PREVALENCE, AWARENESS AND RISK FACTORS FOR TYPE 2 DIABETES MELLITUS AND HYPERTENSION AMONG SECONDARY SCHOOL ADOLESCENTS IN MOROGORO REGION, TANZANIA

MAKBEL, KHADIJA AHMED

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THEREQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN HUMAN NUTRITION OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA

2020

ABSTRACT

The prevalence of non-communicable diseases is increasing rapidly in Tanzania; triggered by changes in lifestyles, dietary patterns, and increasing early obesity. This study reports the prevalence, awareness and risk factors for Type 2 diabetes mellitus and hypertension among adolescents. A cross-sectional survey was conducted from January to March 2020 which involved 384 adolescent students aged 14-19 years. Standard procedures were used to measure weight, height, body fat percentage, blood pressure and blood glucose. Hyperglycemia was diagnosed using American Diabetes Association criteria while hypertension was diagnosed using American Heart Association Guidelines for childhood hypertension. Dietary assessment was done using a validated dietary diversity questionnaire. Physical activities were assessed using a self-administered 7-day recall physical activity questionnaire for adolescents. Awareness on diabetes and hypertension was obtained through self-administered questionnaire. Statistical Packages for Social Sciences version 21 was used to analyze descriptive statistics and bivariate logistic regression at 5% level of significance. About 50% of the respondents were aware of type 2 diabetes mellitus and hypertension. Prevalence of pre-diabetes was higher in urban (7.3%) compared to rural areas (3.1%). The risk factors for pre-diabetes were overweight and obesity (AOR 2.05; 95%CI 2.17-6.86), and elevated body fat (AOR 1.95; 95% CI 1.23-7.18). The prevalence of hypertension was much higher in urban (17.2%) compared to rural areas (5.7%). The risk factors for hypertension observed were overweight and obesity (AOR 6.45 95% CI 1.64-13.94), elevated body fat (AOR 3.91 95%CI 1.94-8.96), living in urban area (AOR 3.43 95% CI 1.67-7.04) and physical inactivity (AOR 1.98 95% CI 1.65-5.49). High prevalence of pre-diabetes and hypertension due to high rates of overweight and obesity in adolescents was alarming. Therefore; nutrition and healthy lifestyle education has to be integrated in school programs to reduce the risk of developing diabetes and hypertension in the future.

DECLARATION

I, KHADIJA AHMED MAKBEL, declare to the Senate of Sokoine University of Agriculture, that, this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution for a degree award.

_____ _____

KHADIJA AHMED MAKBEL **Date**

(MSc. Human Nutrition Candidate)

_____ _____

DR. AKWILINA WENDELIN MWANRI **Date**

(Supervisor)

COPYRIGHT

ACKNOWLEDGEMENTS

I convey my special thanks to the almighty living God for protecting me and making me healthy living and complete my studies. I am also highly indebted to my supervisor, Doctor Akwilina Wendelin Mwanri for her professional guidance, encouragement and support throughout my study, for making time to provide the necessary inputs and supervision for this study and for creating an enabling environment for me to explore my potential and skills in undertaking this study. Words cannot express my appreciation for the keen interest she showed in my work and her trust in me which was central to my achievement.

My profound gratitude goes to Professor Kaushik Ramaiya for technical, academic and financial support. Your commitment to this work from the early stages of proposal development during field work in Morogoro is really appreciated. Thank you for being very positive and supportive during the entire study period.

I would also like to thank Department of Food Technology, Nutrition and Consumer Sciences (DFTNCS); academic staff members, non-academic staff members and postgraduate students for their support, assistance, consultation, guidance and encouragement throughout this study.

I am sincerely grateful to all adolescent students who participated in this study for their cooperation and willingness to share their experience, without them this study would not be possible. Special thanks to National Institute for Medical Research (NIMR) for the review of the proposal and the release of the ethical clearance document for the go ahead of the study.

I am highly indebted to my loving parents, Mr. Ahmed Makbel and Mrs. Amina Salim for their financial moral support, love and for laying down the foundation of my education. Your prayers and encouragement is what sustained me this far and thank you very much for endless love my parents. I also appreciate the contribution of my aunt, Amina Kavirondo for her support and encouragement since my undergraduate studies. You were like a shining star for me on academic and family issues. God bless you and your family.

DEDICATION

This dissertation is dedicated to my beloved parents Mr. Ahmed Makbel and Ms. Amina Salim; for believing, supporting and teaching me the values of education and resilience.

I would also like to dedicate this work to my friends and society as I hope it brings good to the society, inspire and shed light to more young individuals to further their studies for their good and the good of society as a whole.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

LIST OF ABBREVIATIONS AND SYMBOL

T2DM	Type 2 Diabetes Mellitus
WHO	World Health Organization
NCDs	Non-communicable diseases
BMI	Body Mass Index
GSHS	Global School-based Student Health Survey
DRP	Drop-out rate
BP	Blood Pressure
RBG	Random blood glucose
ADA	American Diabetes Association
AHA	American Heart Association
SPSS	Statistical Packages for Social Sciences
DDS	Dietary diversity score
NBP	Normal Blood Pressure
HbA1C	Glycated Hemoglobin
kg/m^2	Kilogram per meter square

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1.1 Background Information

Type 2 Diabetes Mellitus (T2DM), also referred to as Non-Insulin-Dependent Diabetes (NIDDM) is a term used for individuals who have insulin resistance and or insulin deficiency (Hayashi and Yukita, 2016). In the past, T2DM was considered as a disease of adults, however, in the last decade; a worldwide increase in prevalence of T2DM in both adults and children has been reported (De Moura *et al.,* 2015).The rise in the incidence of T2DM has mirrored the rise in prevalence of obesity in both developed and developing countries and this is attributed to a more sedentary lifestyle and high consumption of refined foods (Jaja and Yarhere, 2015; Song, 2012).

Until 10 years ago, T2DM accounted for less than 3% of all cases of new-onset diabetes in adolescents, and at present it represents 8 to 45% of new cases and is commonly diagnosed between the ages of 12 and 16 years and in those with positive family history of T2DM (D'Adamo and Caprio, 2011). Type 2 diabetes mellitus is still rare in childhood and adolescence, but recent reports indicate an increasing prevalence around the world possibly due to increasing prevalence of obesity in children and adolescents (Reinehr, 2013).

Hypertension in adolescents has also increasingly become a public health problem of global concern in the last few decades (Okpokowuruk *et al.,* 2017). The prevalence of hypertension in children and adolescents in developing countries has been

established through systematic reviews to be between 1 and 5% (Redwine *et al.*, 2012; Kollias *et al.,* 2014). Also, a cross-sectional study conducted among adolescents and youths (12-24 years of age) attending schools and college in Tanzania and Uganda determined the prevalence of high blood pressure (BP) and associated factors. The overall prevalence of high BP was 40% whereas the prevalence of pre-hypertension was 29% and that of hypertension was 11% (Nsanya *et al.*, 2019).

Obesity is a risk factor for T2DM, hyperlipidemia, renal disease, hypertension, other cardiovascular diseases, and certain cancers, all of which reduce life expectancy (Akinola *et al.,* 2016). Worldwide, the prevalence of childhood overweight and obesity combined has risen by 47.1% between 1980 and 2013 (Cullinan and Cawley, 2017).World Health Organization (2015) reported that the global prevalence of childhood obesity has increased from 31 million to 42 million children, and increased in Africa alone from 4 to 10 million children during the period from 1990 to 2013 (Farrag *et al.,* 2017).

Longitudinal studies of obesity and chronic disease risk among adolescents and youth (10-24 years of age) suggest an increased risk of morbidity and premature mortality from coronary heart disease, stroke, hypertension, diabetes, and asthma among adults who were overweight or obese during adolescence (Stang and Stotmeister, 2017). Therefore, the onset of obesity and overweight during adolescence may persist to adulthood and cause greater health effects in the future, thus there is a need for routine nutrition assessment among secondary school adolescents so as to prevent further complications.

1.2 Problem Statement and Study Justification

One of the critical inputs to the strategies for combating T2DM and hypertension is to create awareness and build knowledge within a population. This contributes to early detection and changes the modifiable risk factors (Khan *et al.,* 2019). However, several studies have consistently shown that awareness about symptoms, complications and management of diabetes mellitus and hypertension is inadequate among adolescents (Al-Hussaini and Mustafa, 2016; Omisore *et al.*, 2014).

Type 2 Diabetes Mellitus is associated with chronic complications such as micro vascular damage with end stage kidney failure, blindness, and amputation which has huge financial cost. Early detection, prompt and adequate management can prevent and halt progression of these complications (WHO, 2016). World Health Organization has predicted a worldwide rise in the prevalence of diabetes mellitus (DM) that is expected to affect 300 million people by 2025 and 366 million by 2030 from 171 million in 2000. This increase is more important in developing countries particularly in Sub-Saharan Africa because of adding to the burden of infectious diseases and under nutrition plaguing the region (Animaw and Seyoum, 2017).

While the burden of non-communicable diseases (NCDs) is increasing in developing countries, there has been little focus on adolescence, when the majority of behavioral risk factors for NCDs first emerge. Yet Target 3.4 of Sustainable Development Goal 3, which covers NCDs among other non-communicable diseases, makes no mention of young people, and it does not address the need to focus on prevention with this age group (WHO, 2017). Indeed, young people are often neglected when it comes to policymaking about the health risks, they face prompting the researcher's interest to

conduct the present investigation. Therefore, the study aimed at determining the prevalence, awareness and risk factors associated with T2DM and hypertension among secondary school adolescents in Morogoro, Tanzania.

Understanding the magnitude and risk factors for T2DM and hypertension in Tanzanian adolescents will help in planning and implementation of appropriate prevention strategies (Muhihi *et al.*, 2018). Therefore, the findings of this study will form a baseline for planning and designing education interventions for adolescents focusing on reducing occurrence of the risk factors.

1.3 Objectives and Research questions

1.3.1 Overall objective

The general objective of this study was to determine the prevalence, awareness and risk factors for T2DM and hypertension among secondary school adolescents in urban and rural areas of Morogoro, Tanzania. To achieve the overall objective, three specific objectives and three research questions were formulated:

1.3.2 Specific objectives

i. To determine the prevalence of T2DM and hypertension among secondary school adolescents in Morogoro region
ii. To identify the potential risk factors for T2DM and hypertension among secondary school adolescents in Morogoro region
iii. To assess awareness of adolescents on the causes, symptoms, complications and risk factors for T2DM and hypertension in Morogoro region

1.3.3 Research Questions

i. What is the prevalence of T2DM and hypertension among secondary school adolescents in Morogoro?
ii. What are the potential risk factors for T2DM and hypertension among secondary school adolescents in Morogoro?
iii. Are the adolescents' aware of the causes, symptoms, complications and risk factors for T2DM and hypertension?

CHAPTER TWO

2.1 LITERATURE REVIEW

2.1.1 Burden and Trends of T2DM and Hypertension

Until recently, T2DM was barely diagnosed in children, since it was considered a disease of adulthood. Over the past two decades, an increase in prevalence of T2DM in children and adolescents has been reported in several countries (Farsani *et al.*, 2013). Currently; children with T2DM are usually diagnosed over the age of 10 years and are in middle to late puberty. This is due to largest percentage of these children being overweight or obese and present with glycosuria without ketonuria, and little or no weight loss (Bray, 2017).

The burden and trends of T2DM among adolescents varies in terms of ethnicity, socioeconomic status, and geographic regions. For example, the incidence of T2DM in youth is six times higher in Australian Indigenous individuals than in the general population (Farsani *et al.*, 2013). Also, diabetes study in USA, reported that a higher incidence rate was observed among youths aged 15–19 years in Hispanic whites, African Americans and native Americans (17.0 to 49.4 per 100,000 person years) compared with 5.6 per 100,000 person-years in non-Hispanic whites (Chen *et al.*, 2012).

Several decades ago, the burden of diseases among African populations was from infectious diseases. Cardiovascular disorders were then seen as rare among these populations but today, these nations are witnessing epidemiological transition which has placed on them a double burden of disease (BeLue *et al.*, 2009).

Early in the century, the prevalence rate of T2DM in Africa was less than 1% but today the prevalence has increased (Okafor, 2012). The burden of hypertension in Sub-Saharan Africa has also been increasing over the past few decades (Ataklte *et al.*, 2015). Hypertension among adolescents is now a burden; a systematic review and meta-analysis of data from 25 studies involving 54,196 individuals aged 2-19 years found a pooled prevalence of elevated blood pressure of 5·5% and a pooled prevalence of slightly elevated blood pressure of 12.7% in children and adolescents in Africa (Noubiap *et al.*, 2017). Another study in South African adolescents also reported a high prevalence of hypertension (21.3%) (Bhimma *et al.*, 2018).

Generally, with these trends in Africa and other regions of the world, Tanzanian adolescents are also at a great risk for hypertension and T2DM due to urbanization and economic growth accelerating the rate of this epidemiological transition (Mfinanga *et al.*, 2011). Therefore, it is becoming urgent to identify and address risk factors for these common NCDs and more especially among adolescents.

2.1.2 Awareness on T2DM and Hypertension

It is predicted that awareness on hypertension and T2DM will prompt people to seek health care timely and reduce possibilities of developing complications (Mbuya *et al.*, 2014). Several studies have consistently shown that awareness about symptoms, complications and management of diabetes mellitus and hypertension is inadequate among adolescents (Al-Hussaini and Mustafa, 2016; Omisore *et al.*, 2014). Also, a study conducted in Pune-India by Banerjee *et al* (2007) reported that awareness about modifiable risk factors such as obesity, physical inactivity, was very low among the school-going adolescents. Divakaran *et al* (2010) also reported that

majority (84.8%) of school children had low awareness regarding lifestyle risk factors of NCDs and only 0.8% of students were having good awareness regarding lifestyle risk factors. Therefore, awareness at the level of public is crucial since it is a critical component of behavioral change (Mahrooqui *et al*., 2013).

