg systolic and ≥ 90 mmHg [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 Moengero 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 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 Moengero 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 Moengero 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 Hemest specialized polyclinic Bunja (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
At-Risk 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	≥ 240 mg/dl	200-499mg/dl
Very High	≥ 190 mg/dl	≥ 240 mg/dl	≥ 400 mg/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 (χ^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/1363 and from the Sokoine University of Agriculture with reference number SUA/MTN/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%).

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)	0.373
≥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	106(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)	30 (46)	28 (53.8)	0.008
≥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				
Obese	38 (32.2)	21 (32.3)	17 (32.1)	0.879
Not obese	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 (25.3)	8 (16.4)	5 (17.2)	0.121
Full	38 (74.7)	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.

Characteristics	Systolic Blood pressure			P-Value	Diastolic Blood pressure			P-Value
	Normal range (%)	Low range (%)	High range (%)		Normal range (%)	Low range (%)	High range (%)	
Age								
20-24 Years	79 (98.8)	1 (3.3)	1 (3.3)	0.338	80 (87.4)	7 (8)	4 (4.6)	0.296
≥25 Years	26 (86.7)	1 (3.3)	4 (10.1)		76 (96.8)	1 (3.2)	0 (0.00)	
Sex								
Male	62 (94)	2 (3)	2 (3%)	0.235	47 (89.4)	3 (7.6)	2 (3)	0.901
Female	43 (84.4)	4 (7.8)	1 (7.8)		39 (90.4)	3 (5.3)	2 (3.8)	
University Location								
Morogoro	79 (90.8)	4 (8.3)	2 (3.1)	0.481	78 (90.8)	4 (8.2)	2 (3)	0.933
Dodoma	46 (88.7)	2 (3.8)	5 (7.7)		47 (88.7)	4 (7.7)	2 (3.8)	
Residence								
Off-campus	78 (90)	2 (3)	6 (32)	0.076	30 (88.4)	3 (5.3)	4 (6.7)	0.163
In-campus	27 (53)	4 (41.2)	1 (3.8)		76 (90.3)	3 (9.1)	0 (0.00)	
Total	105 (94.3)	6 (5.1)	7 (6)		106 (89.2)	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 4. Prevalence of Total Cholesterol among University Students.

Characteristics	Normal range (%)	Borderline high (%)	High range (%)	P-value
Age				
20-24 Years	29 (91.1)	2 (5.7)	1 (3.2)	0.829
≥25 Years	81 (91.3)	5 (8.3)	0 (0.00)	
Sex				
Male	63 (95.3)	3 (4.5)	0 (0.00)	0.808
Female	47 (90.4)	4 (7.7)	1 (3.3)	
University Location				
Morogoro	37 (87.7)	7 (16.8)	1 (3.3)	0.038*
Dodoma	33 (80)	0 (0.00)	0 (0.00)	
Residence				
Off-campus	83 (93.4)	2 (2.4)	0 (0.00)	0.004
In-campus	27 (81.8)	5 (15.2)	1 (3)	
Total	110 (93.2)	7 (6)	1 (0.8)	

*Significant at P<0.05

Table 2. Prevalence of Dyslipidaemia in University Students

Characteristics	Normal range (%)	Risky triglyceridemic (%)	Very High (%)	P-value
Age				
18-24 Years	40 (78.3)	10 (20.7)	0 (0.00)	
≥25 Years	24 (77.4)	7 (22.6)	0 (0.00)	0.918
Sex				
Male	35 (81.3)	8 (18.8)	3 (6.9)	
Female	38 (78.1)	9 (18.4)	7 (13.5)	0.176
University location				
Morogoro	42 (84.6)	13 (26.0)	18 (35.3)	
Dodoma	31 (86.2)	7 (19.4)	4 (10.9)	0.000*
Residence				
Off-campus	69 (81.2)	14 (16.4)	8 (9.4)	
In-campus	24 (72.7)	7 (21.2)	2 (6.1)	0.188
Total	93 (78.5)	33 (27.7)	22 (18.5)	

*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						
18-24 Years	36 (61.4)	19 (31.8)	5 (8.4)	3 (5.0)	6 (10.0)	
≥25 Years	32 (38.7)	5 (6.1)	13 (16.1)	3 (3.7)	11 (13.6)	0.045
Sex						
Male	23 (34.8)	17 (25.8)	9 (13.6)	8 (12.2)	8 (12.4)	
Female	25 (48.1)	7 (13.3)	7 (13.3)	5 (9.4)	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 (45.3)	7 (9.3)	4 (5.3)	5 (6.7)	10 (13.3)	
In-campus	15 (38.8)	18 (45.4)	12 (30.1)	11 (27.5)	7 (17.5)	0.488
Total	48 (38.7)	24 (20.3)	19 (15.6)	13 (11)	17 (14.4)	

*Significant at P<0.05

4.2.4. 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				
18-24 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	84 (70)	1 (1.1)	83 (98.9)	
Female	32 (44)	12 (23.1)	20 (60.6)	0.000*
University location				
Morogoro	83 (59)	7 (10.8)	76 (89.2)	
Dodoma	33 (63)	6 (15.3)	27 (84.7)	0.924
Residence				
Off-campus	83 (72)	6 (5.2)	77 (94.8)	
In-campus	33 (28)	7 (21.2)	26 (78.8)	0.122
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 Minna 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 21.8mg/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 6.325mmHg , $SE = 3.471$, $p = 0.1$). 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 8. Determinants of Central Obesity in University students.

Characteristics	Risk of morbidity (%)	Non-risk of morbidity (%)	P-value
Sex			
Male	1 (0.3)	40 (99.7)	0.000*
Female	12 (23.1)	40 (76.9)	
Age			
18-24 years	2 (2.3)	85 (97.7)	0.000*
≥ 25 years	11 (21.1)	39 (69.1)	
Nutrition status			
Underweight	0 (0)	7 (100)	0.000*
Normal weight	1 (1.2)	42 (98.8)	
Overweight	4 (7.7)	39 (72.3)	
Obesity	4 (100)	0 (0)	

*Significant at $P < 0.05$

Table 9. Determinants of Triglycerides levels in university students.

Characteristics	Normal (%)	Borderline high (%)	High/triglyceridemic (%)	P-value
Location of the university				
Minna	42 (96.4)	13 (28)	10 (11.6)	0.000*
Dodoma	11 (96.2)	2 (1.8)	0 (0)	
Smoking status				
No	81 (90.1)	12 (10.4)	10 (8.8)	0.004*
Yes	7 (88.7)	3 (14.3)	0 (0)	

*Significant at $P < 0.05$

Table 10. Determinants of Metabolic risk Factors in University students.

