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Colorectal cancer epidemiology in Tanzania: patterns in relation to dietary and lifestyle factors

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COLORECTAL CANCER EPIDEMIOLOGY IN TANZANIA: PATTERNS IN RELATION TO DIETARY AND LIFESTYLE FACTORS

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Life Sciences and Bio-Engineering of the Nelson Mandela African Institution of Science and Technology

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ABSTRACT

Chronic non-communicable diseases are increasingly captured as contributing to morbidity and mortality in low and middle income countries. This study has designed to investigate the epidemiology of colorectal cancer and the potential modifiable local risk factors in Tanzania.

A cross sectional retrospective chart audit study was conducted to establish the pattern and distribution of colorectal cancer, The Food Frequency Questionnaire and the Step® survey tool were used to collect data. Descriptive statistics, Chi square tests and regression analysis were employed and augmented by data visualization to display risk variable differences.

Tanzania's colorectal cancer incidence has increased six times in the last decade in which major towns and cities of Dar es Salaam (20.2 per 100 000), Pwani (7.2 per 100 000), Kilimanjaro (4.4 per 100 000), Arusha (4.2 per 100 000) and Morogoro (3.6 per 100 000) had the highest percentage. This study reported that, almost 45% of the participants were hypertensive. Two major dietary patterns, namely "healthy" and "western", existed among the study sample. Obesity was found in 25% of participants, whereas overweight was present in 28%; of note, the prevalence was higher in females (26.9%) than in males (23.6%) respectively. The prevalence of alcohol consumption was 21.5%, with a significantly lower rate of smoking (12.2%) noted within the study subjects. Both alcohol consumption and tobacco smoking were more common in men than women (22.7 vs. 20.6% and 24.5 vs. 3.2%, respectively). The prevalence of vigorous, moderate, and low physical activity for both sexes was 18.6%, 54.1% and 42.3%, respectively.

Evidence from this study demonstrated that, lifestyle factors, such as diet, obesity, tobacco smoking, alcohol consumption, and sedentary behaviors, have a significant role in the rising trend of non communicable diseases and colorectal cancer in Tanzania. We recommend a large longitudinal study with robust methodology which can establish cause and effect relationships between specific lifestyle behaviors and the prevalence of colorectal cancer.

DECLARATION

I, **LEONARD KAMANGA** do hereby declare to the Senate of Nelson Mandela African Institution of Science and Technology that this dissertation is my own original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

_____ _____

Name and signature of candidate **Date**

The above declaration is confirmed

_____ _____

Name and signature of supervisor **Date**

_____ _____

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for examination of a dissertation entitled "**Colorectal Cancer Epidemiology in Tanzania: Patterns in relations to, Dietary and Lifestyle Factors"** in fulfillment of the requirements for the Degree of Doctor of Philosophy in Life Sciences and Bio-engineering (LSBE) at Nelson Mandela African Institution of Science and Technology (NM-AIST).

The above declaration is confirmed

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Name and signature of supervisor	**Date**
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Name and signature of supervisor	**Date**

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DEDICATION

To my wives, parents and children

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LIST OF ABBREVIATIONS

ARR	Adjusted Relative Risk
CRC	Colorectal Cancer
CI	Confidence Interval
ASR	Age Standardized Rate
MNH	Muhimbili National Hospital
ORCI	Ocean Road Cancer Institute
RR	Crude Relative Risk
SE	Standard Error
WHO	World Health Organization
FAO	Food and Agriculture organization
BMI	Body Mass Index
CI	Confidence Interval
CRC	Colorectal Cancer
FAO	Food and Agriculture Organization
FFQ	Food Frequency Questionnaire
OR	Odds Ratio
NCDs	Non Communicable Diseases
HTN	Hypertansion
SBP	Systolic Blood Pressure
DBP	Diastolic Blood Presure

MABP	Mean Arterial Blood Presure

CHAPTER ONE

1.1 Background information

This dissertation examined petterns and distribution of CRC in Tanzania. It sought to find out the magnitude of the problem (incidence rate) and possible factors associated with the observed pattern and distribution of cases. The dissertation is paper based, with four original papers, three of them are published papers in different scientific journals and one is a manuscript awaiting for publication.

1.1.1 Global burden of non communicable diseases

Chronic non-communicable diseases (NCDs), cancer in particular are becoming significant causes of morbidity and mortality in low and middle income countries (Msyamboza *et al.,* 2011). Currently the World Health Organization (WHO) projects that by 2020, eighty percent of the global burden of disease will be accounted for by NCDs. Similarly, deaths from NCDs are projected to increase by 15% globally between 2010 and 2020. The greatest increases will be in Africa, South-east Asia, and the Eastern Mediterranean regions, where they will increase by over 20%. In the African region, NCDs will be the primary cause of approximately 3.9 million deaths by 2020 (Ferlay *et al.,* 2015).

1.1.2 Global burden of cancer

Cancer is anticipated to be a growing cause of morbidity and mortality in the next few decades, in all regions of the world. Cancer incidence is estimated to rise from 12.7 million new cancer cases in 2008 to 21.4 million by 2030, with nearly two thirds of all cancer diagnoses occurring in low and middle-income countries (Fusterb *et al.,* 2011). The challenges of tackling cancer are enormous and when combined with population ageing increases in cancer prevalence are inevitable (Fusterb *et al.,* 2011).

Cancer morbidity and mortality patterns vary globally, the patterns vary by geography and economic status. The majority of cancers in more developed countries are those associated with more affluent lifestyles prostate and breast cancers are the most commonly diagnosed in high income countries followed by lung and colorectal cancers (Islam *et al.,* 2014). In contrast, cancers of the liver, stomach, esophagus, and cervix all related to infectious agents are relatively more common in developing countries although rapid change in lifestyle is modifying this pattern (Gelband and Sloan, 2007).

From 2008 to 2012, colorectal cancer (CRC) has grown globally, although consistently the third most common cancer in men and the second in women, with the prevalence rising from 663 000 cases to 746 000 cases among men and 570 000 cases to 614 000 cases among women (Ferlay *et al.,* 2010; Ferlay *et al.,* 2012). A wide geographical variation in CRC incidence is noted, with almost 55% of the cases occurring in more developed regions. A tenfold variation in both sexes has been reported worldwide, with the highest rates being observed in Australia, New Zealand and Western Europe and the lowest in Western Africa (Ferlay *et al.,* 2015)**.** Studies suggest that CRC is determined largely by environmental exposures, as evidenced by elevated risk among second and third generations of migrants from a low- to high-risk country (Flood *et al.,* 2000), trends analysis of past and present population, comparison of rural and urban dwellers, and inter-racial variations in the same country like South Africa (Packard, 1989). The variation of CRC between regions has been associated with difference in environmental exposures including diet, tobacco smoking, physical activity and modified by individual genetic factors (Center *et al.,* 2009). Lifestyle factors have been established to contribute to the development of CRC (Wiseman, 2008)**.** These factors can interact with genetic factors in the process of carcinogenesis and finally the balance between genetic predisposition and these factors determines individual susceptibility to develop CRC (Lima and Gomes-da-Silva, 2005).

Evidence suggests that, diet and other lifestyle factors play a major role in the etiology of CRC (Parkin and Boyd, 2011b; Weiderpass, 2010). Although studies examining the effect of diet and other lifestyle factors on CRC have produced inconsistent results (Butler *et al.,* 2008; Slattery *et al.,* 2007), the weight of evidence points towards an elevated risk (Chen *et al*., 2015; Egeberg *et al.,* 2013; Parkin, 2011b; Parkin and Boyd, 2011b).

There is convincing evidence from epidemiological and experimental studies that dietary, environmental, and/or lifestyle factors in combination with genetic factors are likely to have a major influence on the risk of colorectal cancer. Data available suggest that, diets high in red meat and perhaps in refined carbohydrates less consumption of fruits and vegetables increase risk of CRC. On the other hand, excessive alcohol consumption, higher BMI, less physical activities and smoking during a long period of time appear to increase risk.

1.1.3 Research problem and justification of study

While CRC rates are stabilizing in historically high risk countries, the opposite is observed to the previously known low risk countries. In 2015, Globocan (2015) predicted that approximately 286 530 men and 412 912 women will be diagnosed with cancer in sub Sahara Africa. By 2035, cancer incidence is predicted to increase by 83–87% (Rebbeck, 2014). In Tanzania, although there are no published data on CRC incidence but predictions shows that, by 2012 CRC cases were 1239 in both sex and it was projected to increase by 37.5% by 2035 (Ferlay *et al.*, 2015). Like in many other developing countries, where cancer registries are not well established, Tanzania lacks reliable and accurate data on cases of cancer.

WHO (2013) recommend assessment of the epidemiological situation by identifying the distribution of risk factors among different population groups as an important step in planning for prevention and control of NCDs and their risk factors (WHO, 2013). Due to the fact that local, high quality data to inform policies are lacking, this study aimed to understand the epidemiology of CRC and that of potential modifiable local factors in Tanzania. Therefore the purpose of this study was to visualize patterns and distribution of CRC and then characterize potential lifestyle factors associated with CRC distribution in Tanzania.

1.2 Objectives

1.2.1 General objective

To determine CRC incidence, visualize its pattern and distribution and determine dietary and lifestyle factors associated with it in Tanzania.

1.2.2 Specific objectives

(i) To establish CRC incidence and visualize the distribution and pattern of cases in Tanzania through document review.

(ii) To determine dietary patterns as a potential risk factor of CRC in a region with high incidence.

(iii) To determine prevalence and predictors of other CRC lifestyle risk factors in a region with high incidence.

(iv) To determine prevalence of hypertension in the general population

1.3 Research questions

(i) What is the incidence of CRC in Tanzania? How is CRC distributed in Tanzania? Is there any specific pattern which can be identified?

(ii) Could diet be one of the potential factors which determine the observed incidence and distribution of CRC in Tanzania? What are the common diets/foods eaten by the community with high incidence of CRC in Tanzania. Does diet put the community at a high risk of CRC?

(iii) What is the prevalence of obesity, physical activities, cigarette smoking and alcohol intake in a region with high incidence of CRC? Do these factors put the community at high risk of getting CRC?

(iv) What is the prevalence of other non communicable diseases in the community with high incidence of CRC?

1.4 Significance of the research

This study potentially fills a knowledge gap on CRC incidence and its distribution in Tanzania. An attempt to assess needs and priorities in health logically starts with an examination of the extent of the problem, who in the population is most affected, what are the factors etc. The availability of local high quality epidemiological data on the burden of CRC and their risk factors in Tanzania is of great importance. Information on a risk factor profile will help to predict the future burden of disease. This, in turn, would help to make a strong case for advocacy and constitutes an evidence base for planning interventions and policy. Findings from this study also provide the basis for further studies.

CHAPTER TWO

Pattern and Distribution of Colorectal Cancer in Tanzania: A Retrospective Chart Audit at Two National Hospitals[1]

Abstract

Background: Colorectal cancer (CRC) is a growing public health concern with increasing rates in countries with previously known low incidence. This study determined pattern and distribution of CRC in Tanzania and identified hot spots in case distribution. *Methods:* A retrospective chart audit reviewed hospital registers and patient files from two national institutions (Muhimbili National Hospital and Ocean Road Cancer Institute). Descriptive statistics, Chi square (χ^2) tests, and regression analyses were employed and augmented by data visualization to display risk variable differences. *Results*: CRC cases increased six-fold in the last decade in Tanzania. There was a 1.5% decrease in incidences levels of rectal cancer and 2% increase for colon cancer every year from 2005 to 2015. Nearly half of patients listed Dar es Salaam as their primary residence. CRC was equally distributed between males (50.06%) and females (49.94%), although gender likelihood of diagnosis type (i.e., rectal or colon) was significantly different (P = 0.027). More than 60% of patients were between 40 and 69 years. *Conclusions*: Age (p = 0.0183) and time (P = 0.004) but not gender (P = 0.0864) were significantly associated with rectal cancer in a retrospective study in Tanzania. Gender (P = 0.0405), age (P = 0.0015), and time (P = 0.0075) were all significantly associated with colon cancer in this study. This retrospective study found that colon cancer is more prevalent among males at a relatively younger age than rectal cancer. Further, our study showed that, although more patients were diagnosed with rectal cancer, the trend has shown that colon cancer is increasing at a faster rate.

Keywords: colorectal cancer; colon cancer; rectal cancer; cancer risk factors; Tanzania; incidence; developing countries

[1]Journal of Cancer Epidemiology 2016

2.1 Introduction

2.2 Lifestyle risk factors for colorectal cancer

CRC incidence has risen dramatically in the last fifty years, especially in developing contexts (Pericleous *et al.,* 2013) often related to risk factors such as adoption of westernized diets, obesity, and reduced physical activity (Center *et al.,* 2009; Wiseman, 2008). CRC has been called a disease of the environment as it is frequently evidenced in the second and third generations of migrants from low- to high-risk CRC incidence countries. This attribution to the environment is also evident through comparison of rural and urban dwellers and racially diverse people within the same nation, such as in South Africa, where there is a confirmed limited genetic contribution in the etiology of this disease (Hemminki *et al.,* 2014; Packard, 1989).

2.3 Dietary factors

Dietary factors account for between 30% and 50% of all CRC incidences (Ott *et al.,* 2011). Diet variably acts as a pro-and antitumor risk modifier across the CRC tumor genesis process, which includes tumor initiation, promotion, and progression (Cappell, 2008). Developing countries undergo profound changes in societal and behavioral patterns, including shifting dietary patterns due to socioeconomic and cultural changes, globalization of food markets, urbanization, and economic growth (Keding *et al.,* 2011).

In Tanzania, the nutrition transitions in recent years have contributed to low fiber, high sugar, and saturated fat-ladened diets often related to processed and packaged foods (Maletnlema, 2002). The exponential growth in availability of inexpensive calorie-ladened foods (i.e., cakes, sugary drinks and chocolate) has led to gradients in energy intake between rural and urban populations (Tanner and Lukmanji, 1987). Daily consumption by urbanites in Dar es Salaam was 1600 kcal for the low-income groups and 3000 kcal or more for the high-income group with most originating from fats (43%) (Tanner and Lukmanji, 1987). Keding *et al.* (2011) described five rural dietary patterns, with the "Purchase" pattern characterized by bread and cakes (usually fried), sugar and black tea being the most prevalent pattern. The remaining four patterns included "Traditional-coast" (i.e., fruits, nuts, starchy plants, and fish), "Traditional-inland" (i.e., cereals, oils and fats, and vegetables), "Pulses" (i.e., pulses, with few or no vegetables) and "Animal Products" (i.e., meat, eggs, and/or milk).

Epidemiological studies report a significant relationship between red meat consumption and CRC development (Alaejos *et al.,* 2008; Oostindjer *et al.,* 2014), yielding recommendation that it should be eaten less frequently or avoided. The mechanism suggested for red meat carcinogenesis includes exposure to different carcinogens produced by meat during the cooking processing and level of doneness (Alexander *et al.,* 2010). Meat prepared at high temperatures and well done produces more heterocyclic amines compared to that prepared at lower temperatures (Alexander *et al.,* 2011). Consumption of 50 grams of processed meat on a daily basis has been shown to increase the risk of CRC by 18% over the lifetime (Chan *et al.,* 2011).

World Health Organization [WHO] (Larsson and Wolk, 2006) estimated that 14% of gastrointestinal cancer deaths are caused by insufficient intake of fruits and vegetables worldwide. A number of authors (Chan *et al.,* 2011; Norat *et al.,* 2002; Aune *et al.,* 2013; Ho, 2014) indicated that higher intake of vegetables probably lowers the risk of CRC. Reports from East African countries suggest lower consumption of fruits and vegetables than the recommended daily 400g (Larsson and Wolk, 2006). Most people in Tanzania consume 164 g per day only, more than 200 g below the recommended dietary guidelines (Zheng and Lee, 2009).

There is an evidentiary association between body mass index (BMI) and colon cancer (Parkin, 2011). Specifically, studies have shown that, overweight and obesity are related to cancer of the colon and several types of cancers (Aune *et al.,* 2013; International Agency for Research on Cancer, 2015; WHO 2015a). Obesity is associated with a 30–70% increased risk of colon cancer in men, but such association is not consistently reported in women (Amine e*t al.,* 2002). Visceral fat, or abdominal obesity, is more predictive than subcutaneous fat obesity (World Bank, 2015). In a multi country study of urban areas in Africa, analysis of BMI data on women found that the prevalence of overweight and obesity was higher than the prevalence of underweight in 17 of 19 countries (Vainio, 2003). In Tanzania, several studies assessing obesity have been done (Bardou *et al.,* 2013; Ihucha, 2011; Renehan *et al.,* 2010; Vainio, 2003; World Cancer Research Fund International/American Institute for Cancer Research, 2007).

2.4 Physical activity

Studies with diverse populations showed that physically active individuals, especially lifelong adherents, are at a lower risk for CRC, an effect which was independent of other risk

factors (i.e., diet and body weight) (Aleksandrova *et al.,* 2012; Dai and Niu, 2007). Different types of physical activity, even a relatively moderate level of activity (i.e., walking fast for one hour daily), can reduce risk of colon cancer (Mendez *et al.,* 2005). The level of physical inactivity varies between genders and between rural and urban residents in Tanzania with most reporting that urban dwellers and women were less active (Hoffmeister *et al.,* 2005; Renehan *et al.,* 2010) than their rural and male cohorts.

2.5 Cigarette smoking

Cigarette smoke contains over known 60 carcinogens and free radicals, which could affect the colorectal mucosa, thereby potentiating the alteration of cancer related genes (Nyaruhucha *et al.,* 2003). The association between cigarette smoking and CRC depends on the number of cigarettes smoked, length of exposure, and age of initiation, which cumulatively yields a risk trajectory over an extended, continuous period (Keding *et al.,* 2013). Limited information is available regarding tobacco smoking in Tanzania, with an estimation of 18% of males and 1.3% of females as daily smokers in the age range of 25–64 years (Keding *et al.,* 2013).

2.6 Alcohol

An association between alcohol consumption and CRC was reported in more than 50 prospective and case control studies, with no difference in the risk for colon and rectal cancers (Muhihi *et al.,* 2012). In a meta-analysis of eight studies of colon cancer, a combined relative risk (RR) of 1.09 (1.03–1.14) per 10 g intake per day (Shayo and Mugusi, 2011) was reported, which was mirrored in the meta-analysis findings (RR 1.06 (1.01–1.12) per 10 g daily intake) of the meta-analysis by McMichael (2008).

2.7 Risk factors for colon and rectal cancer sub-sites

Studies have suggested different etiologies for colon and rectal cancer sub-sites (Calton *et al.,* 2006; Blarigan and Meyerhardt, 2015; Van *et al.,* 2009). Although the findings are not conclusive, evidence has linked colon cancer with lifestyle factors (i.e., physical inactivity, body mass index (BMI), and gender) (Aspray *et al.,* 2000; Parajuli *et al.,* 2013; WHO, 2015b) more than rectal cancer. For example, physical inactivity and body mass index (BMI) have been associated strongly with colon cancer but not with rectal cancer (Jagoe *et al.,* 2002). Conversely, several studies found no association between body weight and BMI with

rectal cancer (Baan *et al.,* 2007). Still other studies have indicated no or slight difference in risk between the two types of cancer (Pericleous *et al.,* 2013; WHO, 2015b).

2.8 Age and gender in relation to CRC

Although CRC can occur at any age, the chances of developing the disease increase with age and peak after the age of fifty (Cho, 2004). Of note, age-gender difference in CRC incidence exists with women developing CRC at an older age than men (Mc Michael, 2008; Moskal *et al.,* 2007). In general, a four-to ten-year age difference by gender has been reported, with female incidence higher in the age range of 70–74 and male incidence higher in the age range of 60–64 (Iacopetta, 2002 and WHO, 2004). In most developing countries, diagnosis occurs at a relatively younger age than in developed countries (Cao *et al.,* 2015). Age distributions must be a consideration in the predictions of current and future prevalence of CRC.

2.9 Accessibility of health services for diagnosis

For CRC, health care accessibility is important for early detection and treatment. People in low-to-middle income countries have less access to health services than those in developed countries (Colditz *et al.,* 1997). Several barriers to health service accessibility are reported in the literature, which have been categorized at the patient level, provider level, and system level (Pischon *et al.,* 2006). At the patient level, barriers relate to individual traits (i.e., sex, ethnicity and income); at the provider level to services characteristics (i.e., skills and attitudes); and at the system level traits to broad factors (i.e. policy and organizational factors).

2.10 Summary

Adoption of cancer risky lifestyles has been associated with a rapid increase in cancer incidence in Africa (Moore *et al.,* 2009). In general, dietary patterns (i.e., high consumption of red meat and high caloric foods) and lifestyle choices (i.e., alcohol, smoking, and sedentary lifestyle) are significantly associated with an increased risk of CRC (Baan *et al.,* 2007; Maletnlema, 2002; Mendez *et al.,* 2005; Ott *et al.,* 2011; Parkin, 2011; Wiseman, 2008). Demographic risk factors have also been linked to CRC including being male, increased age, and low socioeconomic status (Wei *et al.,* 2004). High consumption of fiber, fruits, and vegetables is associated with protective roles against CRC (Adámková *et al.,* 2011). Lack of access to health care services may also influence pattern and distribution of CRC (Colditz *et al.,* 1997; Pischon *et al.,* 2006).

In light of these complex and emergent issues, the aim of this study was to determine the patterns and distribution of known CRC cases in Tanzania in order to inform future policy planning and the design of targeted interventions.

2.11 Materials and methods

2.11.1 Study area

Tanzania is situated in East Africa sharing borders with Kenya and Uganda to the North, Rwanda, Burundi, and the Democratic Republic of Congo to the West, and Zambia, Malawi, and Mozambique to the South with the Indian Ocean forming its eastern border (URT, 2015). As of the 2012 census, Tanzania's population was nearing 45 million with 43 625 354 in Tanzania mainland and 1 303 569 in Zanzibar Islands (NBS and MFS, 2013). Thirty administrative regions make up the country; 25 regions are found in the Mainland and 5 in Zanzibar (NBS and MFS, 2013). Zanzibar was grouped as one region for the purpose of this study. Tanzania's population is comprised primarily of native Africans (99%) utilizing more than 120 local languages. The majority of people follow Christian and Muslim religions, although there are small numbers following Hinduism and other faiths (NBS and MFS, 2013). The economy is reliant upon agriculture, contributing to more than 27% of the Gross Domestic Product and accounting for 80% of the total workforce (NBS and MFS, 2013).

2.11.2 Study sites

This study was conducted between September and November 2015 in two national hospitals [Muhimbili National Hospital (MNH) and Ocean Road Cancer Institute (ORCI)], both based in Dar es Salaam. Established over a century ago, MNH is a university teaching hospital and the only national hospital. Currently, MNH has a bed capacity of 1500, serving 1000 to 1200 outpatients per week, as well as admitting approximately the same number weekly (MNH, 2015). The major role of MNH in cancer care and treatment is to receive patients from all parts of the country who need further investigation and treatment plus providing referral as appropriate for radiation treatments to ORCI. Ocean Road Cancer Institute is the only specialized facility for cancer treatment in Tanzania. The facility was established in 1895 by the German colonial government. In 1996, it was made an independent autonomous institute by an Act of Parliament. Ocean Road Cancer Institute offers patient services including laboratory services, diagnostic imaging, chemotherapy, radiotherapy, palliative care services, cervical cancer screening, and an HIV/AIDS care and treatment clinic (ORCI,2015). These

hospitals (MNH and ORCI) are the two major hospitals for diagnosis and treatment of cancers in Tanzania.

2.11.3 Study design

This study was a cross sectional study which employed a retrospective chart audit method approach to collects, codes and analyzes data that were originally collected for non research purposes, such as admission and discharge documentation, as well as laboratory and diagnostic testing reports (Hess, 2004).