2.1.3 Nutrition Situation among Adolescents

2.1.3.1 Dietary pattern, diversity and practices

Adolescence is a period where general health is at its best and stage where risks health behavior such as unhealthy diets are expressed and increased. There is a growing tendency to consuming greater quantities and variety of energy dense foods, high in fat, sugar and salt, as well as rising levels of promotion and marketing of dense foods, and increased frequency of eating occasions and use of soft drinks to replace water especially in schools (Olumakaiye *et al.*, 2010). Most of the adolescents eat snacks and fast foods (Allafi *et al.,* 2014; Abdel-Hady *et al.,* 2014) and majority tend to skip family meals (Olumakaiye *et al.,* 2010; Abudayya *et al.,* 2009).

Unhealthy diets during adolescence have been reported to be a risk factor for a number of non-communicable diseases in adulthood (WHO, 2013). Adolescents' diets are low in diversity and characterized with low micronutrients source foods, but plenty of fats and oils, sweets and cereals. A study conducted by Isabirye *et al.,* (2020) reported on adolescents' dietary diversity and associated factors. The results show that adolescents (10-19 years) diet is characterized by high consumption of fats and oils but with low intake of micronutrient-rich foods such as fruits and vegetables. Also, in a systematic review reported by Ochola and Masibo, (2014) observed

limited dietary diversity mainly comprising of plant-based food source, with limited animal foods, fruits and vegetable intakes among adolescents and school children (6-19 years) in developing countries. The observed dietary habit, coupled with sedentary lifestyle may increase the risk for overweight and obesity.

2.1.3.2 Nutritional status and body composition among secondary school adolescents

Nutrition transitions have significantly contributed to overweight and obesity among adolescents. World Health Organization reported an increase of overweight and obese children and adolescents that has increased, from 4% in 1975 over 18% in 2016 worldwide which is associated by urbanization, changes in lifestyles and social economic transition (WHO, 2016). The majority of these children live in developing countries, mainly in Asia and Africa where the rate of increase was estimated to be 30% higher than in developed countries. In adolescents, the rate is even higher, reaching to over 340 million in 2016 globally (WHO, 2016).

In Tanzania, the prevalence of overweight and obesity is significantly higher among private school students compared to their counter parts in public schools, without exception; there are more overweight and obese adolescent girls than boys (Mosha and Fungo, 2010).

Furthermore, the gap between rural and urban overweight and obesity in Tanzania is closing, and this has been reported by various researchers that there is rural-urban variations on the prevalence of overweight and obesity among school aged children and adolescents aged 5-19 years (Chomba *et al., 2019*; Tluway *et al.*, 2018). For-

example, a study by Chomba *et al* (2019) found that the prevalence of overweight and obesity among school age children and adolescents aged 7-17 years in Urban Arusha was 17.7% in which 5.1% were overweight and 12.6% were obese. Also, another study conducted by Tluway *et al* (2018) in Babati sub-rural region found that the prevalence of overweight and obesity among children and adolescents aged 10-19 years was 9.2%.

Excess body fat in adolescents also increases the risk for development of several medical conditions during adulthood, including insulin resistance, adult-onset T2DM and cardiovascular problems such as hypertension, heart disease and stroke (Todd *et al.*, 2015). However, there are limited studies on body composition and energy balance including body fat percentage among Tanzanian adolescents.

2.1.4 Risk factors for T2DM and Hypertension among Adolescents

2.1.4.1 Non-modifiable risk factors

The prevalence of T2DM and hypertension increases with age, but the age of onset has moved down in younger adults and even adolescents, especially in countries where a major balance between energy intake and expenditure has changed (Hills *et al.*, 2018). Type 2 Diabetes Mellitus and hypertension are also associated with genetic predisposition; although is not a guarantee of a diagnosis because lifestyle plays an important part in determining who gets it (Sakurai *et al.*, 2013). It has also been shown that lower birth weight is associated with higher rates of adult hypertension, T2DM and metabolic syndrome. Being born with low birth weight (LBW) is recognized as a disadvantage due to risk of early growth retardation, fast catch up growth, infectious disease, developmental delay, and death during infancy

and childhood (Fall, 2013). It has also repeatedly been associated with obesity and non-communicable diseases (NCDs) later in life, such as coronary heart disease and diabetes, as well as with risks associated with these diseases, such as hypertension, glucose intolerance, and hyperlipidemia. Hence, healthy dietary patterns during pregnancy such as consumption of fruits, vegetables and dairy products can reduce the risk of a low birth weight baby and hence reduce the risks of NCDs later in life (Kjollesdal and Holmboe-Ottesen, 2014).

2.1.4.2 Modifiable risk factors

The risk of T2DM and hypertension increases tenfold in people with a body mass index (BMI) over 30 kg/m^2 or above 95th percentile in adolescents (Pearson *et al.*, 2014). Physical activity levels have also decreased over recent decades in the population, and this has been a major contribution to the current global rise of obesity (AbouElmagd, 2016).The principal factors responsible for the increase in the rates of obesity in children includes an increase in their caloric intake and a more sedentary lifestyle. Availability of large quantities of caloric rich fast foods, combined with more time spent watching TV, playing video games, and working on the computer, has produced a generation of overweight children (Reinehr, 2013). In addition, many elementary and secondary schools, facing financial constraints, have limited their physical activity programs while at the same time offering caloric rich foods at lunch and hence an increase in overweight and obese children and adolescents (Martin *et al.*, 2018). It is well known that participating in regular and adequate physical activity such as walking, cycling, or doing sports has significant benefits for health. It helps to build and maintain healthy muscles and bones, reduce hypertension, coronary heart disease, stroke, diabetes, cancer, depression, control weight and promote psychological well-being (AbouElmagd, 2016).

Unhealthy eating also contributes largely to obesity which is a risk factor for diabetes and hypertension. Kohei, (2010) attributes T2DM and hypertension with changes in dietary energy sources, that is, the increase in fat intake, and consumption of simple sugars as well as the decrease in starch intake, dietary fiber intake and inadequate consumption of fruits and vegetables. The 2015 Tanzania Mainland National Global School-based Student Health Survey (GSHS) reported that the dietary practices of students were moderate; and slightly over half usually ate breakfast at home. However, some students went to school hungry most of the time due to lack of food at home. Fruits and vegetables were seen to be part of daily diet to less than half of students and drinking carbonated soft drinks, eating at fast food restaurants was a common habit for the students (Nyandindi, 2017).

Life style related behavioral risk factors such as smoking and alcohol consumption are also implicated for increased burden of T2DM and hypertension (Slagter *et al.*, 2014; Ghimire and Dhungana, 2018). These lifestyle risk factors which include smoking, excessive alcohol use, poor dietary patterns and physical inactivity have been observed in adolescents in both developed and developing countries and increases the risk of developing non-communicable diseases among adolescents (NCDs) (May *et al.*, 2012; Odunaiya *et al.*, 2010).Uses of alcohol and cigarette smoking among students exist; and some start drinking and smoking before 14 years of age. Heavy alcohol use increases the risk for cardiovascular diseases, epilepsy, diabetes mellitus, and infectious diseases (pneumonia and tuberculosis). Smokers have high risk of multiple cancers particularly lung cancer, heart disease, stroke, and hypertension (Nyandindi, 2017). Hence, awareness on the risk factors for T2DM and hypertension mentioned above is a first and critical step towards prevention, early diagnosis and better management among adolescents.

CHAPTER THREE

3.1 METHODOLOGY

3.1.1 Description of the study area

The study was conducted in Morogoro region in two districts, Morogoro municipality representing an urbanized population, and Kilosa district representing rural area. Morogoro is one of the thirty-one main regions in Tanzania. It is made up of seven districts namely; Morogoro rural, Morogoro urban (municipality), Ulanga, Kilombero, Gairo, Mvomero and Kilosa. The 2012 Tanzania National Population Census reported that the estimated total population of Morogoro region was 2,218,492. Rural and urban population constitutes different proportions where by rural areas population was 1,582,434 and urban population being 636,058. For the age group 10-19 years (adolescents) the population was 495, 654 (NBS, 2012).

3.1.2 Study Design

A descriptive cross-sectional study design was used to conduct this research which involved the collection of information at one point in time.

3.1.3 Study Population/Sampling frame

The study included adolescent students both males and females with age ranging from 14 to 19 years (WHO, 2016) , attending ordinary level secondary schools from private and government schools with the exclusion of boarding schools. Boarding schools were excluded because of lack or limited individual variation in dietary intakes. The study also excluded handicapped students due to difficulties in obtaining anthropometric measurements, the students on blood pressure lowering medication,

known Type 1 or T2DM cases, truants and those from advanced levels (high schools) were also excluded.

3.1.4 Sampling procedures

In this study, the population of 243 secondary schools served as universe from which students were selected. The fact that Morogoro region has seven (7) districts and basing on the geographical location (i.e. urban and rural environment), school type and location; Morogoro urban (municipality) and Kilosa district served as a sampling unit of the study. A total number of 50 secondary schools in Morogoro municipality and 43 secondary schools in Kilosa district served as a sampling frame from which the sample was drawn. A total of eight secondary schools, that is; four government and four private schools located in urban and rural areas were selected randomly to constitute a sample. To acquire a total sample of 405, stratified sampling technique was used. This is a probability sampling technique; where a population of students in each school was divided into strata basing on age, gender and education level; then 50 up to 51 students were selected in each school to acquire a total of 405, by simple random selection without replacement so that each student can only be selected once and hence a smaller sampling error.

3.1.5 Sample size

The sample size was calculated according to Overall *et al.* (2006).

$N = N_0 / (1\text{-}DRP)$

Where:

N = desired sample size.

N_0 = Cochran's sample size recommendation where by $N_0 = \underline{Z^2\ p\ (1\text{-}p)}$

e^2

Z is level of statistical significant at 95% confidence interval =1.96, p is proportion of adolescents to be included = 50%/0.5 and e= precision = 5%/0.05

Therefore, $N_0 = ((1.96)^2 (0.5) (0.5)) / (0.05)^2 = 385$

DRP = average dropout rate across all subjects (5%)

Substituting for this would be;

$$N = (385) / (1-0.05) = \mathbf{405}$$

Therefore, the sample size was 405 respondents

3.1.6 Data Collection

Adolescent students were interviewed about their age, education level, and family history of diabetes and hypertension, using a pre-tested structured questionnaire. Data collected on each objective were obtained as follow;

Objective 1: Prevalence of T2DM and hypertension

Capillary blood sample was collected (whole blood sample) for random blood glucose measurement using standardized Gluco Plus machine (Glucometer Type 25 KB JPG). Hyperglycemia was diagnosed using Random Blood Glucose ≥11.1 mmol/L (ADA, 2016) (Table 1). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured from mid-upper-arm of the left side while the students were sitting and relaxed for 10 minutes before the actual measurement, using a standardized digital blood pressure (BP) device (Omron Digital HEM-907, Tokyo, Japan). Two BP measurements were taken within an interval of five minutes. Average systolic and diastolic BP was recorded in mmHg and was used for analysis.

Stage 1 and 2 hypertensions were combined as both were already hypertensive (Table 2).

Table 1: Cut-points for RBG measurement

Diagnosis	RBG level (mmol/L)
Normal	≤7.8
Pre-diabetes	>7.8 - <11.1
Diabetes mellitus	≥11.1

Source: ADA (2016)

Table 2: Blood pressure cut-points for Hypertension among adolescents (≥13 years of age)

Hypertension status (stages)	Blood Pressure categories
Normal blood pressure	<120/<80mm Hg
Elevated blood pressure	120/<80 to 129/<80mm Hg
Stage 1 hypertension	130/80 to 139/89 mm Hg
Stage 2 hypertension	≥140/90 mm Hg

Source: AHA Guidelines for childhood hypertension (2017)

Objective 2: Assessment of risk factors for T2DM and hypertension

BMI for age

Weight was measured using standard weighing scale (digital electronic SECA scale; Model 8811021659, Germany) that was kept on a firm horizontal surface. The subject was weighed without shoes on and with light clothing and the weight was recorded to the nearest 0.1kg. Height was measured using a stadiometer (Model No PE-AIM-101-USA) and recorded to the nearest 0.1cm. Subjects were requested to stand upright without shoes on with their back kept against the wall and heels put together in a V-shape and looking forward. Age, sex, weight, and height information were entered in WHO AnthroPlus software and provided the BMI for age percentiles. Table 3 shows the standard cut off points for adolescents that were used to interpret the data collected for BMI for age.

Table 3: The standard cut off points for children and adolescents 5-19 years of age

Weight status	Body mass index percentiles
Underweight	Less than 5^{th} percentile
Normal	5^{th} -85^{th} percentile
Overweight	85^{th} - < 95^{th} percentile
Obese	≥ 95^{th} percentile

Source: WHO, 2009

Dietary diversity

Dietary assessment was done using a validated dietary diversity questionnaire (Kennedy *et al.,* 2011). Respondents were asked to recall all the foods consumed in the previous 24 hours prior to the survey and during the weekend. They were prompted to include all snacks and foods eaten outside home and details of the ingredients added to each food were noted. Consumption of a particular group scored 1, and if a group was not consumed a score of 0 was given. Number of food groups used in dietary diversity can vary according to the study objective; and currently there is no internationally recommended food group list to be included in the score at individual level for different age/sex groups (Kennedy *et al.,* 2011). We used the questionnaire with 12 aggregated food groups (Kennedy *et al.,* 2011) to capture micronutrients intake as well as consumption of sweets and beverages which are known to be associated with metabolic syndrome (Mwanri *et al.*, 2015). The food groups included cereals; white roots and tubers; vegetables; fruits; meat; eggs; fish and other sea foods; legumes, nuts and seeds; milk and milk products; oil and fats; sweets; spices, condiments and beverages. Dietary Diversity was divided into three categories and classified as low (≤3), medium (4 to 5) and high (≥6) (Kennedy *et al.*, 2011).

Body fat percentage

Body fat was assessed by using Tanita bioelectrical impedance analysis (BIA) (Model, Tanita MC-180MA (Tanita, Tokyo, Japan), and students were required to remove their shoes, socks and metal materials like watches and ear rings. Two body fat measurements were taken at an interval of three minutes and the average body fat was used for analysis. The interpretation of body fat was based on World Health Organization criteria (WHO, 2006) (Table 4 and 5).

