PREVALENCE AND RISK FACTORS OF UNDIAGNOSED TYPE 2 DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA CATHOLIC MISSION HOSPITAL, THARAKA NITHI COUNTY, KENYA

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DECLARATION AND APPROVAL

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This thesis is my original work and has not been presented for a degree in any other university or any other award.

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DEDICATION

This electrifying research is dedicated to a myriad of people who contributed to my growth and development knowingly or unknowingly. First and foremost, to My Dear Mum, Elizabeth Mumu, and her belated spouse, my Dad Gerald Nkonge M'bandi, M'Murungi. Who foresaw and encouraged, enriched, tuned; motivated my early day's dreams, and consistently supported them with unreserved consistent, and supportive generous hand. To my dear sisters and brothers, and many cousins and friends and teachers of whatever wing who have remained vivid in my mind since my tender age and in one way or another were continuously supportive and as a cheering squad towards the realization of my dream.

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ABBREVIATIONS

ACEIs	Angiotensin Converting Enzyme Inhibitors
ADA	American Diabetes Association
AGE	Angiotensin-Converting Enzymes
AGR	Abnormal Glucose Regulation
ARBs	Angiotensin receptor blockers
BMI	Body Mass Index
BP	Blood Pressure
CHD	Coronary Heart Disease
CKD	Chronic Kidney Disease
DASH	Dietary Approaches to Stop Hypertension
DM	Diabetes Mellitus
DPP-4	Dipeptidyl peptidase-4 (DPP-4)
GI	Glycemic Index
GLM	Generalized linear models
HDL	High Density Lipoprotein
HTN	Hypertension
IDF	International Diabetes Federation
LDL	Low Density Lipoprotein

LUTS	Lower Urinary Tract symptoms
NCDs	Non-communicable diseases
NSAIDs	Non-steroidal Anti-inflammatory Drugs
OHAs	Oral hypoglycemic agents' ix
OR	Odds ratio
PCI	Percutaneous Coronary Intervention
RAAS	Renin-Angiotensin-Aldosterone System
ROS	Reactive Oxygen Species
SGLT-2	Sodium-glucose cotransporter-2
UKPDS	United Kingdom Prospective Diabetes Study
UTI	Urinary Tract Infections
WHO	World Health Organization

DEFINITION OF OPERATIONAL TERMS

Abnormal Glucose Regulation (AGR): It's described as any condition in which blood sugar levels are not within the normal range. This can include pre-diabetes, diabetes, and other conditions that affect the body's ability to regulate blood sugar.

Diabetes Mellitus (DM): This is a metabolic disorder characterized by high blood sugar levels, resulting from the body's inability to produce or effectively use insulin, a hormone that regulates blood sugar. The WHO currently defines it as fasting blood glucose level over 7.0 mmol/l, or a glycated hemoglobin A1C above 6.5%.

Hypertension (HTN): Condition in which the force of the blood pushing against the wall of arteries is consistently higher than normal. A systolic blood pressure of less than 140 mm Hg and/or a diastolic blood pressure of less than 90 mm Hg are the WH O's definitions of it.

Pre-diabetes: Is a state of blood sugar levels that are greater than usual, although not abnormally high to be classified as diabetes. It's defined by a glycated hemoglobin between 6.0 and 6.4%.

Undiagnosed diabetes: It refers to a condition where an individual has diabetes (typically type 2 diabetes) but is unaware of their condition

because they have not yet been formally diagnosed by a healthcare professional.

ABSTRACT

Background: According to the WHO, Non-Communicable Diseases (NCD) were a major cause of death in 2022 accounting for 41 million (74%) of deaths worldwide. Diabetes Mellitus (DM) and Hypertension (HTN) are the two illnesses that are not contagious but linked closely. The objective of the research was to establish the prevalence and risk factors of undiagnosed diabetes among hypertensive patients attending St. Orsola Hospital in Tharaka Nithi County, Kenya.