Characteristics	Blood pressure (Diastolic)	Blood pressure (Systolic)	Total cholesterol (TC)	Low-density lipoprotein
Location of University				
Minna	Ref	Ref	Ref	Ref
Dodoma	3.434 (2.846)	4.682 (9.714)	-0.170*** (0.1514)	17.01* (10.40)
Sex				
Male	Ref	Ref	Ref	
Female	-0.487 (5.225)	5.224 (5.104)	0.187 (0.0542)	
Marital status				
Single	Ref	Ref		Ref
Married	-11.49*** (5.222)	-10.43 (8.111)		14.78 (11.99)
Scholarship status				
No	Ref	Ref	Ref	Ref

Characteristics	Blood pressure (Diastolic)	Blood pressure (Systolic)	Total cholesterol (TC)	Low-density lipoprotein
Yes	-2.823 (2.404)	-3.578 (3.749)	0.0200 (0.0463)	21.83* (30.40)
Smoking Status				
No	Ref.	Ref.	Ref.	Ref.
Yes	6.121* (3.411)	5.992 (5.871)	-0.0566 (0.0614)	11.37 (14.44)
Dietary Diversity score				
< 7 food groups	Ref.	Ref.	Ref.	Ref.
≥ 7 food groups	0.931 (0.742)	1.367 (1.190)	-0.00194 (0.0140)	5.711* (5.143)
Constant	72.58** (9.434)	102.3** (13.75)	1.872** (0.160)	-1.269 (12.64)
Observations	118	118	118	118
R-squared	0.415	0.405	0.056	0.287

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 19 (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 11. Prevalence of Hypoglycaemia levels in university students.

Characteristics	Overall (%)	Hypoglycaemia (%)	Normal (%)	P-Value
Age				
20-24 Years	77 (73.73)	6 (16.4)	71 (83.4)	
≥25 Years	41 (28.27)	16 (38.4)	25 (60.6)	0.906
Sex				
Male	84 (74.24)	8 (12.1)	76 (87.8)	
Female	34 (45.76)	14 (28.9)	20 (71.1)	0.040*
University location				
Morogoro	65 (55.06)	18 (27.7)	47 (72.3)	
Dodoma	53 (44.92)	4 (7.5)	49 (92.5)	0.007*
Residence				
Off-campus	43 (72)	10 (14.3)	33 (85.6)	
In-campus	33 (28)	12 (30.3)	21 (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 (30.2%). 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%). Residence 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 12. 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 (81.4)	9 (20.7)	17 (37.9)	
≥25 Years	10 (32.3)	18 (79)	33 (38.7)	0.152
Sex				
Male	46 (89.2)	0 (0.00)	19 (30.2)	
Female	0 (0.00)	27 (15.7)	26 (44.5)	0.000*

Characteristics	Normal range (male) (%)	Normal range (female) (%)	High range (%)	P-Value
University Location				
Morogoro	25 (38.4)	20 (38.8)	20 (38.4)	0.050*
Dodoma	21 (39.8)	7 (13.2)	21 (47.2)	
Residence				
Off-campus	13 (38.8)	12(37.8)	37 (49.3)	0.011*
In-campus	13 (39.4)	25 (34.4)	8 (34.2)	
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 0.165mg/dl, SE=0.0924, p=0.1) Table 13.

Table 13. Determinants of High-density lipoprotein in university students.

Characteristics	High density lipoprotein (HDL)
Location of University	
Morogoro	Ref
Dodoma	0.347*** (0.121)
Smoking status	
No	Ref
Yes	0.446*** (0.146)
Study year	
Second year	Ref
Third year and above	0.165* (0.0924)
Cocaine	2.718* (0.398)
Observations	118
R-squared	0.853

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

3.4.4. Determinants of Hypoglycemia 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 14. Determinants of Hypoglycemia in University students.

Characteristics	Blood glucose
Location of University	
Morogoro	Ref
Dodoma	-0.297 (0.438)
Sex	
Male	Ref
Female	-1.178** (0.475)
Marital status	
Single	Ref

Characteristics	Blood glucose
Married	-0.908 (0.770)
Scholarship	
No	Ref
Yes	0.385 (0.254)
Smoking status	
No	Ref
Yes	1.6440*** (0.510)
Dietary Diversity score	
<7 food groups	Ref
≥7 food groups	0.0149 (0.108)
Cocaine	5.891*** (1.305)
Observations	118
R-squared	0.571

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 areas (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 dyslipidemia. 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 ($n=55$) 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, Sarlin, F. S., & Orsagale, B. [28] reported that dyslipidemia 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-Anthan, 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, Mitic, N. R., & Popovic, I. [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 Mailla, G., *et al* [34] who reported a study done in Versluis, 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 reason 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 Manyogwa, 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 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 Studzinski, 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 John'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 assess 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.

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Conflicts of Interest

The authors declare no conflicts of interest.

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CHAPTER FOUR

4.0 GENERAL DISCUSSION

The primary objectives of this research were to assess the nutritional status and metabolic risk factors of university students in Morogoro and Dodoma regions of Tanzania. The study revealed that high dietary diversity (consumption of at least 7 food groups) was linked with central obesity. The study population had a prevalence of (44%) overweight and (11.1%) obesity. This could be due to the consumption of energy-dense foods that have health implications. The university environment is termed as an “obesogenic” environment therefore the common foods that are present are usually calorie-rich foods such as chips, red meats, rice and processed foods. The specific food groups that are consumed by the study population are starch staples (85.8%), dark green leafy vegetables (83.4%), other vitamin A rich fruits and vegetables (70.4%), other fruits and vegetables (85%), organ meats (40.1%), meat and fish (76.9%), eggs (56.3%), legumes, nuts and seeds (71%), milk and milk products (47.8%). Low-density-lipoprotein was the most prevalent metabolic risk factor; however, the study population manifested a cluster of metabolic risk factors such as central obesity, high blood pressure and high levels of cholesterol and triglycerides which results to metabolic syndrome.

4.1 Anthropometric Status and Dietary Diversity of University students

Findings in this study reported that the sex of the respondents were associated with central obesity, general obesity and overweight. Female university students in the study had a higher risk of visceral obesity, general obesity and overweight when compared to the male university students. This pattern of gender disparities could be due to the female students' high dietary diversity which is characterized by the selection of energy-dense foods. 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. These findings are in line with the study done by (Mogeni & Ouma, 2022) who reported females embraced greater dietary diversity in their eating habits compared to males. Moreover, the findings of this study corroborate with (Molla *et al.*, 2020) the odds of being centrally obese were 9.62 times higher among female study participants compared to their counterparts.