Table 4: Body fat status for Boys (14-19 years)

Body fat status	Body fat percentiles and percentages
Low body fat	< 3th percentile (0-7.99%)
Normal body fat	≥ 3 to < 85th percentile (8.0-15.99%)
Moderately elevated	≥ 85th to < 95th percentile (16.0-29.99%)
Elevated	≥ 95th to < 97th percentile (30.0-34. 99%)
Very elevated	≥ 97th percentile (35.0-42.99%)

Table 5: Body fat status for Girls (14-19 years)

Body fat status	Body fat percentiles and percentages
Low body fat	< 3th percentile (0-10.49%)
Normal body fat	≥ 3 to < 85th percentile (10.5-21.49%)
Moderately elevated	≥ 85th to < 95th percentile (21.5-32.99%)
Elevated	≥ 95th to < 97th percentile (33.0-36.49%)
Very elevated	≥ 97th percentile (36.5-42.99%)

Source: WHO, 2006

Physical activity levels

Physical activity was assessed using a self-administered, 7-day recall physical activity questionnaire for adolescents (PAQ-A) which was translated into Kiswahili. The PAQ-A tool is designated and tested for adolescents approximately 14 to 19 years of age, which is a reliable and valid measure developed by Kowalski *et al.*, (1997). The questionnaire was administered in a classroom and students were asked to recall their activities from the day of the interview up to seven days backward. The questionnaire provided a summary of physical activity scores derived from eight

items (spare time physical activities and activities conducted during weekend, evenings and right after school) each scored on a 5-point scale where a score of 1 indicated low physical activity, whereas a score of 5 indicated high physical activity (Kowalski *et al.,* 2004).

Family history of diabetes and hypertension

Family history of diabetes and hypertension of the participants' first-degree relatives (mother, father, sisters or brothers) was collected by a pre-tested structured questionnaire. Students were required to put a tick in any of the first-degree relatives mentioned above if they have diabetes or hypertension.

Objective 3: Awareness on T2DM and Hypertension

A self-administered questionnaire on seven main sections, with each section focusing on different aspects of diabetes mellitus and hypertension, namely; general awareness about T2DM and hypertension, awareness on risk factors, symptoms, complications, treatment and available medications, lifestyle and non-medical measures, and management of diabetes and hypertension was used (Appendix 1). A total score was calculated by adding the scores for all questions in each section after giving score 1 for yes answers and 0 for no or do not know answers. The total correct score was used as criteria to assess the general awareness of adolescents on the causes, symptoms, complications and risk factors for T2DM and hypertension (Al-Hussaini and Mustafa, 2016).

3.1.7 Ethical Considerations

This study was commenced upon receiving ethical approval from National Institute for Medical Research with reference number NIMR/HQ/R.8a/Vol.IX/3319 and

Sokoine University of Agriculture. After the objectives and benefits of the study were explained to the subjects (parents/guardians and children), they were requested to sign an informed written consent form to affirm their willingness to participate in the study. Permission to conduct the study was also obtained fromthe regional administrative officer, respective District Executive Officers and head teachers of the school.All measurements were done by trained staff/personnel, and for the students who were identified with problems that is either having pre-diabetes or hypertension; head teachers of the schools were informed so that they can inform the parents of the respective students to seek for medical care. Also, the personnel (nurse) that was taking the measurements of hypertension and diabetes advised the students with problems to visit the nearby hospital or clinic to have another check-up; that is fasting blood glucose for those who were having pre-diabetes. Those with hypertension were advised to visit health institutions as soon as possible to monitor their health periodically. Data were kept confidential and communicated without disclosing individual identity.

3.1.8 Data Analysis

Data were entered in IBM Statistical Packages for Social Sciences (SPSS version 21) for coding and analysis. Descriptive statistics such as frequencies and percentages were calculated and presented in tables and graphs. In addition to descriptive analysis, chi-square (X^2) test was used as a test of significance for categorical variables, and differences were considered significant at $p \leq 0.05$. The strength of the associations between the dependent variables and the independent variables was obtained from Logistic regression which was used to evaluate the influence of the explanatory variables on the risk factors within our study. All variables that were

significant (p-value of ≤0.05) in the Univariate analysis were included in the multivariate models and a stepwise modeling procedure (backward conditional) was adopted to select the variables that were used to build the final model. Only variables with a p-value of ≤0.05 have been retained in the final model. Multivariate analysis were performed following Bivariate analysis to adjust the effect of confounders using multiple logistic regression, both crude odds ratio (COR) and adjusted odds ratio (AOR) with 95% CI were reported.

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

A total of 405 adolescent students were recruited in this study. Among the 405 selected students, 9 students refused to provide consent of participation after explaining the details of the study, and thus we remained with 396 students. After data collection, the data obtained from the questionnaires went through data cleaning and entry and obtained 4 questionnaires that were empty (complete non-responses) only names written on them, and 8 questionnaires that had some questions not answered (partial non-response) and thus; only 384 questionnaires were accurately filled and hence used in the analysis.

4.2 Socio-demographic characteristics and family history of diabetes and hypertension

Age, education level of the study population together with family history of diabetes and hypertension of the participants' first-degree relatives is depicted in Table 6. The majority of the participants were in the age group of 14-16 years (79.7%) and only 20.3% were in the age group of 17-19 years. As for education level, adolescents were selected equally (33.3%) in each level (form 2, 3 and 4). In terms of family history of diabetes and hypertension, 15.6% had diabetes and 16.7% had hypertension amongst the first-degree relatives of the participants.

Table 6: Socio-demographic characteristics and family history of diabetes and hypertension (N=384)

Variables	No of respondents	Percent
Age group (years)		
14-16	306	79.7
17-19	78	20.3
Education level		
Form two	128	33.3
Form three	128	33.3
Form four	128	33.3
First degree relatives with diabetes	60	15.6
First degree relatives with hypertension	64	16.7

4.2 Prevalence of T2DM and Hypertension

4.2.1 Prevalence of pre-diabetes

The overall prevalence of pre-diabetes was 5.2%, the prevalence being slightly higher in urban areas (7.3%) than in rural areas (3.1%) (p = 0.070). The prevalence of pre-diabetes was also slightly higher among males (6.3%) than in females (4.2%) but not statistically significant (p = 0.361) (Figure 1).

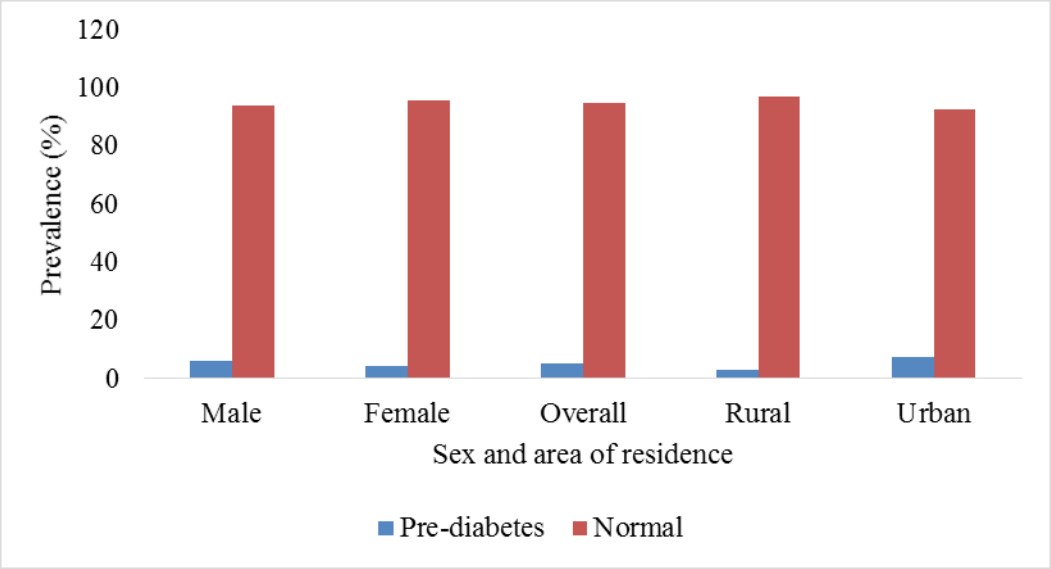

Figure 1: Prevalence of pre-diabetes according to sex and area of residence

4.2.2 Prevalence of Hypertension

The overall prevalence of hypertension was 11.5%, with higher prevalence in urban areas (17.2%) than in rural areas (5.7%) (p = 0.001). The prevalence of hypertension was slightly higher among females (13%) than in males (9.9%) but not significant (p = 0.338) (Figure 2).

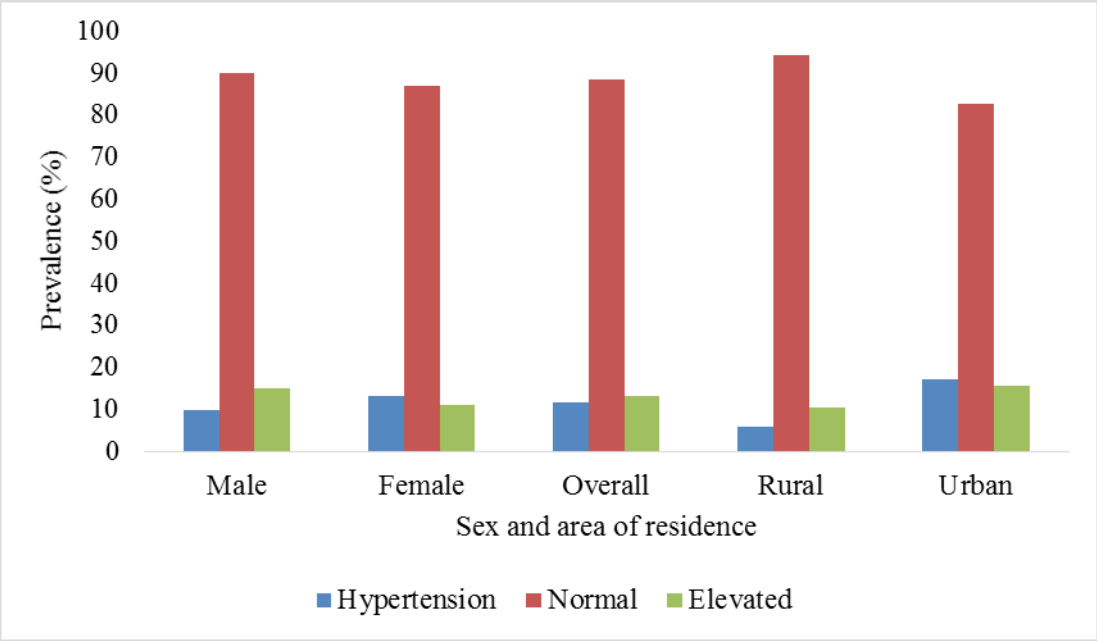

Figure 2: Prevalence of hypertension according to sex and area of residence

4.3 Risk Factors for T2DM and Hypertension

4.3.1 Commonly consumed food groups and dietary diversity scores

Table 7 shows that most of the participants consumed spices and beverages (88.5%), cereals (87.5%), sweets (87.2%), oils and fats (78.9%), legumes (75%) and roots and tubers (60.9%). The least consumed foods included; fish and sea products (41.9%), vegetables (38%), meat (32.6%), milk and milk products (15.9%), fruits (11.5%), and eggs (4.7%).

Table 7: Commonly consumed food groups by the participants (N=384)

Food groups	Respondents	Percent
Cereals	336	87.5
White roots and tubers	234	60.9
Vegetables	146	38.0
Fruits	44	11.5
Meat	125	32.6
Eggs	18	4.7
Fish and other sea foods	161	41.9
Legumes, nuts and seeds	288	75.0
Milk and milk products	61	15.9
Oils and fats	303	78.9
Sweets	335	87.2
Spices, condiments and beverages	340	88.5

Table 8 shows that most of the studied population had a high dietary diversity score (DDS) which accounted for about 69.3%, followed by medium DDS (31%) and lastly low DDS (6%). When sex was considered, there was no significant difference between male and female ($p = 0.856$), as both sexes were good at diversifying their diets and most of them had high DDS (67.7% and 70.8% respectively). Also, both types of the school that is private and government schools had a high DDS (65.6% and 72.9% respectively), and hence there was no significant difference between the two types of school ($p = 0.403$). Lastly, adolescent students in both urban areas and rural areas had high DDS (68.8% vs.69.8%), therefore there was no significant difference in terms of where the schools were located ($p = 0.081$).

Table 8: Comparison of dietary diversity according to sex, location and school type (N=384)

Characteristics	Low DDS N=40	Medium DDS N=225	High DDS N=119	P- value*
Sex				0.856
Male	24 (4.7%)	115 (59.9%)	53 (67.7%)	
Female	16 (7.3%)	110 (57.3%)	66 (70.8%)	
School type				0.403
Government	22(3.6%)	115 (30.7%)	55 (65.6%)	
Private	18 (8.3%)	110 (18.8%)	64(33.3%)	
Location				0.081
Rural	26 (8.3%)	111 (57.8%)	55 (68.8%)	
Urban	7 (3.6%)	51(26.6%)	64 (69.8%)	
Total	**40 (6%)**	**22 5 (58.6%)**	**119(69.3%)**	

P-value is from chi-square test

4.3.2 Body Mass Index (BMI) for Age

Table 9 shows that the prevalence of underweight, overweight and obesity according to the WHO (2009) criteria in the population studied were 5.7%, 8.9% and 10.9% respectively. The prevalence of overweight was 12% in females and 5.7% in males, while underweight was 9.4% in males and 2.1% in females (p = 0.246), hence no statistical difference between the two groups. When school type was considered, prevalence of obesity in private schools was two times that of the government schools (14.6% vs. 7.3%), and underweight was significantly higher in government schools compared to private schools (7.3% vs. 4.2%), (p = 0.006).The prevalence of obesity was also higher in urban areas compared to rural areas (16.7% vs. 5.2%), but the reverse was true for underweight (3.1% vs. 8.3%), (p = 0.000).