Methodology: A cross-sectional study involving 384 HTN patients attending the outpatient medical clinic was conducted from October to December 2022. The study population were patients under anti-hypertensive medication and visiting St. Orsola Catholic Mission Hospital HTN outpatient clinic. The hypertensive patients who were under anti-diabetes medication and pregnant patients were excluded from the study. A questionnaire containing socio-demographics and behaviors was used to collect data, while the diabetes state was confirmed based on glycated haemoglobin (HbA1c) classification. The data was analyzed using SPSS version 20.0, performing univariate, bivariate correlation and Chi-square analysis, multivariate and looking at statistical significance at p-value less than 0.05 at 95% confidence level.

Results: The age of the participants ranged between 20-89 years, with majority (62%) being below 60 years. Of these participants (66%) were women while (34%) were male. Seventy-five percent (288/384) of participants were found to be non-diabetic, with 21 (5%) with undiagnosed DM and 75 (19.5%) being pre-diabetic. Risk factors associated with undiagnosed diabetes were found to be age (χ^2 = 24.837, df =4 p = .000), body mass index (BMI) (χ^2 = 45.838, df =4, p = .000) and marital status (χ^2 = 11.992, df = 4, p = .017).

Conclusion: The study found hypertensive patients with undiagnosed diabetes in clinical setup, indicating a missed opportunity for diagnosis. The risk factors for undiagnosed diabetes are; age, BMI >25 kg/m^2 and marital status. Therefore, the study recommends a targeted screening for DM among hypertensive patients to enable early detection and proper intervention management.

CHAPTER 1: INTRODUCTION

1.1 Background

Hypertension and diabetes are two of the most common non-communicable diseases (NCDs) worldwide which are chronic conditions that are not caused by infectious agents and generally develop over a long time. The coexistence of these two conditions can have dire consequences, as it increases the risk of cardiovascular events, kidney disease, vision impairment, and other complications. Of particular concern is the presence of undiagnosed Type 2 diabetes among hypertensive patients. Diabetes, when undetected and untreated, can lead to severe health issues, making early diagnosis and management is crucial. Both hypertension and diabetes are significant cardiovascular illness risk variables, they are the leading cause of death globally, accounting for 74% of deaths (WHO, 2022).

Elevated blood pressure, sometimes referred to as hypertension, is a condition characterized by elevated blood pressure levels in the arteries (Hendriks et al., 2012). It is a chronic condition that typically develops over time and can be caused by factors such as genetics, lifestyle habits, and underlying health conditions. Hypertension can lead to complications such as heart attack, stroke, kidney disease, and vision loss.

According to WHO (2018), hypertension (HTN) affects nearly 1.13 billion individuals worldwide and is most prevalent in Africa (27% of people over 25 have been confirmed to have it). Treatment for hypertension usually involves lifestyle changes, such as lowering intake of salt and increasing physical activity, as well as medication to lower blood pressure (WHO, 2010).

Type 2 diabetes is a metabolic disorder characterized by elevated blood glucose levels due to insulin resistance or insufficient insulin production. It is a major health issue, with an increasing global prevalence. In addition to its direct health impacts, Type 2 diabetes is associated with several comorbidities and complications, making it a significant contributor to the global burden of disease. There are two main types of diabetes: type 1 diabetes, which is an autoimmune disorder that usually develops in childhood or adolescence and requires insulin treatment, and type 2 diabetes, which is often associated with lifestyle factors such as obesity, physical inactivity, and poor diet (Hall et al., 2011).

Type 2 diabetes can usually be managed with lifestyle changes and medication, but if left unattended, it may cause serious health complications such as cardiovascular issues, kidney disease, nerve damage, and blindness (WHO, 2013). There is a strong link between hypertension and DM, as both conditions are risk factors for cardiovascular complications. People with diabetes are more likely to develop hypertension, and having both conditions increases the risk of cardiovascular complications (Chatterjee et al., 2013).

Managing both conditions requires a combination of lifestyle changes and medication, as well as regular monitoring and check-ups with a healthcare provider. Prevention is also key in managing hypertension and diabetes. Healthy lifestyle habits such as regular exercise, maintaining a healthy weight, and feeding a nutritional diet rich in fruits and whole grains can aid in preventing the development of these conditions.