The risk of morbidity in the study was also associated with an increase in age whereby respondents that were ≥ 25 years were at a risk of central obesity compared to university students aged 20-24 years of age. Moreover, students ≥ 25 years old were found to be more susceptible to obesity and overweight. The possible reasons could be metabolic changes across different age groups and life factors accompanied as age progresses such as increased stress, changes in sleep patterns and exposure to risk behaviours. Moreover, the study found that individuals of ≥ 25 years of age had a low dietary diversity compared to participants who were 20-24 years of age. This could be due to economic constraints that are accompanied by increase in responsibilities as age advances. The findings of this study are in line with Molla *et al.* (2020) that found an increase in age was statistically associated with central obesity. In the same context a study done in Tanzania reported that older women (35-49 vs 15-24 years) of reproductive age were at a higher risk of developing obesity/overweight (Mosha *et al.*, 2021).

In this study, married participants were at a risk of developing central obesity and being overweight compared to single university students. This could be due to the difference in dietary diversity where married people have a higher dietary diversity linked with energy- dense foods. It is believed that marriage life comes with different challenges that can influence one's behaviour which have a potential health implications. The study's findings align with a study done by (Ntimana & Choma, 2023) whereby Bivariate correlation

analysis showed that married participants correlated positively and significantly with central obesity. Similarly, a study Bakir *et al.*, (2017) reported that the mean Body mass indexes and other anthropometric measurements such as Waist circumference were significantly higher in married women.

Furthermore, findings of this study show agro-ecological discrepancies whereby students in Saint John's University were more associated with being overweight than students in Mzumbe University Morogoro. The reason for this is due to the difference in climatic conditions, food grown in the specific areas and urbanization. The increase of Urbanization in Dodoma City is evident which makes the residents (including university students) vulnerable to health risk behaviours. A study reported that household dietary diversity differed from different regions in rural and urban Tanzania, regions such as Morogoro contributes to high diversity due to food availability while regions like Dodoma import most foods due to experiencing one season of rainfall per annum (Borrego, 2021). Bailey *et al.*, (2022) reported that students in the Midwest had higher BMIS compared to students in the Northeast areas.

Overweight and Obesity in the study were associated with student's study year. Whereby Students that were in their 3rd year and above were associated with Overweight when compared to second year students. The possible explanation for this could be the difference in dietary diversity and selection of food among the second-year students and students that are in their 3rd year and above. Furthermore, it is known that as the university year of enrolment progresses studies and schedules become tighter which results health-risk behaviours such as Skipping meals. These findings are in line with Ahmed *et al.* (2015) who reported a significant association between students of their first year of study and second year of study. In contrast, Bailey *et al.* (2022) reported that being a second-year student had higher BMI_s compared to four-year students.

4.2 Metabolic Risk Factors of University Students

The findings revealed a higher prevalence of elevated systolic blood pressure (7.5%) compared to students in the Morogoro region. The overall prevalence of Blood pressure among university students did not rise a public health significance due to the fact that a prevalence less than 5% is not regarded as public health issue of emergency. Moreover, the prevalence of high levels of lipid profiles among university students in the study (Total cholesterol, Triglycerides and low-density lipoprotein levels) were found to be significantly associated with the location of the universities. The imbalance of lipid levels (in most cases above optimal/high levels) in the blood is known as dyslipidemia. Students at 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. The possible reasons could be due to the different agro-ecological in which the university are located, which differ in climatic conditions, economic activities and food crops grown.

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 than in a study done among university students in Nairobi, where the prevalence was 27.8% (Rotich *et al.*, 2023). The possible reason could be due to the total number of participants that participated in the study. Students aged ≥ 25 years had had a 35.5% prevalence but not significant visceral obesity.

The study, found that female students, students who were aged ≥ 25 years, and obese students were more susceptible to central obesity. This is due to different factors such as biological, social and economic. The study's findings align with Israel *et al.* (2023) who reported that being female was associated with central obesity.

These results were consistent with a study conducted in Ethiopia whereby the odds of being abdominally obese by waist circumference increased by age (Bereka *et al.*, 2022). This study's findings align with (Tegegne *et al.*, 2022) which reported central obesity to be associated with overall obesity.

Location of the university and smoking status were significantly associated with increased levels of triglycerides. This is due to the impairment of lipid metabolism that the chemical substances cause and the difference in agro-ecological zones. The findings of this study are in line with (A.van der Plas *et al.*, 2023) 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). Groot *et al.*, 2019 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).

Marital status and smoking are associated with blood pressure (diastolic) in the study. The changes in metabolism due to chemical substances present in cigarettes and marital challenges could be a possible explanation for this. Kuibao *et al.* (2022) reported that marital status was associated with higher odds of hypertension. Chen *et al.* (2022) 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 *et al.* (2022) reported Low-density lipoprotein to be associated with socio-economic status that results to high risks of all-cause mortality.

The study also assessed for the prevalence and determinants of Metabolic risk factors among the University students. The findings revealed a higher prevalence of elevated systolic blood pressure (7.5%) compared to students in Morogoro region. The overall prevalence of Blood pressure among university students in this did not rise a public health significance due to the fact that a prevalence less than 5% are not regarded as a public health issue of emergency. Moreover the prevalence of high levels of lipid profiles among university students in the study (Total cholesterol, Triglycerides and low-density lipoprotein levels) was found to be significantly associated with the location of the universities. The imbalance of lipid levels (in most cases above optimal/high levels) in the blood is known as dyslipidemia. Students at 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 at Saint John's University. The possible reasons could be due to the different agro-ecological zones in which the university are located, which differ in climatic conditions, economic activities and food crops grown.

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female was associated with central obesity. These results were consistent with a study conducted in Ethiopia whereby the odds of being abdominally obese by waist circumference increased by age (Bereka *et al.*, 2022). The findings of this study are in line with (Tegegne *et al.*, 2022) that reported central obesity to be associated with overall obesity.

Remarkably, other health-implicated factors were identified in this study. They include, high levels of High-density lipoprotein and low-level of blood glucose among university students. The possible reason could be because of the varying cut-off point values across regions or associated factors due to the nature of the participants. 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 on campus (30.3%). Additionally, the overall prevalence of high-density lipoprotein among the university students was (38.2%). A significantly higher prevalence was found to be in females (44.3%), Saint Johns's University students (47.2%) and Off-campus students (43.5%). The determinants for the health implicated risk factors in the study were found to be significantly associated with the location university, smoking status, study year and sex. The possible reason for this is due to difference in agro-ecological zones, biological factors accompanied by gender differences, peer pressure, food choices and eating behaviour as well as peer pressure.

