PREVALENCE OF TYPE 2 DIABETES MELLITUS AND ASSOCIATED RISK FACTORS AMONG LOCAL GOVERNMENT WORKERS AT BARIADI TOWN COUNCIL, TANZANIA

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ABSTRACT

Type 2 Diabetes Mellitus is the predominant form of human diabetes. It is worldwide increasing rapidly. In Tanzania, over 1.7 million people have diabetes, about 1.3 million live undiagnosed and prevalence is higher in urban than rural areas. The goal of this study was to determine the prevalence of T2DM and associated risk factors among Local Government Authority workers at Bariadi Town Council, Tanzania. A cross-sectional study approach was applied, five clusters of study units were purposively formed, and stratified by gender. Subjects were sampled from each stratum by applying systematic sampling technique and a sample of 229 subjects was selected proportional to size. Data were collected through face-to-face interview using structured questionnaires. Anthropometric measurements were taken. Subjects were also screened for random blood glucose and those with values ≥ 5.6 and ≤11.1 mmol/l were scheduled for fasting blood glucose, and individuals with fasting blood glucose values above (7.0 mmol/l) were confirmed to be diabetic. Epi Info and SPSS software were used in data analysis. Risk factors were subjected to bivariate analysis and those factors that were associated with T2DM and known T2DM predictors were subjected to logistic regression through backward step-wise elimination method; Likelihood ratio statistic of 0.1 was set as removal criterion to determine the final model. Strength of association was assessed by Odds Ratios and 95% Confidence Intervals. The overall prevalence was found to be 7.9% (95%CI=4.7-12.1). Risk factors for T2DM were found to be sex (OR=4.545, 95%CI: 1.069-19.325), age between 30-41 and 41-50 years (OR=8.08, 95%CI: 1.215-53.741; OR=15.08, 95%CI: 2.315-98.342) and history of raised blood sugar (OR=0.032, 95%CI: 0.006-0.167). Female subjects and primary school workers were mostly affected. Sex, age, history of diabetes had significant association with T2DM. Control efforts should be directed on screening and public nutrition programmes.

DECLARATION

I, Chacha Magige Nyabisaga, do declare to the senate of Sokoine University of Agriculture, that this dissertation is my own original work and it has neither been submitted nor being concurrently submitted for a degree award in any other institution.

_____ _____

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DEDICATION

This work is dedicated to my beloved parents, the late Magige Marwa Nyabisaga and Wankuru Chacha Rong'ang'a, who laid the foundation of my education, self-discipline and self-help spirit. May the Almighty God rest their souls in eternal peace, Amen!

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LIST OF ABBREVIATIONS AND ACRONYMS

BMI	Body mass index
BP	Blood pressure
BSc	Bachelor of Science
CDC	Centre for Disease Control
CFPG:	Capillary Fasting Plasma Glucose
CI	Confidence interval
DBP	Diastolic blood pressure
FBG	Fasting blood glucose
IDF	International Diabetes Federation
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
LDL	Low- density lipoprotein
MSc	Master of Science
NBS	National Bureau of Statistics
NEFA	Non-Esterified Fatty Acids
NHIF	National Health Insurance Fund
NIMR	National Institute for Medical Research
OGTT	Oral Glucose Tolerance Test
OHA	Oral Hyperglycaemic Agent
OR	Odds Ratio
PR	Prevalence Ratio
RAS	Regional Administrative Secretary
RBG	Random blood glucose
RMO	Regional Medical Officer
SBP	Systolic blood pressure

T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Diabetes Mellitus is a chronic, non-communicable disease, characterized by high levels of glucose in the blood. It occurs either because the pancreas failure to produce the hormone insulin, Type 1 Diabetes Mellitus (T1DM); or through the combination of the pancreas having reduced ability to produce insulin alongside the body being resistant to its action, Type 2 Diabetes Mellitus (T2DM) (ADA, 2012). Type 2 Diabetes Mellitus is the predominant form of diabetes and accounts for about 90% of all cases of diabetes mellitus; whereas, Type 1 Diabetes Mellitus represents around 10% of all cases of diabetes (Ozougwu *et al*., 2013).

The global prevalence of diabetes was estimated to be 9.0% among adults in 2014. About 1.5 million deaths were caused by diabetes; and more than 80% of the deaths occurred in developing countries (WHO, 2014). More shockingly, it is projected that by 2030, diabetes will be the seventh most leading cause of death (Mathers *et al.*, 2006). However, it is estimated that over 175 million people live with undiagnosed T2DM (IDF, 2013).

In addition, the prevalence of diabetes mellitus was 7.1% in Africa in 2014. It is projected to increase from 19.8 million in 2013 to 41.5 million people in 2035. Undiagnosed diabetes mellitus was estimated to be high as 50% (Peer *et al.*, 2014; WHO, 2016). The projected increase for sub-Saharan Africa is around 98%; expected to rise from 12.1 million in 2010 to 23.9 million in 2030; Impaired glucose tolerance in sub-Saharan Africa is expected to rise by 75.8%, from 26.9 million in 2010 to 47.3 million in 2030 (Mbanya *et al*., 2010).

In 2012, the prevalence of diabetes mellitus was estimated to be 9.1% in Tanzania. It was estimated to have over 1.7 million people with diabetes mellitus and about 1.3 million people were estimated living undiagnosed (WHO, 2012; IDF, 2013). The prevalence was higher among urban dwellers, over 5.0% more than the rural counterpart who accounts about 2.0% (Mayige *et al.*, 2012). In 2014, the prevalence of T2DM in Mwanza city, the city around Lake Victoria neighbouring Bariadi urban, was 11.9% (Ruhembe *et al.*, 2014).

1.2 Problem Statement

The prevalence of T2DM is increasing rapidly within the country, and the increase is associated with the change of dietary habits and lifestyles from a traditional to a sedentary, western lifestyle which leads to overweight and obesity (Mayige *et al.*, 2012). As a matter of fact, T2DM increases the risk of dying from heart diseases and stroke by 50%. The overall risk of dying among people with diabetes is double to the risk of their peers without diabetes; it is among the leading causes of kidney failure, blindness and emergency limb amputation (Alwan, 2010).

People with diabetes require at least two to three times health-care resources compared to people who do not have diabetes (Zhang *et al.*, 2010). The economic burden is generally higher for people with relatively lower household incomes, who lack health insurance coverage (Seuring *et al.*, 2015).

Despite the increase in prevalence of diabetes mellitus, most studies and interventions to address the disease have been directed to both rural areas and urban areas; but in Tanzania none has focused exclusively on public workers (Peer *et al.*, 2014; Masaki *et al.*, 2015).

1.3 Study Justification

Despite the initiatives which have been taken by the government to address the risk of lifestyle-related non-communicable diseases, the prevalence of T2DM is still high at 9.1% and is estimated that, there are over 80% of undiagnosed people (Mayige *et al*., 2012; WHO, 2012). T2DM occur among people younger than 60 years old which represents the working age population and its burden is high and have negative impact on the health of the workforce, it undermines productivity and adversely affecting national economies as well as compromising social and family welfare (WHO, 2005).

This study was undertaken to determine the prevalence and the associated risk factors of the disease and will provide information required for developing strategies for intervening against T2DM among Local Government Authority workers at Bariadi Town Council, and the country at large.

1.4 Objectives

1.4.1 Overall objective

The overall objective of this study was to determine the prevalence of Type 2 Diabetes Mellitus and associated risk factors among Local Government Authority workers at Bariadi Town Council, Tanzania.

1.4.2 Specific objectives

To realise the main objective, the study's specific objectives were as follows:

i. To determine the prevalence of Type 2 Diabetes Mellitus among Local Government Authority workers at Bariadi Town Council.
ii. To identify the risk factors influencing the prevalence of Type 2 Diabetes Mellitus among Local Government Authority workers at Bariadi Town Council.

1.4.3 Research questions

The current study was guided by the following questions:

i. What is the prevalence of Type 2 Diabetes Mellitus among Local Government Authority workers at Bariadi Town Council?

ii. What are the risk factors associated with the prevalence of Type 2 Diabetes Mellitus among Local Government Authority workers?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

For the person to develop T2DM, the dynamic interaction between insulin action and insulin secretion must be in place. In addition, T2DM is characterised by both defects, insulin resistance and impaired insulin secretion. These two defects disrupt the balance by which insulin-target tissues communicate with the β-cells (Scheen, 2004).

T2DM is preceded by years of impaired glucose tolerance or IGT. The progression from IGT to T2DM occurs when the β-cell becomes unable to maintain its previously high rate of insulin secretion in response to glucose. This gradual change occurs along the natural history of obesity; during the first year of obesity; the subjects are no longer normoglycaemic but hyperglycaemic. But subject become hyperglycaemic at a time when hyperinsulinaemia is not maintained anymore (Pearson *et al*., 2014). Once they have developed, either from insulin deficiency or from insulin resistance, hyperglycaemia accelerates both defects insulin resistance and impaired insulin secretion (Kaku, 2010).

2.1.1 Normal insulin response

Insulin release from the β-cell, occurs in a characteristic biphasic pattern; an acute first phase that last only for a few minutes, followed by a sustainable second phase. The first phase, emerges at a rapid release for the first 10-15 minutes after administration of glucose stimulus. It involves the plasma membrane fusion of a small, rapidly releasable pool of granules; these granules discharge their contents in response to both nutrient and non-nutrient secretagogues (Bilous *et al*., 2014).

The second phase of insulin secretion is invoked exclusively by nutrients; its more gradual and long lasting, usually reaching a plateau 1-2 hour after stimulation in people with normal glucose tolerance. (Bilous *et al*., 2014; Jenssen *et al.*, 2015); as the secretion progresses over time, the second phase insulin release declines; blood glucose levels rise and remain above the normal level (Jenssen *et al*., 2015). Both phases of insulin secretion play an important role in the glucose haemostasis, but the importance of first phase insulin section being relatively greater (Cheng *et al.*, 2013).

In normal subjects, blood glucose concentrations are maintained within relatively narrow limits at around 5 mmol/l (90 mg/dl). This is achieved by a balance between glucose uptake into the peripheral tissues such as muscle and adipose tissue. Insulin is secreted at a low, basal level in the non-fed state, with increased, stimulated levels at the mealtimes. At rest in the fasting state, the brain consumes about 80% of the glucose utilized by the whole body, but brain glucose uptake is not regulated by insulin (Bilous *et al.*, 2014).