2.11.4 Data collection

Data collection involved all available patient charts for the period between January 2005 and November 2015. Review of patient files was done at MNH. File numbers were generated via the hospital's computer system with records from January 2005 to November 2015 identified with the actual files retrieved by medical record staff. A total of 704 records were found in the computer system; however, the file search retrieved 366 files. Data cleaning removed 59 files that were incorrectly recorded, presented unconfirmed diagnosis, and/or had important information missing. The status of most missing files was attributed to the fact that patients referred to ORCI physically carry their MNH files, which then remain at ORCI unless the patient is re-referred to MNH. At ORCI, the new patients register book and, when necessary, patient files were used to collect information. All register books from 2005 to 2015 were found except that of 2007 which was reported as unaccounted for. Records of patients from MNH and from other parts of the country were located. For patients coming from MNH, we recorded the original MNH file number which was then used to remove duplicates from those found at MNH by using the Excel computer software program. Finally, 901 charts were included in this study (Table 1).

2.11.5 Ethical considerations

This study received ethical approval from the MNH Institutional Review Board (Permission Number 625), as well as approval by the National Institute of Medical Research Ethical Committee

Table 1: Number and source of patient charts

Source of record	Number of charts in the record	Retrieved charts	Removed charts	Total
Patient charts retrieved from MNH	704	366	59	307
Patients charts retrieved from ORCI with referral letter from MNH	286	286	0	286
Patients charts retrieved from ORCI with referral letter from other hospitals	308	308	0	308

2.11.6 Inclusion and exclusion criteria

This study included all patient charts indicating a diagnosis of CRC in accordance with the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)-WHO Version for 2016. This categorization considers the relevant elements of the C18 (malignant neoplasm of colon) palette, such as C18.0, C18.2, C18.4; C18.6, C18.7, C18.8, C18.9 and C19, C20, C21, and C21.1. Any incomplete (missing diagnosis, i.e., gender, age, and residence) or wrongly categorized charts were not retrieved for the purpose of this analysis.

2.11.7 Data collection tool and techniques

A customized retrospective audit form was used to collect information from patient records. File number, age, gender, and geographical region where the patient was coming from were all recorded. To avoid recording patients' temporary residences, we used referral letters to locate original residences. Also, we were aware that the referral hospital may not reflect the area of residence as some patients seek medical attention from hospitals which they trust; so the study used any other information such as patient history to determine the region of primary residence.

Data extraction was done by the principal investigator and a trained nurse. Data were extracted digitally with single extraction only. To ensure data integrity, the research assistant was trained and the principal investigator remained available for consultation throughout the data extraction period. Further screening was done during data analysis with all charts which did not meet the inclusion criteria being removed from the analysis.

2.11.8 Standardization

Age standardization of incidence rates was done by using the direct method and age specific rates for 5-year age groups using the world standard population (Boschi-Pinto *et al.,* 2001).

2.11.9 Data analysis

The data abstracted from the records were entered in an Excel™ file, edited for consistency, and analyzed by Statistical Analysis System (SAS) Software (Version 9. 4) as well as the R software. Descriptive statistics were used to determine patterns and distribution according to age, gender, tumor site, and region of primary residence. Heat and contour maps showing distribution of cases were drawn to identify the most affected regions. Chi square (χ^2) tests were used to determine association between categorical independent variables and the response variable. To estimate the gender difference in prevalence of CRC, crude relative risk (RR) with a 95% confidence interval was calculated using the univariate Log–Binomial Regression model. Multivariable log-binomial regression analysis was employed to determine how gender was associated with risk of having either colon or rectal cancer, the association was adjusted for age of the patients and the time difference (years) from the starting period of the study. P-values were estimated by two-sided tests. Statistical significance was set at a p-value of less than 0. 05.

During analysis of CRC sub-sites, patients with recto-sigmoid cancer were excluded because our interest was on colon and rectal cancers only. Four (4) patients of age less than 15 years were excluded because the number was too small and could have affected the analysis. Thus, a total of 822 subjects were included in the analysis.

2.12 Results

2.12.1 Distribution of CRC incidence by hospital and gender

CRC cases were almost equally distributed between the two genders (Fig. 1). Within the 901 charts reviewed, 451(50.1%) were male patients and 450 (49.9%) were female patients. More than 65% of patient's charts were retrieved from ORCI. At ORCI, male patients (307) represented 51.6% of the total. About one-third of patients charts included in this study were recorded at MNH. The majority (53%) of patients at MNH were females.

2.12.2 Distribution of colorectal cancer incidence by age and gender

Figure 2 shows the age and gender distribution of CRC patients whose charts were reviewed. The range in years was from 3 to 108 with the majority of males being at the age of 60-64 years (12.6%) and females at the age of 50-54 years (15.6%). People aged 0- 39 years comprised almost one quarter of all patients (26%). Patients aged 40 to 69 years represented the largest proportion (62%). However, the Cochran-Mentel- Haenszel statistical test for association between age and sex of CRC patients was not statistically significant (P=0.724).

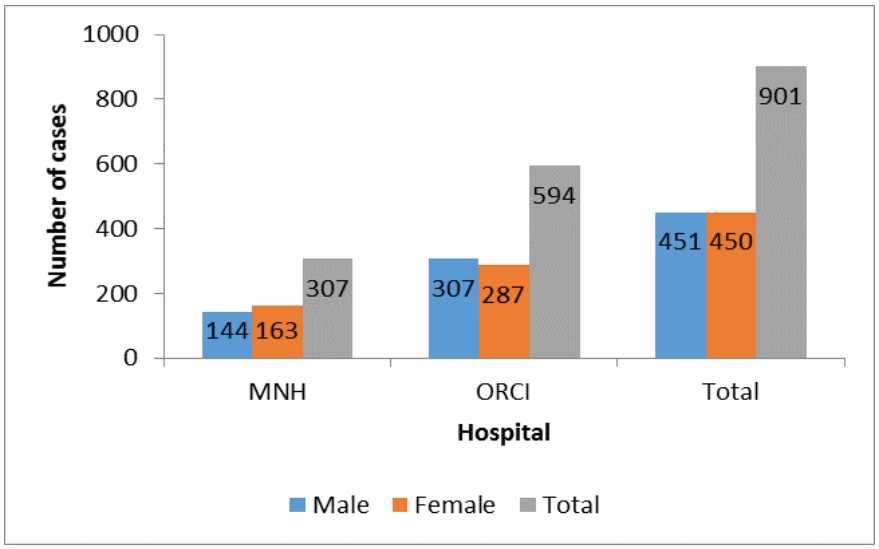

Figure 1: Distribution of colorectal cancer by hospital and gender (n = 901)

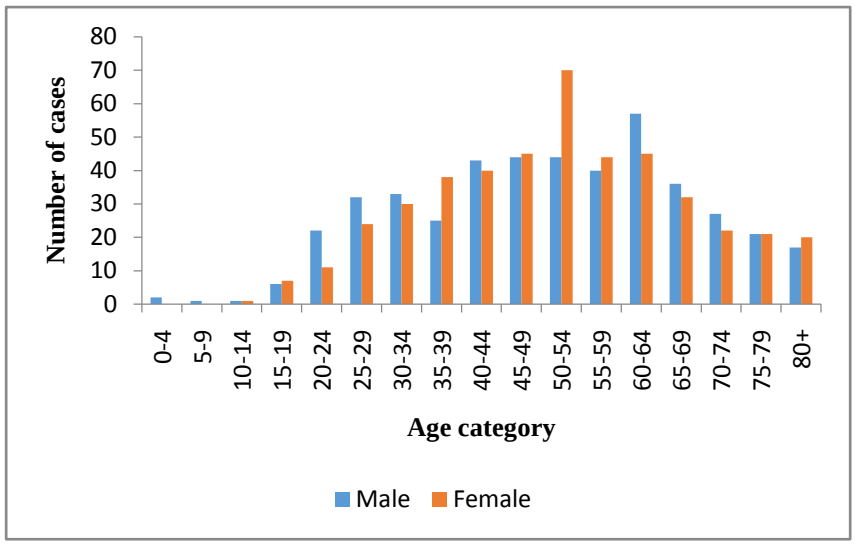

Figure 2: Colorectal cancer distribution by age and gender

2.12.3 Distribution of colorectal cancer incidence by geographical area

The number of CRC patients by region is visualized in Fig. 3 and 4. Eastern zone showed high occurrence of the disease followed by the Northern, Central, and North West zones. Southern and Southern Highlands's zones showed lower occurrence (Fig. 3). The number of patients (shown as density) is shown by shift in color from low intensity to high intensity red colors as shown on the scale.

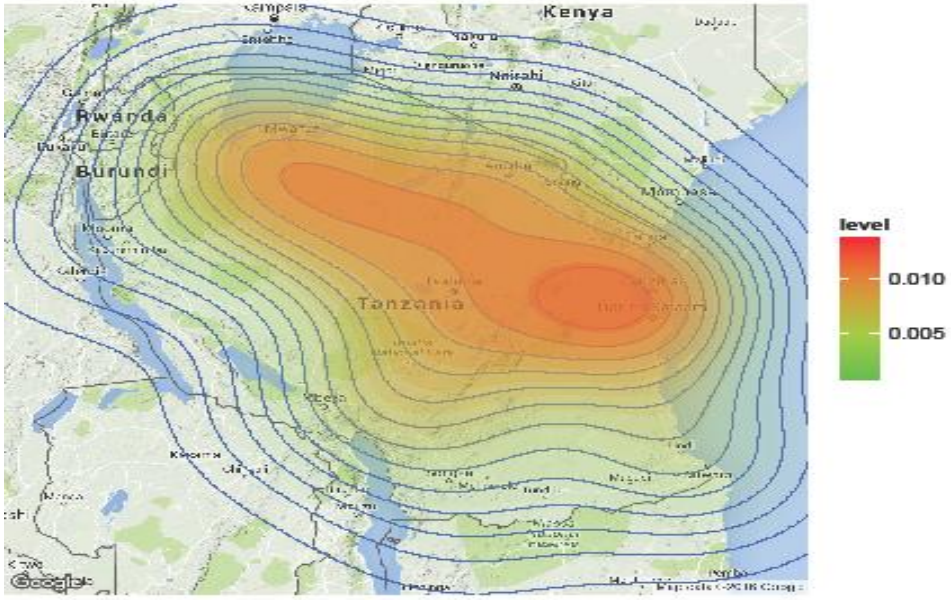

Figure 3: Contour map showing pattern of CRC cases among regions in Tanzania

2.12.4 Distribution of colorectal cancer incidence by region and year of diagnosis

About 406 (45.1%) of all patients reported Dar es Salaam region as their primary residence. Since 2005, the number of CRC cases in Dar es Salaam was higher compared to other regions. The peak number was recorded in 2014, although since 2008 there was an observable annual increase (Fig. 4). The distribution of CRC cases by region and year of diagnosis is shown in Figure 4. The y-axis shows regions of residence of patients and the x-axis shows the year of diagnosis. The number of patients is plotted in white to hot red color scale. The hot red color of the tiles indicates high abundance and white indicates low abundance.

After standardization of age to obtain the age adjusted incidence rates (ASR) (standardized to the world standard population). The ASR varied more than 100 times among the 25 populations analyzed. The highest rate was recorded in Dar es Salaam (20.2 per 100 000) and the lowest (0.1 per 100 000) in Geita. Table 2 reports the ASR for all regions.

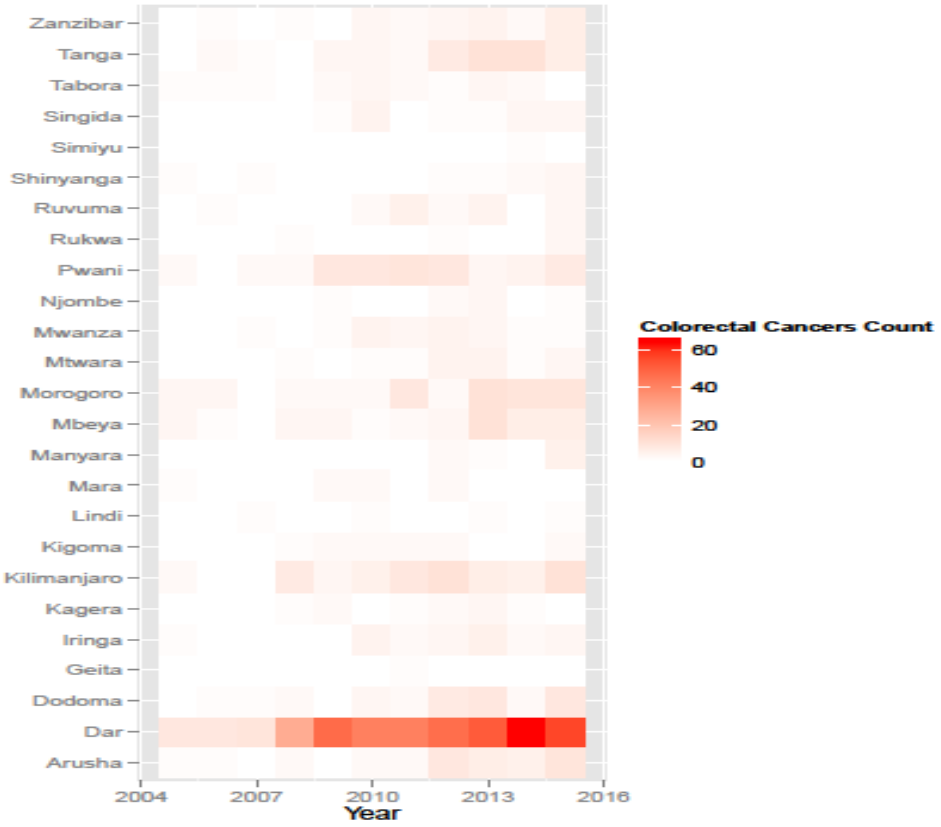

Figure 4: Heat map showing distribution of CRC cases by region from 2005 to 2015

Table 2: Age-Standardized Incidence Rates per 100 000 (World Standard) in Tanzania and different administrative regions of Tanzania

Geographical area	Adjusted rates	Crude rates
Tanzania	3.8315	64.9289
Arusha	4.1922	73.3286
Dar es Salaam	20.2370	330.2031
Dodoma	2.6565	46.6107
Geita	0.1421	2.6467
Iringa	3.4605	60.6899
Kagera	0.8421	13.3165
Kilimanjaro	4.4420	79.2557
Kigoma	0.9455	13.3127
Lindi	0.7185	15.1840
Mara	0.8413	15.3057
Manyara	1.0509	15.5328
Mbeya	2.4859	41.4311
Morogoro	3.5965	61.3643
Mtwara	1.6603	30.2506
Mwanza	1.5907	28.8150
Njombe	1.7629	33.7530
Pwani	7.2179	125.8674
Rukwa	1.2272	19.5729
Ruvuma	1.9364	33.3709
Shinyanga	1.0888	20.8959
Simiyu	0.1562	4.2003
Singida	1.8455	31.0773
Tabora	1.3639	25.6195
Tanga	3.5017	60.9436
Zanzibar	2.9867	58.5952

2.12.5 Trends of colorectal cancer by year

There is a positive growth trend of CRC patients from the year 2005 to the year 2015. Albeit missing data in 2007 and non-growth in 2006 and 2014, the number of CRC patients increased continually from 23 patients in 2005 to 146 patients in 2015. There has been a six fold increase in CRC incidence in a period of eleven years (Fig. 5).

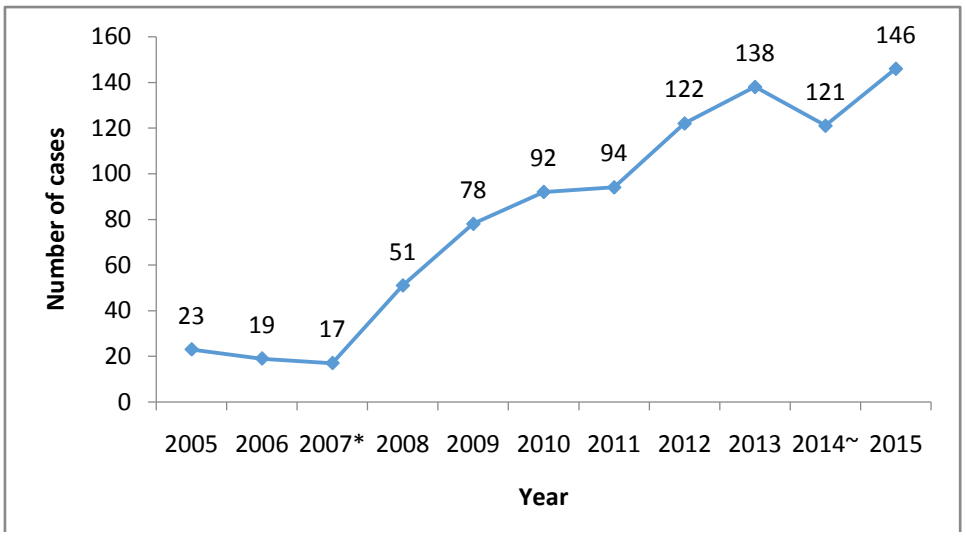

Figure 5: Number of colorectal cancer cases by year

2.12.6 Distribution of colorectal cancer incidence according to CRC sub site affected

Among the 901 charts included for analysis, cases of rectal cancer (482) were more common compared to colon cancer (344) and recto-sigmoid junction cancer (75). Females were diagnosed more often with rectal cancer than their male counterparts (265: 219) while males were diagnosed more often with colon cancer (162: 182). More than two third of patients (50) with recto sigmoid junction cancer were males (Fig. 6).

2.12.7 Distribution of two major sub-sites (colon and rectal) cancer by gender and age

Out of the 822 subjects to be considered, 478 (58.15%) and 344 (41.85%) were reported to have rectal and colon cancer, respectively. Table 3 summarized the percentage distribution of CRC sub-sites by gender and age of patients. There was significant difference between males and females in the probability of getting either colon or rectal cancer (P = 0.027). With regard to age, rectal cancer was found to be common in older adults such that patients aged 80+ years were more susceptible to rectal cancer (78.13%) followed by patients of age 50-54 (65.71%) years. On the other hand, patients in the younger age categories of 20-24 (54.84%) and 15-19 (53.85%) years were more susceptible to colon cancer as compared to subjects in other age categories but the differences were not statistically significant (P = 0.3744) (Table 3).

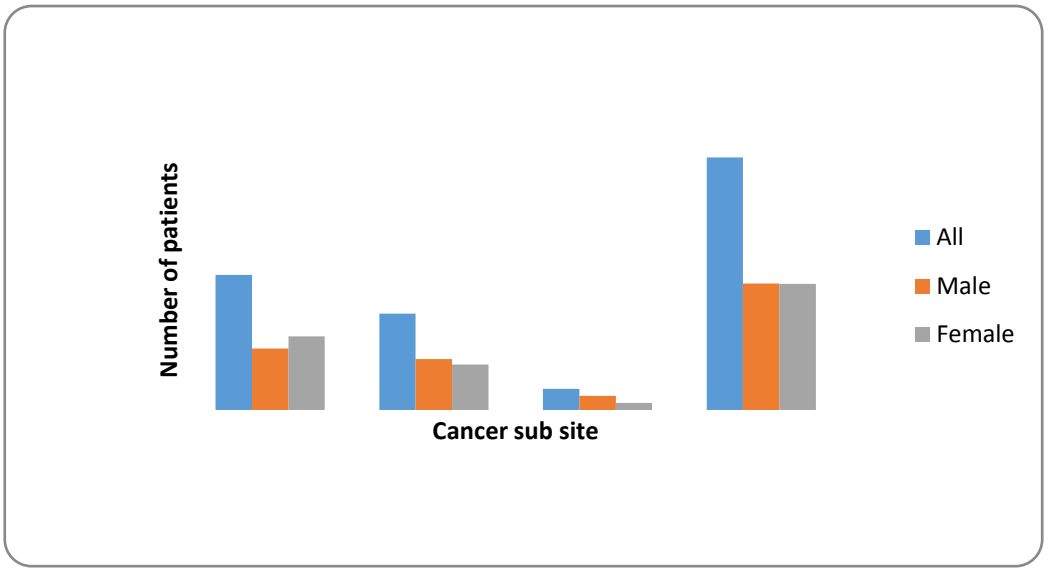

Figure 6: Colorectal cancer distribution by sub-site affected

Table 3: Percentage distribution of colon and rectal cancer by gender and age

Variable	Total Frequency n (%) = 822	Rectal Cancer n (%) = 478(58. 15)	Colon Cancer n (%) = 344(41. 80)	P Value
Gender				
Male	398(48. 36)	216(54. 27)	182(45. 73)	0. 0270
Female	425(51. 64)	262(61. 88)	162(38. 12)	
Age (Years)				
15-19	13(1. 58)	6(46. 15)	7(53. 85)	
20-24	31(3. 77)	14(45. 16)	17 (54.84)	
25-29	54(6. 57)	27(50)	27(50)	
30-34	59(7. 18)	32(54. 24)	27 (45.76)	
35-39	61(7. 42)	35(57. 38)	26(42.62)	
40-44	78(9. 49)	47(60. 26)	31(39.74)	
45-49	77(9. 37)	47(61.04)	35(38. 96)	
50-54	105(12. 77)	69(65.71)	36 (34.29)	
55-59	77(9. 37)	43(55.84)	34 (44.16)	0. 3744
60-64	94(11. 44)	56(59.57)	38 (40.43)	
65-69	62(7. 54)	33(53.23)	29 (46.77)	
70-74	42(5. 11)	23(54.76)	19 (45.24)	
75-79	37(4. 50)	21(56.76)	16 (43.24)	
80+	32(3. 89)	25(78.13)	7(21.88)	

2.12.8 Gender, age and time in relation to colon cancer incidence

The results of univariate analysis for colon cancer (Table 4) shows that there was significantly gender difference (P=0.0428) in risk of having colon cancer, with males at a greater risk. Adjusting for age and time (years), the results of the fitted multivariable log–binomial regression model confirmed that male patients were 1.2 times more likely to

develop colon cancer than their female counterparts [ARR=1.203, 95% CI: 1.02, 1.41]. The risk of having colon cancer was significantly higher to people aged less than 35 years. People aged 15-19 (P=0.0325), 20-24 (P=0.0134**),** 25-29 (P=0.0219**)** and 30-34 (P=0.042**)** years had higher risk of developing colon cancer as compared to older patients (80+years). Higher risk were also observed to people aged 65-69 (P=0. 035) years. People aged 20-24 (ARR=2.43, 95% CI: 1.18, 5.01) years were 2.4 more likely to be diagnosed with colon cancer as compared to older patients (80+years).

With respect to time difference, increase in time (years) was significantly associated with increased likelihood of having colon cancer (P=0. 005). Results of multivariable analysis revealed that there was significantly positive association between time and risk of having colon cancer (ARR=1.05, 95% CI: 1.01, 1.08), with one year increase, the chance of diagnosing a colon cancer case increased by 2 percent (Table 4).