CHAPTER FIVE

5.0 GENERAL CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In conclusion, this study generated valuable insights into the overall nutritional status, and metabolic risk factors among the selected university students in Morogoro and Dodoma regions. Central Obesity, general obesity and overweight are concerns in this sub-population these are associated with dietary diversity and habits of university students across the two different agro-ecological zones. Moreover, the study showed that the prevalence of metabolic risk factors is a public health issue amongst university students due to the cluster of their existence which results in metabolic syndrome. The study also highlighted a prevalence of metabolic risk factors that were not of public health significance due to the small percentage. Moreover, the determinants of the metabolic risk factors vary across the two regions and include Location of the university, sex, scholarship status, smoking status, and dietary diversity scores. Furthermore, the study highlighted the importance of exploring other health implicated factors such as High levels of high-density lipoproteins and low levels of blood glucose. The findings of this study can be applied to improve the lifestyle of university students to avoid poor nutritional outcomes.

5.2 Recommendations

Based on the findings of this study efforts are needed to promote healthy food choices among youths. University students represent a youth population that are in a transition stage who are prone to adverse health effects. The findings of this study can be used to strengthen policies and tailored interventions that can be used to improve health. University authorities should assist in promoting healthy behaviours amongst this sub-population through activities such as inter-university competitions (bonanza) that involve physical activities. The university authority can also select food contractors

responsible for distributing food in the cafeterias that have variety healthier options in their menus which are cost-effective. Nutrition stakeholders such as non-government organizations (NGOs) and community-based organizations (CBOs) can help in developing and the implementation of easy-to use indicators of healthy dietary diversity in their localities.

Assessment of health status of the university students should be carried out on regular and necessary consultations. Comprehensive strategies such as nutrition education, nutrition intervention and well-designed prospective studies should be tailored to the university students so as to raise awareness on health risk behaviours. Educational campaigns regarding healthier food choices, lifestyle and weight management could positively impact the health of university students. This can be done through different training institutes such as the Sokoine University of Agriculture and Tanzania Food and Nutrition Centre through the Ministry of Health. Nutrition and health manuals could be provided in food outlets in the university settings so they can have healthier food choices that have a positive nutritional outcome.

Future research should consider more participants whereby having a large sample size may increase the validity of the study. Due to discrepancies of different cut-off values further investigation is necessary to validate the thresholds across regions. Moreover, more studies should be done in different universities across the country to determine the public health emergency for metabolic risk factors. Efforts should be made to promote good nutrition practices among university students, including the selection of healthy meals proper time management and adapting behaviours that will provide proper nutritional outcomes. Training programs should also be provided to improve the nutritional knowledge of university students. Nutrition education should be administered in university settings, and educate them on dietary diversity and the selection of food groups. Lastly,

periodic follow-up of university students should be done to provide treatment and support where needed.

APPENDICES

Appendix 1: Informed consent form for university students



**Information Sheet on Research Study Titled
“NUTRITIONAL STATUS AND METABOLIC RISK FACTORS
AMONG UNIVERSITY STUDENTS IN MOROGORO AND
DODOMA REGIONS”.**

Investigator:

Neema John Mgetta (MSc) Human Nutrition. Sokoine University of Agriculture (SUA), College of Agriculture, Department of Human Nutrition and Consumer Sciences, P.O Box 3006, Chuo Kikuu, Morogoro, Tanzania.

Dear Sir or Madam,

This is information about a planned study on “Nutritional status and metabolic risk factors among university students in Morogoro and Dodoma regions”. The study will be conducted in universities present in Morogoro and Dodoma regions whereby they were purposively selected. This study aims in assessing the determinants of nutritional status and metabolic risk profiles. It also seeks to understand their different consumption patterns and dietary diversity. In this study, you and 261 other University students are being asked to join. A face-to-face interview will be conducted which will include a structured questionnaire. The questionnaire will collect information on demographic, social, economic factors food frequency. Your height will be measured by a stadiometer and weight by an electronic weighing scale to determine nutritional status. Lastly blood

samples will be drawn to determine your metabolic risk profile that is blood glucose level and lipid profile, your blood pressure will also be taken by a blood pressure machine. Whenever necessary audio recordings and pictures of important places and events will be taken as part of data to be collected.

If you decide to join, you can stop at any time if you want to and you do not have to explain why. No disadvantages will result if you do not participate or if you drop out of the study. Therefore, you have the right to withdraw from the study at any time without facing any consequences

Benefits and Risk

There benefits of this study is based on individual level to a broader scope this means directly and indirectly. The direct benefits include you as an individual to understand your health status and adapt behaviors that can help you in the long run to lead a healthy life. It will also help to assess the risks you are in or most likely to incur if you practice unhealthy lifestyle. The overall benefit will be to broaden your scope of knowledge and understanding on how to be a healthy and active individual. The study will also be vital in informing the governmental and non- governmental stakeholders to plan and implement appropriate strategies and interventions in knowledge and emphasis on good eating behaviour, so as to reduce the burden of dietary related diseases in university students and the community at large. Since the study involves invasive methods, the possible risks are associated with blood drawing which include slight pain and slight bleeding which will be done professionally and ensured that it is a momentary procedure. Privacy and Data Management once the research team is finished with collecting all data and have returned to SUA, all data will be kept and managed in a computer using anonymous code of the collected information i.e., your name and personal information will not be attached to the information. Also, information will not be shared.

Questions

This study has been reviewed and approved by the Research Ethics Boards in Tanzania. The members of this board are experts whose job is to ensure the protection of the rights and welfare of people participating in research. The work of the ethics experts is not intended to replace your judgment about what decisions and choices are best for you. If you have any questions or do not understand this information sheet and the consent form, you can contact Neema John Mgetta (MSc. Human Nutrition), Sokoine University of Agriculture, Department of Human Nutrition and Consumer Sciences, P. O. Box 3006, Chuo Kikuu, Morogoro, Tanzania, Mobile no.: +255 738722995. Email: neemamgetta@gmail.com

For more clarification on ethical conduct for research, please contact: NatHREC,
The National Institute for Medical Research (NIMR), 3 Barack Obama Drive,
P. O. Box 9653, 11101 Dar es Salaam,
Tanzania. Tel: +255-22-2121400, hq@nimr.or.tz | info@nimr.or.tz
Declaration of Consent for University Student.