Table 9: Comparison of BMI for age according to sex, location, and school type (N=384)

Characteristics	Underweight N=22	Normal N=286	Overweight N=34	Obese N= 42	P-value
Sex					0.246
Male	18 (9.4%)	144 (75%)	11 (5.7%)	19 (9.9%)	
Female	4 (2.1%)	142 (74%)	23 (12%)	23 (12%)	
School type					0.006*
Government	14 (7.3%)	147 (76.6%)	17 (8.9%)	14 (7.3%)	
Private	8 (4.2%)	139 (72.4%)	17 (8.9%)	28 (14.6%)	
Location					0.000*
Rural	16 (8.3%)	148 (77.1%)	18 (9.4%)	10 (5.2%)	
Urban	6 (3.1%)	138 (71.9%)	16 (8.3%)	32 (16.7%)	
Total	**22 (5.7%)**	**286 (74.5%)**	**34 (8.9%)**	**42 (10.9%)**	

* Characteristics with significant difference in terms of BMI status. P-value is from chi-square test

4.3.3 Body fat percentage

Table 10 shows that the prevalence of normal body fat (NBF), moderately elevated body fat (MEBF), elevated body fat (EBF) and very elevated body fat (VEBF) according to WHO (2006) criteria. Most of the studied participants had a MEBF status (60.2%), followed by EBF (15.6%). The prevalence of VEBF and EBF was higher among female than male which was (17.7% vs. 13%) and (22.9% vs. 8.3%) respectively, compared to NBF which was higher in female compared to male (9.4 % vs. 7.8 %), ($p = 0.002$). The prevalence of VEBF was also higher in urban areas compared to rural areas (20.3% vs. 10.4%), ($p = 0.010$).

Table 10: Comparison of body fat percentage according to sex, location, and school type (N=384)

Characteristics	NBF n=22	MEBF n=286	EBF n=34	VEBF n= 42	P-value
Sex					0.002*
Male	15 (7.8%)	135 (70.3%)	16 (8.3%)	25 (13%)	
Female	18 (9.4%)	96 (50%)	44 (22.9%)	34 (17.7%)	
School type					0.152
Government	10 (5.2%)	121 (63%)	33 (17.2%)	28 (14.6%)	
Private	23 (12%)	110 (57.3%)	27 (14.1%)	31 (16.1%)	
Location					0.010*
Rural	19 (9.9%)	122 (63.5%)	31 (16.1%)	20 (10.4%)	
Urban	14 (7.3%)	109 (56.8%)	29 (15.1%)	39 (20.3%)	
Total	**33 (8.6%)**	**231 (60.2%)**	**60 (15.6%)**	**59 (15.4%)**	

* Characteristics with significant difference in terms of body fat status. P-value is from chi-square test

4.3.4 Physical activity levels

Generally, physical activities among adolescent students was very low, since the majority had a relatively low physical activity (RLPA) (46.6%), followed by moderate physical activities (MPA) (26.6%), low physical activities (LPA) (20.1%) and few of them (6.8%) engaged in relatively high physical activities (RHPA). Moreover, male adolescents were more physically active compared to females (p = 0.000) (Table 11).

Table 11: Comparison of physical activity levels according to sex, location, and school type (N=384)

Characteristics	LPA (n=77)	RLPA (n=179)	MPA (n=102)	RHPA (n=26)	P-value
Sex					0.000*
Male	34 (17.7%)	81 (42.2%)	55 (28.6%)	22 (11.5%)	
Female	43 (22.4%)	98 (51%)	47 (24.5%)	4 (2.1%)	
School type					0.120
Government	28 (14.6%)	90 (46.9%)	57 (29.7%)	17 (8.9%)	
Private	49 (25.5%)	89 (46.4%)	45 (23.4%)	9 (4.7%)	
Location					0.099
Rural	30 (15.6%)	86 (44.8%)	61 (31.8%)	15 (7.8%)	
Urban	47 (24.5%)	93 (48.4%)	41 (21.4%)	11 (5.7%)	
Total	**77 (20.1%)**	**179 (46.6%)**	**102 (26.6%)**	**26 (6.8%)**	

* Characteristics with significant difference in terms of physical activities. P-value is from chi-square test

4.4 Risk Factors for Pre-diabetes among Adolescents

Univariate logistic regression analysis of age, sex, school type, location of the school (area of residence), BMI status, body fat percentage, DDS, family history of diabetes, hypertension and physical activities was conducted. The model revealed that age, sex, DDS and physical activities were not significantly related to hypertension, therefore were removed from the model. Significant variables remained in the model for further analysis by binary logistic regression adjusting for confounding factors by backward conditional. Significant independent association were found for overweight/obesity (OR 2.05; 95% CI 2.17–6.86) and elevated body fat (EBF) (OR 1.95; 95% CI 1.23 – 7.18). Age, sex, school type, area of residence, DDS, family history of diabetes, hypertension and physical activities were not significantly related with diabetes mellitus (Table 12).

4.5 Risk Factors for Hypertension among Adolescents

Univariate logistic regression analysis of age, sex, school type, location of the school (area of residence), BMI status, body fat percentage, DDS, family history of hypertension, pre-diabetes and physical activities was conducted. The model revealed that age, sex and DDS were not significantly related to hypertension, therefore were removed from the model. Significant variables remained in the model for further analysis by binary logistic regression adjusting for confounding factors by backward conditional. Significant independent association were found for area of residence (OR 3.43; 95% CI 1.67 – 7.04), overweight/obese (OR 6.45; 95% CI 1.64 – 13.94), elevated body fat (EBF) (OR 3.91; 95% CI 1.94 – 8.96) and low physical activities (OR 1.98; 95% CI (1.65 – 5.49). Age, sex, school type, DDS, family history of hypertension and pre-diabetes were not significantly related with hypertension (Table 13).

Table 12: Risk factors for pre-diabetes in adolescents (Crude OR and Adjusted OR)

Characteristic	Crude OR (CI)	Adjusted OR (CI)
Age (years)		
14-16	1	1
17-19	1.21 (0.80 – 1.83)	0.79 (0.43 – 1.46)
Sex		
Female	1	1
Male	1.53 (0.61 – 3.84)	0.92 (0.71 – 2.17)
School type		
Government	1	1
Private	1.97 (1.78 – 7.49)	1.06 (0.98 – 4.99)
Location		
Rural	1	1
Urban	1.44 (1.29 – 6.49)	1.12 (0.81 – 3.59)
BMI for Age		
Normal	1	1
Overweight/obese	2.82 (2.48 – 7.12)	2.05 (2.17 – 6.86) *
Body fat percentage		
Normal BF	1	1
Elevated BF	5.76 (2.05 – 16.20)	1.95 (1.23 – 7.18) *
DDS		
Low	1	1
Medium	0.54 (0.11 – 2.55)	0.42 (0.06 – 2.19)
High	1.79 (0.83 – 3.09)	0.93 (0.09 – 2.67)
Family history of diabetes		
No	1	1
Yes	1.38 (1.44 – 4.76)	1.08 (0.31 – 3.43)
Hypertension		
No	1	1
Yes	3.67 (1.33 – 10.13)	1.16 (0.98 – 5.47)
Physical activities		
Relatively high	1	1
Medium	0.79 (0.45 – 1.64)	0.73 (0.41 – 1.49)
Low	1.48 (0.69 – 3.18)	0.98 (0.65 – 2.19)

*p≤0.05 indicating the potential risk factor, binary logistic regression considering the simultaneous effect of all the explanatory variables

Table 13: Risk factors for hypertension in adolescents (Crude OR and Adjusted OR)

Characteristic	Crude OR (CI)	Adjusted OR (CI)
Age (years)		
14-16	1	1
17-19	1.01 (0.46 – 2.20)	0.93 (0.65 – 1.32)
Sex		
Female	1	1
Male	1.36 (0.72 – 2.57)	1.18 (0.51 – 2.75)
School type		
Government	1	1
Private	1.88 (1.98 – 3.59)	1.53 (0.96 – 3.61)
Location of the school		
Rural	1	1
Urban	3.42 (1.67 – 6.98)	3.43 (1.67 – 7.04) *
BMI status		
Normal	1	1
Overweight/obese	3.88 (6.05 – 39.49)	6.45 (1.64 – 13.94) *
Body fat percentage		
Normal BF	1.09	1
Elevated BF	6.17(2.29 – 16.62)	3.91 (1.94 – 8.96) *
DDS		
Low	1	1
Medium	1.37 (0.31 – 6.19)	1.09 (0.37 – 3.19)
High	1.01 (0.49 – 2.09)	1.36 (0.69 – 2.69)
Family history of hypertension	1	1
No	1.75 (1.65 – 4.98)	0.76 (0.33 – 1.75)
Yes		
Pre-diabetes		
No	1	1
Yes	3.67 (1.33 – 10.13)	1.16 (0.98 – 5.47)
Physical activities		
Relatively high	1	1
Medium	0.98 (0.49 – 1.68)	1.73 (0.41 – 4.49)
Low	1.58 (1.75 - 3.48)	1.98 (1.65 – 5.49) *

*p≤0.05 indicating the potential risk factor, binary logistic regression considering the simultaneous effect of all the explanatory variables

4.6 Awareness on Diabetes Mellitus and Hypertension

4.6.1 Awareness on T2DM

Table 14 shows the responses of the participants for different items of the questionnaire. The lowest percentage of correct answer was for ‘‘Diabetes is not curable’’ (27.1%) in the general awareness section, ‘‘Pregnancy’’ (9.1%) in risk factors section, ‘‘Headache’’ (32.8%) in symptoms section, “Stroke and heart diseases” (34.9%) in complications section, ‘‘Body weight maintenance’’ (52.6%) in lifestyle section and “Regular eye check-up” (47.9%) in management section.

4.6.2 Awareness level for the five domains (sections)

Table 15 lists for each section, the maximum score and the average percent of correct answer for each section. A total score was calculated by adding the scores for all 34 questions after giving score 1 for correct answer and 0 for wrong or not sure answers. Scores were also calculated for the 5 sections: general awareness, risk factors, symptoms and complications, medications available, lifestyle changes and management.

The overall average correct answer was 51.4%. The percentage correct answer was highest in lifestyle changes and management section (67.6%) followed by medications available section (54.1%) and general awareness section (53.5%). The lowest was in awareness of risk factors section and symptoms and complications section (32.1% and 49.5% respectively).

Additional analysis was carried out to identify the questions with percentage of correct responses less than overall average, 51.4% (Table 16). Sixteen questions had a percentage lower than the average, two from general awareness section, six from risk factors, three from symptoms, three from complications, one from medications

available, and one from management section. This shows that most of the studied population was not aware of the risk factors for diabetes mellitus since six questions had a lower percentage than the overall average, but they are aware on lifestyle changes to control and prevent diabetes mellitus from occurring since all questions in this section had a percentage higher than the overall average.

Table 14: Responses of the participants for different sections of the questionnaire (N = 384)

~~Table 14: Responses of the participants for different sections of the questionnaire (N = 384)~~

Questions	YES		NO		DON'T KNOW	
General awareness of diabetes	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Diabetes is a condition of high blood sugar	250	65.1	68	17.7	66	17.2
Diabetes is a condition of not enough insulin in blood	198	51.5	48	12.5	138	35.9
Diabetes is a condition of the body not responding to insulin	156	40.6	63	16.4	165	43
Diabetes is not curable	104	27.1	205	53.4	75	19.5
Diabetes occurs in children, adolescents and adults	319	83.1	33	8.6	32	8.3
Risk factors						
Family history of diabetes	85	22.1	143	38	153	39.8
Unhealthy diet	189	49.2	63	16.4	132	34.4
Overweight and obesity	158	41.1	96	25	130	33.9
Low physical activity	218	56.8	65	16.9	101	26.3
Age above 40 years old	42	10.9	211	54.9	131	34.1
Pregnancy	35	9.1	212	55.2	137	35.7
Alcohol consumption	136	35.4	114	29.7	134	34.9
Symptoms						
Headache	126	32.8	119	31	139	36.2
Tiredness and weakness	217	56.5	58	15.1	109	28.4
Visual disturbances or problems	168	43.8	100	26	116	30.2
Slow healing of cuts and wounds	217	56.5	87	22.7	80	20.8
Frequent urination	265	69	49	12.8	70	18.2
Constant feeling of thirsty	222	57.8	57	14.8	105	27.3
Too much sweating	197	51.3	82	21.4	105	27.3
Complications						
Eye problems	206	53.6	58	15.1	120	31.3
Kidney problems or disease	182	47.4	75	19.5	127	33.1
High blood pressure	210	54.7	53	13.8	121	31.5
Loss of sensation in arms and legs	139	36.2	87	22.7	158	41.1
Stroke and heart diseases	134	34.9	79	20.6	171	44.5
Medications available						
Medicines are available for the control of BGL	223	58.1	26	6.8	135	35.2
Insulin injections are available for the control of BGL	192	50	37	9.6	155	40.4
Lifestyle changes and non-medical measures						
Regular physical activities	270	70.3	64	16.7	50	13
Stop alcohol use	251	65.4	45	11.7	88	22.9
Body weight maintenance	202	52.6	76	19.8	106	27.6
Diet modification	256	66.7	52	13.5	76	19.8
Management						
Testing blood sugar regularly	301	78.4	42	10.9	41	10.7
Regular eye check-up	184	47.9	90	23.4	110	28.6
Regular check-up for general health	318	82.8	21	5.5	45	11.7
Healthy lifestyle changes	294	76.6	19	4.9	71	18.5

Table 15: Maximum possible score (MPS) and average correct answer (ACA) for the 5 sections (N= 384)

Section	MPS	ACA (n)	ACA(%)
General awareness	5	205	53.5
Risk factors	7	123	32.1
Symptoms and complications	12	190	49.5
Medications available	2	208	54.1
Lifestyle changes & management	8	260	67.6
Total score	34	197	51.4

Table 16: Questions with percent correct answer less than overall average, 51.4% (N= 384)

Questions	(n)	(%)
General awareness about diabetes		
Diabetes is a condition of the body not responding to insulin	156	40.6
Diabetes is not curable	104	27.1
Risk factors		
Family history of diabetes	85	22.1
Unhealthy diet	189	49.2
Overweight and obesity	158	41.1
Age above 40 years old	42	10.9
Pregnancy	35	9.1
Alcohol consumption	136	35.4
Symptoms		
Headache	126	32.8
Visual disturbances or problems	168	43.8
Too much sweating	197	51.3
Complications		
Kidney problems or disease	182	47.4
Loss of sensation in arms and legs	139	36.2
Stroke and heart diseases	134	34.9
Medications available		
Insulin injections are available for the control BGL	192	50
Management		
Regular eye check-up	184	47.9

4.6.3 Awareness on hypertension

Table 17 shows the responses of the participants for different items of the questionnaire. The lowest percentage of correct answer was for ‘‘Hypertension is not curable’’ (14.3%) in the general awareness section, ‘‘Pregnancy’’ (19.8%) in risk factors section, ‘‘Blood in the urine’’ (16.7%) in symptoms section, “Trouble with memory” (32.3%) in complications section, ‘‘Hydrazaline injections are available for the control of hypertension’’ (42.2%) in medications available section and “Regular eye check-up” (44.5%) in management section.