Postprandial hyperglycaemia usually develops when the first phase of insulin release decompensates together with insulin resistance. The consequence of this results to elevated endogenous glucose production in the liver and kidneys as well as reduced uptake of glucose in the liver, kidneys, muscle and adipose tissues. Person with T2DM also, exhibits an inappropriate release of glucagon with reduced postprandial glucagon suppression, which leads to higher hepatic glucose release due to increased gluconeogenesis (Jenssen *et al*., 2015).

Early defect in β-cell function and insulin release that occurs with development of IGT or T2DM results in the reduction or even absence of first phase insulin release, allowing hyperglycaemia to develop over the following two hours, with a compensatory increase in

second phase insulin release (Jenssen *et al.*, 2015). People with fasting hyperglycaemia lack first phase insulin secretion and people with impaired glucose tolerance (IGT) have reduced plasma insulin levels after a glucose load (Abdul-Ghani *et al.*, 2008; Cheng *et al.*, 2013).

2.1.2 Impaired insulin secretion

Impaired insulin secretion is a decrease in glucose responsiveness, which is observed before the clinical onset of the disease. It is induced by a decrease in glucose-responsive early-phase insulin secretion, and a decrease in additional insulin secretion after meals causing post-prandial hyperglycaemia (Kaku, 2010). An individual with impaired glucose tolerance (IGT) and markedly high insulin resistance shows an over-responsiveness to oral glucose tolerance test (OGTT) (Kaku, 2010) and Abdul-Ghani *et al.* (2008) affirm that, even when an over-response is seen in persons with obesity or with other factors, they show a decrease in early-phase secretory response, which is an essential part of the disease and an important basic pathological change during the onset of the disease.

The progression of the impairment of pancreatic β-cell function greatly affects the long-term control of blood glucose (Kaku, 2010). According to Scheen (2004) three mechanisms contribute on alteration of insulin secretion: first, a genetic defects which leads to beta-cell ability to respond to raised blood glucose diminished. Second, in-utero malnutrition which leads to insufficient beta-cell development and later partial insulin secretory defect, commonly known as *Thrift Phenotype Hypothesis* and third, unfavourable metabolic environment plays a deleterious role by increasing glucose level that induce glucotoxicity and chronic increase in Non-Esterified Fatty Acids (NEFA) levels that again induces lipotoxicity.

2.1.3 Insulin resistance

Insulin resistance is a condition in which insulin in the body does not exert sufficient action proportional to its blood concentration (Alberti *et al.*, 2007). The impairment of insulin action in major target organs (liver and muscles) demonstrates the common pathophysiological features of T2DM, this implies that, insulin resistance develops and is established prior to disease onset (Scheen, 2004). Early before the onset of diabetes, it is preceded by responsive insulin resistance which stimulates massive insulin secretion by the pancreatic cells, causing a state of high insulin in the blood; as these continuous beta-cells become unable to compensate adequately, and blood glucose rises, producing the condition known as *hyperglycaemia*. When no intervention has been taken, further beta-cells keep failing and the ability to control glucose in the blood deteriorates and treatment becomes a necessity; this progression develops for many years before diagnosis of diabetes (Pearson *et al.*, 2014).

Insulin resistance is related to genetic factors (such as insulin receptor and insulin receptor substrate (IRS)-1, gene polymorphisms), and environmental factors (such as hyperglycaemic, free fatty acids and inflammatory mechanisms) that directly affect insulin signals and promote insulin resistance in obese persons (Makrilakis *et al*., 2003).

2.2 Epidemiology of Type 2 Diabetes Mellitus

Prevalence of diabetes is defined as the number of people with fasting plasma glucose value of greater than or equal to 7.0 mmol/l, or on medication for diabetes/raising blood glucose (WHO, 2016).

The global prevalence of diabetes among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014. The number of people with diabetes has risen from 108 million

in 1980 to 422 million in 2014. Forty percent of the rapid rise of prevalence has been associated with population growth and ageing, 28% from the rise in age-specific prevalence, and 32% from the interaction of the two (WHO, 2016). The prevalence has risen faster in low-and middle-income countries than in high-income countries. The WHO Eastern Mediterranean region has highest rise in diabetes prevalence, and is now the WHO region with highest prevalence of 13.7% (WHO, 2016). Alberti *et al.* (2007) report that, the rapidly increasing prevalence of T2DM is due to the role played by lifestyle factors which provide a potential means for controlling the global epidemic of T2DM.The factors include changes in diet and reduction of physical activities which result in increases in the prevalence of overweight and obesity. The risk factors of T2DM have been classified into two: non-modifiable and modifiable.

The incidence of T2DM increases with age, most cases being diagnosed after the age of 40 years (Neil *et al.,* 1987; as cited by Ozougwu *et al.,* 2013). People aged 40 to 60 years are mostly affected (Shaw *et al.,* 2010; as cited by Ozougwu *et al.,* 2013).

2.2.1 Non-modifiable risk factors

2.2.1.1 Genetic factors

Normally, Type 2 Diabetes Mellitus is associated with genetic predisposition; in the magnitude of the differences between ethnic groups when exposed to similar environment it responds differently in the causation of disease condition (Alberti *et al*., 2007). A study conducted by Steyn *et al.* (2004) shows that, there existed a difference of prevalence rate of T2DM among Asian Indians compared with the indigenous population living in the United Kingdom, Fiji, South Africa and in Caribbean.

Additionally, a study by Sakurai *et al*. (2013) show that, individuals with family history of diabetes had 80% greater risk of incident diabetes than those without a family history of diabetes, and this association was independent of other risk factors, such as obesity, insulin resistance, dietary and lifestyle factors.

2.2.1.2 Age and gender

Alberti *et al.* (2007) report that, the prevalence of T2DM 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. A study conducted in Mwanza city shows that, individuals aged between 41-50 years old were mostly affected and women were more affected than men because of higher body mass index (BMI), fat mass and waist-hip-ratio (Ruhembe *et al.*, 2014).

2.2.1.3 Previous Gestational Diabetes Mellitus

According to the American Diabetes Association (ADA) (2005), gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy, whether or not the condition persisted after pregnancy, and not excluding the possibility that the unrecognised glucose intolerance may have antedated or begun concomitantly with pregnancy.

It is more frequently among women from sub-groups of population who are aged over 35 years, overweight or obese and certain ethnic groups such as Indians and Blacks (Steyn *et al*., 2004). An offspring of diabetic pregnancies are often large and heavy at birth; they tend to develop obesity in childhood and are at high risk of developing T2DM at an early age (Clausen *et al.*, 2008).

2.2.2 Modifiable risk factors

2.2.2.1 Overweight and obesity

In 2014, it was globally estimated that, more than one in three adults aged over 18 years were overweight and more than one in ten were obese. Women were more overweight or obese than men (WHO, 2016). Pearson *et al.* (2014) report that, the risk of T2DM increases tenfold in people with a BMI over 30 kg/m^2. Again, Alberti *et al*. (2007) assert that, interventional measures directed at reducing obesity had positive effects on reducing the incidence of T2DM. Likewise, Hussain *et al*. (2010) report that, visceral obesity plays an important role in developing insulin resistance through inflammatory cytokines produced by the resident fat macrophages; these inflammatory cytokines are involved in the increased cardiovascular risk of the obese patient.

2.2.2.2 Physical inactivity

Alberti *et al.* (2007) observe that, the physical activity level has decreased over recent decades in population, and this has been a major contribution to the current global rise of obesity. Insufficient energy utilisation and obesity due to lack of exercise has been found to be closely linked with induced insulin resistance (Kaku, 2010). A study by Petroski (2009) shows that, physical inactivity during adolescence is a strong predictor of a risk of obesity in adulthood, favouring a vicious circle of obesity and physical inactivity, and that, physical inactivity is associated with the time spent watching television in female adolescents.

Numerous epidemiologic studies show that an increased physical activity reduces a risk of diabetes whereas sedentary behaviours increase the risk. For instance, each two hour/day increment of time spent watching television was associated with a 14% increase in diabetes risk whereas each two hour/day increment of standing or walking around at home

was associated with a 12% reduction in the risk. In addition, Each one hour/day increment of brisk walking was associated with a 34% reduction in the risk of T2DM (Hu *et al.*, 2003). Kagaruki *et al.* (2014) report that, the development of T2DM has significant association with poor participation on vigorous physical activities, obesity and raised blood levels of low density lipoprotein (LDL) as well as inadequate consumption of fruits and vegetables.

2.2.2.3 Nutritional factors

Studies show that, a high total calorie with low dietary fibre intake as well as high glycaemic load and a low polyunsaturated to saturated fat ratio predispose to T2DM (Alberti *et al.,* 2007). Kaku (2010) attributes T2DM 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 and dietary fibre intake. Steyn *et al.* (2004) are of the view that, early inclusive feeding is associated with subsequent development of T2DM in later adult life.

2.2.2.4 Place of up-bringing

A study conducted in Bangladesh showed that, the prevalence of T2DM was higher in urban at 8.1% than in rural areas at 4.0%, and this was associated with cigarette smoking, change of diet composition and exposure to processed food (Saquib *et al.*, 2013). In Tanzania, there was marked difference in prevalence of T2DM among rural and urban dwellers; rural prevalence accounting for less than 2.0% and more than 5.0% to urban respectively (Mayige *et al.*, 2012).

Studies show that, risk of T2DM is higher in certain ethnic groups, independent of metabolic risk factor profile. For instance, Pima Indians have a ten-fold high prevalence of

T2DM than the general US population (Tudies *et al*., 2012) and complex factors in physical and social environment affect health, and these elements collectively known as the social determinants of health (such as income, education, housing and access to nutritious food) act as primary influencers and central to the development and progression of T2DM (Hill *et al*., 2013).

2.3 Prediction and Prevention of Type 2 Diabetes Mellitus

2.3.1 Measurement of Impaired Glucose Tolerance

A person with IGT has the highest risk for progression to T2DM and is the main target for preventive strategies. IGT and impaired fasting glucose (IFG) are defined as an intermediate state between overt diabetes and normal subjects during an OGTT (WHO, 2006). A person has an IGT if the fasting plasma glucose is (<7.0 mmol/l or <126 mg/dl) and 2 hours plasma glucose is ≥7.8 mmol/l and ≤11.1 mmol/l or (140 mg/dl and 200 mg/dl). Likewise, a person has IFG if the fasting plasma glucose is between 6.1mmol/l and 6.9 mmol/l or (110 mg/dl and 126 mg/l) (WHO, 2006).