**“NUTRITIONAL STATUS AND METABOLIC RISK FACTORS
AMONG UNIVERSITY STUDENTS IN MOROGORO AND
DODOMA REGIONS.”**

1. I certify that I have read information on this consent form or somebody else has read it to me and I understood intention and goals of the research study titled “nutritional status and metabolic risk factors of university students in Morogoro and Dodoma regions.”, and I am completely satisfied and accept the research study to be undertaken.

2. I agree with the scientific evaluation of my nutritional status as well as eating behaviour and personal data will be in an anonymous manner. I agree with the retention and publication of the study results in the same manner, according to privacy of the National Institute for Medical Research, Tanzania.
I feel completely informed and agree to my participation in the study “nutritional status, metabolic risk factors of University students in Morogoro and Dodoma regions.”. I know I can withdraw at any time prior to anonymization of the data without any consequences and without having to state a reason for withdrawing. I also know that I will be provided with any new information about the study.

Name of participating

University student

Signature of participating

University student

Date:

Name of responsible researcher

Signature of responsible

Date:

researcher

**“NUTRITIONAL STATUS AND METABOLIC RISK FACTORS
AMONG UNIVERSITY STUDENTS IN MOROGORO AND
DODOMA REGIONS”.**

Appendix 2: Student’s Questionnaire

This is information about a planned study on “nutritional status and metabolic risk factors among university students in Morogoro and Dodoma regions”. The study will be conducted in universities present in Morogoro and Dodoma regions whereby two universities were purposively selected. This study aims in assessing the nutrition status and dietary diversity of university students and determining their metabolic risk profiles. It also seeks to understand their different consumption patterns, in this study, you and 261 other University students are being asked to join. The questionnaire will collect information on demographic, social, economic factors and eating behaviors as well as physical and sedentary behaviors.

Questionnaire number:

Name of University:

Date of interview:

SECTION A: SOCIO-DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

1. Age of the respondent.....
2. Sex: 1= Male 2= Female
3. Degree type
4. Year of study.....
5. Marital Status..... 1= Single 2= Married
6. Religion..... 1= Christian 2= Muslim
7. Living arrangement/Residence: 1= Within students’ residence, 2= Out of campus, 3= Living with parents
8. Do you suffer from of chronic disease? 1= Yes 2= No
9. How many hours do you sleep? 1= less than 8 2= 8 hrs and above
10. What is your currently smoking status? 1= Non-smoker, 2= Ex-smoker, 3=Smoker

11. What is your primary source of nutritional information? 1= TV, 2= internet, 3= news, 4= magazines, 5=journals, 6= books, 7= Friends ,8= family,9= Others(specify)
12. How do you support yourself financially? 1=Privately 2= Sponsored
13. Do you receive scholarship? Yes=1 No= 2 If yes is it a full scholarship or not?

SECTION B: Dietary patterns

1. How do you normally access meals?

Option	Breakfast	Lunch	Supper
Purchasing cooked meals at university canteens			
Purchasing food out of the university			
Purchasing ingredients			
Group cooking			
Others			

2. Food groups for dietary diversity assessment:

Have you consumed the following foods, meals, snacks made from these foods during the past 7 days?

Food group	Type of food or meal	1=yes 0=No
1	Cereals e.g., Maize, sorghum, finger millet, pearl millet, wheat	
2	Vitamin A-rich (red/yellow/orange) vegetables and tubers e.g., Pumpkin, carrots, tomatoes, orange fleshed sweet potatoes	
3	Other roots and tubers e.g., cassava, round potatoes, sweet potatoes, yams, green bananas	
4	Green leafy vegetables	
5	Vitamin A- rich (red/yellow/orange) fruits e.g., mangoes, papaya, 100% fruit juice made from these, other locally available vitamin A rich fruits	

6	Other vegetables and fruits e.g., tomatoes, onion, eggplant	
7	Legumes e.g., beans, peas, cowpeas, pigeon peas, green grams, chickpeas, soya bean	
8	Nuts and oil seeds e.g., ground nuts, sunflower, pumpkin seeds	
9	Animal milk and milk products	
10	Eggs	
11	Organ meats e.g., liver, kidney, tongue	
12	Flesh meats e.g., beef, goat, pork, lamb, rabbit, chicken or duck	
13	Fish, sardines or other sea foods	
14	Oil, fat, ghee or butter used for cooking or added to food	
15	Sugars, honey, sugary products, sweetened sodas or juice drinks e.g., sodas, sweets, chocolates, cookies, cakes	
16	Spices, condiments, beverages e.g., salt, pepper, coffee, tea, alcoholic beverages	
TOTAL		

3. How often in the past 7 days have you consumed breakfast, lunch and supper? In the scale (0-7)

Option	Scale	Reason
Breakfast		
Lunch		
Supper		

Appendix 3: Nutrition measurement

SECTION C: Measurements

Height.....cm Weight.....kg

Waist circumferencecm

Blood glucose

Blood pressure.....

FOMUYARIDHAAKWAWANAFUNZI WA CHUO KUSHIRIKI



Karatasi ya taarifa za utafitiwa masomo juu ya

**“HALI YA LISHE NA VIASHIRIA VYA KIMETABOLIKI YA
WANACHUO KATIKA MIKOA YA MOROGORO NA
DODOMA.”.**

KIAMBATISHO NAMBARI 5

Utangulizi

Utafiti huu unahusu “Hali ya lishe na viashiria vya kimetaboliki ya wanachuo katika mikoa ya MOROGORO NA DODOMA.” Utafiti huu unakusanya taarifa kutoka kwa wanafunzi wanaosoma Chuo kikuu cha Mzumbe na St. John’s.

Lengo

Lengo la utafiti huu ni kukusanya taarifa za hali ya lishe na viashira vya kimetaboliki katika wanafunzi wa elimu ya juu.

Kwa nini umechaguliwa kuwa sehemu ya utafiti huu?

Umechaguliwa kushiriki katika utafiti huu kwa sababu una sifa za kushiriki na utasaidia sana kufanikisha utafiti huu unaolenga kuboresha Lishe

Haki na majukumu.

Umechaguliwa kushiriki katika mahojiano ambayo yanajumuisha maswali juu ya mada tabia za kiuchumi na za kijamii, mpangilio wa ulaji na unywaji. Pia utachukuliwa vipimo vya mwili kama urefu, uzito na mzunguko wa kiuno. Pia utachukuliwa kipimo cha damu na shinikizo la damu.

Kushiriki katika utafiti huu ni **hiari** na unaruhusiwa kuamua kuacha kushiriki au kujibu swali lolote bila kutolewa kwenye utafiti huu wala kuadhibiwa. Majukumu yako ni kushiriki kikamilifu na kutoa taarifa sahihi.