Table 4: Crude and Adjusted Relative Risk of Colon Cancer among CRC Patients

Variable	**Univariate Analysis**				**Multivariable Analysis**			
	RR	**95% CI**		**P-Value**	**ARR**	**95%CI**		**P-Value**
		Lower limit	**Upper limit**			**Lower limit**	**Upper limit**	
Gender								
Male	1. 2027	1.02	1.41	0.0252	0.18	1.01	1.39	0.0428
Female	Reference							
Age (Years)								
15-19	2.46	1.08	5.62	0.0325	2.36	1.04	5.35	0.0408
20-24	2.51	1.21	5.19	0.0134	2.43	1.18	5.01	0.0162
25-29	2.29	1.13	4.64	0.0219	2.19	1.09	4.43	0.0286
30-34	2.09	1.03	4.26	0.042	2.07	1.02	4.20	0.0441
35-39	1.95	0.95	3.99	0.068	1.98	0.97	4.05	0.0604
40-44	1.82	0.89	3.69	0.0991	1.83	0.91	3.72	0.092
45-49	1.78	0.87	3.63	0.1121	1.75	0.86	3.56	0.1199
50-54	1.57	0.77	3.18	0.2124	1.60	0.79	3.24	0.1894
55-59	2.02	1.00	4.07	0.0496	2.03	1.01	4.08	0.0471
60-64	1.85	0.92	3.72	0.0852	1.87	0.93	3.76	0.0772
65-69	2.14	1.05	4.33	0.035	2.04	1.01	4.12	0.0473
70-74	2.07	0.99	4.31	0.0525	2.03	0.98	4.21	0.0575
75-79	1.98	0.93	4.19	0.0756	1.88	0.89	3.98	0.0983
80+	Reference							
Time (years)	1.05	1.01	1.08	0.0052	1.05 (0.02)	1.01	1.08	0.0075

*ARR refer to adjusted relative risk and SE stand for standard error of relative risk

2.12.9 Gender, age and time in relation to rectal cancer incidence

The results of univariate analysis (Table 5) indicated that, gender, time, and age were significantly associated with risk of rectal cancer, with males having lower chance of developing rectal cancer (RR= 0.88, 95% CI: 0.78-0.99) than females. In the multivariable analysis, after controlling for age and time, gender was no longer significantly associated with risk of rectal cancer (P=0.098). With exception of patients in age 15-19 (ARR=0. 1238, 95% CI:0. 34-1.14), 40-44 (ARR= 0.79, 95% CI; 0.61, 1.01) and 50-54 (ARR= 0. 84,95% CI; 0.67, 1.040) years patients in other age categories were significantly less likely to have rectal cancer as compared to patients in 80+ years. Increase in time (years), was significantly associated with decreased likelihood of diagnosing a new rectal cancer patient (ARR=0. 97, 95% CI: 0.95-0.99). With increasing time, the chance of diagnosing rectal cancer decreased by 1.5% per year.

Table 5: Crude and Adjusted Relative Risk of Rectal Cancer among CRC Patients

Variable	**Univariate Analysis**				**Multivariable Analysis**			
	RR	**95% CI**		**P-Value**	**ARR**	**95%CI**		**P-Value**
		Lower limit	**Upper limit**			**Lower limit**	**Upper limit**	
Sex								
Male	0.88	0.78	0.98	0.02480	0.91	0.81	1.02	0.098
Female	Reference							
Age (Years)								
15-19	0.59	0.32	1.09	0.0935	0.62)	0.34	1.14	0.1238
20-24	0.58	0.38	0.89	0.0123	0.59	0.39	0.91	0.0167
25-29	0.64	0.46	0.88	0.0069	0.65	0.47	0.90	0.0088
30-34	0.69	0.52	0.93	0.0162	0.70	0.52	0.94	0.0173
35-39	0.73	0.55	0.98	0.0329	0.74	0.56	0.97	0.0316
40-44	0.77	0.60	1.00	0.0477	0.79	0.61	1.01	0.0608
45-49	0.78	0.60	1.01	0.0587	0.78	0.61	1.00	0.0472
50-54	0.84	0.67	1.06	0.1397	0.83	0.67	1.04	0.1041
55-59	0.71	0.55	0.94	0.0149	0.73	0.56	0.95	0.0212
60-64	0.76	0.60	0.98	0.0319	0.79	0.62	1.00	0.0515
65-69	0.68	0.51	0.92	0.0113	0.69	0.51	0.92	0.0106
70-74	0.70	0.50	0.98	0.0351	0.71	0.51	0.98	0.0358
75-79	0.73	0.52	1.02	0.0621	0.71	0.51	0.99	0.0431
80+	Reference							
Time (years)	0.97	0.95	0.99	0.0069	0.97	0.95	0.99	0.0047

2.13 Discussion

2.13.1 Pattern and distribution of CRC incidence in Tanzania

In previous years, nutritionists in developing countries have focused on childhood malnutrition, protein energy malnutrition, and how to feed the world's population (Prentice, 2006). Currently, WHO estimates 38 million people die annually from non-communicable diseases (NCDs') including cancer with almost three quarters of these deaths occur in low- and middle income countries (WHO, 2011).

In this study we have seen CRC incidence rates are generally increasing for both males and females. A six-fold increase has been seen in a period of eleven years. One quarter of CRC patients were below 40 years of age, with no discernable difference in the distribution of CRC cases among males and females. The majority of female are diagnosed at earlier age than men. Regional distribution shows that Dar es Salaam was disproportionately over represented for CRC in comparison to other regions.

Multiple factors acting either singly or in combination may be responsible for the trends in incidence and distribution of CRC patients in Tanzania. Epidemiological studies are highly suggestive of a direct correlation between the incidence of CRC and several lifestyle factors (Calton *et al.,* 2006; Prentice, 2006; Renehan *et al.,* 2010)

Physical inactivity and excess body weight are two modifiable and interrelated risk factors. It is recommended to be physically active, and to avoid overweight and obesity in order to prevent CRC (Wolin *et al.,* 2009). Higher levels of physical activity are associated with a lower risk of CRC, although the evidence is stronger for colonic than for rectal cancer (WHO, 2011). The proposed biologic mechanisms of physical activities in reducing CRC risk include raised metabolic rate and increased maximal oxygen uptake (Hassan *et al.,* 2010). Long term and regular physical activities increase the body's metabolic efficiency and capacity, as well as reducing blood pressure and insulin resistance (Lee *et al.,* 2007). In Tanzania, the level of physical inactivity has been reported to vary between gender and between rural and urban residents. Studies have reported low physical activity levels in urban areas compared to rural areas (Aspray *et al.,* 2000) and low in women compared to men (Parajuli *et al.,* 2013).

The lack of physical activity has been attributed to the increased incidence of obesity in men and women, another factor associated with CRC (Morrison *et al.,* 2013). Obesity has been linked to CRC in several studies (Bardou *et al.,* 2013; Prentice, 2006; Renehan *et al.,* 2010; WCRF/AICR, 2007). The greater future burden of obesity and non-communicable diseases was predicted to affect developing countries including the world's poorest countries especially urban areas (WHO, 2000). Several biologic mechanisms have been suggested to explain the association between obesity and CRC. Circulating estrogens and decreased insulin sensitivity as a result of abdominal adiposity was related to increased CRC levels (Lee *et al.,* 2007). Together with excess energy intake, metabolic inefficiency has been cited to cause increase in overweight and obesity (Boyle *et al.,* 2000). Prevalence of obesity is high in Tanzania especially among women and urbanites and people with high social-economic status (Shayo *et al.,* 2011; Wollin *et al.,* 2010). Dar es Salaam records the highest prevalence of obese people (Muhihi *et al.,* 2012; Shayo *et al.,* 2011) than other cities (Keding *et al.,* 2011; Nyaruhucha *et al.,* 2003). The rates, especially among women, are almost comparable to those reported in the United States (Flegal *et al.,* 2009).

Another factor for consideration is alcohol consumption. Regular consumption of alcohol is associated with increased risk of developing CRC (Haggar and Boushey, 2009). Younger age onsets as well as increase of tumors in the distal colon are also associated with alcohol consumption (Haggar *et al.,* 2009; Tsong *et al.,* 2007; Zisman *et al.,* 2006). Reactive metabolites of alcohol such as acetaldehyde are suspected to be carcinogenic (Zisman *et al.,* 2006). Additionally, alcohol has been linked to the production of prostaglandins, lipid peroxidation, and the generation of free radical oxygen species (Zisman *et al.,* 2006). Tanzania reports the prevalence of current alcohol consumers to be between 23% and 37% in males and 13% to 23% in females (Mayige *et al.,* 2012). More than 40% of adults in Tanzania consume alcohol (Iacopetta, 2002) with local brews accounting for about 86% of all alcohol consumed (Mayige *et al.,* 2012).

Some authors have suggested the possibility of change in dietary pattern and nutrition transition as the factor for increase in CRC incidence (Hjartaker *et al.,* 2013; Morrison *et al.,* 2013). Diets high in fat, especially animal fat, and low in fibers are a major risk factor for CRC (Hjartaker *et al.,* 2013). Fat is implicated in favoring the development of a bacterial flora capable of degrading bile salts to potentially carcinogenic compounds (Larsson, 2006). High meat consumption has also been associated with development of CRC. Meat

consumption is strongly positively associated with colon cancer than rectal cancer (Larsson, 2006). Possible mechanisms for a positive association of red meat consumption with CRC include the presence of heme iron in red meat and production of heterocyclic amines and polycyclic aromatic hydrocarbons believed to have carcinogenic properties as a result of cooking meats at high temperatures (Kabat *et al.,* 2007; Puangsombat *et al.,* 2012). Eating less fruits and vegetables have been associated with increased risk of CRC (Amine *et al.,* 2002; WHO, 2015a; WHO, 2015b).

Smoking is harmful to the colon and rectum (Zisman *et al.,* 2006) with the carcinogens found in tobacco linked to increasing risk of being diagnosed with CRC and cancerous growth in the colon and rectum, It has been reported cigarette smoking facilitate formation and growth of adenomatous polyps (Botteri *et al.,* 2008). Young age onset of CRC is also linked to cigarette smoking (Tsong *et al.,* 2007; Zisman *et al.,* 2006). Studies shows that 35% of adults smoke regularly in Tanzania and 32% of all cancers at one institute in Dar es Salaam were attributed to tobacco use (Giles, 2010). Almost 20% of Tanzanian males and less than 2% of females aged 25-64 are current smokers (Jagoe *et al.,* 2002).

Gender difference in CRC epidemiology has been established in several studies. Our findings resemble those reported in low incidence populations, such as Thailand, India and Chile (Johnson *et al.,* 2013). Conversely, our findings differ from the work of Chalya *et al.* (2013) and other studies done in Africa where males were the primary CRC group (Curado *et al.,* 2007; Rostato *et al.,* 2013). These latter findings are similar to findings from high risk populations and previously low risk populations but with rising CRC incidence, such as Japan, Hong Kong and Singapore (Morrison *et al.,* 2013). The global cancer estimates suggested that there are more females with CRC than males in developing countries (Ferlay *et al.,* 2015), which may be attributable to methodological differences. Regarding gender-age at diagnosis our findings contradicted those previously reported (Brenner *et al.,* 2007) where female were reported to be diagnosed at older ages than their male counterparts and reports of non-difference (Wei *et al.,* 2004).

The above discussed factors could partially explain why CRC incidence has been increasing in the previous eleven years in Tanzania. However, other considerations should be given equal weight and these include patient awareness and improved data capture (i.e., electronic records at MNH). Other factors such as availability of and accessibility to health services improved, diagnostic methods at MNH, ORCI, and other referral hospitals.

2.13.2 Distribution of colorectal cancer by sub site

In this study more case of rectal cancer were reported compared to colon cancer, a finding similar to those in other African countries (Giles, 2010) but differing from a Tanzanian study (Chalya *et al.,* 2013) which showed prevalence of recto-sigmoid cancer in comparison to other CRC sub-sites. An interesting observation from this study was the decreasing trend in rectal cancer and increase in colon cancer. Rectal cancer was decreasing at an average of 1. 5% per year [ARR=0. 97, 95%CI: 0. 95, 0. 99] while colon cancer was increasing at an average of 2% per year [ARR=1. 05, 95% CI: 1. 01, 1. 08]. Changes in environmental factors as discussed above may be shaping CRC distribution in Tanzania.

In this study we found that gender had no influence on rectal cancer despite being more common among females in the last decade. However, gender is a significant determinant for developing colon cancer with males having more chance than females [ARR=1. 18, 95% CI: 1. 01-1. 39]. Our findings differ from those observed by Curado *et al.* (2007) where, in low incidence populations, sex ratio between these two sub-sites was comparable but rectal cancer was consistently higher among males than colon cancer in high incidence countries.

We also found rectal cancer was more common to people of older age compared to young people while colon cancer was more common to young adults. People aged less than 40 years were more likely to develop colon cancer than people with 80+ years. Our findings align with the current state of knowledge but somehow contrary to what was reported by Rosato *et al.* (2013). In his study, Rosato reported that rectal cancers occurred more in younger patients while colon cancer occurred in patients on average a decade older. Population differences, and exposure to risk factors may account for the difference. Furthermore, alcohol consumption and cigarette smoking were associated more with young onset of CRC (Chalya *et al.,* 2013; Johnson *et al.,* 2013; Tsong *et al.,* 2007).

2.14 Conclusions

CRC cases in Tanzania have shown an upward trend for the period 2005 through 2015. Rectal cancers were most prevalent among the Tanzanian population compared to colon cancer. Colon cancer is increasing at higher rate than rectal cancer. Females were diagnosed at relatively younger age than males. The population category belonging to 50 to 54 years among females and 60 to 64 years among males was the peak age. CRC was equally distributed among males and females. Colon cancer exists most among the young population

while rectal cancer was diagnosed more among older adults. Major towns and cities of Dar es Salaam, Pwani, Kilimanjaro, Arusha, Morogoro, Tanga, and Dodoma had the highest share of CRC patients. Gender of an individual significantly predicted the occurrence of colon and not rectal cancer. As we have seen change in lifestyle, can account in whole or part of the observed trend shift between colon and rectal cancers in Tanzania. As a result, future research directions should include population level longitudinal studies.

CHAPTER THREE

Dietary pattern as a predictor of colorectal cancer among general health population in Arusha Tanzania: A population based descriptive study 2

Abstract

Proper diet is important in preventing many diseases, and CRC is no exception. The aim of this study was to identify major dietary patterns among the general population in Arusha Tanzania to determine whether diet is one of the predictors contributing to the observed pattern and distribution of CRC in Tanzania. A population based cross-sectional study recruited a sample of self-reported healthy individuals residing in four wards of the City of Arusha, Tanzania. A total of 549 participants were recruited on a voluntary basis. The Food Frequency Questionnaire and the World Health Organization (WHO) Step® survey tool were used to collect data. Factor analysis, Pearson correlation (Pearson's r), and logistic regression were used to analyze the data.

Two major dietary patterns, namely "healthy" and "western", and one minor pattern existed among the study population. The "healthy" pattern was generally associated with females (56.2%, p=0.074), people with primary level of education (62.7%, p=0.667), age category of 25 to 44 years (66.3%, p= 0.370), normal range body mass index (BMI) (42.4%, p=0.967), self-employed (78.5%), non-smokers (86.6%) and non-alcohol drinkers (51%), although the differences were not statistically significant. "Western" dietary pattern adherence was associated with area of residence (P=0.0001), gender (P=0.003) and BMI status (P=0.04) in univariate analysis. In multivariate analysis, higher odds were observed in individuals aged 25 to 34 years (OR=1.104, 95%, CI 0.537-2.2267) and 45 to 54 years (OR=1.091, 95%, CI 0.521-2.283), alcohol drinkers (OR=1.2, 95%, CI 0.767-1.877), people with college or high levels of education (OR=0. 853, 95%, CI 0.260-2.803) and OR=0.550, 95%,CI 0. 159-1.897), smokers (OR=1.030, 95%, CI 0.519-2.044) and overweight or obese (OR=2.676, 95%, CI 0.981-7.298) and OR=2.045, 95%, CI 0.767-5.454). These data support our previous hypothesis that diet could be an important potential predictor of the previously observed pattern and distribution of CRC in Tanzania.

[2]**International Journal of Nutrition and Metabolism, Vol. 9(3), pp. 20-29, March 2017**

3.1 Introduction

Colorectal cancer (CRC) is largely attributable to unhealthy lifestyle and behavior patterns (Kirkegaard *et al.,* 2010). Western lifestyle, characterized by being overweight or obese, physically inactive, eating certain types of food, smoking and heavy alcohol drinking are modifiable lifestyle risk factors (Johnson *et al.,* 2013).

Specifically, diet, which is modifiable, is said to account for between 30% and 50% of all CRC incidences and 70% to 90% of CRC prevention (Vargas *et al.,* 2012). The World Cancer Research Fund (WCRF) and the American Institute for Cancer Research (AICR) have classified several food components as being convincing, probable or suggestive causative factors of CRC. The evidence is convincing that foods containing dietary fiber are protective against CRC (WCRF and AICR, 2011). Evidence indicating increased CRC risk with the consumption of red and processed meat, and ethanol from alcoholic beverages is convincing for men and probable for women. Consumption of garlic, milk, and calcium probably protect against this cancer (WCRF and AICR, 2011).

Diet exposures are likely to play a key role in CRC etiology (Chan *et al.,* 2010). Nutrient–nutrient interactions, complementary and synergistic effects of different food components, and difficulties ascribing nutritional effects to single dietary components all play a role (Cross *et al.,* 2010; Fedirko *et al.,* 2011; Johnson *et al.,* 2013; Limsui *et al.,* 2010; Vargas *et al.,* 2012). But there remains a tentativeness and even suspiciousness surrounding this etiological connection. Historically, analysis of the independent effects of specific nutrients or foods revealed several conceptual and methodological limitations yielding inconsistent or conflicting findings (Marmot *et al.,* 2007). Furthermore, the effects of single nutrients may be too small to detect, and assessing the effect that numerous nutrients or food items may produce associations simply by chance (Kant, 2010).

So many researchers have suggested that analyzing diet instead of isolated nutrients or food items may be more suitable, to account for exposure to a variety of foods with complex combinations of nutrients (Kant, 2010; Magalhaes *et al.,* 2012). Dietary patterns represent food and nutrient consumption patterns which have become a focus for nutritional epidemiology as predictive of diseases risk (Miller *et al.,* 2010).

The extant literature demonstrates that certain dietary patterns are associated with risk of colon and rectal cancer. Randi *et al.* (2010) conducted a systemic review of 32 articles:

dietary patterns labeled healthy, prudent, fat-reduced/diet foods, healthy eating index-2005, recommended food and Mediterranean diet scores were all associated with reduced risk of CRC with risk estimates varying from 0.45 to 0.90. In contrast, diets dubbed Western, and traditional patterns were associated with increased risk of CRC with risk estimates varying from 1.18 to 11.7 (Randi *et al.,* 2010). An American-based study identified three dietary patterns: fruit and vegetables, fat-reduced/diet foods, and 'meat and potatoes'. Findings revealed that low-frequency consumption of meats and potatoes and frequent consumption of fruit and vegetables and/or fat-reduced foods were associated with a decreased risk of colorectal cancer (Flood *et al.,* 2008). In another study, four dietary patterns -healthy, Western, drinker, and meat eaters -were identified. The meat-eaters pattern was positively associated with CRC risk (RR=1.58, 95%, CI (0.98-2.53); p=0.02) (Clavel *et al.,* 2006). A systematic review of cohort studies dating from 2000-2011implicatedWestern dietary pattern, mainly consisting of red and processed meat and refined grains, with an elevated risk of development of CRC. Healthy or prudent diet, which consisted of vegetables, fruits, fish, and poultry, were found to be protective against CRC (Yusof *et al.,* 2012). Beyond CRC, in Tanzania a case-control study examined dietary pattern impacts on breast cancer risk among women in the Kilimanjaro Region. A study by Jordan *et al.* (2013) found an increased risk for fatty diet, characterized by a higher consumption of milk, vegetable oils and fats, butter, lard and red meat (OR = 1.42, 95 % CI 1.08–1.87, P =0.01). Findings from other studies have assigned more risk to people following the western dietary pattern than many other dietary patterns.

However, dietary patterns cannot be measured directly (Hu, 2002). Three statistical approaches commonly used include: factor analysis, cluster analysis, and dietary indices. In both factor analysis and cluster analysis, dietary patterns are derived through statistical modeling of extant data (Trichopoulos *et al.,* 2001). Conversely, in the dietary index approach, the indices are created on the basis of previous knowledge of a `healthy' diet (Chiuve *et al.,* 2012). Hence, the current study's focus on current eating behaviors based on available empirical data without a priori hypothesis, supported either factor and cluster analysis, with selection of the former in order to optimize comparison with previous study findings.

This study was conducted to identify major dietary patterns among general health population in Arusha region of Tanzania. It is an extension of a retrospective chart audit study identifying the pattern and distribution of CRC in Tanzania. It was observed that CRC

incidence rates increased for both males and females. Regions of Dar es Salaam, Coast, Kilimanjaro and Arusha had more CRC cases compared to others. The disease was almost equally distributed between males and females, although gender likelihood of diagnosis type (i.e., rectal or colon) was significantly different. There was a 2% increase in incidences levels of colon cancer and 1.5% decrease for rectal cancer every year from 2005 to 2015. Arusha was among the top four regions with higher rates. We hypothesized that; a number of factors may be acting either singly or in combination to influence the observed trend. Epidemiological studies suggest correlation between the incidence of CRC and several lifestyle factors (diet, alcohol intake, cigarette smoking, lack of physical activities etc) and genetic factors (Katalambula *et al.,* 2016). We decided to evaluate the status of these factors in the general population of Arusha Tanzania. Therefore the study goal was to understand local dietary pattern as a potential predictor contributing to the previously observed pattern and distribution of CRC in Arusha Tanzania.

3.2 Methodology

3.2.1 Study area

The study occurred in the Arusha Region, which is located in the north-eastern corner of Tanzania. It lies below the equator between latitudes 2^{o} and 6^{o}. Longitudinally the region is situated between 35^{o} and 38^{o} east of Greenwich. The region has a common border with Kenya in the north, to the east it borders with Kilimanjaro and Tanga Regions. To the south, it shares a border with Manyara Region and to the west with, Shinyanga and Mara Regions (URT, 2016). The main economic activities of Arusha region are agriculture, tourism, mining, and livestock keeping. Both commercial and peasant farming are carried out in the region. Commercial farming is for seed beans, wheat, coffee, and floriculture. Maize and beans though produced by small landholders are grown widely and substantially contribute to the region's economy. Tourism contributes roughly 20% to the region's Gross Domestic Product (GDP). Similarly, the large livestock population is estimated to make an annual contribution of about 20 percent to the region's GDP. Industries and mining sectors contribute roughly 5 and 2 percent to the regional GDP respectively (URT, 2016). Administratively, the Region is subdivided into seven districts including Arusha City. According to the2012 population census, the city had 416 000 individuals (URT, 2016) across 25 wards of which four (i.e., Sekei, Unga Ltd, Muriet, and Sokon I).

3.2.2 Study population

This population based cross-sectional study recruited a sample of self-reported healthy individuals residing in four wards of the City of Arusha, Tanzania.

3.2.3 Study design

A cross-sectional study design was conducted in which quantitative method of data collection was employed.

3.2.4 Inclusion and exclusion criteria

Inclusion criteria were age between 25 to 64 years old, residence in selected wards within Arusha city, voluntary participation in the study; exclusive criteria were non-residents and not consenting.

3.2.5 Ethical considerations

This study received ethical approval from the National Institute of Medical Research Ethical Committee as well as approval by Arusha Regional Commissioner and Arusha City Council. All subjects in the survey participated voluntarily and provided written informed consents.

3.2.6 Sample size and sampling procedure

The sample size was calculated using the Kish and Lisle (1965) formula for cross-sectional studies $N = \frac{Z^2 P(1-P)}{e^2}$

Where N=sample size, Z=level of confidence, P=baseline level of the selected indicator and e=margin of error.

The values were set at P=0.42 (42%) for the purchase diet to be described later (Keding, Msuya, Maass and Krawinkel, 2011); Z=1.96 (at 95% confidence interval); e=0.05. The sample size was adjusted for a non-response rate of 10%.