4.6.4 Awareness level for the five domains (section)

Table 18 lists for each section, the maximum score and the average percent correct answer for each section. A total score was calculated by adding the scores for all 34 questions after giving score 1 for correct answer and 0 for wrong or not sure answers. Domain scores were also calculated for the 5 sections: general awareness, risk factors, symptoms and complications, medications available, lifestyle changes and management.

The overall average correct answer was 50.2%. The percentage correct answer was highest in lifestyle changes and management section (66.9%) followed by medications available section (52.9%). The lowest was in general awareness, awareness of risk factors and symptoms and complications section (42.6%, 42.6%, and 46% respectively).

Additional analysis of the data was carried out to identify the questions with percentage of correct responses less than overall average, 50.2% (Table 19). Eighteen questions had a percentage lower than the average, three from general awareness

section, five from risk factors, three from symptoms, five from complications, one from medications available, and one from management section. This shows that most of the studied population were not aware of the risk factors for hypertension and its complications since in both sections, five questions had a lower percentage than the overall average, but they are aware on lifestyle changes to control and prevent hypertension from occurring since all questions in this section had a percentage higher than the overall average.

Table 17: Responses of the participants for different sections of the questionnaire (N = 384)

Questions	YES		NO		DON'T KNOW	
General awareness of hypertension	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Hypertension is a condition of high blood pressure	238	62	32	8.3	114	29.7
A condition in which the blood vessels have persistently raised pressure	138	35.9	79	20.6	167	43.5
NBP is defined as a blood pressure of 120mmHg SBP and 80mmHg DBP	122	31.8	35	9.1	227	59.1
Hypertension is not curable	55	14.3	193	50.3	136	35.4
Hypertension occurs in children, adolescents and adults	266	69.3	40	10.4	78	20.3
Risk factors						
Family history of hypertension	140	36.5	117	30.5	127	33.1
Unhealthy diet	178	46.4	83	21.6	123	32
Overweight and obesity	235	61.2	53	13.8	96	25
Low physical activity	255	66.4	57	14.8	72	18.8
Age above 40 years old	91	23.7	156	40.6	137	35.7
Pregnancy	76	19.8	151	39.3	157	40.9
Cigarette smoking and alcohol consumption	171	44.5	86	22.4	127	33.1
Symptoms						
Severe headache and stress	256	66.7	53	13.8	75	19.5
Tiredness and weakness	219	57	62	16.1	103	26.8
Visual disturbances or problems	170	44.3	64	16.7	150	39.1
Chest pain and difficulty breathing	175	45.6	69	18	140	36.5
Irregular heartbeat	265	69	48	12.5	71	18.5
Blood in the urine	64	16.7	138	35.9	182	47.4
Complications						
Eye problems	173	45.1	90	23.4	121	31.5
Heart attack or stroke	183	47.7	73	19	128	33.3
Heart failure	169	44	99	25.8	116	30.2
Trouble with memory or understanding	124	32.3	90	23.4	170	44.3
Kidney problems or disease	146	38	71	18.5	167	43.5
Medications available						
Medicines are available for the control of hypertension	244	63.5	22	5.7	118	30.7
Hydrazaline injections are available for the control of hypertension	162	42.2	46	12	176	45.8

Lifestyle changes and non-medical measures						
Regular physical activities	286	74.5	50	13	48	12.5
Stopping cigarette smoking and alcohol consumption	259	67.4	47	12.2	78	20.3
Body weight maintenance	241	62.8	53	13.8	90	23.4
Diet modification	261	68	42	10.9	81	21.1
Not to use drugs and energizing products	236	61.5	37	9.6	111	28.9
Management						
Measuring blood pressure regularly	298	77.6	39	10.2	47	12.2
Regular eye check-up	171	44.5	83	21.6	130	33.9
Regular check-up for general health	292	76	33	8.6	15.4	59
Healthy lifestyle changes	268	69.8	35	9.1	81	21.1

Table 18: Maximum possible score (MPS) and average correct answer (ACA) for the five domains (N = 384)

Section	MPS	ACA (n)	ACA (%)
General awareness	5	164	42.6
Risk factors	7	164	42.6
Symptoms and complications	11	177	46
Medications available	2	203	52.9
Lifestyle changes & management	9	257	66.9
Total score	34	193	50.2

Table 19: Questions with percent correct answer less than overall average, 50.2 % (N= 384)

Questions	(n)	(%)
General awareness of hypertension		
A condition in which the blood vessels have persistently raised pressure	138	35.9
NBP is defined as a blood pressure of 120mmHg SBP and 80mmHg DBP	122	31.8
Hypertension is not curable	55	14.3
Risk factors		
Family history of hypertension	140	36.5
Unhealthy diet	178	46.4
Age above 40 years old	91	23.7
Pregnancy	76	19.8
Cigarette smoking and alcohol consumption	171	44.5
Symptoms		
Visual disturbances or problems	170	44.3
Chest pain and difficulty breathing	175	45.6
Blood in the urine	64	16.7
Complications		
Eye problems	173	45.1
Heart attack or stroke	183	47.7
Heart failure	169	44
Trouble with memory or understanding	124	32.3
Kidney problems or disease	146	38
Medications available		
Hydrazaline injections are available for the control of hypertension	162	42.2
Management		
Regular eye check-up	171	44.5

CHAPTER FIVE

5.0 DISCUSSION

5.1 Prevalence of Pre-diabetes and Hypertension

This study reports prevalence of pre-diabetes and hypertension, associated risk factors and awareness among secondary school adolescents in Morogoro region. The overall prevalence of pre-diabetes in the present study was 5.2 %; the prevalence being more than twice as much in urban compared to rural areas (7.3% vs. 3.1%). We used ADA criteria including random blood glucose test, because this was the most cost- effective method and easily applicable in the study setting. In this study, small percentage of the adolescents was pre-diabetic and none was diabetic. This could be due to the method used for assessing diabetic status, since random blood glucose test cannot be used alone as a standard method to diagnose diabetes. Therefore; methods like fasting blood glucose tests or use of Glycated haemoglobin (HbA1c) could be relatively more accurate to diagnose diabetes among this age group (Sherwani *et al.,* 2016). However, the observed pre-diabetic situation is alarming since the study population is still young and expected to perform productive and reproductive life in future, hence something should be done to reduce the prevalence.

The prevalence observed in this study is not far from the prevalence's that were reported in various countries across the world, including Mexico (1.5%), United Arab Emirates (5.4%) and China (0.28%) (Spurr *et al.,* 2019). Also, another study conducted in Nigeria among school adolescents reported a prevalence of 4.0 % which is nearly similar to the current study (Arigbede *et al.,* 2017).

In the present study, we also found a slightly higher prevalence of hypertension (11.5%); the prevalence being higher in urban compared to rural areas. This is due to the fact that, adolescents living in the urban areas were living a more sedentary lifestyle that contributed to higher rates of overweight and obesity which was a noticeable risk factor for hypertension and pre-diabetes in the study. The existence of elevated blood glucose and blood pressure increases the risk for cardiovascular diseases for the adolescents (Mansour *et al.,* 2016).

The prevalence obtained in the current study is partially in line with findings from other studies performed in different populations of children and adolescents in other countries. A systematic review and meta-analysis of data from 25 studies in Africa found a pooled prevalence of elevated blood pressure of 5·5% and a pooled prevalence of slightly elevated blood pressure of 12·7% in children and adolescents aged 2-19 years (Noubiap *et al.,* 2017). Also, the prevalence of hypertension in children and adolescents in developing countries has been established through systematic reviews to be between 1 and 5% (Redwine *et al.,* 2012; Kollias *et al.,* 2014). Generally, with these observations, Tanzanian adolescents are at a great risk for hypertension and T2DM and its complications that could be a result of urbanization and economic growth accelerating the rate of this epidemiological transition (Mfinanga *et al.,* 2011).

5.2 Risk Factors for Pre-diabetes and Hypertension among School Adolescents in the Study

5.2.1 Overweight and obesity

This is one of the potential risk factors for pre-diabetes and hypertension in the current study. Overweight and obese adolescents were two times higher and six times higher to be at risk for pre-diabetes and hypertension respectively. Overweight and

obesity is related with majority of cardiovascular diseases such as hypertension, asthma, coronary heart disease and also diabetes (Ajay *et al.*, 2017). These effects are not only for adults above 40 years of age, but they also occur among youths and in young adolescents. This is similar to the ones found in several studies conducted in other regions of the world. Longitudinal studies of obesity and chronic disease risk among youth suggest an increased risk of morbidity and premature mortality from coronary heart disease, stroke, hypertension, diabetes, and asthma among adults who were overweight or obese during adolescence (Stang and Stotmeister, 2017). Also, several studies reported that higher BMI is related with majority of cardiovascular diseases such as hypertension, diabetes, asthma and coronary heart disease (Wu *et al.*, 2016; Kuciene and Dulskiene, 2019).

A number of epidemiological studies from Africa and other regions have previously reported this link between elevated blood pressure and increased BMI (obesity and overweight) both in adults, children and adolescents (Noubiap *et al.*, 2017; Daniels, 2009; Price *et al.*, 2018). Thus; increased BMI is an important risk factor for elevated blood pressure in children and adolescents in Africa. Since it is a modifiable risk, efforts should be directed towards healthy lifestyle at this young age.

5.2.2 Elevated body fat

It has been observed in the current study that adolescents with elevated body fat had increased risk for pre-diabetes and hypertension. Female adolescents were having higher proportions of body fat compared to their counterparts, however; gender was not a risk factor for being pre-diabetic or hypertensive. This is because, naturally the percentage of essential body fat for women is greater than that for men, due to the demands of child bearing and other hormonal functions (Youssef *et al.*, 2015). BMI

is the most widely used diagnostic tool to identify weight problems within a population. Previous studies have shown that increased BMI is associated with an increased risk of metabolic related diseases and may be used as an indicator for the prediction of these diseases (Whitlock *et al.,* 2009). However, because of the inability of BMI to discriminate between body fat and lean mass, its diagnostic performance in intermediate ranges of body weight is limited; it cannot accurately categorize individuals who have a normal body weight with too much body fat but too little muscle and those who have an excessive body weight with too little body fat but too much muscle (Zeng *et al.,* 2012). Generally, BMI has been traditionally used in epidemiological studies as a proxy for adiposity because of its relative simplicity and affordability. Nonetheless, BMI is a measure of excess weight rather that excess body fat and changes with age, gender, and maturation in children (Adom *et al.,* 2020). Therefore, excess weight and elevated body fat remains to be independent risk factors, since excess body fat does not necessarily reflect to excess weight as indicated in the above studies.

These findings can be supported by other previous researchers; for-example (Todd *et al.,* 2015) reported that excess body fat in adolescents increases the risk for development of several medical conditions during adulthood, including insulin resistance, adult-onset T2DM and cardiovascular problems such as hypertension, heart disease and stroke. In addition to that, a study in China also reported that percentage of body fat shows a better prediction of CVDs risk indicating diabetes, hypertension, stroke and heart diseases (Wu *et al.,* 2016). Therefore, to improve diagnostic accuracy of body fat, direct measurement of body fat in diagnosing health and diet related disorders should be considered in addition to BMI.

5.2.3 Low physical activity levels

Other potential risk factor that was also observed to be associated with hypertension was insufficient physical activity levels. Adolescents who were physically inactive were more likely to have elevated blood pressure compared to pre-diabetes. The observed lack of association between sedentary lifestyle with elevated blood glucose levels could be the low prevalence of pre-diabetes observed or due to diagnosis criteria used, that is random blood glucose or due to the nature of the studied population, future studies should use HbA1C test which reveals blood glucose levels for the past three months and it is not affected by the last consumed meal of which is more accurate than the random blood glucose test (Sherwani *et al.,* 2016). In addition, objective physical activity assessment may be used instead of the subjective method of using questionnaire which could be subjective to recall bias. The present study is in contrast to the previous study conducted in Brazil among school adolescents (15-19 years) whereby the most prevalent risk factors for elevated blood pressure and hypertension were physical inactivity (Silva *et al.,* 2014). Also, a study conducted in Tanzania by Shayo (2019), reported that the most prevalent combination of risk factors for NCDs among in school adolescents (13-17 years) were physical inactivity and higher BMI.

5.2.4 Location (area of residence)

In our study, living in urban areas was positively associated with hypertension compared to those living in rural areas. The possible explanation for this is the variation in their socioeconomic status. Adolescents living in urban areas may be from the wealthier households and hence; due to their higher socioeconomic status (SES) these children might have engaged in lifestyles that increased their risk for

hypertension. Although not explored enough in this study, wealthier families are more likely to consume energy-dense foods and drinks, and high salty snacks; thus in combination with insufficient physical activities they are more likely to become overweight/obese and hence pose a risk for diabetes and hypertension. Several studies have shown that the prevalence of the metabolic syndrome in adolescents (10-19 years) significantly increases with high SES in both developing and developed countries (Agirbasli *et al.*, 2006; Buckland *et al.*, 2008). A systematic review conducted by Choukem *et al.*, (2020) in sub-Saharan Africa (SSA) among children and adolescents aged 5-19 years reported a positive association between overweight/obesity and SSA children of higher SES probably due to increased sedentary behaviors and increased accessibility to packaged foods high in sugars and saturated fats, more affordable to families with of higher SES or living in urban settings. Therefore, high SES plays a significant role in developing overweight/ obesity which is the most potential risk factor for pre-diabetes and hypertension among adolescents in this study.