The ADA (2015) states that, a person is diabetic if the random plasma glucose value is ≥ 11.1mmol/l (≥ 200 mg/dl) or, the fasting plasma glucose value is ≥ 7.0 mmol/l (≥126 mg/dl) or, plasma glucose value 2 hours after 75g oral load of glucose is ≥ 11.1 mmol/l (≥ 200 mg/dl). The International Federation for Diabetes recommends that, if the random blood glucose level is between ≥ 5.6 mmol/l and < 11.1 mmol/l or (≥ 100 mg/dl and < 200 mg/dl) is detected, the fasting plasma glucose should be measured and if the fasting plasma glucose is between 6.1 mmol/l and 6.9 mmol/l (110 mg/dl and 125 mg/dl), OGTT should be performed (IDF, 2012).

The ADA (2015) developed a simple model that can be used to identify a person at high risk of developing T2DM; which include BMI ≥25 kg/m^2, physical inactivity, first-degree relative with diabetes, high risk race/ethnic group such African or Asian, women with history of delivery of big baby weighing over 4.5kg or diagnosed with GDM. Others include fasting plasma glucose and fasting serum lipid profile is superior to the 2-hours plasma glucose value after oral glucose (Abbasi *et al*., 2012).

According to the ADA (2003) screening to detect pre-diabetes and diabetes should be considered in an individual's older than 45 years of age, particularly in those with BMI ≥ 25 kg/m^2; and should be considered to those young than 45 years of age who are overweight plus another risk factor of diabetes should be tested every year. Those with normal results, the test should be repeated every three years.

2.3.2 Haemoglobin A_{IC} (HbA_{IC})

Measurement of haemoglobin A_{1C} to the OGTT offers better prediction capabilities for identifying persons at increased risk for the development of T2DM. HbA_{1c} is an indirect measure of the average blood glucose concentration over the preceding two to three months. Its advantages over the OGTT, includes, its measurement is not influenced by the time of the day, recent activity levels, metabolic stress or food intake; requires minimal patient cooperation before and after the test and, only a small amount of blood sample is needed (IDF, 2012).

Despite potential usefulness of HbA_{1c}, the International Expert Committee does not recommend its use for diagnosing T2DM or for any screening purpose (ADA, 2015), requires a stringent quality assurance tests to be in place and assays standardized to the International reference value (IDF, 2012).

2.3.3 Prevention through lifestyle intervention

With regard to lifestyle intervention, Makrilakis *et al.* (2003) show that, application of lifestyle intervention is an effective strategy to prevent pre-diabetes to T2DM progression. When weight loss and physical activities are performed on a regular basis, there is marked improvement in glycaemic control and several diabetes-related cardiovascular risk factors, including hypertension and hypertriglycaemia.

Studies show that, physical activity or moderate exercises or brisk walking that can last for 30 minutes a day, five day a week are potential measure to lower risk of T2DM by 58% (Nathan *et al*., 2007). Health promotion of eating and exercise habits, intensive lifestyle counselling and attentive range of participation in player as well as initiating early treatment of persons with pre-diabetes and diabetes diagnosed during screening is the primary measure of preventing T2DM (Finnish Diabetes Association, 2003).

CHAPTER THREE

3.0 METHODS AND MATERIALS

3.1 Description of Study Area and Population

This study was conducted at Bariadi Town Council in Simiyu Region, Tanzania. The total population of Bariadi Town was 155 620 (NBS, 2014). Bariadi Town is the Headquarters of Simiyu Region. The Council is about 1 192 km from Dar es Salaam city. The council covers an area of 876.71 km² and is bordered by Bariadi District Council to the north and west and, Itilima District Council to the east and south. It has ten wards; Bariadi, Somanda, Sima, Malambo and Nyangokolwa. Others are Guduwi, Nyakabindi, Bunahmala, Mhango and Isanga. The study population involved all Local Government Authority workers at Bariadi Town Council, and the workers were 1 593 (Bariadi Town Council, 2014).

3.2 Study Design

In this study the cross-sectional study design was used.

3.3 Sample Size Determination

The sample size for the study was estimated using the formula:

$[n=Z^2*P\ (Q)*N/\ e^2\ (N-1) + (Z^2*P\ (Q)]$ Kothari, (2004).

Where:

n= sample size,

Z= Statistics for the level of confidence at 95%, (Z value is 1.96)

P= Previous prevalence of 11.9% assumed prevalence of study conducted at Mwanza City by Ruhembe *et al.* (2014).

Q= (1-P),

e= acceptable error (precision at 5%), and

N= total population size

This resulted in a sample size of 146; the original sample size was multiplied by a design effect (D) of 1.56 which increased the sample size to 229 in order to achieve the sample precision due to variability within and between clusters (Bennett *et al*., 1991).

3.4 Sampling Procedure

Clusters were formed purposively per departments which are Health, Education (primary and secondary), Administration and other departments and sections with few workers who were merged together, and then these clusters were stratified by gender. Then study subjects were sampled from each stratum by applying systematic random sampling technique, and units were selected according to probability proportional to size. The sample from health department was 36 (M=14, F=22), from Primary education 133 subjects (M=57, F=76), from Secondary education 43 subjects (M=26, F=17) from Administration 8 subjects (M=4, F=4), and 9 subjects (M=5, F=4) from the remaining sections.

3.5 Data Collection Method

3.5.1 Structured questionnaire

A structured questionnaire translated to Kiswahili was administered to respondents through face-to-face interview and collected data were entered in the Microsoft Excel (Appendix 3). Data were collected on the demographic variables which includes; sex, age, place of work (Department) and level of education, that is, time in years spent at school or in full-time study.

Variables for lifestyle behaviour were also collected; participant was asked whether smoke or ever smoked any of the tobacco products; had he/she ever consumed or currently consume any of alcoholic drink. Also, participant was asked whether involved on a vigorous-intensive activity that causes large increase in breathing or heart rate such as lifting heavy loads for at least 10 minutes; how many days in a typical week and for how much time; or involved on a moderate-intensive activity that causes small increase in breathing or heart rate such as brisk walking for at least 10 minutes; how many days in a typical week and for how much time.

Furthermore, data were collected on the aspects of usual way of traveling to and from place of work; that is, what means of transport does the participant uses at least 10 minutes continuously to get to and from work, how many days in a typical week and how much time. Also, data were collected on the aspects of sports, fitness and recreational activities; that is, whether the participant involved in any vigorous-intensive sports activities that causes large increase in breathing or heart rate such as running or football for at least 10 minutes continuously; how many days in a typical week and for how much time; or involved on moderate-intensive sports activities that causes small increase in breathing or heart rate such as brisk walking or pedalling for at least 10 minutes continuously; how many days in a typical week and for how much time.

Also, data were collected on aspects of Blood Pressure (BP) variables including, “history of raised Blood Pressure”, that is whether participant had ever checked Blood Pressure by a doctor or any other health worker and told that he/she had raised Blood Pressure and, “person with raised Blood Pressure”, that is whether there was a person (first-degree relative) with hypertension in the family.

Finally, data were collected on aspects of blood sugar variables which includes, “history of raised blood sugar”, that is whether participant had ever checked blood sugar by a doctor or any other health worker and told that he/she had raised blood sugar and, “person with raised blood sugar”, that is whether there was a person (first-degree relative) with diabetes in the family.

3.5.2 Anthropometric measurements

Weight of the participants was measured using a standardised digital weighing scale-SECA, model 8 741 021 659, and weight recorded to the nearest 0.1gram. Height was measured by using a graduated height board, whereby subjects were requested to stand upright without shoes with their back against the wall and heels put together, in a V-shape and looking forward and recorded to the nearest 0.1 cm; then the BMI was calculated using the formula: *weight* (*kg*)*/height* (m^2) (WHO, 2000) and results were ranked into four: 16.0-18.4 kg/m^2 as underweight, 18.5-24.9 kg/m^2 as normal weight, 25.0-29.9 kg/m^2 as overweight, and 30-49.9 kg/m^2 as obese (WHO, 2004).

3.5.3 Measurement of Blood Pressure (BP)

Blood pressure (BP) was measured in all participants; three readings each five minute apart were taken, using a fully Automatic Blood Pressure Monitor for upper arm, made by *Geratherm Medical* AG, Germany. With a subject in sitting up position all readings were taken from the right arm and, recorded in mmHg. A subject’s BP status was determined as follows: Normal BP ranges 90-119 Systolic and 60-79 Diastolic; pre-hypertension 120-139 Systolic and 80-89 Diastolic; Stage 1 hypertension 140-159 Systolic and 90-99 Diastolic; and Stage 2 hypertension 160-179+ Systolic and 100-109+ Diastolic (Sforza, 2003; WHO, 2005a).

3.5.4 Biochemical measurements

Random Blood Glucose (RBG) was measured at the time of the interview by using a standardised *Glucometer* machine (GlucoPlus^{TM} Inc. Quebec, Canada); using capillary finger prick method. Subject with RBG level between ≥ 5.6 and <11.1 mmol/l or (≥ 100 and <200 mg/dl) were scheduled for follow-up measurement of Fasting Blood Glucose (FBG); the subjects were requested to fast for at least 8 hours' prior the measurement on the next day. The FBG was measured after the participant confirmed that they have not taken any food for past 8 hours; and a subject with FBG value between 6.1 and 6.9 mmol/l or (110 and125 mg/dl) or above was registered as having fasting blood glucose (at high risk) of T2DM and a subject with value ≥7.0 mmol/l was registered as having Diabetes Mellitus (WHO, 2006).

3.6 Data Analysis

3.6.1 Prevalence

Data from the completed questionnaires were entered in Excel spreadsheet and data cleaning was done to ensure that data were accurate and consistent. Then data were coded into categories such as (1=Yes; 0=No) responses; then the coded data were transferred into SPSS software and here again data were classified into homogenous groups according to attributes and class-intervals; finally, data were analysed and results expressed into percentages, proportions and presented in tables.

The prevalence of T2DM was calculated by dividing the number of participants with diabetes at the time of data collection over the number of all participants in the study and multiplied by 100 (WHO, 2006). The prevalence for category specific for T2DM was also calculated by dividing the number of positive in a category over the number of at risk in the category and multiplied by 100. 95% Confidence Interval were calculated by using *Binomial exact calculator*.

Proportion of positive results = P=X/N

Where: X= number in the sample with result or findings in question

N= Sample size or number of at risk in the category and

CI= Confidence Interval (Pezzelo, 2009).

3.6.2 Risk factor analysis by bivariate analysis for T2DM

Associations between individual potential risk factors and the outcome were subjected to bivariate analysis using Epi Info software version 7 (CDC, 2008). Prevalence ratio was used as a measure of the strength of association and statistical association between categorical variables was analysed using Chi-square test with statistical significance set at $P< 0.05$.