A total of 549 participants were included in this study. Participants were recruited on a voluntary basis, essentially by self motivation after sensitization. One week before each interview signboards were placed around the study area, neighborhoods and public places were visited to sensitize people through local leaders and selected sensitizers inviting them to

attend a free (no cost) health screening assessment and consultation. The interviews occurred in public places such as dispensaries and schools. The questionnaire and other measurements were carried out by trained medical practitioners.

3.2.7 Assessment of dietary intake

Dietary intake information was collected by the adapted standardized Food Frequency Questionnaire (FFQ), whose reliability and validity had been tested previously (Jordan *et al.*, 2013), to assess recalled average food intake over the previous year. The FFQ was validated in Kilimanjaro the neighboring region to Arusha where these regions share so many things in common including diets. The FFQ included 63 commonly consumed food items. For each food item, participants indicated their average frequency of consumption over the past year by checking 1 of 5 frequency categories ranging from "never" to "daily intake." Alcoholic beverages were excluded in the analysis thus we remained with 58 food items. The remaining 58 food items in the FFQ were sorted into 12 predefined food groups as previously classified by Food and Agriculture Organization (FAO) (Kennedy *et al.*, 2011) to minimize within-person variations in intakes of individual foods (Table 6).

3.2.8 Measurement of other variables

The survey was conducted using the WHO recommended STEP® wise approach questionnaire (WHO, 2008). Trained field staff with medical backgrounds administered the questionnaires, which were developed from core, expanded, and optional variables of the tool.

Table 6: Food groups derived from Food Frequency Questionnaire using FAO food classification

SN	Category	Food groups
1	Cereals	maize on cob, beans and maize mix, stiff porridge, porridge from maize/millet/sorghum, rice, spiced rice (pilau), chapati, bread, donut (mandazi), rice cake, pastas, other cereals
2	White tubers and roots	potato (sweet), potato (Irish), chips/french fries, cassava, yams, crips/potato chips, bananas boiled, bananas roasted/fried, bananastew, others
3	Vegetables	eggplant, tree tomatoes, tomatoes, carrot, pumpkin, cucumber, bitter gourd, okra, Chinese cabbage, cabbage, Ethiopian kale, bitter head lettuce, amaranth, cassava leaves, cowpea leaves, pumpkin leaves, sweet potato leaves (matembele), mnavu, saro, other vegetables
4	Fruits	ripe bananas, mangoes, oranges, melons, avocado, papaya, pineapple, passion, baobab, African plum, coconut, other fruits
5	Meat	chicken, beef, pork, mutton, duck and organ meat
6	Eggs	chicken, duck, guinea fowl or any other egg
7	Fish and other seafood	sardines, dried fish, fried fish, fresh fish
8	Legumes, nuts and seeds	beans, lentils, soybeans, mung beans, peanut butter, cashew nuts, ground nuts, other pulses and nuts
9	Milk and milk products	milk, cheese, yogurt, other milk products
10	Oils and fats	margarine, butter, animal fat, lard, coconut milk, sunflower oil, vegetable oil, palm oil
11	Sweets	tea (+ milk / + sugar), tea (+ sugar), coffee (+ milk / + sugar), soda, juice, cake, cookies, jam, honey, sugar
12	Spices, condiments and beverages	ketchup, garlic, tomato, ginger, onion, chili, herbs, lemon, other spices

Adapted from: Food and Agriculture Organization (Kennedy *et al.*, 2011)

3.2.9 Statistical analysis

Principal component factor analysis was used to identify dietary patterns. Varimax rotation method with Kaiser Normalization to achieve a simpler structure with greater interpretability was used where the rotation converged in 5 iterations. To determine the number of factors to retain, we considered eigenvalues >1, the scree plot, the proportion of variance explained by each factor, and the interpretability of the factors. Confirmation of sampling adequacy of the

food group variables was confirmed using the Kaiser–Meyer–Olkin measure with the resultant value of 0.752. As per a study by Chen *et al.* (2015), food groups with factor loadings between -0.4 and 0.4 were disregarded for defining the dietary patterns.

Pearson and Spearman correlation coefficients examined the correlation of factor scores for each dietary pattern with other participant characteristics. Unconditional logistic regression models were used to calculate the odds ratios (OR) and the corresponding 95%confidence intervals (CI) that were used to interpret the associations between dietary patterns and participant characteristics. All statistical analyses were performed using SPSS™ Version 21.

3.3 Results

3.3.1 Demographic characteristics

Demographic characteristics of the study population are presented on Table 7. Two hundred thirty-three men (42.4%) and three hundred and sixteen women (57.6%), with a mean age (standard deviation) of 40.7 (12.07) years participated in this study. The majority of respondents were between 35 and 44 years (34.6%), while people between 55 to 64 years only represented 15.8% of this study population. With respect to marital status background 356 (64.8%) were married or cohabiting and 27 (4.9%) were widowed. Of the 549 participants, more than three quarters (81.2%) had less than or up to primary education level, 78 (14.2%) had secondary education level while only 16 (2.9%) attained college or higher. Eighty-six percent were self employed compared with only 10% employed by either government or private organizations.

Table 7: Demographic characteristics of respondents

Variable	**Number**	**Percent (%)**
Gender		
Male	233	42.4
Female	316	57.6
Age (years)		
25-34	175	31.9
35-44	190	34.6
45-54	97	17.7
55-64	87	15.8
Education level		
Up to primary level	446	81.2
Secondary level	78	14.2
College and higher levels	25	4.6
Employment status		
Employed (private and government)	60	10.9
Self-employed	473	86.2
Students	16	2.9
Marital status		
Married/cohabiting	356	64.8
Single	136	25.1
Separated/divorced	26	5.1
Widowed	27	4.9

3.3.2 Dietary pattern analysis

The factor analysis of the consumption of 12 predefined food groups yielded two major patterns and one minor pattern. Factor-loading matrixes for the three patterns are listed in Table 8. The larger the loading of a given food item or group the greater the contribution of that food item or group to a specific factor. The first factor, referred to as 'healthy' pattern, was loaded heavily with cereals, vegetables, sweets, fruit, and spices, explaining 22.9% of the variance. The second factor, labeled as 'Western' pattern, was loaded heavily with meat, fish, milk and fat. The second factor explained 13.7% of the total variance. The third pattern, referred to as 'complex carbohydrate and legume' pattern, explained only 4.4% of the total variance, with a positive loading for alcohol, roots and tubers, and legumes.

Table 8: Factor Loadings for the dietary patterns identified in an adult population in Arusha

	Dietary patterns		
	Healthy	**Western**	**Complex carbohydrate and legumes**
Sweets	-0.075	0. 029	0.685
Eggs	-0.089	0.408	0.388
Meats	0.024	0.740	0.102
Fish	0.202	0.313	0.191
Milk	-0.085	0.587	0.142
Cereals	0.700	-0.060	0.054
Roots and tubers	0.139	0.025	0.624
Vegetables	0.800	0.092	0.060
Legumes	0.073	0.170	0.608
Fruits	0.576	0.336	-0.151
Fats	0.125	0.502	-0.055
Spices	0.813	-0.048	0.106

Bold: Food groups with higher loadings than 0.4 that largely characterize the respective dietary pattern.

3.3.3 Univariate analysis between dietary patterns and respondents characteristics

Dietary patterns by different subject characteristics are presented onTable 9. Two major dietary patterns derived by Principal Component Analysis were significantly associated with area of residence. The healthy pattern was characterized by more females than males (56.2%) although the difference was not statistically significant (P=0.074). The majority of subjects in this pattern completed primary level of education (62.7%, P=0.667) and were in the age category of 25-44 years (66.3%, P=0.370). The majority of people with normal body weight followed the healthy dietary pattern (42.4%, P=0.967). With respect to employment status, current smoking and alcohol consumption in the 12 months prior to the survey, the majority of respondents reported as self- employed (78.5%), non-smokers (86.6%) and non-alcohol drinkers (51%). All these variables were not statistically significant.

The western pattern was consumed by a higher proportion of women (54.4%), people aged 25 to 44 years (67.3%), and residents of Sokon I ward (38%). Subjects in this pattern had a lower or up to primary level of education (76.4%), were currently married or cohabiting (63.7%), overweight or obese [as reflect in body mass index (BMI) calculations] (52.4%), but did not report currently smoking cigarette (87%) or consuming alcohol in 12 months prior to the survey (51.4%). Our analyses showed a statistically significant association between this dietary pattern and area of residence (P=0.0001) and BMI status (P=0.04), but did not suggest a significant association with other demographic characteristics of respondents.

Table 9: Association between dietary patterns and selected population characteristics

Variable	Dietary patterns					
	Healthy			Western		
	Yes	%	p value	Yes	%	p value
Area of residence (Ward)						
Muriet	126	27.7	0.0001*	121	28.5	0.0001*
Sekei	53	11.6		49	11.6	
Sokon I	147	32.3		161	38	
Unga Ltd	129	28.4		93	21.9	
Gender						
Male	199	43.8	0.074	193	45.6	0.063
Female	255	56.2		230	54.4	
Age						
25-34	148	32.6	0.370	141	33.3	0.667
35-44	153	33.7		144	34	
45-54	85	18.7		74	17.5	
55-64	68	15		64	15.1	
Education level						
Up to primary level	346	76	0.725	324	76.4	0.511
Secondary level	86	18.9		78	18.4	
College and above	23	5.1		22	5.2	
Marital status						
Never married	122	26.8	0.362	115	27.1	0.164
Currently married/cohabiting	290	63.7		270	63.7	
Separated/divorced	23	5.1		21	5	
Widowed	20	4.4		18	4.2	
BMI status						
Underweight	17	3.7	0.967	12	2.8	0.041*
Normal	193	42.4		190	44.8	
Overweight	118	25.9		111	26.2	
Obese	127	27.9		111	26.2	
Employment status						
Employed(government and private)	50	11	0.821	49	11.6	0.686
Self employed	357	78.5		329	77.6	
Unpaid (retired, students, volunteer or trainees)	48	10.5		46	10.8	
Current smoker						
Yes	60	13.2	0.269	54	12.7	0.671
No	394	86.6		349	87	
Missing	1	0.2		1	0.2	
Consumed alcohol last 12 months						
Yes	223	49	0.112	206	48.6	0.260
No	232	51		218	51.4	

*Statistically significant finding

3.3.4 Multivariate analysis for western dietary pattern

The results of univariate analysis showed that area of residence, gender, and BMI status of respondent were significantly associated with western dietary pattern. In multivariate analysis, individuals of age 25-34 years (OR=1.104, CI: 0.537-2.2267) and 45-54 years (OR=1.091, CI: 0.521-2.283) were more likely to follow this dietary pattern than individuals aged 55-64 years. For an individual who consumed alcohol at least once in the previous 12 months, the chance of following this dietary pattern was 1.2 times higher than those who did not drink alcohol in the specified period (OR=1.2, CI: 0.767-1.877). Comparing people with different levels of education, people with college or higher levels of education had a greater likelihood of following the western dietary pattern than people with low levels of education (OR=0. 853, CI: 0.260-2.803 and OR=0.550, CI: 0.159-1.897). The odds of adhering to this dietary pattern was 1.831 (OR=1.831, CI: 0.633-5.296), 1.045 (OR=1.045, CI: 0.398-2.745) and 1.680 (OR=1.680, CI: 0.458-6.159) higher among not married, married/cohabiting, and separated/divorced individuals respectively than their widowed counterparts.

When people with BMIs of less than 18 were compared to people with BMIs above 25, those in the latter group were more likely to follow this dietary pattern (OR=2.676, CI: 0.981-7.298 and OR=2.045, CI: 0.767-5.454). A similar observation was noted among smokers when compared with non-smokers (OR=1.030, CI: 0.519-2.044). Detailed results are shown on Table 10.

Table 10: Multivariate analysis of western dietary pattern and selected population characteristics

Variable	Parameter estimate	Standard error	P-value	Odds ratio	95% CI	
					Lower limit	Upper limit
Age						
25-34	0.099	0.367	0.788	1.104*	0.537	2.267
35-44	-0.014	0.349	0.969	0.987	0.498	1.955
45-54	0.087	0.377	0.817	1.091*	0.521	2.283
55-64	Reference	.	.	.		
Alcohol drinkers						
Yes	0.182	0.228	0.426	1.200*	0.767	1.877
No	Reference	.	.	.	.	.
Education level						
Up to primary level	-0.159	0.607	0.794	0.853	0.260	2.803
Secondary level	-0.599	0.632	0.344	0.550	0.159	1.897
College and above	Reference	.	.	.	.	.
Marital status						
Not married	0.605	0.542	0.265	1.831*	0.633	5.296
Married/cohabiting	0.044	0.493	0.930	1.045*	.398	2.745
Separated/divorced	.519	.663	0.434	1.680*	0.458	6.159
Widowed	Reference	.	.	.	.	.
Employment status						
Employed	-0.030	0.503	0.953	0.971	0.362	2.602
Self employed	-0.221	0.365	0.545	0.802	0.392	1.640
Unpaid	Reference	.	.	.	.	.
BMI status						
Normal	1.224	0.496	0.014	3.402*	1.286	8.995
Obese	0.984	0.512	0.054	2.676*	0.981	7.298
Overweight	0.716	0.500	.153	2.045*	.767	5.454
Underweight	Reference	.	.	.	.	.
Area of residence (ward)						
Muriet	1.779	.346	0.0001	5.926*	3.009	11.668
Sekei	1.112	.420	0.008	3.041*	1.335	6.925
SokonI	1.215	.266	0.0001	3.372*	2.003	5.676
UngaLtd	Reference	.	.	.	.	.
Gender						
Male	0.449	0.248	0.070	1.567*	0.963	2.549
Female	Reference	.	.	.	.	.
Current smokers						
Yes	0.029	0.350	0.007	1.030*	0.519	2.044
No	Reference	.	.		.	.

*OR greater than the referent group

3.4 Discussion

In this study we consider an emerging and under-reflected topic linking dietary patterns to non-communicable diseases in developing contexts. To our knowledge this study is unique in Tanzania considering the link between CRC and dietary patterns. Previous aligned works have included a study linking dietary pattern and breast cancer (Jordan *et al.,* 2013) and one demonstrating a relationship between dietary pattern and nutrition transition among women in Tanzania (Keding *et al.,* 2011).

The dietary pattern gives an overall picture of the food consumption trends segueing to the linkage between diet and disease occurrence; in this case, dietary consumption pattern to CRC occurrence. Many ecologic studies implicate diet in CRC etiology with different studies highlighting the high loadings for red and/or processed meats, refined grains, high-fat diets, sweets, and dairy products (Randi, 2010; Yusof *et al.,* 2012). Different names have been used by different authors and these include but not limited to 'western,' 'pork and processed meat,' 'pork and processed meat, and potatoes,' 'meat, potatoes and refined grains', 'high fat, meat and potatoes' and others. On the other hand, 'prudent,' 'healthy,' 'vegetables,' and 'fruit and vegetables' dietary patterns, which tend to have high loadings for fruit, vegetables, poultry, fish, low-fat dairy, and whole grains, have shown negative association with colorectal cancer although some studies have yielded inconsistent findings (Magalhaes *et al.,* 2012; Randi, 2010). The differences may be due to methodological limitations, differences in population characteristics and/or study designs.

In our study two major and one minor dietary pattern were identified as having significance. The dietary patterns derived from this data resembled those from previous studies which used similar factor analytic approach (Chen *et al.,* 2015; Keding *et al.,* 2011). What we labeled as a western dietary pattern was similar to two dietary patterns found in the breast cancer study in the northern Tanzania. The'chapati' and the 'fatty' pattern includes rice, nuts, eggs, chapati (unleavened East African flat wheat bread), legumes, bread, soda and red meat, high consumption of milk, butter, lard, vegetable oils and fats, and a low consumption of sunflower oil and tea (Jordan *et al.,* 2013). This second pattern was the 'purchase' pattern characterized by bread or cakes, sugar and tea. It was called the 'purchase pattern' because bread and cakes, such as doughnuts, chapati, mandazi, or halfcake, are usually deep-fried or baked in oil and often bought (hence, purchased) from small shops (Keding *et al.,* 2011).

The Western pattern in our study aligns with Keding *et al*. (2011) description of the nutrition transition in Tanzania (Keding *et al.,* 2011). This pattern may be related to a 2% increase in rate of colon cancer and 1.5% decrease in rate of rectal cancer found in the pattern and distribution of CRC in Tanzania study (Katalambula *et al.,* 2016). Evidence has linked colon cancer with lifestyle factors more than rectal cancer (Pischon *et al.,* 2006). Consumption of meat and milk, increased access to junk food and soft drinks, and rising food consumption away from home have increased prevalence in Tanzanian current dietary patterns. In a case control study by Tayyem *et al.* (1998), which collected dietary data from 220 subjects previously diagnosed with CRC, and 281 control subjects, factor analysis revealed three major dietary patterns, namely "Healthy Pattern", "High Sugar/High Tea Pattern" and "Western Pattern". After adjusting for confounding factors, the Western pattern was found to be significantly associated with an increased risk of developing CRC (OR = 1.88; 95% CI = 1.12–3.16). Slattery *et al*. (1998) established six different dietary patterns, where two of them 'Western' and 'Prudent' patterns were the most important in relation to CRC. The Western pattern was rich in red and processed meats, fast food, eggs, margarine, potatoes and refined grains. This pattern was associated with a higher risk of colon cancer (Slattery *et al.,* 1998). Other studies which associated Western dietary pattern and CRC showed similar findings (Magalhaes *et al.,* 2012; Yusof *et al.,* 2012).

The higher a participant's affiliation with the Western dietary pattern, the higher was his/her BMI. Upon further analyses, however, adjusting for BMI did not attenuate associations for the Western pattern, suggesting that BMI was not in fact a mediator due to methodological limitations in previous studies. This finding is consistent with a previous report on the linkage to red meat intake (Vergnaud *et al.,* 2010). We also found that our participants differed in following the Western dietary pattern according to demographic and lifestyles characteristics. Participants aged 25-34 and 45-54 were more likely to follow the Western dietary pattern compared to the old one. Similarly, single, married/cohabiting, and divorced individuals tended to choose this type of food item more frequently than widowed ones. As well, lower adherence to the western dietary pattern seemed among more educated participants, as seen by Olinto *et al.* (2011) who indicated these individuals were generally more likely to have good incomes and access to information which potentially changed their diet as well as other behaviors. However there are contradictory findings offered by Rezazadeh *et al.* (2010). New access to technologies (e.g., cheap edible oils, foods with excessive 'empty calories', modern supermarkets, and food distribution and marketing) and regulatory environments (e.g., free

flow of goods, services, and technologies) are changing diets in low and middle-income countries.

3.5 Conclusion

Two major dietary patterns, namely healthy and western patterns, exist among the study populations. Consumption of alcohol at least once in the previous 12 months, current smoking, and high levels of education puts people at higher likelihood of partaking in a dietary pattern with an elevated risk for CRC. Findings from this study shed light on the possible linkage between diet and colorectal cancer in Tanzania. We recommend a large study with robust methodology which can establish linkage.

CHAPTER FOUR

Prevalence and predictors of colorectal cancer lifestyle risk factors in Arusha City Tanzania: A cross sectional descriptive study[3]

Abstract

Unhealthy diet, excessive alcohol consumption, overweight and obesity, smoking and sedentary lifestyle, contribute to an increased risk of CRC. Despite the increasing burden of this disease, information on the prevalence and predictors (of risk factors) for CRC is limited in Tanzania.

A population based cross-sectional study was conducted in four wards namely Sekei, Muriet, Unga limited and Sokoni I in Arusha City, Tanzania. A total of 549 participants were included in this study. Spring scale and measuring tape were used to measure weight and height, respectively. The WHO formula and standards were used to calculate and categorize people according to their BMI status. The WHO Step® survey tool was used to collect data on tobacco smoking and alcohol intake while the Global Physical Activity Questionnaire was used to determine physical activity status. Pearson correlation and logistic regression were used to analyze the data.

Obesity was found in 25% of participants, over weight was present in 28% of the study participants. Prevalence of obesity in females was higher than in males (26.9% and 23.6% ,respectively). Physical activities, years spent in school, western dietary pattern and age were the main determinants of overweight and obesity.

The prevalence of vigorous, moderate and low physical activity for both sex were 18.6%, 54.1% and 42.3%, respectively.Healthy dietary pattern was significantly associated with physical activities. The prevalence of smoking was 12.2% and was more common in men than women, 24.5 vs. 3.2%, respectively. Gender, education level and alcohol consumption were significant determinants of tobacco smoking. The prevalence of current alcohol drinkers was 21.5%; alcohol consumption was more common in men than women (22.7 vs. 20.6% respectively).

[3] Manuscript

This study revealed a high prevalence of CRC risk factors in the study population. Some of these factors seem to co-exist. Therefore there was a need of not considering unhealthy lifestyle behaviors in isolation during planning of interventions.

4.1 Introduction

Currently, there is extensive evidence that unhealthy lifestyle and behavior patterns such as unhealthy diet, excessive alcohol consumption, overweight and obesity, smoking and sedentary lifestyle, contribute to an increase in morbidity and mortality due to the development of chronic diseases such as CVD, type 2 diabetes and cancer, among others (Johnson *et al.,* 2013).

An association between alcohol consumption and colorectal cancer had been reported by more than 50 prospective and case–control studies, with no difference in the risk for colon and rectal cancers (Baan *et al.,* 2007). The World Cancer Research Fund report considers the evidence for an association of alcohol intake with these sites as convincing (McMichael, 2008). Quantitatively, a borderline statistically significant 16% risk increase for people drinking 30–45 g per day of alcohol and 41% risk increase for people drinking greater than 45 g per day was observed in a pooled analysis of eight cohort studies (Cho *et al.,* 2004). Another meta-analysis of cohort studies found a 15% increase in the risk of colon or rectal cancer for an increase of 100 g alcohol intake per week with no difference between men and women(Moskal *et al.,* 2007). The WCRF (2007) conducted a meta-analysis of eight studies of colon cancer and yielded a combined RR of 1.09 (1.03–1.14) per 10 g intake per day, and another meta-analysis of nine studies of rectal cancer yielded an RR of 1.06 (1.01–1.12) per 10 g intake per day (McMichael, 2008).

The relationship between smoking and colorectal cancer (CRC) risk remains controversial. Several large cohort studies linked smoking with CRC, (Giovannucci *et al.,* 1994; Heineman *et al.,* 1994) and, in a meta-analysis, it was reported that smoking doubles the risk of colorectal polyps (Botteri *et al.,* 2008). However, other studies have failed to significantly detect a relationship between smoking and CRC (Akiba, 1994; Freedman *et al.,* 1996). This inconsistency among studies has been associated with difference in study designs, population characteristics, and the difference in treating the most likely confounders, such as diet, alcohol, physical activity, and body mass index (Humans, 2004). The association between cigarette smoking and CRC depends on the number of cigarettes smoked, the amount of time exposed to them, and the age when the habit started, so the relation with colorectal cancer

appears after a sufficiently long and continuous period of exposure (up to 35-40 years) (Franco *et al.,* 2005). Explanation for the increased risk with cigarette smoking is unknown, however cigarette smoke contains over 60 carcinogens and free radicals, which could affect the colorectal mucosa for example, altering the expression of important cancer-related genes (Giovannucci, 2001).

Many studies conducted in diverse populations show that more physically active individuals, especially lifelong, are at a lower risk for colon cancer and this effect is independent of other risk factors such as diet and body weight (Thune and Furberg, 2001; Samad *et al.,* 2005). The World Cancer Research Fund summarizes the evidence as 'convincing' for cancer of the colon (Wiseman, 2008) while the evidence were considered sufficient and convincing by the International Agency for Research on Cancer (IARC) evaluation and WHO/FAO technical report respectively (IARC and WHO, 2004; WHO, 2003). Different types of physical activity, even a relatively moderate level of activity for example, walking fast for one hour daily or moderate jogging 3-4 hours per week, which can be achieved by many individuals can reduce colon cancer risk (Martínez *et al.,* 1997).