5.3 Dietary Diversity among Adolescents

In the present study, a considerable proportion of adolescents consumed foods that are not healthy. Foods such as oils and fats, sweets and sweetened beverages were highly consumed. Low consumption of vegetables and fruits was noted. This practice could be due to the fact that most of the students skip breakfast and provided with some pocket money to buy something to eat at school. Around the school environment, the available foods are mainly deep-fried roots and tubers or other snack and sweetened beverages. In that case, students will buy something satisfying without considering nutrients. Presence and provision of healthier school meals would improve the situation and hence rectify unhealthy eating habits among the targeted group. Various studies have reported on adolescents' dietary habits and eating pattern. The results are pointing out that; just a few of the adolescents eat healthy food items most of them eat snacks and fast foods (Allafi *et al.*,2014; Abdel-Hady *et al.,* 2014) and majority tend to skip meals (Olumakaiye *et al.,* 2010; Abudayya *et al.,* 2009). In this study, DDS was not associated with hypertension or pre-diabetes. This could be due to the nature of data used in DDS which is mainly qualitative grouping of food groups rather that amount consumed. Further studies should explore specific nutrient consumption or deficiency and risk for metabolic syndrome among adolescents.

5.4 BMI for Age among the Study Participants

The findings of this study revealed the co-existence of under nutrition and over nutrition among secondary school adolescents. About 6% of the adolescents were underweight, which was lower than the prevalence of overweight (9%) and obesity (11%). This observation signifies the existence of nutrition transition from under nutrition to over nutrition and the double burden of malnutrition in Tanzania. Some

of the contributing factors could be changes in food consumption pattern, increased availability of cheap energy dense foods coupled with sedentary lifestyle. A study by Keding *et al* (2013) reported an increase in prevalence of overweight and obesity among adults even in the rural setting. In comparison to previous studies which were done in primary schools in Dar-es-Salaam, there is an increase in the prevalence of overweight and obesity among adolescents in Tanzania. (Muhihi *et al.*, 2013) reported prevalence of 9.8% for overweight and 5.2% obesity and (Pangani *et al.*, 2016) reported 15.9% and 6.7% for overweight and obesity, respectively, among school-going children aged 8-13 years.

In the present study, the prevalence of overweight and obesity was significantly higher among adolescents in private than in government schools regardless of the location. These results are compatible with a study done by (Teshome *et al.*, 2013) in Ethiopia which involved adolescents aged 10-19 years that reported that, the prevalence of overweight and obesity was high in non-government school (20.4%) compared to government schools (6.5%).The prevalence of obesity was also higher in urban schools (16.7%) compared to rural schools (5.2%) ($p = 0.000$). A sedentary lifestyle among adolescents in urban schools could be a reason for the increased prevalence of overweight/obesity. These results are seen to be similar to a study conducted by (Omigbodun *et al.*, 2010) in Nigeria that observed higher BMIs and higher heights in urban adolescents aged 10-19 years compared with those in rural areas.

5.5 Body Fat Percentage

In the present study, the results show that girls have a higher percentage of body fat mass than boys (22.9% vs. 8.3% p = 0.002). Epidemiologically, the percentage of body fat in an individual varies according to sex and age. The percentage of essential body fat for women is greater than that for men, due to the demands of child bearing and other hormonal functions (Youssef *et al.,* 2015). A study conducted by (Mushengezi and Chillo, 2014) in Dar es Salaam, Tanzania reported that the total body fat percent for adolescent girls aged 12-19 years was more than twice that of boys. Excess body fat which is due to obesity and overweight in adolescents also increases the risk for development of several medical conditions during adulthood, including insulin resistance, adult-onset T2DM and cardiovascular problems such as hypertension, heart disease and stroke (Todd *et al.,* 2015). A study conducted in India among adolescents aged 11-17 years reported that high percentage of body fat was significantly associated with pre-diabetes and pre-hypertension hence; it shows a better prediction of CVDs risk (Ramya *et al.,* 2016). Therefore, low physical activities and higher BMI for Age among adolescent girls contributed to the rise in body fat overtime and risk of developing diseases such as diabetes and hypertension in early life.

5.6 Physical Activities

In general, the present study demonstrates that male adolescents were more physically active compared to female ones. This implies that, female adolescents spend much more of their time engaging in low and moderate activities than in high

physical activities. Although not explored enough in this study, there is a strong common myth that sports are not “feminine”. This is could be due to the social stigma that exists in our daily life. Girls engaging in sports face discrimination based on the real or perceived sexual orientation and gender identity and experience bullying, social isolation and some tagged as gay (Meyer, 2015). Therefore, this is strong enough to push many girls out of sports and other physical exercise and hence being physically inactive compared to male counterparts.

The findings of this study are in contrast to a study conducted in Nigeria among adolescents aged 14-19 years which demonstrated that females participated more in low and moderate activities while the males participated more in high activities. This can be viewed as a behavioral habit as females tend to engage more in low and moderate activities than males who tend to engage in more vigorous activities (Odunaiya *et al.,* 2010). Also, another study conducted by (Olga *et al.,* 2019) in Benin reported that female adolescents aged 10-19 years were less active when compared to male adolescents. This was observed in the multivariate analysis, where girls were about twice more likely to be insufficiently active than boys (OR=1.87; CI 95%: 1.57-2.23).

Physical inactivity has been shown to contribute to NCDs and higher BMI. The increase in prevalence of obesity in childhood has led to the appearance of T2DM and other cardiovascular diseases such as stroke and hypertension in children and young adults (Forouhi and Wareham, 2019). Therefore, physical education classes can be introduced in schools, as a key institution to learn and practice movement and physical activity behavioral skills through participating in games and activities (Pangrazi and Beighle, 2019).

5.7 Awareness on T2DM and Hypertension

Studied adolescent students had an average level of awareness on T2DM and hypertension.This average was lower than expected, since students at this level are expected to have more information since they are at secondary school level. Students also performed best in the lifestyle changes and management section and worst in risk factors section, symptoms and complications sections. With regards to risk

factors, less than 20% of the students knew that pregnancy increases the risk for elevated blood glucose and hypertension due to decreased maternal insulin sensitivity, or increased insulin resistance, which begins near mid pregnancy and progresses in the third trimester of which later may result into outcomes such as pregnancy-induced hypertension (Mwanri *et al.*, 2014). Therefore, adolescents especially female should be educated on pregnancy induced diabetes and hypertension so as to prevent its occurrence at an early age.

Students' awareness on the complications associated with diabetes and hypertension was also low. This could be contributed by deficiencies in our education curriculum hence need further investigations. Despite the level of awareness being fairly good, there is a need for providing education at this age which would be very important for early detection and diagnosis of the diseases. Understanding diabetes and hypertension risk factors and possible complications especially at a younger age may improve individual efforts in prevention strategies. In light of these findings, similar results were obtained by Al Hussaini and Mustafa (2016) that assessed adolescents' knowledge and awareness of diabetes mellitus in Kuwait. The adolescent students also had an average awareness on diabetes and they also performed best in lifestyle changes sections and performed worst in other sections. In other studies, conducted in Pune-India by Banerjee *et al* (2007) reported that awareness about modifiable risk factors such as obesity and physical inactivity was very low among the school-going adolescents. Divakaran *et al* (2010) also reported that majority (84.8%) of school children had low awareness regarding lifestyle risk factors for NCDs and only about one percent of students were aware regarding lifestyle risk factors.

Low awareness on T2DM and hypertension risk factors observed in this study may be partly attributed to the media, especially television, which is the most influential source of dietary changes and information, for example, the food advertisements that persuade young children with colorful sweets and chocolate products. This influences their food choices, leading to family preferences for "junk food" or fast food which may lead to development of diet related NCDs. Generally, diabetes and hypertension are the two NCDs that are of a global issue. With the rising of NCDs in developing countries, this suggests that one-fifth of the studied sample would be diagnosed in the future as diabetic or hypertensive. Therefore it is highly recommended to increase awareness about diabetes and hypertension in young ages.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Moderate prevalence of pre-diabetes and higher rates of hypertension was observed among adolescents in the current study. Among the identified risk factors for hypertension and pre-diabetes; overweight and obesity, elevated body fat, and physical inactivity were the modifiable risk factors. Although majority of the adolescents consumed foods high in fat and sugars, dietary diversity did not contribute to the observed prevalence of pre-diabetes or hypertension. This study also showed that adolescents had an average level of awareness on T2DM and hypertension risk factors.

6.2 Recommendations

Monitoring of adolescent's nutrition and health status is very crucial, and the health sector should take the lead in routine health and nutrition assessment, monitor level of physical activities, dietary practices, and nutrition status among day and boarding scholars as both of them are at risk. Ministry of education should also include topics on non-communicable diet related diseases in primary and secondary school curriculum. In addition, media awareness campaigns should be established using a simple communication language to cut across all age groups. Food vendors should also be educated on selling nutritious foods around the schools, and children should be educated about healthier choices so that they can make informed decision when purchasing foods and incorporate these practices into their daily lives to build the foundation for a healthy generation tomorrow. Further research to establish eating

pattern and exposure to obesogenic environments and using more objective assessments should be conducted to ascertain the current findings.

REFERENCES

Abdel-Hady, D., El-Gilany, A. H. and Sarraf, B. (2014). Dietary habits of adolescent students in Mansoura, Egypt. *International Journal of Collaborative Research on Internal Medicine and Public Health*6(6):132.

AbouElmagd, M. (2016). Benefits, need and importance of daily exercise. *International Journal of Physical Education, Sports and Health*, *3*(5).

Abudayya, A. H., Stigum, H., Shi, Z., Abed, Y. and Holmboe-Ottesen, G. (2009).Sociodemographic correlates of food habits among school adolescents (12 15 years) in North Gaza Strip. *Biomed Central Public Health* 9(1): 185.

Adom, T., Kengne, A. P., De Villiers, A., Boatin, R., & Puoane, T. (2020). Diagnostic accuracy of body mass index in defining childhood obesity: analysis of cross-sectional data from Ghanaian children. *International Journal of Environmental Research and Public Health*, *17*(1), 36.

Agirbasli, M., Cakir, S., Ozme, S., &Ciliv, G. (2006).Metabolic syndrome in Turkish children and adolescents. *Metabolism*, *55*(8), 1002-1006.

Ajay, V. S., Watkins, D. A., & Prabhakaran, D. (2017). Relationships among major risk factors and the burden of cardiovascular diseases, diabetes, and chronic lung disease. *Disease Control Priorities*, *5*.

Akinola, I. J., Jarrett, O. O., Oduwole, A. O., Senbanjo, I. O., Njokanma, O. F., &Rogol, A. D. (2016). Prevalence of overweight and obesity among secondary school adolescents in an urban area of Lagos, Nigeria. *Afri J Diabetes Med*, *1*, 24-2.

Al-Hussaini, M. and Mustafa, S. (2016).Adolescents' knowledge and awareness of diabetes mellitus in Kuwait. *Alexandria Journal of Medicine* 52(1): 61 – 66.

Allafi, A., Al-Haifi, A. R., Al-Fayez, M. A., Al-Athari, B. I., Al-Ajmi, F. A., Al-Hazzaa, H. M. and Ahmed, F. (2014). Physical activity, sedentary behaviours and dietary habits among Kuwaiti adolescents: gender differences. *Public Health Nutrition* 17(9): 2045 – 2052.

American Diabetes Association.(2016). 2. Classification and diagnosis of diabetes. *Diabetes care*, *39* (Supplement 1), S13-S22.

Animaw, W., &Seyoum, Y. (2017).Increasing prevalence of diabetes mellitus in a developing country and its related factors. *PloS one*, *12*(11), e0187670.

Arigbede, O., Adeoye, I., Jarrett, O., & Yusuf, O. (2017).Pre-diabetes among Nigerian adolescents: A School-based study of the prevalence, risk factors and pattern of fasting blood glucose in Ibadan, Nigeria. *International Journal of Diabetes in Developing Countries*, *37*(4), 437-445.

Ataklte, F., Erqou, S., Kaptoge, S., Taye, B., Echouffo-Tcheugui, J. B., & Kengne, A. P. (2015). Burden of undiagnosed hypertension in sub-saharan Africa: a systematic review and meta-analysis. *Hypertension*, *65*(2), 291-298.

Banerjee, A. (2007). Letter to Editor-Coronary heart disease: Awareness of risk factors and lifestyle among school-going adolescents.

BeLue, R., Okoror, T. A., Iwelunmor, J., Taylor, K. D., Degboe, A. N., Agyemang, C., & Ogedegbe, G. (2009). An overview of cardiovascular risk factor burden in sub-Saharan African countries: a socio-cultural perspective. *Globalization and health*, *5*(1), 10.

Bhimma, R., Naicker, E., Gounden, V., Nandlal, L., Connolly, C., & Hariparshad, S. (2018). Prevalence of Primary Hypertension and Risk Factors in Grade XII Learners in KwaZulu-Natal, South Africa. *International journal of hypertension*, *2018*.

Bray, G. A. (2017). Obesity and the risk for type 2 diabetes. In: *Nutrition in the Prevention and Treatment of Disease*. Academic Press,pp. 677 – 689.

Buckland, G., Salas-Salvadó, J., Roure, E., Bulló, M., & Serra-Majem, L. (2008).Sociodemographic risk factors associated with metabolic syndrome in a Mediterranean population. *Public health nutrition*, *11*(12), 1372-1378.

Chen, L., Magliano, D. J., & Zimmet, P. Z. (2012).The worldwide epidemiology of type 2 diabetes mellitus—present and future perspectives. *Nature reviews endocrinology*, *8*(4), 228-236

Chomba, H., Martin, H. D., & Kimywe, J. (2019). Prevalence and predictors of obesity among 7-to 17-year-old schoolchildren in Urban Arusha, Tanzania. *Journal of nutrition and metabolism*, *2019*.