3.6.3 Risk factor analysis by Multivariate Logistic Regression

The factors found to be associated with T2DM in the analysis of individual factors (bivariate analysis) and those that have been shown to be risk factors in other studies were subjected to a logistic regression analysis to identify risk factors of T2DM in this study. Response variables (Diabetic 1=Yes, 0=No) were assessed against predictor variables which were sex, age, years of education, history of raised BP, ever checked BP, person with raised BP, mean systolic blood pressure (SBP), mean diastolic blood pressure (DBP), ever checked blood sugar, history of raised blood sugar and person with raised blood sugar, Others predictor variables were BMI and time spent sitting. The strength of associations was assessed by Odds Ratios (OR) and their 95% Confidence Intervals (CI).

All diabetic risk factors and other potential risk factors were entered in the Statistical Package for Social Sciences (SPSS) Software (IBM, 2012) where the logistic regression model by backward step-wise method was run in which case, all independent variables

were entered in the model at once. The probability of likelihood-ratio statistic of 0.1 was set as a removal criterion. The variables with the highest probability were sequentially removed from the model at each step. An option for interactions for all variables was applied. Classification cut-off was set at 0.5 and a maximum of 20 iterations was allowed. Goodness-of-fit of the model was tested by Hosmer-Lemeshow test at 5% significance level.

3.7 Ethics Procedures

Ethical clearance certificate (No. NIMR/HQ/R.8a/Vol. IX/2084) was obtained from the Medical Research Coordinating Committee of the National Institute for Medical Research (NIMR). Permission to conduct the research was obtained from Bariadi Town Council authorities. Before each subject was enrolled informed consent was signed, and confidentiality protocols were observed.

CHAPTER FOUR

4.0 RESULTS

4.1 Socio-demographic Characteristics of Participants

A total of 229 participants were sampled from five formed groups, namely; Primary education 133 (58.1%), Secondary education 43 (18.8%), health 36 (15.7%) and, Administration and others 17 (7.4%) (Table 1). Among these 123 (53.7%) were female and 106 (46.3%) were male. The age was grouped into four groups; years between 21-30 were 48 (21.0%), years between 31-40 were 74 (32.3%), years between 41-50 were 60 (26.2%) and years between 51-60 were 47 (20.5%). Majority of the participants 109 (47.6%) had college education, 98 (42.8%) were first degree graduates and 17 (7.4%) had postgraduate education; while 5 (2.2%) had primary education only.

The participants were interviewed on various health behaviours, which included tobacco use, alcohol consumption, physical activities and leisure. Majority of the respondents 226 (98.7%) had not used any tobacco product, whereas 3 (1.3%) had used and were still using tobacco products. Regarding alcohol consumption; 78 (34.1%) of the respondents had taken alcohol before the interview, among these 71 (91%) were currently taking alcohol and 151 (65.9%) had never taken alcohol. Among the participants 12 (5.2%) had vigorous activities as well as vigorous exercise and more than 60% had moderate activities and moderate exercises. About 173 (75.5%) agreed to have walked or pedalled for at least 10 minutes continuously to and from work on each working day whereas 56 (24.5%) used other means of transport to and from work. It was found that, 145 (63.3%) of the respondents spent around 0 to 1.30 hours sitting, 56 (24.5%) spent 1.30 to 3.00 hours sitting, 19 (8.3%) spent 3.00 to 4.30 hours sitting; while 9 (3.9%) spent 4.30 to 6.00 hours sitting.

Participants were interviewed on aspects related to their Blood Pressure (BP); 160 (69.9%) had checked their BP prior to the interview, 94 (41%) had person (first-degree relative) with raised BP; 50 (21.8%) had history of being told by a doctor or health worker to have raised BP in the past 12 months. For each participant, BP was also measured; for Systolic BP 99 (43.2%) had raised SBP, 65 (28.4%) had normal SBP, 45 (19.7%) had moderately raised SBP and 20 (8.7%) had severely raised SBP. On Diastolic BP; 180 (79.0%) had normal DBP, 28 (12.2%) had raised DBP, 15 (6.6%) had moderately raised DBP and 5 (2.2%) had severe raised DBP and only 7 (3.1%) had previous treatment of raised BP.

Blood sugar; 92 (40.2%) have had their blood sugar checked previously, 65 (28.4%) had person (first-degree relative) with raised blood sugar, 18 (7.9%) had history of being told to have raised blood sugar; but only 3 (1.3%) were on insulin or oral anti-hyperglycaemic agent. Random Blood Glucose; 158 (69.0%) had taken food 8 hours past and 71 (31.0%) denied taking any food. Among these 100 (43.7%) were found to have blood glucose value $\geq$ 5.6 mmol/l. and 129 (56.3%) had normal RBG. Among 100 participants who had Fast Capillary blood glucose (FBG) 18 (7.9%) had FBG value $\geq$ 7.0 mmol/l.

Participants were also screened for fat deposition by measuring weight in kg and height in meters and expressed as Body Mass Index (BMI kg/m^2); among these 80 (34.9%) were in normal range, 79 (34.5%) were overweight, 66 (28.8%) were obese, and 4 (1.8%) underweight.

Table 1: Socio-demographic Characteristics of the study Participants

Variables	Category	Frequency	Percent
Department	Health	36	15.7
	Sec. Edu	43	18.8
	Prim. Edu	133	58.1
	Admin_others	17	7.4
Sex	Male	106	46.3
	Female	123	53.7
Age group	21-30	48	21.0
	31-40	74	32.3
	41-50	60	26.2
	51-60	47	20.5
Years of Education	1-7	5	2.2
	8-13	109	47.6
	14-17	98	42.8
	18-24	17	7.4
Ever Smoked	Yes	3	1.3
	No	226	98.7
Current Smoker	Yes	3	1.3
	No	226	98.7
Ever Drink Alcohol	Yes	78	34.1
	No	151	65.9
Currently Drink Alcohol	Yes	71	31.0
	No	158	69.0
Vigorous Activities	Yes	12	5.2
	No	217	94.8
Moderate Activities	Yes	141	61.6
	No	88	38.4
Walking or Pedalling	Yes	173	75.5
	No	56	24.5
Vigorous Exercise	Yes	13	5.7
	No	216	94.3
Moderate Exercise	Yes	65	28.4
	No	164	71.6
Time Spent Sitting (minute)	0-90	145	63.3
	91-180	56	24.5
	181-270	19	8.3
	271-360	9	3.9
History_raised BP*	Yes	50	21.8
	No	179	78.2
Person_raised BP family**	Yes	94	41.0
	No	135	59.0
Mean SBP	90-119	65	28.4
	120-139	99	43.2
	140-159	45	19.7
	160-179+	20	8.7
Mean DBP	60-79	181	79.0
	80-89	28	12.2
	90-99	15	6.6
	100-109+	5	2.2
History_raised Blood Sugar*	Yes	18	7.9
	No	211	92.1
Person_raise blood sugar in family**	Yes	65	28.4
	No	164	71.6
Body Mass Index (BMI Kg/m^2)	16-18.4	4	1.8
	18.5-24.9	80	34.9
	25.0-29.9	79	34.5
	30.0-40.9+	66	28.8

Key:
*Participant with previous history of raised Blood Pressure or Blood Sugar
** Person in the family (first-degree relative) with history of raised Blood Pressure or Blood sugar
BMI: Body Mass Index
DBP: Diastolic Blood Pressure
SBP: Systolic Blood Pressure
BP: Blood Pressure

4.2 Prevalence of Type 2 Diabetes Mellitus

Overall prevalence of T2DM was found to be 7.9%. (95% CI=4.7-12.2) as shown in (Table 2). The prevalence of T2DM was 9.8% for females and 5.7% for males. The age group between 51-60 years had the highest prevalence of T2DM 17.0%, followed by 41-50 years 8.3%. Also, prevalence was found to be highest in participants working in primary education at 9.0% and lowest in participants working in the administration and other sections at 5.9%. Furthermore, participants with BMI between 30.0-49.9 kg/m^2 were found to be mostly affected at 21.7% and those with BMI between 25.0-29.9 kg/m^2 and 18.5-24.9 kg/m^2 were least effect at 5.0%.

Table 2: Prevalence of T2DM among different categories of Participants

Variables	Category	n*	n+ve**	Prevalence (%)	95% CI
Department	Health	36	2	5.6	0.7-18.7
	Sec. Education	43	3	6.9	1.5-19.1
	Pri. Education	133	12	9.0	4.7-15.2
	Admin_others	17	1	5.9	0.1-28.7
Sex	Male	106	6	5.7	2.1-11.9
	Female	123	12	9.8	5.1-16.4
Age group	21-30	48	3	6.3	1.3-17.2
	31-40	74	2	2.7	0.3-9.4
	41-50	60	5	8.3	2.8-18.4
	51-60	47	8	17.0	7.6-30.8
BMI kg/m^2	16-18.4	4	0	0.0	0.0-60.2
	18.5-24.9	80	4	5.0	1.4-12.3
	25.0-29.9	79	4	5.06	1.4-12.5
	30.0-49.9	66	10	21.7	10.7-36.4
Diabetic	All	229	18	7.9	4.7-12.1

Key:
N*=Number of participants in each category T2DM: Type 2 Diabetes Mellitus
N**=Number of positives in each category
Blood glucose values: CFPG ≥ 7.0 mmol/L
CFPG: Capillary Fasting Plasma Glucose
BMI: Body Mass Index
CI: Confidence Interval

4.3 Bivariate Association of Type 2 Diabetes Mellitus to Different Variables

The factors significantly associated with T2DM among workers at Bariadi Town Council are given in Table 3. Participants with mean SBP between 160-179 mmHg had 5.4 times the prevalence of those with normal SBP (PR=5.42, CI: 1.42-20.70) and those with mean DPB between 90-99 mmHg had 4 times the prevalence of those with normal DBP (PR=4.00, CI:1.47-10.89), all association were statistically significant.

In addition, participants who had checked blood sugar had 2.9 times the prevalence of those who had not checked their blood sugar (PR=2.98, CI: 1.16-7.65) and, participants with history of raised blood sugar had 9.3 times the prevalence of those without the history of raised blood sugar (PR=9.38, CI: 4.23-20.78), while participants with a person in the family with history of raised blood sugar had 3 times the prevalence of those without such a history in the family (PR=3.15, CI: 1.30-7.64), all association were statistically significant. Furthermore, participants with BMI ranging 30.0-49.9 kg/m^2 had 3 times the prevalence of those ranging with BMI between 18.5-24.9 kg/m^2 (PR=3.03, CI: 1.00-9.22), the results were statistically significant.