The underlying mechanisms of protective effects of physical activities have been hypothesized to be related to insulin resistance (Abbott, 2005; Wolin *et al.,* 2009) and reduction in intestinal transit time, which would reduce the contact period between the colon mucosa and cancer promoting contents (secondary bile acids, dietary toxics). It also may reduce body mass index (McTiernan *et al.,* 1998; Samad *et al.,* 2005). With all the evidence above, the current recommendation is to be physically active, and to avoid overweight and obesity in order to prevent CRC (Wolin *et al.,* 2009).

Epidemiological data suggest that obesity is associated with a 30–70% increased risk of colon cancer in men, although the association is less consistent in women. Similar trends exist for colorectal adenoma, although the risk appears lower (Aleksandrova *et al.,* 2012). The association between overweight and obesity and CRC is confirmed by the report of the World Cancer Research Fund (WCRF) Panel on Food, Nutrition, Physical Activity, and the Prevention of Cancer which considered that there was convincing evidence for an association between BMI and colon cancer (Marmot *et al.,* 2007). Furthermore; the International Agency for Research on Cancer Handbook on Weight Control and Physical Activity concluded that overweight and obesity are related to cancer of the colon and several

others such as, endometrial, kidney and esophagus, as well as postmenopausal breast cancer (Vainio *et al.*, 2002)

Despite the increasing burden of non-communicable diseases (NCDs) including CRC in Tanzania, information on the prevalence and predictors of preventable risk factors for NCDs is restricted. This population-based survey aimed to describe the prevalence and predictors of lifestyle risk factors for CRC in Arusha City.

4.2 Methodology

4.2.1 Study area

Arusha Region is one of Tanzania's 30 administrative regions. Its capital and largest city is the city of Arusha. Arusha City is located close to the foot of Mount Meru. According to the 2012 National Census, Arusha city has a population of 416 000 people with a growth rate of 4.1% (The United Republic of Tanzania, 2015). Arusha is one among the most developed regions of Tanzania with a HDI of 0.721 (World Bank Group, 2015). Administratively the city is divided into 25 wards and most of them are found in the urban area and very few in the peri urban all residents of the district are considered urban (The United Republic of Tanzania, 2015). The region is bordering with Kenyato the north, Kilimanjaro to the east, Manyara and Singida regions to the south, and Mara and Simiyuregions to the west. Arusha Region is a global tourist destination and several national parks and reserves are found in this region including Ngorongoro Conservation Area, Arusha National Park, the Loliondo Game Controlled Area, and part of Lake Manyara National Park (The United Republic of Tanzania, 2015). The city is divided into 25 municipal wards, four of which were randomly selected for this study.

4.2.2 Recruitment of participants

Consenting adults (25-64 years) within the wards of Muriet, Sekei, Sokon I and Unga Ltd. in the City of Arusha, Tanzania were included in this study. A number of interview/screening and follow up sessions took place in public community buildings. A first come, first served model was adopted. More ddetails on participants recruitment have been explained elsewhere (Katalambula *et al.,* 2017).

4.2.3 Data collection

(i) Height and weight measurement and calculation of BMI

A spring scale was used to measure weight while height was measured using measuring tape affixed to the wall. Body mass index (BMI) was calculated based on the standard cut-off points set by the WHO (2016). BMI was categorized into four major categories (underweight, normal, overweight and obese).

(ii) Physical activities, alcohol intake and cigarette smoking

Following physical screening to determine BMI, participants were interviewed regarding alcohol consumption, and cigarette smoking using the standardized Swahili translated version of the WHO STEPwise© survey questionnaire (WHO, 2016). The Global Physical Activity Questionnaire was used to estimate levels of physical activities. Duration, intensity and frequency of physical activities performed in a typical week were used to determine Metabolic Equivalent (MET). Metabolic Equivalent (MET) was used as the unit for measuring physical activity energy expenditure. According to WHO (2016) definition, one MET is equivalent to the energy cost of sitting quietly (1 kcal/kg/hour). Intensity of physical activity was assigned a value called MET value. A moderate intensity activity during work, commuting and recreation was assigned a value of 4 METs; vigorous intensity activities were assigned a value of 8 METs. Formulas for computation of MET-minutes are based on the intensity of specific physical activities. Physical activity levels were classified into vigorous, moderate and total as defined by the GPAQ analysis framework. Vigorous physical activities were defined as vigorous intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week. Moderate physical activity was defined as three or more days of vigorous-intensity of at least 20 minutes per day or five or more days of moderate-intensity and/or walking of at least 30 minutes per day. Total physical activity was defined as five or more days of any combination of walking, moderate-or vigorous-intensity activities accumulating at least 600 MET-minutes/weeks. Low activity defined as having no or some activities but not sufficient enough to meet the classification of vigorous, moderate or total physical activities (GPAQ, 2016).

4.3 Data analysis

4.3.1 Descriptive statistics

The data collected were entered in Excel™ and analyzed by Statistical Analysis System™ (SAS) Version 9.4 and SPSS™ Version 21. The prevalence of categorical variables is reported as proportions with 95% confidence interval (CI) while continuous variables are reported in form of means.

4.3.2 Analytic statistics

Chi-squared test (Pearson chi-squared) was performed to test the relationship between socio-demographic and physical activity, smoking, alcohol intake and BMI status variables, at a significance level of 0.05.

Classification of physical activities provided a binary response success (met standards) and failure (not met standard) which follow a binomial distribution. Logistic regression was used to model non-linear relationship between the probability of success (met standards) and risk factors. The same logistic regression model was used for alcohol drinking and cigarette smoking variables; the alcohol drinking individuals were classified as drinkers and non-drinkers while smoking individuals were classified as smokers and non-smokers.

The probability (odds ratio) of an individual to meet recommended level of physical activities, drink alcohol or smoke cigarette was associated with other variables. The estimated probabilities were considered to be associated with the risk factors if the p–value was less than cut-off point (p-value<=0.05). The models used were as follows:-

(i) Probability that an individual met recommended levels of physical activities against risk factors:

$$\text{logit}\,[\text{Prob}(Y_i = \text{met standard}|\text{risk factors})] = \alpha + \beta x_i \quad \ldots\ldots 1$$

(ii) Probability that an individual is drinking alcohol against risk factors:

$$\text{logit}\,[\text{Prob}(Y_i = \text{drinking alcohol}|\text{risk factors})] = \alpha + \beta x_i \quad \ldots\ldots 2$$

(iii) Probability that an individual is current smoking against risk factors:

$$\text{logit}\,[\text{Prob}(Y_i = \text{current smoking}|\text{risk factors})] = \alpha + \beta x_i \quad \ldots\ldots 3$$

Where: α = constant coefficient, β = regression coefficient and x_i = risk factors

The BMI status of individuals are ordinal outcomes, that is an individual can be classified as *normal* if BMI is between 18 and 20, *underweight* if BMI is less than 18, *overweight* if BMI is between 20 and 25, and *obesity* if BMI is more than 25. A proportional odds logistic regression was used to compare BMI and other variables. The risk factors with p-value less than 0.05 were considered to be associated with probability of observing normal BMI (reference category) versus higher level outcomes.

Probability of observing an individual with normal BMI versus higher outcomes against risk factors:

$$\text{logit}\,[\text{Prob}(Y_i \leq k \,|\text{risk factors})] = \alpha + \beta x_i \ldots\ldots\ldots\ldots\ldots\ldots 4, \quad k$$
$$= \text{levels of ordinal outcomes (normal, underweight, overweight and obesity)}$$

Where: α = constant coefficient, β = regression coefficient and x_i = risk factors

4.4 Results

4.4.1 General characteristics of the study population

A total of 650 eligible adults participated in the survey and consented. Of these, 101 (15.54%) had incomplete data set thus were removed from analysis. The final sample had 549 (84.46%) respondents. The average age of participants was 40.7 years (SD=12.07). Of the 549 participants who were included in the analysis 57.6% were female and 81.2% had less than or up to primary level of education, while 34.6%,and were in the 35 to 44 year age range. The fewest participants were 55 years and older (15.8%) while more than two thirds (86.2%) were self-employed, and more than half (64.8%) were married or cohabiting (Table 11).

Table 11: Demographic characteristics of respondents

Variable	Number	Percent (%)
Gender		
Male	233	42.4
Female	316	57.6
Age (years)		
25-34	175	31.9
35-44	190	34.6
45-54	97	17.7
55-64	87	15.8
Education level		
Up to primary level	446	81.2
Secondary level	78	14.2
College and higher levels	25	4.6
Employment status		
Employed (private and government)	60	10.9
Self-employed	473	86.2
Students	16	2.9
Marital status		
Married/cohabiting	356	64.8
Single	136	25.1
Separated/divorced	26	5.1
Widowed	27	4.9

4.4.2 Prevalence of overweight and obesity and their associated factors

The mean body mass index was almost the same for male (26.083±0.357SE) and female 307SE) and for both sex (26.0958±0.232SE) (Table 12). Obesity was found in 25% (141/549) of participants. Overweight was present in 28% (152/549) of the study participants as shown in Fig. 7.

Table 12: Mean Body Mass Index (BMI) of the study sample

Risk Factor	Mean± SE		
	Both sex	**Male**	**Female**
Mean body mass index - BMI (kg/m2)	26.0958±0.232	26.083±0.357	26.105±0.307

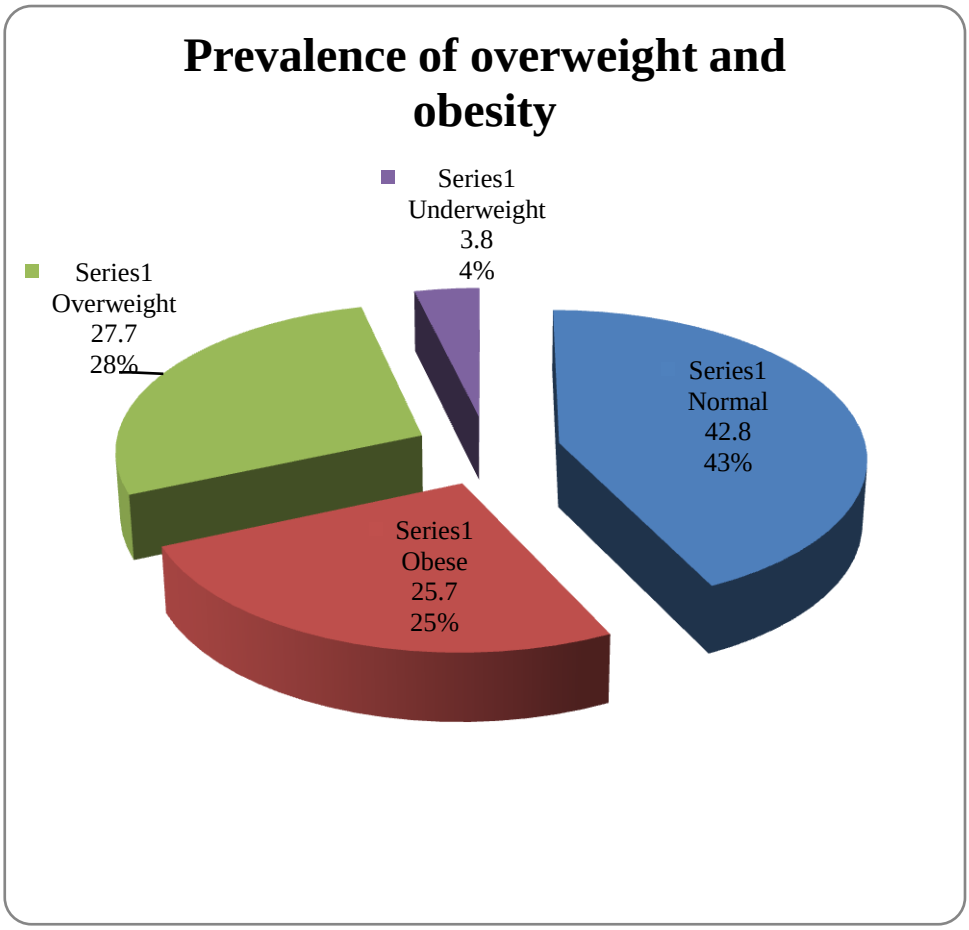

Figure 7: Body Mass Index distribution among study sample

4.4.3 Overweight and obesity in relation to other variables

Prevalence of obesity in females was higher than in males (26.9% and 23.6%, respectively). The prevalence of obesity (33.3%) was highest among respondents who were widowed although not statistically significant (P=0.472) (Table 13).

Obesity prevalence was highest (38.7%) among older people age 45-54 years closely followed by age group 55-64 years (35.7%). Age group differences in obesity were statistically significant, (P< 0.001) (Table 13). Prevalence of obesity was higher in participants with secondary level of education (26.7%) compared to those with primary level (25.4%), and college level of education (23.1%), (P= 0.478) (Table 13). It was noted that, those who were employees had the highest prevalence of obesity (28.3%), followed by those who were self employed (25.9%) while those who were neither employees nor self employed had obesity prevalence of 7.6%, (p < 0.001, for trend.) (Table 13).The prevalence of obesity

was highest among those with low levels of physical activity (35.3%) as compared to those with high levels (18.3%) (P< 0.001) (Table 13). Prevalence of obesity was higher among those who drunk alcohol in the past 30 days (19.5%) compared to those who did not drink alcohol in the past 30 days(18.6%) but it was not statistically significant, (P=0.797) (Table 12). The prevalence of obesity was more frequent in people who tested positive (71.4%) for fecal occult blood test compared to those who tested negative (25.1%) and the difference was statistically significant (P=0.04).

Table 13: Association of BMI with other variables

Variable	Underweight n (%)	Normal n (%)	Overweight n (%)	Obese n (%)	P Value
Gender					
Male	7(3)	105(45.1)	66(28.3)	55(23.6)	0.626
Female	14 (4.4)	131(41.5)	86(27.2)	85(26.9)	
Age (Years)					
25-34	3(2.2)	78(58.2)	42(31.3)	11(8.2)	0.0001
35-44	11(5.7)	86(44.6)	50(25.9)	46(23.8)	
45-54	4(3.2)	35(28.2)	37(29.8)	48(38.7)	
55-64	3(3.1)	37(37.8)	23(23.5)	35(35.7)	
Education level					
Up to primary level	15(3.6)	185(44.3)	112(26.8)	106(25.4)	0.478
Secondary level	5(4.8)	44(41.9)	28(26.7)	28(26.7)	
College and higher levels	1(3.8)	7(26.9)	12(46.2)	6(23.1)	
Employment status					
Employed	2(3.3)	25(41.7)	16(26.7)	17(28.3)	0.873
Self employed	15(3.5)	184(42.9)	119(27.7)	111(25.9)	
Unpaid jobs	4(6.7)	27(45)	17(28.3)	12(20)	
Marital status					
Married/cohabiting	17(4.8)	153(43.0)	97(27.2)	89(25)	0.472
Single	2(1.4)	55(39.9)	43(31.2)	38(27.5)	
Separated/divorced	1(3.6)	15(53.6)	8(28.6)	4(14.3)	
Widowed	1(3.7)	13(48.1)	4(14.8)	9(33.3)	
Current smokers					
Yes	2(3.0)	34(50.7)	24(35.8)	7(10.4)	0.02
No	19(3.9)	202(41.9)	128(26.6)	133(27.6)	
Physical activities					
Met recommended level of activity (defined as > 600 MET-minutes per week)*	16(5.0)	168(53.0)	75(23.7)	58(18.3)	0.0001
Didn't meet recommended level of activity (defined as > 600 MET-minutes per week)*	5(2.2)	68(29.3)	77(33.2)	82(35.3)	
Drunk alcohol in the past 30 days					
Yes	3(2.5)	57(48.3)	35(29.7)	23(19.5)	0.797
No	1(3.8)	14(53.8)	8(30.8)	3(11.5)	
Fecal occult blood test					
Positive	0(0.00)	2(28.6)	0(0.00)	5(71.4)	0.04
Negative	20(4)	210(42.5)	140(28.3)	124(25.1)	

4.4.4 Determinants of BMI status

Years spent in school, physical activities and age group were significantly related to BMI status. Years in school was positively (OR>1) related to BMI status, that is, spending more years in school was highly associated with increased BMI (OR = 1.066). Overall, a person spending more years in school is likely to become obese The results also revealed that, physical activities were negatively (OR<1) related to BMI, Respondents who met the recommended levels of physical activities had lower odds of being overweight/obese and vice versa (OR= 0.423).

With respect to age group Body Mass Index increased with age, people aged 35 -44years had an odd of 1.427 and people aged 45- 64 years had almost two times (OR = 1.992) higher risk of having higher BMI compared to people aged 24-34 years. The results showed that, BMI was increasing from low to high age groups, suggesting that old persons were at higher risk than young persons (Table 14).

Table 14: Determinants of BMI status

Risk factors	OR	SE	P- value	95% CI	
				Lower limit	Upper limit
Years spent in school	1.0662	0.02721	0.018	1.01	1.12
Western dietary pattern	1.0656	0.1997	0.750	0.75	1.58
Physical activities (MET)	0.4232	0.1672	0.000	0.30	0.59
Drunk alcohol last 30 days	0.7193	0.1978	0.090	0.49	1.79
Age (ref. 25 -34) years					
35 – 44	0.5645	0.220	0.009	0.37	0.87
45 - 64	1.9917	0.1928	0.000	1.36	2.91
Marital status	0.9691	0.1061	0.767	0.79	1.19
Constant1 (underweight)	0.0355	0.4026	0.028	0.02	0.08
Constant 2 (overweight)	0.9144	0.3399	0.452	0.17	1.78
Constant3 (obesity)	3.4794	0.3437	0.628	1.77	6.82

* OR = Odds Ratio and SE = Standard Error

4.4.5 Prevalence of physical activities

In this study sample only 25.3% of males and 13.6% of females met WHO recommendations of vigorous physical activities and the difference between the two genders was statistically significant (p< 0.0001). Fifty nine point seven percent (59.7%) of males and 50% of females met the WHO recommended levels of moderate physical activities (P= 0.015) while 36.9% of males and 46.2% of females had low levels of physical activities defined as <600 MET-

minutes per week (P= 0.018). The prevalence of vigorous, moderate and low physical activity for both sexes was 18.6%, 54.1% and 42.3%, respectively (Table 15).

Table 15: Prevalence of physical activities

Physical activities	Gender			P value
	Both n (%)	Male n (%)	Female n (%)	
Percentage who met WHO recommendations of vigorous physical activities (defined as 75 minutes of vigorous-intensity activity per week)	102 (18.6)	59 (25.3)	43 (13.6)	<0.0001
Percentage who met WHO recommendations of moderate physical activities (defined as 150 minutes of moderate-intensity activity per week)	297 (54.1)	139 (59.7)	158 (50)	0.015
Percentage with low levels of activity (defined as < 600 MET-minutes per week)*	232 (42.3)	86 (36.9)	146 (46.2)	0.018

4.4.6 Association between physical activity levels and other variables

The association between physical activity levels and other variables are presented in Table 6. The prevalence of adequate physical activity was higher among the 25-34 age group (62.7%), those with secondary level of education (64.8%) normotensive (63.2%) and individuals with normal blood sugar (55.7%). Overall, physical activity energy expenditure did not show any significantly association with age, level of education or marital status (Table 16).

Intensity of Physical activity (vigorous) had a significant association with age, smoking status, and diet. Although it was not significant, vigorous physical activity energy expenditure also had an association with smoking and alcohol intake. Participants who were more than 35-44 years old, secondary level of education, employed, married or cohabiting and those with normal blood sugar were involved in moderate intensity occupations than their counterparts. Their differences were not significant (Table 16).

4.4.7 Determinants of physical activities

In multivariate analysis, healthy dietary pattern was significantly associated with physical activities. Adherent of healthy dietary pattern were 5.6577 times more likely to be physically active than non adherent (Table 17). Marital status was found to be significantly associated with physical activities. Separated/divorced individuals were less likely to meet the

recommended levels of physical activities than married/cohabiting individuals (OR= 0.861). People with normal body weight were two times (OR= 2.224) most likely to meet the recommended levels of physical activities than underweight people while the opposite was observed among overweight/obese (Table 17).

Table 16: Association between physical activities and other variables

Variable	Vigorous n(%)	P value	Moderate n (%)	P value	MET equivalent n (%)	P Value
Age (Years)						
25-34	35(26.1)		71(53.0)		84(62.7)	
35-44	47(24.4)	<0.0001	114(59.1)	0.363	116(60.1)	0.231
45-54	15(12.1)		63(50.8)		67(54)	
55-64	4(4.1)		49(50.0)		50(51)	
Education level						
Up to primary level	78(18.7)		220(52.6)		235(56.2)	
Secondary level	17(16.2)	0.691	64(61.0)	0.283	68(64.8)	0.262
College and higher levels	6(23.1)		13(50)		14(53.8)	
Employment status						
Employed	13(21.7)		36(60.0)		16(26.7)	
Self employed	74(17.2)	0.411	226(52.7)	0.444	119(27.7)	0.873
Unpaid jobs	14(23.3)		35(58.3)		17(28.3)	
Marital status						
Married/cohabiting	72(20.2)		202(56.7)		97(27.2)	
Single	21(15.2)	0.255	71(51.4)		43(31.2)	0.472
Separated/divorced	6(21.4)		13(46.4)	0.262	8(28.6)	
Widowed	2(7.4)		11(40.7)		4(14.8)	
Current smokers						
Yes	19(28.4)	0.022	38(56.7)	0.372	40(59.7)	0.729
No	82(17)		259(53.7)		277(57.5)	
Healthy dietary pattern						
Yes	86(18.9)	0.561	240(52.7)	0.162	75(23.7)	0.0001
No	15(16)		57(60.6)		77(33.2)	
Western dietary pattern						
Yes	65(15.3)	0.001	237(55.9)	0.119	35(29.7)	0.797
No	36(28.8)		60(48.0)		8(30.8)	
Dietary pattern 3						
Yes	90(20.8)	0.002	233(53.9)	0.883	260(60.2)	0.026
No	11(9.4)		64(54.7)		57(48.7)	
Fecal occult blood test						
Positive	0(0.00)	0.206	2(28.6)	0.359	5(71.4)	
Negative	20(4)		210(42.5)		284(57.5)	0.459
Fasting blood sugar						
Normal	43(17.5)	0.779	136(55.3)	0.144	137(55.7)	0.461
Raised blood sugar or diabetic	3(12)		10(40.0)		12(48)	
Current alcohol drinkers						
Yes	18(15.3)	0.351	65(55.1)	0.446	68(57.6)	0.977
No	83(19.3)		232(53.8)		249(57.8)	
Blood pressure						
Normotensive	31(24.8)		68(54.4)		79(63.2)	
Pre-hypertensive	28(15.6)	0.183	100(55.9)	0.263	106(59.2)	0.241
Hypertensive – Stage 1	20(15.9)		59(46.8)		64(50.8)	
Hypertensive – Stage 2	22(18.5)		70(58.8)		68(57.1)	
Body mass index (BMI)						
Underweight			12(57.1)			
Normal			160(67.8)	<0.0001		
Overweight			66(43.4)			
Obese			59(42.1)			

Table 17: Determinants of physical activities

	OR	SE	P- value	95% CI	
				Lower limit	Upper limit
Healthy dietary pattern	5.658	4.565	0.032	1.16	27.51
Complex carbohydrates and legumes dietary pattern	0.3102	0.181	0.045	0.10	0.97
Number of people in the family	0.864	0.111	0.257	0.67	1.11
Income	0.999	7.2107	0.209	0.99	1.01
Marital status					
Married /cohabiting	0.4565	0.232	0.122	0.18	1.23
Separated/divorced	0.1393	0.123	0.026	0.02	0 .79
Widowed	0.1325	0.138	0.052	0.02	1.01
BMI status					
Normal	2.225	2.351	0.449	0.281	7.66
Overweight /obese	0.247	0.261	0.186	0.03	1.96
Underweight (Reference)	3.736	4.951	0.320	0.285	0.18

* OR = Odds Ratio and SE = Standard Error

4.4.8 Prevalence and determinants of tobacco smoking

The prevalence of smoking was 12.2%; smoking was more common in men than women (24.5% vs. 3.2%, respectively). Twenty four point five per cent (24.5%) of males were current smokers and among those, 89.7% smoked daily compared to only 3.2% and 10.3% of females who were currently smoking and smoking daily, respectively. The difference between the genders was statistically significant (p< 0.0001)as shown in Table 18.