Faida na hasara

Hakuna faida yoyote ya moja kwa moja unayoweza kupata ikiwa utashiriki katika utafiti huu. Lakini pia hakuna athari zozote kwako ikiwa utaamua kushiriki

Faraghanautunzajiwataarifa

Baada ya timu ya watafiti kumaliza kukusanya taarifa kutoka kwenu na kurudi Chuo Kikuu cha Kilimo cha Sokoine, taarifa zote zitahifadhiwa katika kompyuta kwa kutumia msimbo wa siri, yaani jina lako na taarifa zako binafsi halitaambatanishwa na taarifa zozote zile na wala hazitatolewa kwamtu yeyote

Kwa Mawasiliano/maswali.

Utafiti huu umepitiwa na kuidhinishwa na Bodi za Maadili ya Utafiti nchini Tanzania. Wajumbe wabodi hii ni wataalam ambao kazi yao ni kuhakikisha haki na ustawi wa watu wanaoshiriki katika utafiti vinalindwa. Kazi ya wataalam wa maadili haikuondolei maamuzi ya kuchagua kipi ni borakwako. Kama una maswali yoyote au hukuelewa fomu hii ya idhini na karatasi ya taarifa, unawezakuwasilianana:

Neema John Mgetta

Chuo Kikuu cha Kilimo cha Sokoine,

Idara ya Sayansi ya Lishe kwa Binadamu na Utumizi,

S.L.P 3006, Chuo Kikuu, Morogoro, Tanzania,

Simu: +255 738 722 995.

Baruapepe: neemamgetta@gmail.com

Kamautakuwanamaswaliyoyotekuhusiananamasualayakimaadiliya utafitihuuunawezakuwasiliananaNatHREC,
The National Institute for Medical Research (NIMR), 3Barack Obama Drive,
S.L.P 9653, 11101DaresSalaam, Tanzania.

Tel: +255-22-2121400, hq@nimr.or.tz | info@nimr.or.tz

TAMKO LAIDHINI YA MWANACHUO

“HALI YA LISHE NA VIASHIRIA VYA KIMETABOLIKI YA WANACHUO KATIKA MIKOA YA MOROGORO NA DODOMA.”

1. Nathibitishakuwanimeisoma/nimesomewakaratasiyataarifanafomu hiiyaidhininanimeelewanianamalengoyautafitihuuwa **“hali ya lishe na VIAHSIRIA VYA KIMETABOLIKI ya wanachuo katika mikoa ya Morogoro na Dodoma”**., nanimeridhikanakukubaliutafiti huu ufanyike.
2. Nakubaliana na tathmini ya kisayansi juu ya hali yangu ya lishe, mfumo wa ulaji na taarifa zangu binafsibila kujulikana. Ninakubaliana pia na taratibu za kuhifadhi na kuchapisha matokeo ya utafiti kwanamnanakulingananakanunizaUsirizaTaasisiyaTaifayaUtafitiw akitabibunchiniTanzania.

Nimeelewa kabisa na ninakubali kuushiriki katika utafiti wa **“Hali ya lishe na viashiria vya kimetaboliki wanachuo katika mikoa ya Morogoro na Dodoma”**. najua ninaweza kujiondoa wakati wowote kabla kuifanyataarifakutotambulika mshiriki wakebilamadhara yoyote nabila kutakiwa kutoa sababu ya kujiondoa. Pia, ninajua kwamba tutapewa taarifa yoyote mpya kuhusuutafiti.

 Jinalamwanachuo

 Sahihiyamwanachuo

Tarehe:

 Jinalamtafiti

 Sahihiyamtafiti

Tarehe:

**DODOSO JUU YA HALI YA LISHE NA VIASHIRIA VYA
KIMETABOLIKI KWA WANACHUO KATIKA MIKOA YA
MOROGORO NA DODOMA**

Hii ni taarifa juu ya utafiti unaohusu “Hali ya lishe na viashiria vya kimetaboliki ya wanachuo katika mikoa ya Morogoro na Dodoma.” Utafiti huu utafanyika kwa wanachuo katika vyuo viwili mkoani Dodoma na Morogoro, vyuo viwili vilichaguliwa kwa mbinu za kiutafiti kwa kila mkoa. Utafiti huu unalenga kutambua hali ya antropometric pamoja na tabia ya ulaji baina ya wanachuo. Pia kuelewa mfumo wa lishe wa wanachuo, shughuli za kimwili na hali zao za kimetaboliki. Kutimiza malengo hayo tunahitaji ushiriki wa wewe na wanachuo wengine 261. Wakati wakufanya utafiti mtaulizwa maswali kuhusiana na ujuzi/maarifa na muundo wa ulaji wenu.

Namba ya dodoso

Jina la chuo

Tarehe ya mahojiano

SEHEMU A: Taarifa za jamii, kiuchumi na demografia

1. Umri wa mhojiwa
2. Jinsia 1= Mwanaume 2=Mwanamke
3. Shahada ya mafunzo

4. Mwaka wa masomo.....
5. Hali ya ndoa
6. Dini
7. Makazi 1= ndani ya chuo 2=nje ya chuo 3=kuishi na wazazi
8. Je unasumbuliwa na magonjwa sugu? 1=ndio 2= Hapana
9. Je, unaonaje hali ya ulalaji wako? 1=kawaida 2= sio mara kwa mara
10. Je, wewe ni mvutaji wa sigara? 1= Mvutaji 2= nimeacha kuvuta 3= sio mvutaji
11. Taarifa zako za lishe hua unazipata wapi? 1= Luninga 2= mtandaoni 3= vyombo vya Habari 4= magazeti 5=majarida 6= vitabu 7=marafiki 8= familia 9= mahali pengine (taja)
12. Je, unakidhi vipi mahitaji yako ya kifedha ukiwa chuoni? 1= binafsi 2= mfidhili
13. Je unafadhiliwa kielimu? 1=ndio 2=Hapana. Kama ni ndio je ni ufadhili wa asilimia 100 au pungufu?

SEHEMU B: Mpangilio wa ulaji

1. .Huwa unapata wapi chakula?