However, the following risk factors were not statistically associated with the T2DM: sex, age, mean SBP between 140-159 mmHg and 120-139 mmHg, mean DBP between 80-89 mmHg as well as BMI ranging 25.0 -29.9 kg/m^2.

Table 3: Prevalence ratio of T2DM for different Risk Factors

Variable (s)	Category	n*	n(+ve) **	Prevalence Ratio (PR) [95% CI]	P-value
Sex	Male	106	6	1	
	Female	123	12	1.72 [0.67-4.43]	0.132
Age group	21-30	48	3	1	
	31-40	74	2	0.43 [0.08-2.49]	0.190
	41-50	60	5	1.37 [0.34-5.30]	0.355
	51-60	47	8	2.72 [0.80-9.70]	0.057
Treated BP within	Yes	7	2	1	
2 weeks	No	122	16	0.46 [0.13-1.61]	0.154
Mean SBP	90-119	65	3	1	
	120-139	99	7	1.53 [0.41-5.571]	0.276
	140-159	45	3	1.44 [0.30-6.84]	0.330
	160-179+	20	5	5.42 [1.42-20.70]	0.009*
Mean DBP	60-79	180	12	1	
	80-89	28	2	1.07 [0.25-4.54]	0.437
	90-99	15	4	4.00 [1.47-10.90]	0.014*
	100-109+	5	0		
Checked blood	Yes	92	12	2.98 [1.16-7.65]	0.011*
sugar	No	137	6	1	
History raised	Yes	18	8	9.38 [4.23-20.78]	0.000*
blood sugar**	No	211	10	1	
Person_raised	Yes	65	10	3.15 [1.30-7.64]	0.007*
blood sugar ***	No	164	8	1	
BMI (kg/m^2)	16-18.4	4	0		
	18.5-24.9	80	4	1	
	25.0-29.9	79	4	1.01 [0.26-3.91]	0.493
	30.0-49.9	66	10	3.03 [1.00-9.22]	0.023*

Key:
n*=Number of participants in each category
n**=Number of positives in each category
*=Statistically significant results ($p<0.05$)
**=Participant with previous history of raise blood sugar
***=Person in the family (First-degree relative) with history of raised blood sugar
BP: Blood Pressure
BMI: Body Mass Index
DBP: Diastolic Blood Pressure
SBP: Systolic Blood Pressure
CI: Confidence Interval
T2DM: Type 2 Diabetes Mellitus
PR: Prevalence Ratio

4.4 Risk Factor Analysis by Multivariate Logistic Regression for T2DM

From the logistic regression procedure, five variables formed the final model. These are sex, age, years of education, time spent sitting and history of raised blood sugar (Table 4). The odds of developing T2DM were 4 times higher for female subjects compared to male subjects; (OR=4.6, CI: 1.069-19.325); the difference was statistically significant. The odds of developing T2DM were 8 times higher for subjects aged between 30-41 years and the odds of developing of T2DM were 15 times higher for subject aged 41-50 years compared to subject aged 21-30 years; (OR=8.080, CI:1.215-53.741; OR=15.080, CI: 2.315-98.342); these results were all statistically significant

Subjects with no history of raised blood sugar had reduced odds for developing T2DM compared to those with the history of raised blood sugar. (OR=0.032, CI: 0.006-0.167). The results were statistically significant given that the 95% CI did not bracket the null value. The odds of developing T2DM were 3 times higher for subjects aged between 51-60 years compared to subjects aged 21-30 years; (OR=3.673, CI: 0.805-16.548) However, these results were not statistically significant

Years of education and time spent sitting were not statistically associated with the development of T2DM in this study. There were no significant interactions from the regression procedure (Table 4). The multivariate regression model fitted the variables well as shown by Hosmer-Lemeshow test (x^2=1.881, df = 8 and p-value of 0.984).

Table 4: Logistic regression model results for T2DM

Variables	Category	N*	N (+ve%)**	Odds Ratio	95% CI	
Sex	M	106	6 (5.7)			
	F	123	12 (8.9)	4.545	1.069	19.325
Age group	21-30	48	3 (6.25)			
	31-40	74	2 (2.7)	8.080	1.215	53.741
	41-50	60	5 (8.3)	15.080	2.315	98.342
	51-60	47	8 (17.0)	3.673	0.805	16.548*
Years of	1-7	5	0 (0.0)			
Education	8-13	109	6 (5.5)	724374200	0.000	-
	14-17	98	11(12.2)	0.345	0.019	6.406*
	18-24	17	1 (6.9)	0.103	0.006	1.829*
Time Sitting	0-90	145	14 (9.6)			
	91-180	56	3 (5.3)	0.000	0.000	-
	181-270	19	1 (5.3)	0.000	0.000	-
	271-360	9	0 (0.0)	0.000	0.000	-
History raised	YES	18	18 (100)			
blood sugar**	NO	211	10 (4.7)	0.032	0.006	0.167

Key:
N*=Number of participants in each Category
N**=Number and percentage positives in each Category
*=Not statistically significant
**=Participant with previous history of raised blood sugar
CI: Confidence Interval
T2DM: Type 2 Diabetes Mellitus
+ve: Positive

CHAPTER FIVE

5.0 DISCUSION

An overall prevalence of T2DM in this study was found to be 7.9%, lower than the national prevalence of 9.1% as reported in Tanzania STEPS Survey 2012 (WHO, 2012). A recent study by Ruhembe *et al*. (2014) conducted in Mwanza urban reported higher prevalence of 11.9% and observed that, public education on diet-related diseases should be emphasised and routine check-up of blood glucose levels be undertaken among adults. A study conducted by Prem-Kumar *et al*. (2014) on the prevalence of T2DM and its associated factors among public university staff in Selangor, Malaysia revealed a bit higher prevalence of 12.8%. This was associated with age, gender, physical inactivity, smoking status, alcohol consumption, obesity, history of hypertension and hyperlipidaemia.

Much higher prevalence was reported in a study conducted in South Africa among the mixed ancestry population of the Western Cape where the prevalence of T2DM was as higher as 28.2% (Erasmus *et al.*, 2012). This was thought to be attributed by high socio-economic status, differences in obesity and geographical location of the population.

In our study, prevalence was found to be higher among workers in primary schools than those workers in other departments. This could be attributed to the level of education and working environment. Most of them had secondary education and acquired certificate of teaching; they fall short of basic health principles for disease prevention. Furthermore, their earnings may not enable them to pay for regular medical check-up and treatments, so they solely depend on the government health facilities which accept National Health Insurance Fund (NHIF), which does not include check-up services. A recent study by

Sacerdote *et al.* (2012) showed that, lower education level is associated with the high prevalence of T2DM in men and women in western European countries; even though it does not have a direct biological effect on disease, its effects are mediated by other risk factors that are biologically related to disease such as smoking, high BMI and physical inactivity. Similar results by Ross *et al.* (2010) reveal that there is association between educational level and T2DM incidence, which was more evident to female with low education than male counterpart.

Conclusively, studies have shown that the existence of socio-economic inequalities have a role in the epidemiology of T2DM. A person living in residential areas with no access to necessary needs, having lower education, lower income and employment grades has an increased prevalence of T2DM and other chronic illnesses (Connolly *et al.*, 2000; Espelt *et al*., 2008).

Regarding risk factors, the study found out that, age had significant association with the development of T2DM. This could be explained that, as an individual advance in age tends to change lifestyle behaviour, including physical activity, eating habits as well as physiological changes, such as increased tendency of fat deposition and weight gain. A recent study affirms that, there is a strong association between the development of T2DM and age; this was found to be influenced by reduced lean mass, physical inactivity and impairment in carbohydrate intolerance (Basu *et al.,* 2003; Gambert *et al.,* 2006). Ruhembe *et al.* (2014) also observe that, diabetes tends to increase with age between 41-60 years and decrease at the age of over 60 years for both men and women; and advanced age poses a triple risk of developing T2DM as compared to young age and that, worsening glycaemic status was associated with increasing age, smoking and eating behaviour.

Moreover, a recent study conducted by Peer *et al.* (2014) show that, in Africa the prevalence of T2DM was rising rapidly; the majority with diabetes being below the of 60 years old, the highest proportion 43.2% in the age of 40-59 years, and the situation could be attributed to economic development in Africa and increased in life-expectancy. Global data show that, the largest proportion of people with T2DM are between 40-59 years (Whiting *et al.*, 2011); for developed countries the majority are aged over 60 years, whereas for developing countries most people are of working age, between 40 to 60 years (Shaw *et al.*, 2010).

The results in this study also revealed that women had significant higher risk of developing T2DM than men. This could be explained by the lifestyle of women workers in urban setting; most of them do not take enough time walking or pedalling, instead they use vehicles and motorcycle going and coming back from work. They also, do not attend to household chores regularly instead housemaids undertake most of the work at home while they remain sitting watching movies and television. The World Health Organization (2016) reports that, across the world women are less active than men, with 27% of women and 20% of men classified as insufficiently physically active; adding that, physical inactivity is alarmingly common among adolescent girls by 84% and 78% of boys not meeting minimum requirements for physical activity.

Contrary to our findings, other studies show that, men had a greater risk for developing T2DM than women (Perreault *et al*., 2008). This could be due to the effects of testosterone and oestradiol hormones on storage of fat around the abdominal tissues and of insulin resistance on men (Leslie *et al*., 2005; Nordström *et al.*, 2016).

The current study revealed that previous history of raised blood sugar had significant association with developing T2DM. This could be explained that, most of the respondents had been told to have raised blood sugar by health service providers but did not seek medical care. A study conducted in Uganda highlights that, the previous history of raised blood sugar had strong association with glucose intolerance and consequently the development of overt T2DM (Mutebi *et al.*, 2012). Likewise, Safari *et al.* (2014) report that, an individual with previous history of raised blood sugar is more likely to develop T2DM at later life. Nathan *et al.* (2007) show that, transition from the early metabolic abnormalities that precede diabetes, impaired fasting glucose (IFG) and impaired glucose tolerance (IGT), to diabetes takes many years; however, 60% of these individuals with pre-diabetic status eventually develop diabetes. Also, studies provides evidence that, changes in lifestyles of both men and women at risk for the T2DM can prevent the disease by 58% (Tuomilehto *et al.*, 2001).