Table 18: Prevalence of tobacco smoking among general population in Arusha City

Smoking status	Gender			P value
	Both sex n (%)	Male n (%)	Female n (%)	
Current smokers	67(12.2)	57(24.5)	10(3.2)	<0.0001
Current daily smokers among smokers	39(58.2)	35(89.7)	4(10.3)	0.179
Ex-daily smokers among all respondents	47(8.6)	28(13.7)	19(7.1)	0.013

4.4.9 Relationship between tobacco smoking and other variables

The prevalence of current smoking was highest among those aged 35-44 years of age (13.0%), among those (76%) were daily smokers. The prevalence of smoking was significantly higher among college and higher level (30%), as compared with other levels of education although people with secondary school level of education had more daily smokers than other groups (76%). In terms of marital status, the prevalence of current smoking was highest among single (13.8%) and lowest among those who were widowed (3.7%). The same group reported high prevalence of daily smokers (63.2%). Of the occupations included the prevalence of current smokers was significantly high among the employed (18.3%) and lowest among the self employed (10.7%) although majority of daily smokers were the self employed (63%). The prevalence of smoking was high among alcohol drinkers (23.7%) and followers of western dietary pattern (12.7%). Tobacco use was associated with higher blood pressure but low BMI (Table 19).

4.4.10 Determinants of smoking habit among general population in Arusha city

Gender was observed to be a significant determinant of smoking (P=0.000). The estimated odds of smoking were 11.617 times higher for males as compared to females. Similarly education level was positively associated with the current smoking habit (Table 20). With regard to education level, the odds of smoking were about 5.008 times higher for college graduates than primary school leavers. People with secondary level of education were 2.61 times more likely to smoke than primary school leavers. The odds of smoking was (1-0.8609)*100) 13.9% more for each additional year spent in school. Further analysis showed that, alcohol drinkers were 3.7408 times more likely to smoke than non alcohol drinkers (P=0.000) as shown on Table 20.

Table 19: Smoking habit in relation to other variables

Variable	Current smokers	P value	Daily smokers n (%)	P value	Ex-daily smokers n (%)	P Value
Age (Years)						
25-34	17(12.7)		12(70.6)		13(11.8)	
35-44	25(13)	0.957	19(76.0)	0.005	13(7.5)	0.519
45-54	14(11.3)		6(42.9)		11(10.2)	
55-64	11(11.2)		2(18.2)		10(12.7)	
Education level						
Up to primary level	43(10.3)		25(58.1)		35(9.6)	
Secondary level	16(15.2)	0.005	12(75)	0.065	8(9.3)	0.310
College and higher levels	8(30.0)		2(25)		4(20.0)	
Employment status						
Employed	11(18.3)		5(45.5)		6(11.5)	
Self employed	46(10.7)	0.129	29(63.0)	0.483	35(9.3)	0.581
Unpaid jobs	10(16.7)		5(50.0)		6(14)	
Marital status						
Married/cohabiting	44(12.4)		26(59.1)		25(7.5)	
Single	19(13.8)	0.532	12(63.2)	0.501	20(18.2)	0.004
Separated/divorced	3(10.7)		1(33.3)		3(14.3)	
Widowed	1(3.7)		0(0.00)		0(0.00)	
Health dietary pattern						
Yes	59(13.0)	0.229	36(61.0)	0.206	43(11.1)	0.084
No	8(8.5)		3(37.5)		4(4.8)	
Western dietary pattern						
Yes	54(12.7)	0.483	30(55.6)	0.369	39(10.7)	0.326
No	13(10.4)		9(69.2)		8(7.5)	
Dietary pattern 3						
Yes	48(11.1)	0.133	29(60.4)	0.560	32(8.6)	0.059
No	19(16.2)		10(52.6)		15(15.0)	
Fecal occult blood test						
Positive	1(14.3))	0.904	0(0.00)	0.238	1(20.0)	0.500
Negative	62(12.8)		37(58.7)		45(10.6)	
Fasting blood sugar						
Normal	25(10.2)	0.135	13(52.0)	0.743	17(7.7)	0.294
Raised blood sugar or diabetic	5(20)		3(60.0)		3(14.3)	
Current alcohol drinkers						
Yes	28(23.7)	<0.0001	16(57.1)	0.881	27(26.2)	<0.0001
No	39(9.0)		23(59.0)		20(5.4)	
Blood pressure						
Normotensive	10(8.00)		6(60.0)		9(8.7)	
Pre-hypertensive	25(14.0)	0.063	13(52.0)	0.882	20(13.1)	0.449
Hypertensive – Stage 1	11(8.7)		7(63.6)		8(7.4)	
Hypertensive – Stage 2	21(17.6)		13(61,9)		10(9.3)	
Body mass index (BMI)						
Underweight	2(9.5)		1(50.0)		0(0.00)	
Normal	34(14.4)	0.020	22(64.7)	0.726	26(13.3)	0.099
Overweight	24(15.8)		12(50.0)		13(10.0)	
Obese	7(5.0)		4(57.1)		8(6.3)	

Table 20: Determinants of smoking habit among general population in Arusha city

Risk factors	OR	SE	P- value	95% CI	
				Lower limit	Upper limit
Gender	11.617	4.4916	0.000	5.4449	24.7860
Education level					
Secondary	2.6117	1.1864	0.035	1.0722	6.3618
College +	5.0083	3.2775	0.014	1.3889	18.0605
Years spent in school	0.8609	0.0511	0.012	0.7663	0.9671
Drunk alcohol last 30 days	3.7408	1.1588	0.000	2.0384	6.8648
Constant	0.0461	0.0232	0.000	0.1721	0.1237

* OR = Odds Ratio and SE = Standard Error

4.4.11 Prevalence of alcohol consumption

The prevalence of current drinkers was 21.5%; alcohol consumption was more common in men than women (22.7% vs. 20.6%, respectively). Thirty percent of male took alcohol in the past 12 months while only 17.4% of females had similar status. The difference between the genders was statistically significant (P< 0.0001). Fifty one percent (51%) of males and 50.4% of females never took alcohol in their lifetime (Table 21).

Table 21: Prevalence of alcohol consumption among general population in Arusha City

Alcohol consumption status	Gender			P value
	Both Prevalence n (%)	Male n (%)	Female n (%)	
Drunk alcohol past 12 months not now	125(22.8)	70 (30)	55 (17.4)	<0.0001
Percentage who currently drink (drank alcohol in the past 30 days	118(21.5)	53 (22.7)	65 (20.6)	0.305
Percentage who are lifetime abstainers	240(50.6)	105 (51)	135 (50.4)	0.486

4.4.12 Relationship between alcohol consumption and other variables

Alcohol intake was statistically significant associated with current smoking (P< 0.0001) and employment status (P= 0.005). Although not statistically significant, alcohol consumption was associated with old age (45-64 years) education level, marital status where most of the lifetime abstainers were single or married compared to separated/divorced and widowedTable 22.

4.4.13 Determinants of alcohol drinking behaviour

In multivariate analysis it was found that income, age and interaction between income and employment were significantly related to current drinking. The odds of drinking alcohol in

the last 30 days were found to be 0.000 009 for each additional TSH gained. In addition, it was revealed, that for a given income, the alcohol drinking behaviour differs with employment status. The odds of alcohol drinking among employees was 0.000 004 less than non-employees, and it was twice (0.000 004*2) as much for self-employed compared to employees. The findings further indicated that, the odds of drinking alcohol was 2.8943 times higher for individuals aged between 45 to 64 years as compared to those aged between 35 to 44 years, and twice as much compared to persons aged 25 to 34 years (Table 23).

Table 22: Association between alcohol consumption and other variables

Variable	Current drinkers n (%)	P value	Past drinkers n (%)	P value	Lifetime abstainers n (%)	P Value
Age (Years)						
25-34	27(20.1)		27(20.1)		64(55.2)	
35-44	37(19.2)	0.536	46(23.8)	0.850	86(51.5)	0.583
45-54	32(25.8)		30(24.2)		51(47.2)	
55-64	22(22.4)		22(22.4)		39(47)	
Education level						
Up to primary level	90(21.5)		89(21.3)		186(51.7)	
Secondary level	21(20.0)	0.743	27(25.7)	0.211	47(51.1)	0.194
College and higher levels	7(29.6)		9(34.6)		7(31.8)	
Employment status						
Employed	15(25)		23(38.3)		23(42.6)	
Self employed	93(21.7)	0.529	93(21.7)	0.005	192(51.3)	0.422
Unpaid jobs	10(16.7)		9(15)		25(54.3)	
Marital status						
Married/cohabiting	77(21.6)		85(23.9)		153(50.5)	
Single	32(23.2)	0.306	31(22.5)		66(53.2)	0.798
Separated/divorced	7(25)		8(28.6)	0.095	11(44)	
Widowed	2(7.4)		1(3.7)		10(45.5)	
Health dietary pattern						
Yes	96(21.1)	0.620	104(22.9)	0.913	196(50.1)	0.633
No	22(23.4)		21(22.3)		44(53)	
Western dietary pattern						
Yes	86(20.3)	0.203	95(22.4)	0.709	187(50.8)	0.882
No	32(25.6)		30(24)		53(50.0)	
Dietary pattern 3						
Yes	98(22.7)	0.192	104(24.1)	0.161	182(49.7)	0.468
No	20(17.1)		21(17.9)		58(53.7)	
Fecal occult blood test						
Positive	0(0.00)	0.155	0(0.00)	0.141	4(57.1)	
Negative	111(22.5)		117(23.7)		212(49.9)	0.703
Fasting blood sugar						
Normal	52(21.1)		53(21.5)		110(52.9)	
Raised blood sugar or diabetic	8(32)	0.213	8(32)	0.233	9(40.9)	0.285
Current smokers						
Yes	28(41.8)	<0.0001	33(49.3)	<0.0001	21(33.9)	<0.0001
No	90(18.7)		92(19.1)		219(53.2)	
Daily smokers						
Yes	16(41)	0.881	20(51.3)	0.695	12(34.3)	0.937
No	12(42.9)		13(46.4)		9(33.3)	
Blood pressure						
Normotensive	24(19.2)		20(16)		68(62.4)	
Pre-hypertensive	35(19.6)	0.383	39(21.8)	0.119	76(48.7)	0.029
Hypertensive – Stage 1	34(27)		33(26.2)		54(49.1)	
Hypertensive – Stage 2	25(21)		33(27.7)		42(42.4)	
Body mass index (BMI)						
Underweight	3(14.3)		4(19)		10(55.6)	
Normal	57(24.2)	0.264	58(24.6)	0.399	101(50.8)	0.217
Overweight	35(23)		38(25)		58(43.9)	
Obese	23(16.4)		25(17.9)		71(56.8)	

Table 23: Determinants of alcohol drinking behaviour

Risk factors	OR	SE	P- value	95% C. Interval	
				Lower Limit	Upper Limit
Income	1.0009	4.26e-06	0.028	1.0001	1.0018
Employment (ref: unpaid job)					
Employed	0.2014	0.3000	0.282	0.0109	3.7302
Self-employed	0.3237	0.3081	0.236	0.0501	2.0907
Age (ref. group: 35-44) years					
Youth (25-34)	1.4181	0.8908	0.578	0.4140	4.8572
Adult (45-64)	2.8943	1.5897	0.049	0.9864	8.4933
Income*employment	0.9996	2.1e-06	0.043	0.9992	0 .9999
Constant	0.0630	0.0556	0.002	0.0112	0.3549

* OR = Odds Ratio and SE = Standard Error

4.5 Discussion

The aim of this study was to outline the epidemiology of colorectal cancer risk factors in Arusha City. In this study, we found high prevalence rate of risk factors for CRC in the population such as overweight and obesity, low levels of physical activity and current tobacco smokers.

Overweight and obesity are associated with increased risk of CRC. The mean BMI of the sample surveyed was 26.0958±0.232 kg/m^2 almost the same in both sexes which was higher than the national average (Tanzania Steps Survey Report, 2012) but similar to that found in Dar es Salaam (Muhihi *et al.,* 2012). According to the data from this survey more than half of the study population was overweight/obese. Proportion of obesity among women and men exceeded those in the national step survey (women 26.9% vs. 15% men 23.6%vs 2.5%) (Tanzania Steps Survey Report, 2012) but somehow similar to those found in Dar es Salaam (Muhihi *et al.,* 2012). High prevalence of overweight/obesity in Dar es Salaam was also reported by Shayo and Njelekela (Njelekela *et al.,* 2009; Shayo and Mugusi, 2011). These findings suggest the possibility of overweight and obesity clustering in large cities to increase the risk of NCD's. High prevalence of overweight/obesity in large cities reflects the nutrition transition in sub-Saharan Africa (Agyei and de-Graft, 2010). The pattern is generally in line with the "diffusion theory" (Mackenbach *et al.,* 2000). The 'diffusion theory' postulates that the rise of CHD starts in high socioeconomic groups, because they are the first groups who can afford diets rich in saturated fats and associated with overweight and obesity, which in turn increase the risk of CHD. The differences also can be explained by differences in sample size and population characteristics.

The prevalence of tobacco smoking in thepresent study (12.2%) was comparable to that of the step survey in Tanzania (12.4%- 15.8%) and another study in Dar es Salaam (Amemori *et al.,* 2011; Tanzania Steps Survey Report, 2012). The prevalence of tobacco smoking observed in this survey was low compared with the one which was documented in three districts located in eastern, central and northern Tanzania (Mori *et al.,* 2013). The prevalence of smoking documented in the survey (12.2%) is different from that of Malawi (14.1%), Gambia (15.6%) and Mali (14%) (WHO STEPS, 2016). Another finding worth noting is the association between tobacco smoking and alcohol consumption. Although western dietary pattern was not a significant predictor of tobacco smoking even in multivariate analysis but there is a possibility of these three behaviors to exist together.

Regarding physical activity, about half of the participants did not meet the recommended level of physical activities (> 600METS). Women were the one who recorded low levels of physical activities; the results are similar to those of Steps Survey in Tanzania (Tanzania Steps Survey Report, 2012). Similar findings have been reported by Go *et al*. (2013); McCarty *et al*. (2014) and Taylor *et al.* (2014). Physical inactivity is one of NCDs risk factors including CRC. Less active individuals are postulated to maintain a positive energy balance hence increasing overweight and obesity. This was shown in this study due to a positive association between low physical activities and increased BMI. Interestingly, physical activity was associated with healthy dietary pattern. This may be explained by increased awareness on healthy lifestyle.

In this study, the prevalence of alcohol drinking was 21% and men proportion was high compared to female. The finding is slightly low compared to that of the Steps Survey where about 30% were current alcohol drinkers (Tanzania Steps Survey Report, 2012) but higher than that of Mbatia (2009). Similar finding with the step survey was about age where it was observed that the prevalence of current drinkers increased with age. Income was another determinant although it was shaped by employment status. Overall, alcohol drinking behaviour was increasing with increasing income, that is, an individual with higher earnings (income) was more likely to drink alcohol than low income individuals. Further analysis suggests that for a given income, drinking behaviour differs between employed and non-employed individuals. For the same given income non-employed individuals were more likely to drink alcohol than employed or non-employed individuals. Also, alcohol drinking behaviour was higher among old persons compared to young ones. Alcohol intake was

associated with greater odds of overweight/obesity consistent with other epidemiological evidence (Thankappan, 2010).

4.6 Conclusion

This study revealed high prevalence ratesof CRC risk factors in the study population. There were high prevalence rates of overweight/obesity where more than half of the study sample were overweigh or obese. Tobacco smoking and alcohol consumption remained comparable to other finding from different regions of the country. Almost half of the study sample didn't meet the recommended levels of physical activities. This study highlight the need of considering co-existence of unhealthy lifestyle behaviors. Thus, comprehensive health promotion interventions should be tailored for specific demographic groups and also should focus on addressing multiple risk factors together.

CHAPTER FIVE

Hypertension prevalence as predicted by dietary pattern and other lifestyle factors in Arusha City, Tanzania: A population-based descriptive study[4]

Abstract

High blood pressures are increasing worldwide as well as in developing countries. Poor health systems and adoption of unhealthy lifestyles have been pointed out to cause the observed change**.** It is important to understand the local prevalence of hypertension and examine specific risk factors related to local conditions.

A cross sectional study was conducted among males and females urban residents of Arusha City to determine prevalence of hypertension and associated risk factors.

Blood pressure was measured using a digital sphygmomanometer. Interviews were conducted using the WHO STEP wise survey questionnaire to assess lifestyle factors. Dietary intake information was collected by a standardized Food Frequency Questionnaire (FFQ)**.** Descriptive statistics were used to analyze demographic characteristics. Means and standard deviations were calculated for continuous variables and percentages for categorical variables. Pearson's Chi-Square (χ^2) tests were used to determine significant risk factors for hypertension in Univariate analysis. Multivariate log binomial regression model was used to reveal potential predictors of Hypertension. Dietary patterns were analyzed by principal component analysis.

Almost 45% of the study population was hypertensive. The mean Arterial blood pressure (MABP) of the sample was 102.3mmHg (SD=18.3). The mean Systolic Blood Pressure and Diastolic Blood Pressure were 136.3 (SD=30.5) and 85.3 (SD=16.1) mmHg, respectively. In multivariate analysis onl**y** Age, BMI and Healthy dietary patterns were independently associated with hypertension. This study did not establish any significant association between Western- dietary pattern, cigarette smoking, alcohol intake and physical activities with increased hypertension.

The prevalence of hypertension in the study area was high and shocking. Obesity, diet and age were found to be significant predictors of hypertension in the study area.

[4]**BMC Public Health (2017) 17:659**

5.1 Introduction

It is well established that high blood pressure, hypertension (HTN) contributes to heart disease, kidney failure, stroke and other numerous morbidities (Strauer, 2012). Further, hypertension prevalence is climbing worldwide, but especially in developing countries, due to a combination of poor health systems and increasingly unhealthy lifestyles (Nulu, 2016). The highest prevalence globally is 46% according to the World Health Organization's African region (Carrera-Bastos *et al.,* 2011). Although hypertension is becoming common in Sub-Saharan Africa (SSA), its prevalence varies significantly between urban and rural settings. Hypertension can be avoided or controlled through lifestyle factors including diet, exercise, weight management, and avoiding smoking, excess alcohol and stress (Carrera-Bastos *et al.,* 2011). Because HTN does not present outward symptoms in the early stages, it often goes undetected, particularly in impoverished conditions where there is limited screening for non-communicable diseases (Nulu, 2016). The costs of undiagnosed and poorly managed hypertension are extremely high for both the individual and society (Ataklte, 2015). As such, it is important to understand the local conditions to better support private and public initiatives to reduce risk, increase early detection and improve treatment. In this study we offer a cursory assessment of high blood pressure in an urban city in northern Tanzania to establish local prevalence and examine specific risk factors, including dietary pattern. This study fills a knowledge gap and better prepares government, decision-makers, medical professionals and residents to make informed policy, programming and personal choices.

5.2 Methodology

5.2.1 Study area

Arusha City is located in northern Tanzania, close to the foot of Mount Kilimanjaro and near the border to Kenya. In keeping with economic conditions throughout East Africa, Tanzania has a very low Gross Domestic Product (World Bank Group, 2016). Poverty rates are high (28.2% experiencing basic poverty and 9.7% living in extreme poverty), however these rates have been improving in recent years (World Bank Group, 2015). All residents of the district are considered urban (population 416 000) (The United Republic of Tanzania, 2016). The city is divided into 25 municipal wards, four of which were randomly selected for this study.

5.2.2 Participant recruitment and data collection

Eight interviews/screening and a number of follow up sessions took place in public community buildings (schools, local government offices and clinics) in each of the wards between April and May 2016. Participants were recruited through poster advertisement to attend the sessions in exchange for free medical advice based on their screening results. Eligible participants were consenting adults reporting their home address within the wards of Muriet, Sekei, Sokon I or Unga Ltd in the City of Arusha, Tanzania.

Registration was completed upon arrival on a first come, first served basis. Weight and height were recorded using a spring scale and a measuring tape affixed to the wall, respectively. Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). BMI measurements were categorized as underweight, normal, overweight, and obese based on the standard cut-off points set by the WHO (2016).

Blood pressure was measured at least fifteen minutes after arrival using a digital sphygmomanometer with automatic inflation (Life Brand™ BM60). Participants' hypertension status was provisionally classified based on blood pressure ranges consistent with the Seventh Joint National Committee (U.S Department of Health and Human Services,). Table 26 illustrates the systolic and diastolic blood pressure (SBP, DBP) ranges used for normotensive, pre-hypertensive and stage 1 and 2 hypertensive classification. When SBP or DBP were in differing classes the more severe classification was applied. Participants with abnormal blood pressure were urged to return for retesting the following day and the second reading was considered for this analysis, a referral was made to an appropriate clinic if necessary.

Following physical screening, participants were interviewed using the standardized Swahili translated version of the WHO STEP wise survey questionnaire consisting of core, expanded and optional variables. The frequency of total, vigorous and moderate intensity physical activities was calculated as per WHO stepwise survey manual (WHO Stepwise approach to surveillance).

Dietary intake information was collected by a standardized Food Frequency Questionnaire (FFQ) assessing average food intake over the previous year. The tool was previously developed and validated (Jordan *et al.,* 2013).

5.2.3 Ethical considerations

This study received ethical approval from the National Institute of Medical Research Ethical Committee and permission from the Arusha City Council. Formal written consent was obtained from participants.

5.2.4 Data Analysis

The data collected were entered in Excel™ and analyzed by Statistical Analysis System software version 9.4 (SAS Institute, Cary, North Carolina, USA) and SPSS Version 21(SPSS Inc., Chicago, Illinois, USA). In all, 549 subjects were included in the study. Descriptive statistics were used to analyze demographic characteristics. Means and standard deviations were calculated for continuous variables and by percentages for categorical variables. Pearson's Chi Square (χ^2) tests were used to determine significant risk factors for HTN. Independent variables significantly associated with HTN in univariate analysis were subjected to multivariate log binomial regression model to reveal potential associations of the predictors of HTN. The independent variables considered include: gender, age, education level, employment, marital status, BMI and dietary pattern. Alpha 0.05 was used as the cutoff for statistics significance. The final model included only the variables which were significantly associated with HTN.

Dietary patterns were analyzed by first classifying the 58 food items in the FFQ into 12 food groups to minimize within-person variations in intakes of individual foods. Principal component factor analysis was conducted to derive dietary patterns based on the 12 foods/groups. Factors were rotated by an orthogonal transformation (resulting in uncorrelated factors) to achieve a simpler structure with greater interpretability. Components with an eigenvalue >1 as well as the interpretability of the factors, were considered when determining the number of factors to maintain. The factor analysis generated three major dietary patterns. We called the first dietary pattern "healthy" as is was loaded with carbohydrate rich foods, vegetables, fruits and spices. The second major pattern was dubbed "Western" on account of the high meat, milk and fat intake. The last, and most minor, dietary pattern was characterized by high intake of sweets, roots and tubers and legumes and thus called "complex carbohydrate".