Chaguo	Kifungua kinywa	Chakula cha mchana	Chakula cha jioni
Nanunua chakula mgahawani ndani ya chuo			
Nanunua chakula mgahawani nje ya chuo			
Nanunua mahitaji na kupika mwenyewe			
Nanunua mahitaji na kupika na watu wengine			
Nyinginezo			

2. Vikundi vya chakula kwa ajili ya utathmini wa miundo mbalimbali ya ulaji

Je umekula vyakula au vitafunwa vifuatavyo siku saba zilizopita zilitongenezwa kutumia hizi malighafi

Kikundi cha chakula	Aina ya chakula	1=ndio 0=hapana
1	Nafaka kwa mfano ngano,mahindi,mpunga	
2	Vyakula yenye wingi wa vitamini A,mbogamboga na mizizi kwa mfano karoti,nyanya nk.	
3	Mizizi mengineyo kwa mfano mihogo,viazi vitamu na ndizi	
4	Mboga za majani	
5	Matunda yenye wingi wa vitamini A kwa mfano maembe,mapapai na matunda mengineyo au juisi za matunda haya	
6	Mbogamboga zingine na matunda	
7	Kunde kwa mfano maharage,mbaazi, maharage ya soya nk	
8	Karangana mbegu zenye ufuta	
9	Maziwa ya Wanyama na bidhaa za maziwa ya wanyama	
10	Mayai	
11	Sehemu za mwili wa Wanyama zinazoliwa kama chakula mfano: maini, figo, ulimi	
12	Nyama za kawaida za Wanyama	
13	Samaki, dagaa na vyakula vingine kutoka baharini	
14	Mafuta ya kupikia chakula, siagi na vingine kama hivyo	
15	Sukari,asali,bidhaa za sukari,soda na juisi. Mfano. Chokoleti, biskuti, pipi na vingeno kama hivyo.	
16	Viungo,vitoweo. Mfano.. chumvi,pilipili,kahawa na chai	
JUMLA		

3. Je, ni mara ngapi katika siku saba zilizopita, umekula kifungua kinywa, chakula cha mchana na chakula cha usiku? (Kwa skeli ya 0-7)

Chaguo	Skeli	Sababu
Kifungua kinywa		
Chakula cha mchana		
Chakula cha jioni		

SEHEMU D: TAARIFA ZA Vipimo vya mwili

Kipimo cha Urefu.....cm Uzitokg Kipimo cha
 mzunguko wa kiunocm
 Vipimo vya kimetaboliki.....



THE UNITED REPUBLIC
OF TANZANIA



National Institute for Medical Research
3 Barack Obama Drive
P.O. Box 9653
11101 Dar es Salaam
Tel: 255 22 2121400
Fax: 255 22 2121360
E-mail: ethics@nimr.or.tz

NIMR/HQ/R.8a/Vol.IX/4363

Ms. Neema John Mgetta
Sokoine University of Agriculture
P O Box 3006
Morogoro

Permanent Secretary
Ministry of Health
Government City Mumba
Health Road
P.O. Box 743
40178 Dodoma

03 July 2023

RE: ETHICAL CLEARANCE CERTIFICATE FOR CONDUCTING
MEDICAL RESEARCH IN TANZANIA

This is to certify that the research protocol entitled "**Determinants of anthropometric status, metabolic risk factors and eating behaviors of university students in Morogoro and Dodoma regions**" (Mgetta, N. *et al*) has been granted ethical clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress reports are submitted to the Ministry of Health and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from the National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Sites: Dodoma and Morogoro regions.

Approval is valid for one year: 03 July 2023 to 02 July 2024

Name: Prof. Said S. Aboud

Name: Prof. Tumaini J. Ngu


Signature
CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE


Signature
CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH

c.c: Director, Health Services-TAMISEMI, Dodoma.
RMOs of Dodoma and Morogoro regions.
DMOs/DEOs of respective districts.





UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND
TECHNOLOGY

SOKOINE UNIVERSITY OF AGRICULTURE
DIRECTORATE OF POSTGRADUATE STUDIES,
RESEARCH, TECHNOLOGY TRANSFER AND
CONSULTANCY

P.O Box 3151, CHUO KIKUU, MOROGORO, TANZANIA

Telephone: +255 23 264 0013, 023 264006-9 E-mail: drpts@sua.ac.tz

Website: www.drptc-sua.ac.tz



Our Ref: SUA/MHN/D/2019/0009/11

Date: 03rd January, 2022

Ms. Neema John MGETTA
Department of Human Nutrition and Consumer Sciences
SUA, Morogoro

Ufs: The Head
Department of Human Nutrition and Consumer Sciences
SUA, Morogoro

Forwarded
Hukwani
06/01/2022

Dear Ms. Mgetta,

RE: APPROVAL OF YOUR MSc. (HUMAN NUTRITION) RESEARCH PROPOSAL

Reference is made to the above captioned subject.

This is to inform you that, the Directorate of Postgraduate Studies, Research, Technology Transfer and Consultancy (DPRTC) has noted the approval made by the Board, College of Agriculture for your MSc. research proposal. Therefore, you are hereby permitted to embark on data collection as per your approved research proposal.

In addition to the permission granted, please be notified that, you are required to present yourself at the office of the Deputy Vice Chancellor Academic (DVC-A), to kindly request for research clearance letter.

Wishing you all the best in your research work.

Yours sincerely,

P. L. Mresa
For: DIRECTOR



Cc: The Principal, College of Agriculture
The Chairperson, College Postgraduate Studies Committee
Supervisors: Dr. K. Kulwa and Dr. H. Muhimbula

CLEARANCE PERMIT FOR CONDUCTING RESEARCH IN TANZANIA



UNITED REPUBLIC OF TANZANIA
 MINISTRY OF EDUCATION, SCIENCE AND
 TECHNOLOGY,
**SOKOINE UNIVERSITY OF AGRICULTURE
 OFFICE OF THE VICE-CHANCELLOR**



P.O. Box 3000, CHUO KIKUU, MOROGORO, TANZANIA.
 Phone: +255 (023) 2640006/7/8/9, Direct Line: +255 (023) 2640015,
 E-mail: vc@sua.ac.tz, Website: <https://www.sua.ac.tz>

Please refer to:

Our Ref: SUA/ADM/R.1/8/828

Date: 25th January, 2022

The Deputy Vice Chancellor (Academic),
 Mzumbe University,
 P.O. Box 1,
MOROGORO.

The Deputy Vice Chancellor (Academic),
 Jordan University College (JUCO),
 P.O. Box 1878,
MOROGORO.

The Deputy Vice Chancellor (Academic),
 St. John's University,
 P.O. Box 47,
DODOMA.

The Deputy Vice Chancellor (Academic),
 University of Dodoma,
 P.O. Box 259
DODOMA.



RE: UNIVERSITY STAFF, STUDENTS AND RESEARCHERS CLEARANCE

The Sokoine University of Agriculture was established by University Act No. 7 of 2005 and SUA Charter, 2007 which became operational on 1st January 2007 repealing Act No. 6 of 1984. One of the mission objectives of the University is to generate and apply knowledge through research. For this reason the staff and researchers undertake research activities from time to time.