In this study, it was found out that, years spent in education had no significant statistical association with the development of T2DM, despite the attributes played by stressful experiences or events during studies and after school, such as missing meal, financial constraints and loads of study materials and examinations. Similar findings by Laramee *et al.* (2007) and Mohan *et al.* (2007) show that, an individual who have no access to some studies have higher prevalence of T2DM in developing societies. Furthermore, recent studies provide evidence that lower educational level is associated with a higher risk of T2DM in men and women in Western European countries (Sacerdote *et al.*, 2012). Similar contention show that, education level is a poor surrogate for general literacy skills and for health literacy; education level only measures the number of years an individual attended school, not how much the individual learned in school (Weiss, 2007).

However; contrary to findings of this study, several studies attribute the development of T2DM to person who had many years in school with dietary habits and breakfast eating behaviour. Breakfast skipping has been reported to be a potential cause of T2DM, due to having higher after-lunch postprandial glucose and insulin level, which eventually leads to impaired postprandial insulin sensitivity (Farshchi *et al*., 2005; Uemura *et al*., 2015).

Our study found out that, longer time spent sitting or reclining have no association with the development of T2DM, despite that workers in urban settings performs most of their duty while sitting and hardly moved; after work hours went back home driving and again sat down watching movies and television for quite long period, which could lead to energy intake and energy expenditure imbalance resulting to overweight and obesity and eventually to relative insulin resistance and T2DM.

However; contrary to findings of this study, several studies conducted shows that, physical inactivity has significant association with the development of T2DM (Mutebi *et al*., 2012). Fritschi *et al.* (2016) suggest that the total amount of time spent sedentarily is associated with higher blood glucose levels, even when adjusted for time spent in light physical activity, gender, and BMI. Wilmot *et al.* (2012) affirmed that, sedentary time is associated with an increased risk of diabetes, cardiovascular disease and all-cause mortality; the strength of the association is most consistent for diabetes. Also, the United Kingdom government stresses that, all adults should minimise the amount of time spent sitting sedentarily for extended periods and should be active for at least 150 minutes of moderate intensity activity per week (British Heart Foundation National Centre, 2012).

Limitation of this study should be considered that, the cross-sectional design of this study prohibited the study from concluding causal relationships between identified risk factors

and the development of T2DM. The study did not include waist-hip-ratio in the investigation of body fat composition as this may have caused some respondents to go unidentified. This study covered one council (Bariadi Town Council); this could result to involving participants having similar ways of living, behaviour and genealogy that could lead to obtain similar results. Also, the study did not investigate the relationships between genetics and T2DM, which could establish the relationships between first-degree relatives with diabetes mellitus and the development of T2DM.

Moreover, study enrolled small number of respondents who participated in the study, this could contribute to failure to exclude confounding factors during data analysis and reporting. Also, the study did not administer oral glucose tolerance test (OGTT) to participants who had FBG values between 6.1mmol/l and 6.9 mmol/l to determine their glucose tolerance status.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

An overall prevalence of T2DM in this study was found to be 7.9% and female subjects showed higher prevalence than the male counterparts. Also, workers from primary school education section exhibited higher prevalence than those from secondary school section and other departments. The factors which were found to be associated with T2DM included sex, age and history of raised blood sugar.

6.2 Recommendations

It is recommended that workers should develop a health seeking behaviour of checking their health status at least once a year and keep records. It is also recommended that, the Local Government Authority through their council health facilities should plan for a sustainable intervention programme that will undertake screening for workers at their place of work instead of waiting for them to fall sick and go to seek for secondary and tertiary services.

It is recommended further that, the government in collaboration with development Partners should plan and carry out a wider study that will cover the entire region or at least all urban centres in the region and beyond and that will involve a larger number of participants and include variables like waist-hip-ratio and genetics.

Finally, there is a need to design a promotional educational programme on the epidemiology of type 2 diabetes mellitus that will be delivered through different means of communication to reach the workers so that they can develop a positive attitude and practice on good eating behaviour and lifestyle.

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APPENDICES

Appendix 1: Questionnaire (English Version)

PART A: INTRODUCTION

SURVEY INFORMATION			
Location and Date		**Response**	**Code**
1	Department ID	……	I1
2	Cluster/Centre/Village name		I2
3	Interviewer ID		I3
4	Date of completion of the instrument	dd…… mm……. year……	I4

"My name is **Chacha Magige Nyabisaga**, Master of Science student at **Sokoine University of Agriculture (SUA)** Morogoro, Tanzania. I am conducting field survey on Prevalence of Type 2 Diabetes Mellitus and Associated Risk Factors among Local Government workers.
The objective of this study is to determine the prevalence of Type 2 diabetes mellitus and its Associated Risk Factors among Local Government workers. The findings from this study will establish the magnitude of Type 2 diabetes mellitus among LGA workers; also, will be used to inform the Government and Local Government Authorities on strategies and interventional measures against the rapid increase of the disease.
All information that will be collected is going to be kept completely confidential. I would like to ask you few questions about this topic and obtain little amount of blood sample for checking the level of blood sugar.

PART B: INFORMED CONSENT

Participant ID └┴┴┘ └┴┴┘ └┴┴┘

Consent, Interview Language and Name R		**Response**	**Code**
5	Consent has been read and obtained	Yes 1 No 2 **If** No, End	**15**
6	Interview Language *[Insert Language]*	English 1 *Kiswahili* 2	**16**
7	Time of interview (24hour clock)	Date: ……/……../……	**17a**
		Hrs. …… mins……	**17b**
8	Family Surname (**Write Initials**)		**18**
9	First Name (**Write Initials**)		**19**
Additional Information that may be helpful			
10	Contact phone number where possible		**110a**
	Signature of respondent		**110b**

PART C: QUESTIONNAIRE

STEP 1: DEMOGRAPHIC INFORMATION			
Question		**Response**	**Code**
11	Sex (*Male / Female as observed)*	Male 1 Female 2	**C1**
12	What is your date of birth? *Don't Know 77*	*If unknown, Go to **C4*** dd ……mm…… year……	**C 2**
13	How old are you?	Years …….	**C3**
14	In total, how many years have you spent at school or in full-time study (excluding pre-school)?	Years…….	**C4**

STEP 1: BEHAVIOURAL MEASUREMENTS
CORE: Tobacco Use
Now I am going to ask you some questions about various health behaviours. This includes things like smoking, drinking alcohol, eating fruits and vegetables and physical activity. Let's start with tobacco.

Question		Response	Code
22	Do you currently smoke any **tobacco products**, such as cigarettes, cigar/ pipes?	Yes 1 No 2 *If No, go to* **A1a**	**T1**
23	Do you currently smoke tobacco products **daily**?	Yes 1 No 2 *If No, go to* **A1a**	**T2**
24	How old were you when you **first started** smoking daily?	Age (years)**……** *If unknown, go to **T5a*** Don't know 77	**T3**
25	Do you remember how long ago it was? *(RECORD ONLY 1, NOT ALL 3)* *Don't know 77*	In Years …… *If Known, go to **T5a***	**T4a**
		OR in Months …… If Known, go to **T5a**	**T4b**
		OR in Weeks ……	**T4c**
26	On average, how many of the following do you smoke each day (RECORD FOR EACH TYPE) Don't Know 77	Manufactured cigarettes ……	**T5a**
		Hand-rolled cigarettes ……	**T5b**
		Pipes full of tobacco ……	**T5c**
		Cigars, chew roots ……..	**T5d**
		Other If Other, go to **T5** other, [. …….] else **go to A1a**	**T5e**
		Other (please specify): …… *Or **Go to** **A1a***	**T5 others**

CORE: Alcohol Consumption			
The next questions ask about the consumption of alcohol.			
Question		**Response**	**Code**
36	Have you **ever** consumed an alcoholic drink such as beer, wine, spirits or fermented cider	Yes 1 No 2 *If No, go to **P1***	A1a
37	Have you consumed an alcoholic drink within the **past 12 months**?	Yes 1 No 2 *If No, go to **P1***	A1b
38	During the past 12 months, **how frequently** have you had at least one alcoholic drink? (**READ RESPONSES**)	Daily 1 5-6 days per week 2 1-4 days per week 3 1-3 days per month 4 < than once in month 5	A2
39	Have you consumed an alcoholic drink within the **past 30 days**?	Yes 1 No 2 *If No, go to **P1***	A3
40	During past 30 days, on how many **occasions** did you have at least one alcoholic drink?	Number…… Don't know 77	A4
41	During past 30 days, when you drank alcohol, **on average**, how many **standard alcoholic drinks** did you have during one occasion?	Number…… Don't know 77	A5
42	During the past 30 days, what was the **largest number** of standard alcoholic drinks you had on a single occasion, counting all types of alcoholic drinks together?	Largest number……... Don't Know 77	A6
43	During the past 30 days, how many times did you have for **men**: (**five or more)** for **women**: (**four or more)** standard alcoholic drinks in a single drinking occasion?	Number of times……. Don't Know 77	A7

CORE: Physical Activity
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time you spend doing work. Think of work as the things that you should do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food,

seeking employment.
[In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate]

Question		Response	Code
Work			
52	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like *[carrying or lifting heavy loads, digging or construction work]* for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to **P 4***	P1
53	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days […….]	P2
54	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours: minutes hrs.....mins……..	P3 (a-b)
55	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking *[or carrying light loads]* for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to **P 7***	P4
56	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days [……]	P5
57	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours: minutes: Hrs.……mins……..	P9 (a-b)

Travel to and from places			
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example, to work, for shopping, to market, to place of worship.			
58	Do you walk or use a bicycle *(pedal cycle)* for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 *If No, go to **P10***	P7
59	In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days [……]	P8
60	How much time do you spend walking or bicycling for travel on a typical day?	Hours: minutes Hrs……. mins……..	P9 (a-b)

CORE: Physical Activity, Continued			
Question		**Response**	**Code**
Recreational activities			
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (leisure).			
61	Do you do any vigorous-intensity sports, fitness or recreational *(leisure)* activities that cause large increases in breathing or heart rate like *[running or football]* for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to **P 13***	P10
62	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational *(leisure)* activities?	Number of days [..……...]	P11
63	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours: minutes Hrs.……. mins…….	P12 (a-b)
64	Do you do any moderate-intensity sports, fitness or recreational *(leisure)* activities that cause a small increase in breathing or heart rate such as brisk walking, *[cycling, swimming, and volleyball]* for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to **P16***	P13
65	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational *(leisure)* activities?	Number of days [……..…]	P14
66	How much time do you spend doing moderate-intensity sports, fitness or recreational *(leisure)* activities on a typical day?	Hours: minutes Hrs.……. mins……..	P15 (a-b)
67	How much time do you usually spend sitting or reclining	Hours: minutes	P16

	on a typical day?	Hrs…….....mins……	(a-b)
CORE: History of Raised Blood Pressure			
Question		**Response**	**Code**
68	Have you ever had your blood pressure measured by a doctor or another health worker?	Yes 1 No 2 *If No, go to **H6***	H1
69	Have you ever been told by a doctor or other health worker that you have raised blood pressure or hypertension?	Yes 1 No 2 *If No, go to **H6***	H2a
70	Have you been told in the past 12 months?	Yes 1 No 2	H2b
71	Are there a person (s) with Hypertension in the Family?	Yes 1 No 2 If yes, who……..	H2c