5.3 Results

5.3.1 General characteristics of the sample

A total of 549 participated in screening from four wards of Arusha city and their demographics are show in Table 24. The average age of participants was 40.7 years (SD=12.07) with all participants between 25-64 years. The majority of the participants, 34.6%, were in the 35 to 44 year age range, while the fewest participants were 55 years and older (15.8%). Females were overrepresented, constituting 57.6% (n=316) of the sample. Of the 549 participants, more than two thirds (81.2%) had less or up to primary level of education, 86.2% were self-employed and more than half (64.8%) were married or cohabiting.

5.3.2 Blood Pressure

Mean arterial blood pressure (MABP) was calculated using the formula [(2*DBP) +SBP]/3. The mean MABP of the sample was 102.3 mmHg (SD=18.3). SBP and DBP had means of 136.3 (SD=30.5) and 85.3 (SD=16.1) mmHg, respectively (Averages by gender are shown in Table 25). About 45% of the study sample was hypertensive, 23% being stage 1 and 21.7% being stage 2. Details are shown in Table 25 and 26.

Table 24: Demographic characteristics of the respondents

Variable	Number	Percent (%)
Gender		
Male	233	42.4
Female	316	57.6
Age (years)		
25-34	175	31.9
35-44	190	34.6
45-54	97	17.7
55-64	87	15.8
Education level		
Up to primary level	446	81.2
Secondary level	78	14.2
College and higher levels	25	4.6
Employment status		
Employed (private and government)	60	10.9
Self-employed	473	86.2
Students	16	2.9
Marital status		
Married/cohabiting	356	64.8
Single	136	25.1
Separated/divorced	26	5.1
Widowed	27	4.9

Table 25: Mean arterial blood pressure values by gender

Gender	MABP	SBP	DBP
Male	102.3 (SD=18.3)	136.3(SD=30.5)	85.3(SD=16.1)
Female	104.6(SD=47.8)	138.4(SD=63.3)	87.6(SD=60.5)
Total	103.6 (SD=38.2)	137.5(SD=52)	86.6(SD=47.1)

Table 26: Hypertension classification and participant prevalence based on systolic and diastolic blood pressure readings, adapted from the Seventh Joint National Committee

	Systolic Blood Pressure range (mmHg)	Diastolic Blood Pressure range (mmHg)	Number of participants N (%)
Normotensive	<120	<80	125 (22.7%)
Pre-hypertensive	120-139	80-89	179 (32.6)
Hypertensive – Stage 1	140-159	90-99	126 (23.0)
Hypertensive – Stage 2	>160	>100	119 (21.7)

5.3.3 Univariate analysis of potential predictors of hypertension in Arusha, Tanzania

The results of univariate analysis demonstrated potential risk factors for HTN, shown in Table 27. The overall prevalence of HTN (Stage 1 and 2) was 44.7% and pre-hypertension was 32.6%. Males were more likely to be hypertensive than females (47.6% of males, 42.4% of females) though the difference was not statistically significant (P=0.22). Females were more likely to be pre-hypertensive (29.6% of males, 34.8% female). Hypertension risk was not significantly associated with the Western diet or Complex Carbohydrate diet (P=0.518 and p=0.352, respectively), alcohol drinking at least once in the previous year (P= 0.083) and current smoking (P= 0.341). As anticipated, healthy dietary plan was found to be protective against hypertension (P=0.01), HTN risk increased with age (P=0.0001), BMI (P= 0.005) and doing vigorous physical activities (P= 0.058). Hypertension risk decreased with higher levels of education (P= 0.042). The prevalence of HTN increased from 26.3% in the youngest age group, up to 70.1% in the oldest (P=>0.000). The risk of hypertension doubled when comparing underweight individuals with obese (P=0.005). The risk of HTN increased among those who didn't meet criteria for moderate or total physical activities although the difference was not significant (P= 0.103 and p = 0.167, respectively). There was statistically significant difference in HTN among various employment statuses whereby the self-employed individuals were more likely to be hypertensive (46.7%) than students or private/public employees (P=0.024).

Table 27: Univariate analysis of demographic variables among hypertensive participants (Stage 1 and 2)

Variable	Hypertensive (Stage 1 and 2) n (%)	P Value
Gender		
Male	111(47.6)	0.22
Female	134(42.4)	
Age (Years)		
18-34	46(26.3)	
35-44	82(43.2)	0.000
45-54	56(57.7)	
55-79	61(70.1)	
Education level		
Up to primary level	45(57.7)	
Secondary level	190(42.6)	0.042
College and higher levels	10(40)	
Employment status		
Employed (private and public)	21(35)	
Self employed	221(46.7)	0.024
Students	3(18.8)	
Marital status		
Married/cohabiting	162(45.5)	
Single	51(37.5)	0.057
Separated/divorced	16(61.5)	
Widowed	16(59.3)	
BMI status		
Underweight	5(23.8)	
Normal	94(38.5)	0.005
Overweight	78(50.0)	
Obese	68(53.1)	
Healthy Dietary Pattern		
Yes	184(42)	0.01
No	61(55)	
Western Dietary Pattern		
Yes	177(44.7)	0.518
No	68(44.4)	
Complex Carbohydrate Dietary Pattern		
Yes	195(44.1)	0.352
No	50(46.7)	
Vigorous physical activities		
Met criteria	39(36.4)	0.058
Didn't meet criteria	206(46.6)	
Moderate physical activities		
Met criteria	133(41.7)	0.103
Didn't meet criteria	112(48.7)	
Total physical activities		
Met criteria	143(42.3)	0.167
Didn't meet criteria	102(48.3)	
Alcohol intake last year		
Yes	127(48.5)	0.083
No	118(41.1)	
Current smokers		
Yes	34(50)	0.341
No	211(43.9)	

5.3.4 Multivariate analysis of potential predictors of hypertension in Arusha, Tanzania

Univariate analysis showed that, age, education level, employment, BMI, vigorous physical activities and Healthy dietary patterns were significantly associated with hypertension. To find the potential predictors of HTN, these variables were subjected to multivariate logistics binomial regression. In building the model, education level, vigorous physical activities and employment were no longer significant correlates and were removed from the final model. Age, BMI and Healthy dietary pattern were independently associated with HTN (Table 28).

Ultimately, a positive association between HTN and age was supported. The risk of being hypertensive for groups aged 35-44 (ARR=1.64, CI: 1.22-2.20) and 45-54 (ARR=2.25, CI: 1.67-3.03) years were almost twice that of the 18-34 year olds, and three times greater for those aged 55-79 (ARR=2.50, CI: 1.88-3.32) years. Compared to obese participants, those who were underweight (ARR=0.44, CI: 0.20-0.94) and normal weight (ARR=0.78, CI: 0.64-0.96) had significantly lower prevalence of hypertension. Though not significant, overweight individuals were also less likely to be hypertensive than the obese (ARR=0.93, CI: 0.77-1.14). Following a Healthy dietary pattern was significantly negatively correlated with HTN (ARR=0.82, CI: 0.68-0.99).

Table 28: Results of multiple log binomial models for significant predictors of hypertension

Variable	Parameter Estimates	SE	P-Value	ARR	95% CI	
					Lower limit	Upper limit
Age (Years)						
25-34	Reference					
35-44	0.4948	0.1501	0.001	1.64	1.22	2.20
45-54	0.8125	0.1518	<0.0001	2.25	1.67	3.03
55-64	0.9147	0.1458	<0.0001	2.50	1.88	3.32
BMI(kg/m^2)						
<18	-0.8276	0.3905	0.0341	0.44	0.20	0.94
18 - 24.9	-0.2427	0.104	0.0196	0.78	0.64	0.96
25-29.9	-0.0675	0.1009	0.5032	0.93	0.77	1.14
30+	Reference					
Health dietary pattern						
Yes	-0.1886	0.0957	0.0488	0.82	0.68	0.99
No	Reference					

5.4 Discussion

There were very few comparable studies of hypertension prevalence and associated risk factors specific to the City of Arusha, Tanzania. Our co-author has previously investigated HTN prevalence in a comparative study of urban Massai in Arusha (27.7%) and their rural traditional counterparts (10.7%) (Ngoye *et al.,* 2014). In another study of predominantly Maasai participants migrating from nearby Simanjiro to Dar Es Salaam, hypertension prevalence rate of 21.4% was reported (Unwin *et al.,* 2010). Given the differences in overall body morphology, cultural and dietary practices between the minority Maasai and the other predominant local ethnicities living in Arusha, it would not be appropriate to generalize these findings to the entire population. Further, the Simanjiro study specifically excluded participants with an established hypertension and therefore did not represent the overall prevalence.

Two previous studies (1999 and 2002) found hypertension rates in Tanzanian's large, coastal urban city of Dar Es Salaam, to be similarly around 30% (Bovet *et al.,* 2016; Edwards *et al.,* 2013). Given the worldwide trend towards increased hypertension predominance, we would expect those figures to be an underestimation of current rates (Nulu *et al.,* 2016). In the city of Mwanza, in north western Tanzania, hypertension amongst males only was 23.7% (Njelekela *et al.,* 2011). We would anticipate a typical diet in Mwanza to be derived of a greater proportion of fish as it is located on Lake Victoria, where fishing is a major industry. In a recent study across four countries in sub Saharan Africa, age standardized hypertension prevalence was 25.9% (Guwatudde *et al.,* 2015). On the other hand, researchers have found much higher hypertension rates in Africa, including in Cameroon, where 47.5% of the study population was found to be hypertensive (Dzudie, 2012).

Our findings demonstrated a higher-than-typical hypertension prevalence in our Arusha study than suggested by the aforementioned Maasai or nearby studies. In part this will be attributed to our methodology and limited resources which did not allow for repeat blood pressure analysis per recommended diagnostic guidelines (United States Department of Health and Human Services,2004). It has been suggested that anxiety with the process and unfamiliarity with blood pressure equipment could elevate initial blood pressure readings (Uwin *et al.,* 2010). Overall, our results were consistent with the extant literature with respect to major risk factors for hypertension including male gender, increased body mass indexI (Dzudie *et al.,* 2012; Edwards *et al.,* 2013; Njelekela *et al.,* 2011; Ngoye *et al.,* 2014; Unwin *et al.,* 2010)

and age (Dzudie *et al.,* 2012; Edwards *et al.,* 2013; Njelekela *et al.,* 2011; Unwin *et al.,* 2010).

Our study also demonstrated the protective effect of eating a healthy diet, but did not establish a significant risk between unhealthy Western-style diets and increased hypertension. Njelekela *et al.* (2003) have shown that salt intake and coconut milk consumption are significantly correlated with increased blood pressure in men and women, respectively, in a study of Tanzanian 47-57 year olds. They also demonstrated that whether one lives pastorally, rurally or in an urban space, there marked differences in the overall foods sources most drawn from, which, naturally has an effect on hypertension risk. This is consistent with the migration study by Unwin *et al.* (2010) who found a protective effect of consuming local porridge, and showed a marked change in eating habits and increase weight and waist circumference when moving from rural to an urban environment (Unwin *et al.,* 2010).

5.5 Conclusions

This study confirms the high prevalence of HTN in developing countries as it has been reported in other studies. Evidence from this study demonstrates that diet, obesity and unhealthy lifestyles have a role to play in the rising trend of HTN in developing countries. Hypertension, if not controlled will result into other severe forms of cardiovascular diseases. In the worldwide crisis of cardiovascular disease and rising incidences of HTN, it is important to understand local contributing factors and conditions. This study has better clarified how eating patterns in Arusha are related to HTN and has established an estimate of HTN prevalence in four local wards. Taken together, these findings can be used to encourage policy-makers to place HTN screening, literacy and prevention campaigns at the forefront of their priorities.

CHAPTER SIX

General discussion, Conclusion and Recommendations

6.1 General discussion

6.1.1 Context

Owing to the absence of published data on CRC epidemiology, this study aimed to determine CRC epidemiology in Tanzania by determining incidence and visualizingpatterns, and distribution among regions. Furthermore, the study aimed to characterize potential lifestyle factors associated with the observed patterns.

6.1.2 Issues under consideration

As a first step toward planning for prevention and control of NCD's,WHO recommend assessment of the epidemiological situation by identifying the distribution of risk factors among different population groups (WHO, 2013). The core objectives of prevention include the reduction or modification of exposure. Quantifying risks to health as an essential prerequisite for effective public health.CRC has been called a disease of the environment often related to risk factors such as adoption of westernized diets, obesity and reduced physical activity (Center *et al.*, 2009; Wiseman, 2008). The study assessed the prevalence and determinants of five major factors established by literature to be causes of CRC. The factors are diet, overweight and obesity, physical activities, tobacco smoking and alcohol intake. Furthermore, the study established prevalence of other NCD's.

6.1.3 Target population

Stage one of this study included all patient charts indicating a diagnosis of CRC in accordance with the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)-WHO Version for 2016. Stage two of the study recruited a sample of self-reported healthy individuals residing in four wards of the City of Arusha, Tanzania aged between 25 to 64 years.

6.1.4 Significance / relevance of the issue

The availability of local high quality epidemiological data on the burden of CRC and their risk factors in Tanzania is of great importance. Information on a risk factor profile will help to predict the future burden of disease and plan for intervention.

6.1.5 Key findings

(i) Pattern and distribution of CRC in Tanzania

a) This study has shown a six fold increase in CRC cases in Tanzania for the period 2005 through 2015.

b) Rectal cancers were most prevalent among the Tanzanian population compared to colon cancer.

c) Major towns and cities of Dar es Salaam, Pwani, Kilimanjaro, Arusha and Morogoro, had the highest share of CRC patients

d) Colon cancer was increasing at higher rate than rectal cancer, there was a 2% increase for colon cancer and 1.5% decrease in incidences levels of rectal cancer every year from 2005 to 2015.

e) Age and time but not gender were significantly associated with rectal cancer incidence while gender , age and time were all significantly associated with incidence of colon cancer.

(ii) Dietary pattern as a potential risk factor for CRC

a) Two major dietary patterns existed in the study sample, the western dietary pattern and the healthy dietary pattern. The western dietary pattern was the one considered to be the risk factor for CRC.

b) Determinants of western dietary pattern were lifetime alcohol intake, current, smoking and high levels of education.

(iii) Other lifestyle factors

a) The study population had high levels of overweight and obesity, less physical activities and high levels of alcohol consumption.

b) The prevalence of hypertension was also very high.

6.1.6 Key learnings

An upward trend of CRC incidence rates was observed for both males and females. A sixfold increase was seen in a period of eleven years from 2005 to 2015. Rectal cancers were more common than colon cancers among the Tanzanian population. However, predictions shows decreasing trend in rectal cancer at an average of 1.5% per year and an increase of colon cancer at an average of 2% per year. Findings from this study showed a possible transition from healthy diet to western diet, lack of physical activities and high prevalence of overweight and obesity in Arusha City. Therefore, changes in lifestyle could be shaping the trend of CRC in Tanzania. Although Dar es Salaam showed over-representation for CRC, major towns and cities of Pwani, Kilimanjaro, Arusha, Morogoro, Tanga, and Dodoma had the highest share of CRC patients in comparison to other regions. With regard to gender, there were no discernable difference in the distribution of CRC cases among males and females although females were diagnosed at relatively younger age than males. Gender of an individual significantly predicted the occurrence of colon but not rectal cancer. Colorectal cancer is known as the disease of old age but in this study wasn't the case, one quarter of CRC patients were below 40 years of age. Colon cancer was most common among the young population compared to older adults. As we have seen in previous chapters, change in lifestyle can account in whole or in part for the observed trend shift of CRC in Tanzania.

With regard to diet as a potential risk factor for CRC, two major and one minor dietary pattern were identified as having significance. The first dietary pattern was labeled as "healthy pattern", which loaded heavily with cereals, vegetables, sweets, fruit and spices. The second dietary pattern was labeled as "Western pattern" which loaded heavily with meat, fish, milk and fat. Our findings support the previous reported nutrition transition in Tanzania which favors energy dense diets rich in meat, fat and sugar (Keding *et al.,* 2011). Epidemiological studies report a significant relationship between western diet and CRC development (Alaejos *et al.,* 2008; Oostindjer *et al.,* 2014). In this study western dietary pattern was significantly associated with higher BMI, consumption of alcohol at least once in the previous 12 months, current smoking and high levels of education. This observation suggests the possibility of superimposition of factors most likely drinking alcohol while eating and smoking at the same time.

Moreover, it was important to look at prevalence and determinants of other lifestyle factors in the general population. The prevalence of overweight and obesity was very high compared to

that found in the Tanzania steps survey (WHO STEPS). Possible explanation for this was difference in the sampled population and sample size. The step survey recruited sample mostly from rural areas. Findings from this study were comparable to other studies from Dar es Salaam, Morogoro and Tanga (Keding *et al.*, 2013; Muhihi *et al.*, 2013). This suggests overweight and obesity may be clustered in large cities. The high prevalence of overweight and obesity correlates with the prevalence of high levels of physical inactivity in the study population. This finding may support the earlier findings in the pattern and distribution of CRC in Tanzania where large cities of Dar es Salaam, Coast, Kilimanjaro and Arusha recorded high incidence of CRC than other regions.

Apart from CRC risk factors, this study assessed the prevalence of one of the non communicable diseases (hypertension) in relation to diet and other lifestyle factors in Arusha City. Nearly 45% of the study population was classified as hypertensive. Our findings are comparable to the prevalence of high blood pressure in African region (46%) and the region is leading in having high prevalence as compared with other world's regions (WHO 2013). Raised blood pressure is a major risk factor for coronary heart disease a as well as hemorrhagic stroke.

A positive association between HTN and age was supported, the risk of being hypertensive for groups aged 35-44 was almost twice that of the 18-34year olds, and three times greater for those aged 55-79 years. Compared to obese participants, those who were underweight and normal weight had significantly lower prevalence of HTN. Following a 'healthy' dietary pattern significantly lowered the chance of being hypertensive. Evidence from this study demonstrated the role of diet, obesity and unhealthy lifestyles in the rising trend of HTN in developing countries.

6.2 Limitations of the study

There are limitations to our study that should not be overlooked when interpreting these findings.

(i) In establishing pattern and distribution of CRC in Tanzania patients files were used. This method has several limitations.

   (a) Retrospective data dependent on clinician legible documentation, the lack of record intactness or completeness could be the limitation.

(b) Although quality assurance measures were in place including extractors training, using standardized forms and maintaining availability of the principal investigator for consultation throughout the data extraction period, medical record abstraction techniques can differ among extractors. Inter-rater reliability was not calculated, and this is a limitation.

(ii) Assessment of dietary pattern may have the following limitations.

(a) There are inherent problems with FFQ, such as self-report bias, and limiting of the food reporting to serving frequencies rather than serving size. In addition, added components, such as oil to prepare the foods, are not reflected through the FFQ. Despite these short comings, FFQ remains a powerful tool for assessing habitual food intake (Thompson *et al.,* 2010).

(b) Principal Component Analysis assists with identifying patterns (in this case of diet) through statistical modeling (Wang *et al.,* 2014). In factor analysis several subjective decisions, such as categorizing of foods, defining the factor loading cut-off, number of factors, and labeling of the identified dietary patterns (Newby and Tucker, 2004) hence, some misclassification of foods may arise which in turn, alter dietary pattern scores (Martinez *et al.,* 1998). However, use of this method is supported by scientific evidence (Smith *et al.,* 2011). As it can capture overall effects of the diet as compared with individual components, and can test the validity of dietary recommendations (Van Dam, 2005). Factor analysis can overcome multicollinearity of various dietary variables, because it is a statistical dimension reduction technique that exploits the correlation of each variable (Olinto *et al.,* 2011).

(iii) Assessment of hypertension, overweight and obesity, tobacco smoking, alcohol consumption and physical activities may suffer the following limitations.

(a) Measurement of these CRC risk factors involved self reporting and measurement, these methods are not always perfect. It is possible that self reporting of unhealthy behaviors may be subject to social desirability biases; thus underestimated.

(b) This study was a cross sectional survey, we cannot, therefore, ascribe causality of unhealthy behaviors to any of the associated factors in the study.

(c) Data were collected from volunteers, in this case volunteer bias probably favored unemployed/underemployed individuals who could come and wait most of the day for a free medical consultation.

6.3 General Conclusion

This study has shown a growing burden of CRC in Tanzania. A steady upward trend of CRC cases was noted, the number of cases increased six times for the period 2005 through 2015. Colon cancer is increasing at higher rate than rectal cancer and this indicate change in lifestyle. There were no difference in the distribution of CRC between males and females but females were diagnosed at relatively younger age than males. Colon cancer exists most among the young population. Major towns and cities of Dar es Salaam, Pwani, Kilimanjaro, Arusha, Morogoro, Tanga and Dodoma had the highest share of CRC patients. The study also report high prevalence of HTN in developing countries as it has been reported in other studies. Evidence from this study demonstrates that diet, obesity, tobacco smoking, alcohol consumption and sedentary behavior have a role to play in the rising trend of NCD in developing countries.

Two major dietary patterns, namely healthy and western patterns existed among the study populations. This finding clarifies how eating patterns in Arusha may be a potential risk factor for CRC. The study also found high prevalence of CRC risk factors. More than half of the study population were overweigh or obese. Tobacco smoking and alcohol consumption remained high while almost half of the study population didn't meet the recommended levels of physical activities. Findings from this study shed light on the possible linkage between lifestyle and CRC and other NCDs in Tanzania.

6.4 Recommendations

Change in lifestyle, can account in whole or part of the observed trend shift of CRC in Tanzania. By considering the fact that this study was a cross sectional survey, we cannot, therefore, ascribe causality of unhealthy behaviors to any of the associated factors in the study. We recommend a large study with robust methodology which can establish cause and effect relationship.

We further recommend that, comprehensive health promotion interventions should be tailored for specific demographic groups and also should focus on addressing multiple risk

factors together. Taken together, these findings can be used by policy-makers in planning CRC screening, literacy and prevention campaigns as part of their intervention programs.

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APPENDICES

Appendix 1: Informed consent form (English version)

THE NELSON MANDELA AFRICAN INSTITUTION OF SCIENCE AND TECHNOLOGY

CONSENT FORM

Research on diet, lifestyle and genetic factors in relation to large intestine health

This Informed Consent Form has two parts:

- Part I: Introduction (to share information about the research, risk and benefits, confidentiality and anonymity of participants)
- Part II: Certificate of Consent (for signatures if you agree to take part)

PART I: **Introduction**

- My name is Leonard Kamanga a ph.D student at Nelson Mandela African Institution of Science and Technology. I am doing a research on the relationship between diet, lifestyle, genetic factor and large intestine health in Tanzania.

Aim of the study

This research is being conducted to help us learn more about risk factors and markers that might be associated with large intestine health. Upon your acceptance you will be asked questions regarding diet and lifestyle in relation to large intestine health. Then you will be asked to donate small portion of stool samples for further checking of intestinal health. Furthermore you will be checked for blood sugar and blood pressure and height and weight measurements will be taken. During interview your responses will be recorded to help us in analysis. Your sincerity and honesty is highly needed for the success of this study. Give the best answers as much as you can and whenever you can not give the exact answer give the best estimate.

Regarding annonymit and confidentiality

You are not obliged to answer any questions that make you feel uncomfortable and you are allowed to withdraw from the study at any stage. Your responses will remain strictly confidential and will be used for research purpose only. You are not supposed to identify

yourself by name rather you and samples collected from you will be identified by your ID number.