Choukem, S. P., Tochie, J. N., Sibetcheu, A. T., Nansseu, J. R., & Hamilton-Shield, J. P. (2020). Overweight/obesity and associated cardiovascular risk factors in

sub-Saharan African children and adolescents: a scoping review. *International journal of pediatric endocrinology*, *2020*, 1-13.

Cullinan, J., & Cawley, J. (2017). Parental misclassification of child overweight/ obese status: The role of parental education and parental weight status. *Economics & Human Biology*, *24*, 92-103.

D'Adamo, E., & Caprio, S. (2011). Type 2 diabetes in youth: epidemiology and pathophysiology. *Diabetes care*, *34* (Supplement 2), S161-S165.

De Moura, I. H., Nadabe, A., dos Anjos, J. S., de Castro, T. H. U., de Almeida, P. C., & da Silva, A. R. V. (2015). Educational strategies with adolescents at risk from diabetes mellitus: a comparative study. *Online Brazilian Journal of Nursing*, *14*(1), 25-31.

Divakaran, B., Muttapillymyalil, J., Sreedharan, J., & Shalini, K. (2010). Lifestyle risk factors of non-communicable diseases: awareness among school children. *Indian journal of cancer*, *47*(5), 9.

Fall, C. H. (2013). Fetal programming and the risk of non-communicable disease. *The Indian Journal of Pediatrics*, *80*(1), 13-20.

Farrag, N. S., Cheskin, L. J., & Farag, M. K. (2017). A systematic review of childhood obesity in the Middle East and North Africa (MENA) region: prevalence and risk factors meta-analysis. *Advances in pediatric research*, *4*.

Farsani, S. F., Van Der, M. P., Van Der Vorst, M. M. J., Knibbe, C. A. J., & De Boer, A. (2013). Global trends in the incidence and prevalence of type 2 diabetes in children and adolescents: a systematic review and evaluation of methodological approaches. *Diabetologia*, *56*(7), 1471-1488.

Flynn, J. T., Kaelber, D. C., Baker-Smith, C. M., Blowey, D., Carroll, A. E., Daniels, S. R., ... &Gidding, S. S. (2017). Clinical practice guideline for screening and management of high blood pressure in children and adolescents. *Pediatrics*, *140*(3).

Forouhi, N. G., & Wareham, N. J. (2019).Epidemiology of diabetes. *Medicine*, *47*(1), 22-27.

Ghimire, H. P., & Dhungana, A. (2018). Cardiovascular risk behavior amongst adolescents of Lekhnath Muncipality of Kaski district, Nepal. *Journal of Gandaki Medical College-Nepal*, *11*(1), 10-13.

Daniels, S. R. (2009). Complications of obesity in children and adolescents. *International journal of obesity*, *33*(1), S60-S65.

Gurzkowska, B., Grajda, A., Kułaga, Z., Napieralska, E., & Litwin, M. (2011). Distribution of body mass index categories among Polish children and adolescents from rural and urban areas. *Med WiekuRozwoj*, *15*(3), 250-7.

Hayashi, Y., & Yukita, S. (2016). Rule extraction using Recursive-Rule extraction algorithm with J48graft combined with sampling selection techniques for the diagnosis of type 2 diabetes mellitus in the Pima Indian dataset. *Informatics in Medicine Unlocked*, *2*, 92-104.

Hills, A. P., Arena, R., Khunti, K., Yajnik, C. S., Jayawardena, R., Henry, C. J., ... &Misra, A. (2018). Epidemiology and determinants of type 2 diabetes in south Asia. *The lancet Diabetes & endocrinology*, *6*(12), 966-978.

Isabirye, N., Bukenya, J. N., Nakafeero, M., Ssekamatte, T., Guwatudde, D., & Fawzi, W. (2020). Dietary diversity and associated factors among adolescents in eastern Uganda: a cross-sectional study. *BMC Public Health*, *20*, 1-8.

Jaja, T., & Yarhere, I. E. (2015). Risk factors for T2DM in adolescents secondary school students in Port Harcourt, Nigeria. *Nigerian Journal of Paediatrics*, *42*(2), 137-141.

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2013). Obesity as a public health problem among adult women in rural Tanzania. *Global health: science and practice*, *1*(3), 359-371.

Kennedy, G., Ballard, T. and Dop, M. C. (2011). *Guidelines for Measuring Household and Individual Dietary Diversity*. Food and Agriculture Organization of the United Nations. Published by EC-FAO "Linking Information and Decision Making to Improve Food Security" Programme. www.foodsec.org

Khan, M. M., Sonkar, G. K., Singh, S. and Sonkar, S. K. (2019). Importance of the Madras Diabetes Research Foundation-Indian Diabetes Risk Score for mass screening of type 2 diabetes and its complications at primary health care centers of North India. *International Journal of Diabetes in Developing Countries* 1-7.

Kjøllesdal, M. K., & Holmboe-Ottesen, G. (2014). Dietary patterns and birth weight—a review. *AIMS Public Health*, *1*(4), 211.

Kohei, (2010). Pathophysiology of type 2 diabetes and its treatment policy. *Japan Medical Association Journal* 53(1): 41 – 46.

Kollias, A., Antonodimitrakis, P., Grammatikos, E., Chatziantonakis, N., Grammatikos, E. E., &Stergiou, G. S. (2014). Trends in high blood pressure prevalence in Greek adolescents. *Journal of human hypertension*, *23*(6), 385-390.

Kowalski, K. C., Crocker, P. R., & Donen, R. M. (1997).The physical activity questionnaire for older children (PAQ-C) and adolescents (PAQ-A) manual. *College of Kinesiology, University of Saskatchewan*, *87*(1), 1-38.

Kowalski, K. C., Crocker, P. R., & Donen, R. M. (2004).The physical activity questionnaire for older children (PAQ-C) and adolescents (PAQ-A) manual. *College of Kinesiology, University of Saskatchewan*, *87*(1), 1-38.

Kuciene, R., & Dulskiene, V. (2019). Associations between body mass index, waist circumference, waist-to-height ratio, and high blood pressure among adolescents: a cross-sectional study. *Scientific reports*, *9*(1), 1-11.

Mahrooqui, B. A., Hadhrami, R., Al-Amri, A., Al-Tamimi, S., Asma Al-Shidhani, A., Al-Lawati, H., A-Ismaili, A., Al-Hooti, K. and Al-Ghafri, T. (2013). Self-Reported Knowledge of Diabetes among High School Students in Al-Amerat and Quriyat Sultan Qaboos. *University Medical Journal* 13: 392–398.

Mansour, M., Nassef, Y. E., Shady, M. A., Aziz, A. A., & El Malt, H. A. (2016). Metabolic syndrome and cardiovascular risk factors in obese adolescent. *Open Access Macedonian Journal of Medical Sciences*, *4*(1), 118.

Martin, A., Booth, J. N., Laird, Y., Sproule, J., Reilly, J. J., & Saunders, D. H. (2018). Physical activity, diet and other behavioural interventions for improving cognition and school achievement in children and adolescents with obesity or overweight. *Cochrane Database of Systematic Reviews*, (1).

May, A. L., Kuklina, E. V. and Yoon, P. W. (2012). Prevalence of cardiovascular disease risk factors among US adolescents, 1999− 2008. *Pediatrics* 129(6):1035 – 1041.

Mbuya, F. E., Fredrick, F., & Kundi, B. (2014).Knowledge of diabetes and hypertension among members of teaching staff of higher learning institutions in Dar es Salaam, Tanzania. *Tanzania journal of health research*, *16*(2).

Meyer, E. J. (2015). *Gender, bullying, and harassment: Strategies to end sexism and homophobia in schools*. Teachers College Press.

Mfinanga, S. G., Kivuyo, S. L., Ezekiel, L., Ngadaya, E., Mghamba, J., & Ramaiya, K. (2011). 6. Public health concern and initiative on the priority action towards non-communicable diseases in Tanzania. *Tanzania Journal of Health Research*, *13*(5).

Mosha, T. C. and Fungo, S. (2010). Prevalence of overweight and obesity among children aged 6-12 years in Dodoma and Kinondoni municipalities, Tanzania. *Tanzania Journal of Health Research* 12(1): 6 – 16.

Muhihi, A. J., Mpembeni, R. N., Njelekela, M. A., Anaeli, A., Chillo, O., Kubhoja, S., ...& Ngarashi, D. (2013). Prevalence and determinants of obesity among primary school children in Dar es Salaam, Tanzania. *Archives of Public Health*, *71*(1), 26.22

Muhihi, A. J., Njelekela, M. A., Mpembeni, R. N., Muhihi, B. G., Anaeli, A., Chillo, O. and Ngarashi, D. (2018). Elevated blood pressure among primary school children in Dar es salaam, Tanzania: prevalence and risk factors. *BioMedCentralPediatrics* 18(1): 1 – 54.

Mushengezi, B., & Chillo, P. (2014).Association between body fat composition and blood pressure level among secondary school adolescents in Dar es Salaam, Tanzania. *The Pan African Medical Journal*, *19*.

Mwanri, A. W., Kinabo, J. L., Ramaiya, K., & Feskens, E. J. (2015). High blood pressure and associated risk factors among women attending antenatal clinics in Tanzania. *Journal of Hypertension*, *33*(5), 940-947.

Mwanri, A. W., Kinabo, J., Ramaiya, K., & Feskens, E. J. (2014). Prevalence of gestational diabetes mellitus in urban and rural Tanzania. *Diabetes research and clinical practice*, *103*(1), 71-78.

Nascente, F. M. N., Jardim, T. V., Peixoto, M. D. R. G., de Souza Carneiro, C., Mendonça, K. L., Póvoa, T. I. R., ..&Jardim, P. C. B. V. (2016). Sedentary lifestyle and its associated factors among adolescents from public and private schools of a Brazilian state capital. *BMC Public Health*, *16*(1), 1177.

National Bureau of Statistics (2012).*Population and Housing Census: Population Distribution by Administrative Areas*. National Bureau of Statistics, Dar es Salaam, Tanzania.

Noubiap, J. J., Essouma, M., Bigna, J. J., Jingi, A. M., Aminde, L. N., & Nansseu, J. R. (2017). Prevalence of elevated blood pressure in children and adolescents in Africa: a systematic review and meta-analysis. *The Lancet Public Health*, *2*(8), e375-e386.

Nsanya, M. K., Kavishe, B. B., Katende, D., Mosha, N., Hansen, C., Nsubuga, R. N., ...& Kapiga, S. (2019). Prevalence of high blood pressure and associated factors among adolescents and young people in Tanzania and Uganda. *The Journal of Clinical Hypertension*, *21*(4), 470-478.

Nyandindi, U. S. (2017). Tanzania Mainland Global School-based Student Health Survey Country Report.

Ochola, S., & Masibo, P. K. (2014).Dietary intake of schoolchildren and adolescents in developing countries. *Annals of Nutrition and Metabolism*, *64*(Suppl. 2), 24-40.

Odunaiya, N. A., Ayodele, O. A. and Oguntibeju, O. O. (2010). Physical activity levels of senior secondary school students in Ibadan, western Nigeria. *West Indian Medical Journal* 59(5): 529 – 534.

Okafor, C. I. (2012). The metabolic syndrome in Africa: Current trends. *Indian journal of endocrinology and metabolism*, *16*(1), 56.

Okpokowuruk, F. S., Akpan, M. U. and Ikpeme, E. E. (2017).Prevalence of hypertension and prehypertension among children and adolescents in a semi-urban area of Uyo Metropolis, Nigeria. *Pan African Medical Journal* 28(1).

Olga, A. H., Benjamin, H., Nadege, H. Y. C., Alphonse, K., Yann, G. K., Charlemangne, V., ... & Xavier, P. R. (2019). Prevalence of Behavioural Risk Factors for Non-communicable Diseases Among Adolescents in Schools in Benin in 2016. *Science*, *7*(6), 214-224.

Olumakaiye, M. F., Atinmo, T. and Olubayo-Fatiregun, M. A. (2010). Food consumption patterns of Nigerian adolescents and effect on body weight. *Journal of Nutrition Education and Behavior42*(3): 144 – 151.

Omigbodun, O. O., Adediran, K. I., Akinyemi, J. O., Omigbodun, A. O., Adedokun, B. O.,& Esan, O. (2010). Gender and rural-urban differences in the nutritional status of in-school adolescents in south-western Nigeria. *Journal of Biosocial Science*, *42*(5), 653.

Omisore, A. G., Alebiosu, C. O., Abe, O. S., Kolawole, B. A., Familoni, O. B., Adeleye, J. O. and Balogun, W. O. (2014). Awareness and knowledge

about diabetes mellitus and hypertension amongst adolescents in secondary schools, Oyo State, Nigeria–an interventional Study by the SIDCAIN Research Group. *Research Journal of Health Sciences* 2(2): 64-78.

Overall, J. E., Tonidandel, S., & Starbuck, R. R. (2006). Rule-of-thumb adjustment of sample sizes to accommodate dropouts in a two-stage analysis of repeated measurements. *International journal of methods in psychiatric research*, *15*(1), 1-11.

Pangani, I. N., Kiplamai, F. K., Kamau, J. W., & Onywera, V. O. (2016). Prevalence of overweight and obesity among primary school children aged 8-13 Years in Dar es Salaam city, Tanzania. *Advances in preventive medicine*, *2016*.

Pangrazi, R. P., & Beighle, A. (2019). *Dynamic physical education for elementary school children*.Human Kinetics Publishers.

Pearson, E.R. and McCrimmon, R. (2014).Diabetes Mellitus.In:*Davidson's Principles and Practice of Medicine*(Edited by Walker, B. R., Colledge, N. R., Stuart, R. H. and Ian, P. D.)Elsevier Ltd.,London, UK.pp. 797 – 836.

Price, A. J., Crampin, A. C., Amberbir, A., Kayuni-Chihana, N., Musicha, C., Tafatatha, T., ... & Smeeth, L. (2018). Prevalence of obesity, hypertension, and diabetes, and cascade of care in sub-Saharan Africa: a cross-sectional, population-based study in rural and urban Malawi. *The lancet Diabetes & endocrinology*, *6*(3), 208-222.