CORE: History of Diabetes			
	Question	**Response**	**Code**
74	Have you ever had your blood sugar measured by a doctor or another health worker?	Yes 1 No 2 *If No, go to **M1***	H6
75	Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?	Yes 1 No 2 *If No, go to **M1***	H7a
76	Have you been told in the **past 12** months?	Yes 1 No 2	H7b
77	Are there a person with diabetes mellitus in the Family?	Yes 1 No 2 If yes, Who……	H7c
78	**For female:** does it associated with Pregnancy?	Yes 1 No 2	H7d

STEP 2: PHYSICAL MEASUREMENTS			
CORE: Height and Weight			
Question		**Response**	**Code**
80	Interviewer ID	…….	M1
81	Device IDs for height and weight	Height …… Weight …….	M2a M2b
82	Height	In Centimetres (cm)……	M3
83	Weight *If too large for scale 666.6*	In Kilograms (kg)……	M4
84	**For women:** Are you pregnant?	Yes 1 If *Yes, go to **M 8*** No 2	M5
CORE: Blood Pressure			
87	Interviewer ID	…….	M8
88	Device ID for blood pressure		M9
89	Cuff size used	Small 1 Medium 2 Large 3	M10
90	Reading 1	Systolic (mmHg)	M11a
		Diastolic (mmHg)	M11b
91	Reading 2	Systolic (mmHg)	M12a
		Diastolic (mmHg)	M12b
92	Reading 3	Systolic (mmHg)	M13a
		Diastolic (mmHg)	M13b
93	During the **past 2** weeks, have you been treated for raised BP with drugs prescribed by a doctor or another H/W?	Yes 1 No 2	M14

STEP 3: BIOCHEMICAL MEASUREMENT			
CORE: Blood Glucose			
Question		**Response**	**Code**
94	During the **past 8** hours, have you had anything to eat or drink, other than water	Yes 1 No 2	B1
95	Technician ID	**……**	B2
96	Device ID	**……**	B3
97	Time of day blood specimen taken (24-hour clock)	Hours: minutes hrs. ……mins……	B4
98	Random blood glucose Choose accordingly mmol/l or mg/dl	mmol/l……	B5a
		mg/dl ……	

99	Fasting blood glucose Choose accordingly: mmol/l or mg/dl **[If RBG is ≥ 5.6- ≤ 11.1 mmol/l or ≥ 100 - ≤200 mg/dl] ***	Date of confirmation DD…….MM……. YY……	B5b
		mmol/l……...	B5c
		mg/dl……	
100	Today, have you taken insulin or other drugs medication) that have been prescribed by a doctor or another H/W	Yes 1 No 2	B6
END			

Appendix 2: Hojaji (Questionnaire in Kiswahili Version)

SEHEMU A: UTANGULIZI

Eneo na Tarehe		**Itikio**	**Alama**
1	Utambulisho wa Idara	……	I1
2	Jina la kundi/kijiji/kituo		I2
3	Utambulisho wa Msailiwa		I3
4	Tarehe ya kukamilisha	siku mwezi mwaka ……/……/……	I4

"Naitwa **Chacha Magige Nyabisaga**, mwanafunzi wa Shahada ya Uzamili katika Chuo Kikuu cha Kilimo **Sokoine** kilichopo Morogoro, Tanzania. Nafanya utafiti juu ya hali ya ugonjwa wa kisukali cha ukubwani na sababu hatarishi zinazoambatana nao miongoni mwa watumishi wa umma.
Kusudi kuu la utafiti huu ni kuwezesha kuanisha ukubwa wa ugonjwa huu wa kisukali cha ukubwani na vihatarishi vyake miongoni mwa watumishi wa umma. Majibu yatakayo tokana na utafiti huu, yatawezesha kuanisha ukubwa wa ugonjwa huu miongoni mwa watumishi wa umma, pia yatatumika kuiarifu serikali kuu na serikali za mitaa juu ya mbinu muafaka za kukabiliana ya tishio la kuongezeka kwa ugonjwa wa kisukali cha ukubwani.
Taarifa his itakayokusanywa kutoka kwako itakuwa na itabaki kuwa siri. Tafadhali naomba uniruhusu nikuulize maswali machache kuhusiana na ugonjwa huu wa kisukali cha ukubwani na pia kuchukua kiasi kidogo cha damu kwa ajili ya kupima kiwango cha sukari mwilini.

SEHEMU B: IDHINI YA KUSHIRIKI USAILI

Utambulisho wa Msailiwa ⌊_⌊_⌊_⌋ ⌊_⌊_⌊_⌋ ⌊_⌊_⌊_⌋			
Idhini, lugha ya Usaili na Jina		**Itikio**	**Alama**
5	Maelezo ya ruhusa yamesomwa na Idhini imetolewa	Ndiyo 1 Hapana 2 Kama **hapana** komea hapo	**15**
6	Lugha ya Usaili	Kiingereza 1 *Kiswahili* 2	**16**
7	Siku na muda wa usaili (Masaa 24)	Tarehe: ……/……/……	**17a**
		Masaa ……... Dakika……	**17b**
8	Jina la Ukoo (Herufi za Jina)		**18**
9	Jina la kwanza (Herufi za Jina)		**19**
Maelezo ya nyongeza kwa msaada zaidi			
10	Numbari ya simu kama ipo		**110a**
	Sahihi ya Msailiwa		**110b**

SEHEMU C: HOJAJI

HATUA YA 1: UTAMBULISHO			
Maswali		**Itikio**	**Alama**
11	Jinsia (*mme/mke)*	Mme 1 Mke 2	**C1**
12	Ulizaliwa tarehe gani? *Sijui 77*	*Kama sijui, nenda C4* Siku…. mwezi… Mwaka..	**C 2**
13	Una umri gani?	Miaka ……	**C3**
14	Kwa ujumla, umetumia miaka mingapi katika masomo yako na kujiendeleza?	Idadi ya Miaka……	**C4**
HATUA YA 1: MWENENDO WA MAISHA			
MSINGI: Matumizi ya Tumbako			
Sasa tutazungumzia kuhusu mwenendo wa maisha ya kiafya. Tutaanze na matumizi ya Tubako.			
Maswali		**Itikio**	**Alama**
22	Je, unatumia aina yoyote ya tubako kwa sasa, kama vile kuvuta sigara?	Ndiyo 1 Hapana 2 *Kama **Hapana,** endelea* **A1a**	**T1**
23	Je, unatumia tubako (kuvuta sigara) kila siku?	Ndiyo 1 Hapana 2 *Kama Hapana, endelea* **A1a**	**T2**
24	Ulikwa na umri gani ulipoanza kutumia tubako **kwa mara ya kwanza**	Umri (Miaka)**……** *Haijulikani endelea **T5a*** Kama hajui, weka 77	**T3**
25	Unakumbuka ni muda gani umepita?	Katika miaka ……...	

	(CHAGUA MOJA TU KATI YA TATU) Sijui 77	**Inajulikana** *nenda T5a*	**T4a**
		Au katika Miezi……... **Inajulikana** *nenda* **T5a**	**T4b**
		Au katika Majuma…….	**T4c**
26	Kwa wastani, unatumia kiasi gani cha aina zifuatazo (JAZA KWA KILA AINA) Sijui 77	Sigara za kiwandani (**Idadi**)……	**T5a**
		Sigara za kukunja karatasi (**Idadi**)……	**T5b**
		Tumbako katika bomba…..	**T5c**
		Ciger au kutafuna mizizi…	**T5d**
		Aina nyingine kama ipo nenda T5 [. …] au endelea na **A1a**	**T5e**
		Aina nyingine (fafanua)... *au **endele na A**1a*	**T5 nyingine**

MSINGI: Matumizi ya Pombe (Vileo)			
Maswali yanayofuata ni kuhusiana na matumizi ya Pombe (Kileo)			
Maswali		**Itikio**	**Alama**
36	Je, umewahi kutumia kileo (pombe) cha aina yoyote?	Ndiyo 1 Hapana 2 *Kama Hapana nenda **P1***	A1a
37	Je, ulitumia kileo cha aina yoyote katika kipindi cha miezi 12 iliyopita?	Ndiyo 1 Hapana 2 *Kama Hapana nenda **P1***	A1b
38	Je, katika kipindi cha miezi 12 iliyopita ni mara ngapi ulipata kutumia angalau aina mojawapo ya kileo? (**soma itikio**)	Kila siku 1 Siku 5-6 kwa Juma 2 Siku 1-4 kwa Juma 3 Siku 1-3 kwa mwezi 4 Pungufu ya 1 kwa mwezi 5	A2
39	Je, ulitumia kileo cha aina yoyote katika kipindi ya siku 30 zilizopita?	Ndiyo 1 Hapana 2 *Kama Hapana nenda **P1***	A3
40	Je, katika siku 30 zilizopita ni matukio mangapi ulitumia kileo?	Idadi…… Sijui 77	A4
41	Je, katika siku 30 zilizopita ulitumia wastani wa chupa ngapi za kileo katika tukio moja?	Idadi…… Sijui 77	A5
42	Je, katika siku 30 zilizopita, ni kiasi gani cha juu kabisa cha kileo ulichopata kutumia?	Idadi ya juu……... Sijui 77	A6
43	Je, katika siku 30 zilizopita, ni kiasi gani ulipata kutumia katika tukio moja? (Wanaume chupa 5 au zaidi; wanawake 4 au zaidi)	Idadi/kiasi……. Sijui 77	A7