Regarding risks and benefits

i. The risk associated with blood draw, stool sample collection and weight and height measurements are minimal.
ii. There are direct benefits to you by participating in this study as you will have an opportunity to know your health status with regard to intestinal health and other non communicable diseases. You will have an opportunity for check up and doctors consultation free of charge.

PART II: **Certificate of Consent**

I have read/ have been read to me the forgiven information, and I have had the opportunity to ask questions and the questions have been answered to my satisfaction. I consent voluntarily to participate in this research.

Name of Participant _____

Signature of Participant _____Date _____ I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Name of Researcher_____

Signature of Researcher _____Date _____

In case of any problem as a result of your participation in the study please contact any of the following;

Leonard Kamanga (Principal investigator)
Nelson Mandela African Institution of Science and Technology,
P. O. BOX 447
Arusha Tanzania
Phone: 0758 92 10 00
OR

National Health Research Ethics Sub-Comitee
National Institute of Medical Research (NIMR)
P. O. BOX 9653
Dar es Salaam
Tel No: +255-22-2121400

Appendix 2: Study questionnaire

Step 1 Demographic Information			
CORE: Demographic Information			
Question		**Response**	**Code**
15	Sex (*Record Male / Female as observed*)	Male 1 Female 2	C1
16	What is your date of birth? *Don't Know 77 77 7777*	⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋⌊_⌋ *If known, Go to C4* dd mm year	C2
17	How old are you?	Years ⌊_⌋⌊_⌋	C3
18	In total, how many years have you spent at school or in full-time study (excluding pre-school)?	Years ⌊_⌋⌊_⌋	C4
EXPANDED: Demographic Information			
19	What is the **highest level of education** you have completed? *[INSERT COUNTRY-SPECIFIC CATEGORIES]*	No formal schooling 1 Less than primary school 2 Primary school completed 3 Secondary school completed 4 High school completed 5 College/University completed 6 Post graduate degree 7 Refused 88	C5
20	What is your **marital status**?	Never married 1 Currently married 2 Separated 3 Divorced 4 Widowed 5 Cohabitating 6 Refused 88	C7
21	Which of the following best describes your **mainwork** status over the past 12 months? *(USE SHOWCARD)*	Government employee 1 Non-government employee 2 Self-employed 3 Non-paid 4 Student 5 Homemaker 6 Retired 7 Unemployed (able to work) 8 Unemployed (unable to 9 Refused 88	C8
22	How many people older than 18 years, including yourself, live in your household?	Number of people ⌊_⌋⌊_⌋	C9

EXPANDED: Demographic Information, Continued			
Question		**Response**	**Code**
23	Taking **the past year**, can you tell me what the average earnings of the household have been? *(RECORD ONLY ONE, NOT ALL 3)*	Per week ⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋ *Go to T1*	C10a
		OR per month ⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋ *Go to T1*	C10b
		OR per year ⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋ *Go to T1*	C10c
		Refused 88	C10d
24	If you don't know the amount, can you give an **estimate** of the annual household income (In Tanzanian shillings) if I read some options to you? Is it *(READ OPTIONS)*	≤ 250,000 1 More than 250,000, ≤ 2 More than 500,000, ≤ 3 More than 750,000, ≤ 4 More than 1,000,000 5 Don't Know 77 Refused 88	C11

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
25	Do you currently smoke any **tobacco products**, such as cigarettes, cigars or pipes? *(USE SHOWCARD)*	Yes 1 No 2 *If No, go to T6*	T1
26	Do you currently smoke tobacco products **daily**?	Yes 1 No 2 *If No, go to T6*	T2
27	How old were you when you **first started** smoking daily?	Age (years) ⌊_⌋⌊_⌋ Don't know 77 *If Known, go to T5a*	T3
28	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
29	On average, **how many** of the following do you smoke each day? *(RECORD FOR EACH TYPE, USE SHOWCARD)* *Don't Know 77*	Manufactured cigarettes ⌊_⌋⌊_⌋	T5a
		Hand-rolled cigarettes ⌊_⌋⌊_⌋	T5b
		Pipes full of tobacco ⌊_⌋⌊_⌋	T5c
		Cigars, cheroots, cigarillos ⌊_⌋⌊_⌋	T5d
		Other ⌊_⌋⌊_⌋ *If Other, go to T5other, else go to T9*	T5e

	Have you **ever** consumed an alcoholic drink such as beer, wine, spirits, fermented cider or	No 2 *If No, go to D1*	
40	Have you consumed an alcoholic drink within the **past 12 months**?	Yes 1 No 2 *If No, go to D1*	A1b
41	During the past 12 months, **how frequently** have you had at least one alcoholic drink? *(READ RESPONSES, USE SHOWCARD)*	Daily 1 5-6 days per week 2 1-4 days per week 3 1-3 days per month 4 Less than once a month 5	A2
42	Have you consumed an alcoholic drink within the **past 30 days**?	Yes 1 No 2 *If No, go to D1*	A3
43	During the past 30 days, on how many **occasions** did you have at least one alcoholic drink?	Number Don't know 77 ⌊_⌋⌊_⌋	A4
44	During the past 30 days, when you drank alcohol, **on average**, how many **standardalcoholicdrinks** did you have during one drinking occasion? *(USE SHOWCARD)*	Number Don't know 77 ⌊_⌋⌊_⌋	A5
45	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
46	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
EXPANDED: Alcohol Consumption			
47	During the past 30 days, when you consumed an alcoholic drink, how often was it with meals? Please do not count snacks.	Usually with meals 1 Sometimes with meals 2 Rarely with meals 3 Never with meals 4	A8
48	During each of the **past 7 days**, how many standard alcoholic drinks did you have each day? *(USE SHOWCARD)* *Don't Know 77*	Monday ⌊_⌋⌊_⌋	A9a
		Tuesday ⌊_⌋⌊_⌋	A9b
		Wednesday ⌊_⌋⌊_⌋	A9c
		Thursday ⌊_⌋⌊_⌋	A9d
		Friday ⌊_⌋⌊_⌋	A9e
		Saturday ⌊_⌋⌊_⌋	A9f
		Sunday ⌊_⌋⌊_⌋	A9g
CORE: Diet			

The next questions ask about the fruits and vegetables that you usually eat. I have a nutrition card here that shows you some examples of local fruits and vegetables. Each picture represents the size of a serving. As you answer these questions please think of a typical week in the last year.

Question		Response	Code
49	In a typical week, on how many days do you **eat fruit**?	Number of days ⌊_⌋⌊_⌋ *If Zero days, go to D3* Don't Know 77	D1
50	How many **servings** of fruit do you eat on **one** of those days? *(USE SHOWCARD)*	Number of servings ⌊_⌋⌊_⌋ Don't Know 77	D2
51	In a typical week, on how many days do you **eat vegetables**? *(USE SHOWCARD)*	Number of days ⌊_⌋⌊_⌋ *If Zero days, go to D5* Don't Know 77	D3
52	How many **servings** of vegetables do you eat on one of those days? *(USE SHOWCARD)*	Number of servings ⌊_⌋⌊_⌋ Don't know 77	D4
EXPANDED: Diet			
53	What type of **oil or fat is most often** used for meal preparation in your household? *(USE SHOWCARD)* *(SELECT ONLY ONE)*	Vegetable oil 1 Lard or suet 2 Butter or ghee 3 Margarine 4 Other 5 *If Other, go to D5 other* None in particular 6 None used 7 Don't know 77	D5
		Other ⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋	D5other
54	On average, how many meals per week do you eat that were not prepared at a home? By meal, I mean breakfast, lunch and dinner.	Number ⌊_⌋⌊_⌋ Don't know 77	D6

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 have to 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			
55	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like lifting heavy loads, manual construction work, digging etc for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P 4*	P1
56	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days ⌊_⌋	P2

57	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes ⌊_⌋⌊_⌋ : ⌊_⌋⌊_⌋ hrs mins	P3 (a-b)
58	Does your work involve moderate-intensity activity, that causes small increases in breathing or heart rate such as brisk walking, *carrying light loads, doing chores like cleaning, washing or ironing clothes etc* ,for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P 7*	P4
59	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days ⌊_⌋	P5
60	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes ⌊_⌋⌊_⌋ : ⌊_⌋⌊_⌋ hrs mins	P6 (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.			
61	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 P 10*	P7
62	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
63	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), *[Insert relevant terms].*			
64	Do you do any vigorous-intensity sports, fitness or recreational *(leisure)* activities that cause large increases in breathing or heart rate like *running, playing football etc*, for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P 13*	P10
65	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational *(leisure)* activities?	Number of days ⌊_⌋	P11
66	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)
67	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, dancing* etc for at least 10 minutes continuously?	Yes 1 No 2 *If No, go to P16*	P13

68	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational *(leisure)* activities?	Number of days ⌊__⌋	P14
69	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)

EXPANDED: Physical Activity

Sedentary behavior

The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, train, reading, playing cards or watching television, but do not include time spent sleeping.
(USE SHOWCARD)

70	How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P16 (a-b)

CORE: History of Raised Blood Pressure

Question		Response	Code
71	Have you ever had your blood pressure measured by a doctor or other health worker?	Yes 1 No 2 *If No, go to H6*	H1
72	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
73	Have you been told in the past 12 months?	Yes 1 No 2	H2b

EXPANDED: History of Raised Blood Pressure

74	Are you currently receiving any of the following treatments/advice for high blood pressure prescribed by a doctor or other health worker?		
	Drugs (medication) that you have taken in the past two weeks	Yes 1 No 2	H3a
	Advice to reduce salt intake	Yes 1 No 2	H3b
	Advice or treatment to lose weight	Yes 1 No 2	H3c
	Advice or treatment to stop smoking	Yes 1 No 2	H3d
	Advice to start or do more exercise	Yes 1 No 2	H3e
75	Have you ever seen a traditional healer for raised blood pressure or hypertension?	Yes 1 No 2	H4

76	Are you currently taking any herbal or traditional remedy for your raised blood pressure?	Yes 1 No 2	H5

CORE: History of Diabetes

Question		Response	Code
77	Have you ever had your blood sugar measured by a doctor or other health worker?	Yes 1 No 2 *If No, go to M1*	H6
78	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
79	Have you been told in the past 12 months?	Yes 1 No 2	H7b

EXPANDED: History of Diabetes

80	Are you currently receiving any of the following treatments/advice for diabetes prescribed by a doctor or other health worker?		
	Insulin	Yes 1 No 2	H8a
	Drugs (medication) that you have taken in the past two weeks	Yes 1 No 2	H8b
	Special prescribed diet	Yes 1 No 2	H8c
	Advice or treatment to lose weight	Yes 1 No 2	H8d
	Advice or treatment to stop smoking	Yes 1 No 2	H8e
	Advice to start or do more exercise	Yes 1 No 2	H8f
81	Have you ever seen a traditional healer for diabetes or raised blood sugar?	Yes 1 No 2	H9
82	Are you currently taking any herbal or traditional remedy for your diabetes?	Yes 1 No 2	H10

Step 2 Physical Measurements			
CORE: Height and Weight			
Question		**Response**	**Code**
83	Interviewer ID	⌊_⌋⌊_⌋⌊_⌋	M1
84	Device IDs for height and weight	Height ⌊_⌋⌊_⌋ Weight ⌊_⌋⌊_⌋	M2a M2b
85	Height	in Centimetres (cm) ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋	M3
86	Weight *If too large for scale 666.6*	in Kilograms (kg) ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋	M4
87	**For women:** Are you pregnant?	Yes 1 *If Yes, go to M 8* No 2	M5
CORE: Waist			
88	Device ID for waist	⌊_⌋⌊_⌋⌊_⌋	M6
89	Waist circumference	in Centimetres (cm) ⌊_⌋⌊_⌋⌊_⌋.⌊_⌋	M7
CORE: Blood Pressure			
90	Interviewer ID	⌊_⌋⌊_⌋⌊_⌋⌊_⌋	M8
91	Device ID for blood pressure	⌊_⌋⌊_⌋⌊_⌋	M9
92	Cuff size used	Small 1 Medium 2 Large 3	M10
93	Reading 1	Systolic (mmHg) ⌊_⌋⌊_⌋⌊_⌋	M11a
		Diastolic (mmHg) ⌊_⌋⌊_⌋⌊_⌋	M11b
94	Reading 2	Systolic (mmHg) ⌊_⌋⌊_⌋⌊_⌋	M12a
		Diastolic (mmHg) ⌊_⌋⌊_⌋⌊_⌋	M12b
95	Reading 3	Systolic (mmHg) ⌊_⌋⌊_⌋⌊_⌋	M13a
		Diastolic (mmHg) ⌊_⌋⌊_⌋⌊_⌋	M13b
96	During the past two weeks, have you been treated for raised blood pressure with drugs (medication) prescribed by a doctor or other health worker?	Yes 1 No 2	M14

EXPANDED: Hip Circumference and Heart Rate				
97	Hip circumference	in Centimeters (cm)	⌊_⌋⌊_⌋⌊_⌋.⌊_⌋	M15
98	Heart Rate			
	Reading 1	Beats per minute	⌊_⌋⌊_⌋⌊_⌋	M16a
	Reading 2	Beats per minute	⌊_⌋⌊_⌋⌊_⌋	M16b
	Reading 3	Beats per minute	⌊_⌋⌊_⌋⌊_⌋	M16c

Step 3 Biochemical Measurements

CORE: Blood Glucose

Question		Response		Code
99	During the past 12 hours have you had anything to eat or drink, other than water?	Yes No	1 2	B1
100	Technician ID		⌊_⌋⌊_⌋⌊_⌋	B2
101	Device ID		⌊_⌋⌊_⌋	B3
102	Time of day blood specimen taken (24 hour clock)	Hours : minutes	⌊_⌋⌊_⌋ : ⌊_⌋⌊_⌋ hrs mins	B4
103	Fasting blood glucose: *mmol/l*	mmol/l	⌊_⌋⌊_⌋.⌊_⌋⌊_⌋	B5
104	Today, have you taken insulin or other drugs (medication) that have been prescribed by a doctor or other health worker for raised blood glucose?	Yes No	1 2	B6

CORE: Blood Lipids

105	Device ID		⌊_⌋⌊_⌋⌊_⌋	B7
106	Total cholesterol: *mmol/l*	mmol/l	⌊_⌋⌊_⌋.⌊_⌋⌊_⌋	B8
107	During the past two weeks, have you been treated for raised cholesterol with drugs (medication) prescribed by a doctor or other health worker?	Yes No	1 2	B9

EXPANDED: Triglycerides and HDL Cholesterol

108	Triglycerides *mmol/l*	mmol/l	⌊_⌋⌊_⌋.⌊_⌋⌊_⌋	B10

Appendix 3: Food Frequency questionnaire

Kinywaji	**Drink**	**Kwasiku**	**Kwawiki**	**Kwamwezi**	**Sikunywa**	**Sijui**
Chai(+maziwa/+	Tea(+milk/+ sugar)					
Chai(+sukari)	Tea(+ sugar)					
Kahawa(+maziwa/+	Coffee(+milk/+ sugar)					
Maziwa	Milk					
Soda	Soda					
Maji	Water					
Juisi	Juice					
Pombeyakienyeji	Local alcoholicdrink					
Bia(chupa)	Beer(bottle)					
Konyagi/Gongo	Konyagi/Spirits					
Mvinyo	Wine					
Vyakula vitokanavyo	Meat and animal	Kwa	Kwa	Kwa	Sikula	Sijui
Kuku	Chicken					
Ng’ombe	Beef					
Nguruwe	Pork					
Mbuzi	Mutton					
Bata	Duck					
maini, moyo, figo	Organ meat					
Dagaa	Sardines					
Samaki mkavu	Dried fish					
Samaki kukaangwa	Fried fish					
Samaki mbichi	Fresh fish					
Mayai	Eggs					
Jibini	Cheese					
Mtindi	Yoghurt					
Vyakula vingine	Other animal products					
Nafaka	Cereals	Kwa	Kwa	Kwa	Sikula	Sijui
Mahindi-kuchoma	Maize on cob					
Makande	Mix of beans and					
Ugali	Stiff porridge					
Uji-mahindi	Porridge from maize					
Uji-mtama	Porridge from millet					
Uji-ulezi	Porridge from					
Wali	Rice					
Pilau	Pilau					
Chapati	Chapati					

Mkate	Bread					
Mandazi	Donut (Mandazi)					
Vitumbua	Rice cake					
Keki	Cake					
Biskuti	Cookies					
Tambi-makaroni	Spaghetti					
Nyingine (nafaka)	Other cereal					
Vyakula vya mizizi na	Roots and tubers	Kwa	Kwa	Kwa	Sikula	Sijui
Viazi vitamu	Potato (sweet)					
Viazi mviringo-	Potato (irish)					
Chips	Chips/french fries					
Mihogo	Cassava					
Magimbi	Yams					
Cripsi	Crips (fried crackers)					
Ndizi- kupika	Bananas boiled					
Ndizi-kukaanga	Bananas roasted/fried					
Mtori	Bananastew					
Vyakula vingine	Other roots/tubers					
Mboga mboga	Vegetables	Kwa	Kwa	Kwa	Sikula	Sijui
Bilinganya	Eggplant					
Ngogwe-	Tree tomatoes					
Nyanya (kachumbali)	Tomatoes (used in					
Karoti	Carrot					
Maboga	Pumpkin					
Matango	Cucumber					
Karela	Bitter gourd / Karela					
Bamia	Okra					
Chiniz kabichi	Chinese Cabbage					
Kabichi	Cabbage					
Sukuma wiki	Ethiopian kale					
Mchunga	Bitter hare lettuce					
Mchicha	Amaranth leaves					
Kisamvu	Cassava leaves					
Majani ya kunde	Cowpea leaves					
Majani ya maboga	Pumpkin leaves					
Matembele	Other green leafy					
Mnavu						
Mboga mboga	Other vegetables					
Mboga jamii ya kunde	Pulses	Kwa	Kwa	Kwa	Sikula	Sijui

Maharage	Beans					
Dengu	Lentils					
Njegere	Peas					
Njugu mawe	Soybeans					
Choroko	Mung beans					
Nyingine	Other pulses					
Tunda	Fruits	Kwa	Kwa	Kwa	Sikula	Sijui
Ndizi mbivu	Bananas, ripe					
Maembe	Mangoes					
Machungwa	Oranges					
Tikiti	Melons					
Parachichi	Avocado					
Papai	Papaya					
Nanasi	Pineapple					
Pashen-juice	Passion					
Ubuyu	Baobab					
Zambarau	African Plum					
Nazi	Coconut					
Matunda mengineyo	Other fruits					
Mbegu za mafuta	Nuts and fats/oils	Kwa	Kwa	Kwa	Sikula	Sijui
Margarine (Tan-bond, Blue-band, Sunflower, Flora)	Margarine					
Siagi	Butter					
Kimbo	Kimbo (vegetable fat)					
Lard (mafuta ya wanyama, samli)	Lard (animal fat)					
Tui	Coconut milk					
Siagi ya karanga	Peanut butter					
Korosho	Cashew nuts					
Karanga	Ground nuts					
Mafuta alizeti	Sunflower oil					
Mchanganyiko wa						
Mchikichi	Palm oil					
Viungo- vingine	Other items	Kwa	Kwa	Kwa	Sikula	Sijui
Jam	Jam					
Asali	Honey					

Sukari ya nyongeza (eg						
Tomato sauce, chili	Ketchup, chili sauce					
Viungo vya mboga	Spices	Kwa	Kwa	Kwa	Sikula	Sijui
Kitunguu saumu	Garlic					
Nyanya	Tomato					
Tangawizi	Ginger					
Vitunguu maji	Onion					
Pilipili	Chili					
viungo vya pilau	Herbs					
Limao-ndimu	Lemon					
Taja vingine	Something we forgot?					
Tafadhaliangaliakama viungovyotevyachakulavimetaywahapojuu						

Appendix 4: Informed consent Swahili version

THE NELSON MANDELA AFRICAN INSTITUTION OF SCIENCE AND TECHNOLOGY

Fomu ya makubaliano

Utafikti kuhusu uhusiano wa afya ya utumbo mkubwa na chakula, mfumo wa maisha na vinasaba

Fomu hii ina sehemu kuu mbili:

- Sehemu ya I: Utangulizi (Utapewa taarifa kuhusu utafiti na malengo yake, haki zako na faida na hasara za kushiriki katika utafiti)
- Sehemu ya II: kutia sahihi makubaliano

Sehemu ya I: Utangulizi

- Jina langu naitwa Leonard Kamanga ni mwanafunzi wa shahada ya uzamivu katika chuo cha sayansi na teknolojia cha Nelson Mandela Arusha. Nafanya utafiti kutaka kujua uhusiano wa afya ya utumbo mkubwa na chakula, mfumo wa maisha na vinasaba

Madhumuni ya utafiti

Utafiti huu unafanyika kwa madhumuni ya kutaka kujua uhusiano uliopo kati ya afya ya utumbo mkubwa na vyakula, mfumo wa maisha na vinasaba. Utakapokubali kushiriki katika utafiti huu, utaulizwa maswali yanyohusu ulaji wako na mfumo wa maisha yako. Baada ya hapo utaombwa kuleta sampuli za choo kikubwa na utapimwa kiwango cha sukari kwenye damu na shinikizo la damu. Utapimwa pia urefu na uzito ili kujua hali yako ya lishe. Majibu yanayotokana na mahojiano yatarekodiwa kwa ajili ya kumbukumbu. Usahihi wa majibu utakayotoa ni muhimu sana ili kufanikisha utafiti huu. Pale ambapo hukumbuki au huwezi kutoa jibu sahihi, toa jibu ambalo linakaribiana kabisa na jibu sahihi hata kama ni kwa kukadiria.

Haki zako na utunzaji wa taarifa

Hulazimishwi kujibu swali lolote au kufanya kipimo chochote ambalo linakufanya usijisikie vizuri. Pia unaruhusiwa kujitoa kutoka kwenye utafiti katika hatua yoyote ile. Katika utafiti huu hautatambuliwa kwa jina wala sampuli zako hazitatambuliwa kwa jina lako bali vyote vitapewa namba ya utambuzi ambayo hata watafiti hawawezi kutambua ni za nani. Majibu yako yatabaki kua siri na yatatumika kwa ajili ya utafiti tu na sio kwa namna yoyote nyingine.

Faida na hasara

Madhara yatokanayo na kuchangia damu, choo na kupima shinikizo la damu, wingi wa sukari kwenye damu na uzito na urefu ni kidogo sana na hayawezi kuhatarisha maisha.

Kuna faida za moja kwa moja kwa kushiriki katika utafiti huu. Kutokana na ushiriki wako utaweza kujua hali ya afya yako kulingana na magonjwa yaliyotajwa hapo juu. Pia utapata nafasi ya kupima magonjwa hayo na kumuona daktari kwa ushauri bila gharama yoyote.

Sehemu ya II: Kuthibitishamakubaliano/ushiriki

Nathibitisha kua nimesomewa/ nimesoma maelezo ya hapo juu na kuelewa. Nimepewa nafasi ya kuuliza maswali na kila swali limejibiwa kwa kiwango kilichoniridhisha. Nina thibitisha kukubali kushiriki katika utafiti huu kama mshiriki.

Jina la Mshiriki _____

Sahihiyamshiriki _____

Tarehe _____

Ninathibitisha kuwa mshiriki alipewa nafasi ya kuuliza maswali kuhusu utafiti na maswali yamejibiwa. Ninathibitisha kwamba mshiriki hajashurutishwa kusaini fomu ya makubaliano na alipewa uhuru wakuthibitisha ushiriki wake yeye mwenyewe.

Jina la mtafiti_____

Saini yamafiti _____

Tarehe _____

Kwa tatizo lolote litakalotokana na ushiriki wako kwenye utafiti huu, tafadhali wasiliana na yeyote kati ya hawa

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Asante kwa kushiriki