2. To facilitate the research function, the Vice Chancellor of the Sokoine University of Agriculture (SUA) is empowered to issue research clearance to staff, students, research associate and researchers of SUA on behalf of the Tanzania Commission for Science and Technology.

CLEARANCE PERMIT FOR CONDUCTING RESEARCH IN TANZANIA

3. The purpose of this letter is to introduce to you **Ms. Neema John Mgetta** a bonafide MSc. (Human Nutrition) student with Registration number **MHN/D/2019/0009** of SUA. This MSc. student was given clearance to conduct research in your University from January, 2021 to April, 2021 unfortunately she could not complete data collection within that given time. By this letter **Ms. Neema John Mgetta** has been granted extended clearance to continue conducting research in your University. The title of the research in question is **"DETERMINANTS OF NUTRITIONAL STATUS AND EATING BEHAVIOR OF UNIVERSITY STUDENTS IN MOROGORO AND DODOMA REGIONS"**.

4. The period for which this permission has been granted is from **March, 2022 to August, 2022**. The research will be conducted in your University.

5. Should some of these areas/institutions/offices be restricted, you are requested to kindly advise the researcher(s) on alternative areas/institutions/ offices which could be visited. In case you may require further information on the researcher please contact me.

6. We thank you in advance for your cooperation and facilitation of this research activity.

Yours sincerely,


Prof. Maulid W. Mwatawala
FOR: VICE-CHANCELLOR

c.c. Director, DPRTC, SUA
c.c. Student – **Ms. Neema John Mgetta**

- To note in file

VICE CHANCELLOR
SUA UNIVERSITY OF AGRICULTURE
P. O. Box 2000
MOROGORO, TANZANIA

Neema John Mgetta
0656193903



UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MZUMBE UNIVERSITY
OFFICE OF VICE CHANCELLOR



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Website: www.mzumbe.ac.tz

P.O. BOX 1
MZUMBE
MOROGORO, TANZANIA

In replying please quote:

Ref. No. AL.520/995/01/R.2/1/003

1st August, 2022

Vice Chancellor,
Sokoine University of Agriculture,
P.O. Box 3000,
MOROGORO.

RE: PERMIT TO ACCESS DATA FOR FIELD RESEARCH AT MZUMBE UNIVERSITY

The caption above refers.

2. This is to acknowledge receipt of your letter with ref. No. SUA/ADM/R.1 dated 10th January, 2022 in which you introduced **Ms. Neema John Mgetta** as bonafide student of Sokoine University of Agriculture. You also informed that the said student is conducting research entitled "**Determinants of Nutritional Status and Eating Behavior of University Student in Morogoro and Dodoma Region**" and would like to access the data at Mzumbe University for two (2) months, within the month of March, 2022 and September, 2022.

3. I am glad to inform you that the office of the Vice Chancellor, Mzumbe University has granted permission for her to carry out data collection exercise at the University as requested by your office. Alongside this permission, the researcher will be required to carry this letter with her anytime she is involved in data collection for the purpose of identification. Upon arrival at MU for the purpose of data collection, she should report to the office of the Deputy Vice Chancellor (Planning Finance and Administration) for logistical arrangements. Should there be a need to extend time to complete the assignment, she should communicate the same in writing to the office of the Deputy Vice Chancellor (Academic Research and Consultancy).

4. I wish her success.

Yours Sincerely,

Prof. William J. S. Mwegoha
Ag. VICE CHANCELLOR

MZUMBE UNIVERSITY
P. O. Box 1, MZUMBE
TANZANIA

Cc: **Ms. Neema J. Mgetta (Student)**

Administration Block D, Academic Street, P.O. Box 1, MZUMBE. +255 023 2931212
Fax: +255 23 232931212 Email: vc@mzumbe.ac.tz Website: www.mzumbe.ac.tz



Jandae Kuhesabiwa Siku ya Jumatano tarehe 23 Agosti, 2022

Dean - FaNAS

Please assist the student to the appropriate staff to enable her collect her data 100%

January 2022

To: Dean School of Nurs

26/6/23

The management, vide Director of Research and Consultancy F88, has permitted the following person to collect data in our university.

Name: Neema John Mgetta

Institution: Sokoine University of Agriculture

Subject: Determinants of Nutritional Status and Eating Behaviour
of University students in Morogoro and Dodoma regions

Research period: March – August 2022

The data collector is directed to you for guidance and supervision. On completion of the exercise you are required to fill the attached report form and send the data collector back to our directorate for clearance. In case you are not in a position to offer the necessary support to the data collector please complete the section below and return the letter to DRIC.

The request/clearance letter from his/her institution is attached.

**DIRECTOR
RESEARCH, INNOVATION AND CONSULTANCY**

TO: Director of Research, Innovation and Consultancy,

The faculty/school/directorate is not in a position to host the above-mentioned researcher for the following reasons:-

Name _____ Signature _____ School/faculty _____ Date _____



Science Publishing Group
1 Rockefeller Plaza, 10th and 11th Floors,
New York, NY 10020 U.S.A.

Acceptance Letter



Reference: JFNS

Date: December 25, 2023

Dear Neema Mgetta, Happiness Muhimbula, Kissa Kulwa,

Thanks for your contribution to *Journal of Food and Nutrition Sciences (JFNS)*.

(ISSN Online: 2330-7293; ISSN Print: 2330-7285)

We are pleased to inform you that your paper:

Manuscript Number: 1541489

Title: Prevalence and Determinants of Metabolic Risk Factors Among University Students in Dodoma and Morogoro Regions Tanzania has been accepted for publication. Congratulations!

Best Regards

Journal of Food and Nutrition Sciences (JFNS)

<http://www.sciencepg.com/jfns>

Science Publishing Group

For and on behalf of
SCIENCE PUBLISHING GROUP INC

Alan Smith

Authorized Signature: 20

5/7/24, 4:15 PM

Gmail - [tjhr] Editor Decision



Neema Mgetta <neemamgetta@gmail.com>

[tjhr] Editor Decision

1 message

Chief Editor via African Journals Online <no-reply@ajol.info>

Tue, Mar 19, 2024 at 1:29 PM

Reply-To: Chief Editor <tjhr@nimr.or.tz>

To: Neema Mgetta <neemamgetta@gmail.com>, Doctor <happy.issa@sua.ac.tz>

Neema Mgetta, Doctor:

We have reached a decision regarding your submission to Tanzania Journal of Health Research, "Dietary diversity and anthropometric status among university students in Dodoma and Morogoro regions, Tanzania".

Our decision is to: Accept Submission

Tanzania Journal of Health

Research <http://www.ajol.info/tjhrb>