MSINGI: Mozoezi ya Mwili			
Sehemu inayofuata nitakuuliza kuhusiana na muda unaotumia katika kufanya shughuli mbalimbali zinazohusu kuushughulisha mwili katika siku saba za Juma. Kumbuka shughuli ulizofanya ziwe za kulipwa au bila malipo; mfano, mazoezi ya mwili, shughuli ya nyumbani au shambani. *[Mazoezi ya mwili makubwa ni yale yanayohitaji matumizi makubwa ya nguvu na yanayopelekea au kusababisha kuongezeka kwa mapigo ya moya na kupumua kwa kasi. Mozoezi ya wastani huhitaji nguvu za wastani na husababisha ongezeka la mapigo ya moyo na kupumua kidogo]*.			
Maswali		**Itikio**	**Alama**
Kazi			
52	Je, kazi unayofanya inakusababishia *matumizi makubwa ya nguvu za mwili na kusababisha kuongezeka kwa mapigo ya moya na kupumua kwa kasi*?	Ndiyo 1 Hapana 2 *Kama hapana nenda **P4***	P1
53	Je, katika siku 7 za Juma, ni siku ngapi unafanya kazi inakusababishia *matumizi makubwa ya nguvu za mwili*?	Idadi ya siku […….]	P2
54	Je, ni muda gani hutumia katika kunafanya	Masaa: Dakika	P3

	kazi inayokusababishia *matumizi makubwa ya nguvu za mwili kwa siku*?	……../……..	(a-b)
55	Je, kazi zako unazofanya *huhitaji nguvu za wastani na kusababisha kuongezeka kidogo kwa mapigo ya moyo na kupumua?*	Ndiyo 1 Hapana 2 *Kama hapana nenda **P7***	P4
56	Je, katika siku 7 za Juma, ni siku ngapi unafanya kazi inakusababishia *matumizi ya wastani ya nguvu za mwili*?	Idadi ya siku [……]	P5
57	Je, ni muda gani hutumia katika kunafanya kazi inakusababishia *matumizi ya wastani ya nguvu za mwili kwa siku*?	Masaa: Dakika ……/……..	P9 (a-b)

Kusafiri			
Maswali yanayofuata nitakuuliza kuhusiana na njia za kawaida unazotumia kusafiria. Kwa mfano, kutoka nyumbani kwenda kazini, sokoni au kwenda kuabudu (Kanisani/Msikitini).			
58	Je, unaweza kutembea au kuendesha Biaskeli angalau kwa muda wa dakika 10 mfululizo kutoka sehemu moja kwenda nyingine?	Ndiyo 1 Hapana 2 *Kama hapana nenda **P10***	P7
59	Je, kwa siku 7 za Juma ni siku ngapi hutembea au kuendesha Biaskeli angalau kwa dakika 10?	Idadi ya siku [……]	P8
60	Je, ni muda gani huweza kuutumia kutembea au kuendesha Biaskeli kwa siku?	Masaa: Dakika ……. ../……..	P9 (a-b)

MSINGI: Mazoezi ya Mwili. kuendelea			
Maswali		**Itikio**	**Alama**
Burudani			
Maswali yafuatayo nitakuuliza kuhusiana na shughuli za maburudisho baada ya kazi. Mfano, michezo, mazoezi na matembezi ya kupunga upepo.			
61	Je, unafanya shughuli yoyote ya maburudisho baada ya muda wa kazi, ambazo husababisha matumizi makubwa ya nguvu mwilini?	Ndiyo 1 Hapana 2 *Kama hapana nenda P**13***	P10
62	Je, kwa siku 7 za Juma ni siku ngapi hufanya maburudisho yanayosababisha matumizi makubwa ya nguvu mwilini?	Idadi ya siku [..……....]	P11
63	Je, ni muda gani huweza kuutumia kwa siku kufanya maburudisho yanayosababisha matumizi makubwa ya nguvu mwilini?	Masaa: Dakika ……./…….	P12 (a-b)
64	Je, unafanya maburudisho ya aina yoyote yanayosababisha uhitaji *nguvu za wastani na kusababisha ongezeka kidogo la mapigo ya moyo na kupumua?*	Ndiyo 1 Hapana 2 *Kama hapana nenda **P16***	P13
65	Je, kwa siku 7 za Juma ni siku ngapi hufanya maburudisho yanayosababisha matumizi ya wastani ya nguvu mwilini?	Idadi ya siku [……..…]	P14
66	Je, ni muda gani huweza kuutumia kwa siku kufanya maburudisho yanayosababisha matumizi ya wastani ya nguvu mwilini?	Masaa: Dakika ……./……..	P15 (a-b)
67	Je, ni muda gani huweza kuutumia ukiwa umekaa sehemu moja au katika kujiburudisha?	Masaa: Dakika …….. ./……	P16 (a-b)
MSINGI: Taarifa kuhusu shinikizo la damu (BP)			
Maswali		**Itikio**	**Alama**
68	Je, umepata kupimwa mapigo ya moyo na Daktari au Mhudumu wa afya?	Ndiyo 1 Hapana 2 *hapana nenda **H6***	H1
69	Je, umepata kuambiwa na Daktari au Mhudumu wa afya kwamba una tatizo la shinikizo la damu?	Ndiyo 1 Hapana 2 *Kama hapana nenda **H6***	H2a
	Je, katika kipindi cha miezi 12 iliyopita	Ndiyo 1 Hapana 2	H2b

70	umepata kuambiwa una shinikizo la damu?		

MSINGI: Taarifa za ugonjwa wa kisukari			
	Maswali	**Itikio**	**Alama**
74	Je, umepata kupimwa kiwango cha sukari mwilini na Daktari au Mhudumu wa afya?	Ndiyo 1 Hapana 2 *Hapana nenda **M1***	H6
75	Je, umepata kuambiwa na Daktari au Mhudumu wa afya kwamba una kisukari?	Ndiyo 1 Hapana 2 *Hapana nenda **M1***	H7a
76	Je, katika kipindi cha miezi 12 iliyopita umepata kuambiwa una ugonjwa wa kisukari?	Ndiyo 1 Hapana 2	H7b
HATUA YA 2: VIPIMO VYA MWILI			
MSINGI: Urefu na Uzito			
Maswali		**Itikio**	**Alama**
80	Utambulisho wa Msailiwa	[…….]	M1
81	Utambulisho wa chombo cha kupimia Urefu na Uzito	Urefu […….] Uzito [……....]	M2a M2b
82	Urefu	(cm) [……...]	M3
83	Uzito (kwa mzito zaidi weka *666.6)*	(kg) [……...]	M4
84	Kwa wanawake tu: Je, una ujauzito?	Ndiyo 1 Hapana 2 *Kama ndiyo nenda M **8***	M5
MSINGI: Mapigo ya Moyo (BP)			
87	Utambulisho wa Msailiwa	[……]	M8
88	Utambulisho wa chombo cha kupimia mapigo ya moyo	[….……...]	M9
89	Sijafu la mkono (Cuff)	Nyembamba 1, ya kati 2, pana 3	M10
90	Kusoma kwa mara ya kwanza 1	*Systolic* (mmHg)	M11a
		Diastolic (mmHg)	M11b
91	Kusoma kwa mara ya Pili 2	*Systolic* (mmHg)	M12a
		Diastolic (mmHg)	M12b
92	Kusoma kwa mara ya 3	*Systolic* (mmHg)	M13a
		Diastolic (mmHg)	M13b
93	Je, kwa kipindi cha majuma mawili yaliyopita umepata kutibiwa kutokana na tatizo la shinikizo la damu?	Ndiyo 1 Hapana 2	M14
HATUA YA 3: VIPIMO VYA CHEMIKALI MWILINI			
MSINGI: kipimo cha sukari mwilini			
Maswali		**Itikio**	**Alama**
94	Je, katika muda wa masaa 8 yaliyopita umepata kula au kunywa kitu chochote isipokuwa maji?	Ndiyo 1 Hapana 2	B1
95	Utambulisho wa Fundisanifu	**……..**	B2
96	Utambulisho wa chombo cha kupimia	**……**	B3
97	Muda ambao kipimo kimechukuliwa (**katika masaa 24**)	Masaa: Dakika ……/…….	B4
98	Kipimo bila kujinyima chakula (**chagua kati ya mmol/l au mg/dl)**	Mmol/l……	B5a
		Mg/dl ……	
99	Kipimo baada ya kujinyima chakula (**chagua kati ya** mmol**/l or mg/dl**) **[kama RBG ni kati ya ≥ 5.6 na ≤ 11.1 mmol/l** au **≥ 100 - ≤200 mg/dl] ***	Tarehe: ……/……. /…….	B5b
		Mmol/l……...	B5c
		Mg/dl…….	
100	Je, kwa siku ya leo umepata kutumia dawa yoyote ya kisukari kama *insulin* au dawa ya vidonge ya kushusha sukari?	Ndiyo 1 Hapana 2	B6
MWISHO			

Appendix 3: Clearance Certificate

THE UNITED REPUBLIC OF TANZANIA

National Institute for Medical Research
3 Barack Obama Drive
P.O. Box 9653
11101 Dar es Salaam
Tel: 255 22 2121400
Fax: 255 22 2121360
E-mail: headquarters@nimr.or.tz
NIMR/HQ/R.8a/Vol. IX/2084

Ministry of Health and Social Welfare
6 Samora Machel Avenue
P.O. Box 9083
11478 Dar es Salaam
Tel: 255 22 2120262-7
Fax: 255 22 2110986

16th December 2015

Mr Chacha Magige Nyabisaga
Sokoine University of Agriculture (SUA)
Department of Veterinary Medicine and Public Health
P O Box 3019
DAR ES SALAAM

CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled: Prevalence of Type 2 Diabetes Mellitus and Associated Risk Factors Among Local Government Workers at Bariadi Urban, Tanzania, (Nyabisaga C M *et al*), has been granted ethical clearance to be conducted in Tanzania.

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

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

Approval is for one year: 16th December 2015 to 15th December 2016.

Name: Dr Mwelecele Malecela

Signature
CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE

Name: Prof. Muhammad Bakari Kambi

Signature
CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH, SOCIAL WELFARE

CC: **RMO**
DED
DMO

Appendix 4: Permission to Conduct Research in Bariadi Town

BARIADI TOWN COUNCIL

Telephone No. 028 2700554
Fax: 028 2700554

Town Director's Office
P.O. Box 526
BARIADI

Date. 04/09/2015

Ref: No. JA.344/346/01/64

Chacha Magige Nyabisaga
Sokoine University of Agriculture
P.O. Box 3015
MOROGORO

RE: PERMISSION TO CONDUCT RESEARCH

In reference to your request to conduct medical research in our council, I am glad to inform you that permission has been granted.

Please remember to fulfill all the ethical requirements before you set to commence the research study; including bringing the ethical clearance certificate from the National Institute of Medical Research, and an approved consent form.

We expect you to share with us the findings of your study and also collaborate with our health department in the study, as operational research is one of our obligations.

Wishing you a successful research study,

Dr. Charles M. Mtabho
For; Town Director
BARIADI TOWN COUNCIL