Rahman, M. S., Akter, S., Abe, S. K., Islam, M. R., Mondal, M. N. I., Rahman, J. S. Rahman, M. M. (2015). Awareness, treatment, and control of diabetes in

Bangladesh: A nationwide population-based study. *PloSOne* 10(2): e0118365.

Ramya, H. S., Goutham, A. S., & Pragyee, D. (2017). Body mass index, waist hip ratio and body fat percentage as early predictors of pre-diabetes and pre-hypertension in adolescents. *Current Pediatric Research*.

Redwine, K. M., Acosta, A. A., Poffenbarger, T., Portman, R. J., & Samuels, J. (2012).Development of hypertension in adolescents with pre-hypertension. *The Journal of pediatrics*, *160*(1), 98-103.

Reinehr, T. (2013). Type 2 diabetes mellitus in children and adolescents. *World journal of diabetes*, *4*(6), 270

Riley, M., & Bluhm, B. (2012). High blood pressure in children and adolescents. *American family physician*, *85*(7), 693-700.

Sakurai, M., Nakamura, K., Miura, K., Takamura, T., Yoshita, K., Sasaki, S., & Naruse, Y. (2013). Family history of diabetes, lifestyle factors, and the 7-year incident risk of T2DM in middle-aged Japanese men and women. *Journal of Diabetes Investigation* 4(3): 261 – 268.

Schneider, B. C., Dumith, S. C., Orlandi, S. P., & Assunção, M. C. F. (2017). Diet and body fat in adolescence and early adulthood: a systematic review of longitudinal studies. *Ciencia&saudecoletiva*, *22*, 1539-1552.

Shayo, F. K. (2019). Co-occurrence of risk factors for non-communicable diseases among in-school adolescents in Tanzania: an example of a low-income setting of sub-Saharan Africa for adolescence health policy actions. *BMC Public Health*, *19*(1), 972.

Sherwani, S. I., Khan, H. A., Ekhzaimy, A., Masood, A., &Sakharkar, M. K. (2016). Significance of HbA1c test in diagnosis and prognosis of diabetic patients. *Biomarker insights*, *11*, BMI-S38440.

Silva, K. S., Barbosa Filho, V. C., Del Duca, G. F., de Anselmo Peres, M. A., Mota, J., da Silva Lopes, A., &Nahas, M. V. (2014). Gender differences in the clustering patterns of risk behaviours associated with non-communicable diseases in Brazilian adolescents. *Preventive medicine*, *65*, 77-81.

Slagter, S. N., van Vliet-Ostaptchouk, J. V., Vonk, J. M., Boezen, H. M., Dullaart, R. P., Kobold, A. C. M. and Wolffenbuttel, B. H. (2014). Combined effects of smoking and alcohol on metabolic syndrome: the LifeLines cohort study. *PloS One* 9(4):e96406.

Song, H. S. (2012). *Emerging Type 2 Diabetes in Young Adults, Diabetes Centre.* Spinger, New York. 61pp.

Spurr, S., Bally, J., Allan, D., Bullin, C., & McNair, E. (2019).Prediabetes: An emerging public health concern in adolescents. *Endocrinology, diabetes & metabolism*, *2*(2), e00060.

Stang, J. S., & Stotmeister, B. (2017). Nutrition in adolescence. In *Nutrition Guide for Physicians and Related Healthcare Professionals* (pp. 29-39). Humana Press, Cham.

Tayyem, R. F., Al Hazzaa, H. M., Abu Mweis, S. S., Bawadi, H. A., Hammad, S. S., &Musaiger, A. O. (2014). Dietary habits and physical activity levels in Jordanian adolescents attending private versus public schools.

Teshome, T., Singh, P., & Moges, D. (2013). Prevalence and associated factors of overweight and obesity among high school adolescents in urban communities of Hawassa, Southern Ethiopia. *Current Research in Nutrition and Food Science Journal*, *1*(1), 23-36.

Tluway, F. D., Leyna, G. H., & Mmbaga, E. J. (2018). Magnitude and factors associated with overweight and obesity among adolescents in in semi-rural area of Babati District, Tanzania. *Tanzania Journal of Health Research*, *20*(2).

Todd, A., Street, S., Ziviani, J., Byrne, N. and Hills, A. (2015). Overweight and obese adolescent girls: the importance of promoting sensible eating and activity behaviors from the start of the adolescent period. *International Journal of Environmental Research and Public Health*12(2): 2306 – 2329.

Ulasi, I. I., Ijoma, C. K., & Onodugo, O. D. (2010).A community-based study of hypertension and cardio-metabolic syndrome in semi-urban and rural communities in Nigeria. *BMC health services research*, *10*(1), 71.

Unadike, B. C., & Chineye, S. (2009). Knowledge, awareness, and impact of diabetes among adolescents in Uyo, Nigeria. *African Journal of Diabetes Medicine*, *3*, 12-14.

Whitlock, G., Lewington, S., Sherliker, P., Clarke, R., Emberson, J., Halsey, J., ... & Peto, R. (2009). Prospective Studies Collaboration: Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet*, *373*(9669), 1083-1096.

World Health Assembly. Update on the Commission on Ending Childhood Obesity: report by the Director-General. Geneva: 2015. A68/10.

World Health Organization. (2006). Body fat percentages percentiles among adolescents: methods and development.

World Health Organization. (2009). Child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development.

World Health Organization. (2016). Consideration of the evidence on childhood obesity for the Commission on Ending Childhood Obesity: report of the ad hoc working group on science and evidence for ending childhood obesity, Geneva, Switzerland.

World Health Organization. (2016). Global report on diabetes.

World Health Organization. (2017). *Programme reporting standards for sexual, reproductive, maternal, newborn, child and adolescent health* (No. WHO/MCA/17.11). World Health Organization.

WHO. The global strategy for women's, children's, and adolescents' health (2016 30). 2015. http://www.who.int/life-course/partners/ global strategy/ewec-globalstrategyreport-200915.pdf?ua=1 (accessed Dec 05, 2020)

Wu, Y. K., Chu, N. F., Huang, Y. H., Syu, J. T., & Chang, J. B. (2016). BMI, body fat mass and plasma leptin level in relation to cardiovascular diseases risk factors among adolescents in Taitung. *Obesity research & clinical practice*, *10*(4), 432-441.

Youssef, M. H., Mojaddidi, M., El Bab, M. F., Abd El Nabi, W., & Salem, M. (2015).Gender differences in body composition, respiratory functions, life style among medical students.

Zeng, Q., Dong, S. Y., Sun, X. N., Xie, J., & Cui, Y. (2012). Percent body fat is a better predictor of cardiovascular risk factors than body mass

index. *Brazilian Journal of Medical and Biological Research*, *45*(7), 591-600

APPENDICES

As I have already introduced myself, my name is Khadija Makbel, a research student from Sokoine University of Agriculture Morogoro. The main aim of this research is to get to know why children nowadays are getting diabetes mellitus and hypertension so that we can overcome this burden to Tanzanian children.

Thank you so much for agreeing to join the study.

APPENDIX 1: Students Questionnaire

Questionnaire no ……Name of the school……

Section A: Demographic information

1. Date of birth of the respondent…….....

Birth weight (if known) ……
2. Sex: a) Male [ ] b) Female [ ]
3. School type a) Government [ ] b) Private [ ]
4. Location of the school a) Rural [ ] b) Urban [ ]
5. Educational level a) Form two [ ] b) Form three [ ] c) Form four [ ]
6. Any close relative with i) diabetes ii) Hypertension (Mother, father, brother/sister)

Anthropometric Measurements and body composition
Height (centimeters)..... Weight (kilograms).....
Body Mass Index (BMI for age)……..
Body fat..... Reading 1: ……Reading 2: ……Average…….
Which food did you last eat before meeting with the researcher? .....
What was the time that you ate your last meal? ……

Random blood glucose measurement (mmol/L).....
Blood pressure measurement
Reading 1.....
Reading 2.....
Average.....

Section B: Awareness on type 2 diabetes mellitus and hypertension

Please select one answer.

Please fill in the questionnaire honestly.

TYPE 2 DIABETES MELLITUS

Section 1: General awareness about diabetes mellitus (Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Diabetes is a condition of high blood sugar			
b) Diabetes is a condition of not enough insulin in blood			
c) Diabetes is a condition of the body not responding to insulin			
d)Diabetes is not curable			
e) Diabetes occurs in children, adolescents, and adults			

Section 2: Risk factors associated with T2DM

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Family history of diabetes			
b) Unhealthy diet – crisps, fast-food, eating too much sugar.			
c) Overweight and obesity			
d) Low physical activity			
e) Age above 40 years old			
f) Pregnancy			
g) Alcohol consumption			

Section 3: Symptoms ofT2DM (Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Headache			
b) Tiredness and weakness			
c) Visual disturbances/problems			
d) Slow heeling of cuts and wounds			
e) Frequent urination			
f) Constant feeling of thirsty			
g) Too much sweating			
h) Feeling too much thirsty			
i) Too much anxious to eat sugary foods			

Section 4: Complications of T2DM

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Eye problems			
b)Kidney problems/disease			

c)High blood pressure			
d)Loss of sensation in arms and legs			
e)Stroke and heart diseases			

Section 5: Treatment and medications available

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Medicines are available for the control of blood glucose level			
b)Insulin injections are available for the control of blood glucose levels			

Section 6: Lifestyle changes and non-medical measures of T2DM

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Regular physical activities			
b)Stopping alcohol use			
c) Body weight maintenance			
d) Diet modification: reducing salt intake, reducing intake of sugars and carbohydrates, reducing intake of fatty foods and high fibre diet			
e) Carry sweets when they are out			

Section 7: Management of T2DM

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Testing blood sugar regularly			
b)Regular eye check-up			
c)Regular check-up for general health			
d) Healthy lifestyle changes, such as eating a healthy diet with less sugar, maintaining a healthy weight and limiting alcohol consumption.			

HYPERTENSION

Section 1: General awareness about hypertension (Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Hypertension is a condition of high blood pressure			
b) Hypertension is a condition in which the blood vessels have persistently raised pressure.			
c) Normal blood pressure is defined as a blood pressure of 120 mm Hg when the heart beats (systolic) and a blood pressure of 80 mm Hg when the heart relaxes (diastolic).			

d) Hypertension is not curable			
e) Hypertension occurs in children, adolescents, and adults			

Section 2: Risk factors associated with hypertension

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Family history of hypertension			
b) Unhealthy diet – crisps, fast-food, eating too much salt.			
c) Overweight and obesity			
d) Low physical activity			
e) Age above 40 years old			
f) Pregnancy			
g) Cigarette smoking and alcohol consumption.			
h)Drugs, substances contained in energizing products			

Section 3: Symptoms of Hypertension

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Severe headache and stress			
b) Tiredness and weakness			
c) Visual disturbances/problems			
d) Chest pain and difficulty breathing			
e) Irregular heartbeat			
f) Blood in the urine			

Section 4: Complications ofhypertension

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Eye problems			
b)Heart attack or stroke			
c)Heart failure			
d)Trouble with memory or understanding			
e)Kidney problems/disease			

Section 5: Treatment and medications available

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Medicines are available for the control of hypertension			
b)Hydralazine injections are available for the control of hypertension			

Section 6: Lifestyle changes and non-medical measures of hypertension

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Regular physical activities			
b) Stopping cigarette smoking and alcohol consumption.			
c) Body weight maintenance			
d)Diet modification: reducing salt intake, reducing intake of fatty foods and high fibre diet			
e)Not to use drugs and energizing products			
Others (mention)			

Section 7: Management of hypertension

(Please tick where appropriate)

Questions	**YES**	**NO**	**DO NOT KNOW**
a) Measuring blood pressure regularly			
b)Regular eye check-up			
c)Regular check-up for general health			
d)Healthy lifestyle changes, such as eating a healthy diet with less salt, maintaining a healthy weight and limiting alcohol intake			

SECTION C

Physical activity levels

We are trying to find out about your level of physical activity from **the last 7 days**(in the last week). These includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like skipping, running, climbing, and others.

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (only one circle per row)

Activities	**Number of times**				
	1-2	**3-4**	**5-6**	**7 times or more**	**Never**
Jumping rope					
Jogging/running					
Bicycling					
Mopping					
Football					
Washing utensils					

Walking for exercise					
Hill walking					
Cooking					

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Tick one only.)

I don’t do PE.....

Hardly ever.....

Sometimes.....

Quite often.....

Always.....

3. In the last 7 days, what did you normally do at lunch (besides eating lunch)? (Tick one only.)

Sat down (talking, reading, doing schoolwork).....

Stood around or walked around.....

Ran or played a little bit.....

Ran around and played quite a bit.....

Ran and played hard most of the time.....

4. In the last 7 days, on how many days right after school, did you do sport, dance, or play games in which you were very active? (Tick one only.)

None.....

1 time last week.....

2 or 3 times last week.....

4 times last week.....

5 times last week.....

5. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Tick one only.)

None.....

1 time last week.....

2 or 3 times last week.....

4 or 5 last week.....

6 or 7 times last week.....

6. On the last weekend, how many times did you do sports, dance, or play games in which you were very active? (Tick one only.)

None.....

1 time.....

2-3 times.....

4-5 times.....

6 or more times.....

7. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.

A. All or most of my free time was spent doing things that involve little physical effort.....

B. I sometimes (1-2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, and did aerobics) .....

C. I often (3-4 times last week) did physical things in my free time.....…….

D. I quite often (5-6 times last week) did physical things in my free time…….....

E. I very often (7 or more times last week) did physical things in my free time.....

8. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Tick one.)

Yes.....

No.....

If yes, what prevented you?

.....

Section D. Dietary assessment (dietary diversity)
Dietary Diversity Questionnaire

Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home (school). Start with the first food or drink eaten in the morning yesterday and during one day of the weekend.

Breakfast	Snack	Lunch	Snack	Dinner	Snack
		YESTERDAY			
		WEEKEND			

THANK YOU SO MUCH FOR YOUR TIME