Regular health screenings and check-ups can also help detect and manage these conditions early on. According to the KSTEPS MOH (2015), Kenya has a projected prevalence of 3.1% for Diabetes mellitus (DM) and 24.4% for HTN. According to the location, this

prevalence varies between 19.1 percent and 32 percent for HTN and between a rate of 4 and 5% for diabetes (Ayah et al., 2013).

The coexistence of diabetes and hypertension is not a random occurrence but is influenced by shared risk factors and underlying pathophysiological mechanisms. Overweight, insulin resistance and lifestyle conditions play pivotal roles in the development and progression of both conditions. Oxidative stress, inflammation, and endothelial dysfunction further play a role in the pathogenesis (Jenson et al., 2011).

Hypertension and Type 2 diabetes often coexist in the same individual. This phenomenon is commonly referred to as the "double burden" of hypertension and diabetes. The coexistence of these conditions results in a higher risk of cardiovascular disease and microvascular complications. Understanding the reasons behind this coexistence is critical for effective management and treatment. Effective management of diabetes and hypertension require a comprehensive approach that targets associated factors. Lifestyle modifications, including regular exercise activity, nutritional diet, and ceasing smoking are essential in preventing and managing both conditions. Additionally, optimizing glycemic control and blood pressure management are crucial for reducing cardiovascular and microvascular complications. Future research should focus on elucidating the intricate interactions between diabetes and hypertension-associated factors, to develop personalized strategies for effective prevention and management of these conditions (Agyei-Mensah & Aikins, 2010).

Early screening and diagnosis are essential for identifying undiagnosed Type 2 diabetes among hypertensive patients. Various diagnostic criteria and tests are available for healthcare providers to detect diabetes, including fasting blood sugar levels, oral glucose

tolerance tests, and HbA1c measurements. Effective screening and diagnosis can facilitate timely intervention and improve health outcomes for individuals living with both conditions (Jenson et al., 2011).

1.2 Statement of Problem

There is a strong link between hypertension and diabetes, as both conditions are risk factors for cardiovascular issues. People having hypertension are highly likely to develop diabetes, and having both conditions increases the risk of cardiovascular complications (WHO, 2010b).

According to a study conducted in 2015, the overall prevalence of Hypertension (HTN) and Diabetes Mellitus (DM) among adults aged 18-69 years in Kenya was approximately 25% and 3.3% respectively. This prevalence is expected to increase over the years due to various factors such as lifestyle changes and aging population (Odili et al., 2019).

Patients receiving HTN follow-up are more likely to have their blood sugar levels checked during the medical facility visit but this does not happen in Kenyan clinical setups, especially in St. Orsola Catholic Mission Hospital. However, two studies by Mutebi et al. (2012) and Kidney et al. (2014) in Uganda found a significant frequency of undetected DM among individuals with high blood pressure in the clinical context, signifying an overlooked chance for early recognition and medical care. Such findings necessitated a need to carry out such this research. In Kenya, the socio-economic burden of the disease and its related complications remains high. This includes the cost of treatment, availability of and supply of monitoring equipment, medication, and hospitalization. As a result,

patients and relatives incur both direct and indirect costs due to low productivity, loss of income, and diversion of family resources to disease management.

Therefore, due to the increased incidence of diabetes in hypertensive individuals and the increasing burden of coexistence of these conditions, interventions need to be put in to control the morbidity and mortality due to these conditions.

1.3 Study Justification

Undiagnosed diabetes is a major public health concern, as it can lead to long-term complications such as retinopathy, neuropathy, nephropathy, and cardiovascular disease. Furthermore, undiagnosed diabetes can also affect the treatment and management of hypertension, as some medications used to treat hypertension may have adverse effects on blood glucose levels in individuals with undiagnosed DM. The rationale for exploring the co-occurrence of diabetes and hypertension is grounded in the recognition of shared risk factors, common pathophysiological mechanisms, and the compounded health risks faced by individuals with both conditions. This research seeks to unravel the underlying factors contributing to the simultaneous presence of diabetes and hypertension, shedding light on the intricate relationship between these two chronic diseases. By understanding the unique challenges posed by their coexistence, healthcare providers can enhance patient care, while public health officials can design more effective prevention strategies (CDC, 2010).

Therefore, research into undiagnosed diabetes among hypertension patients is essential for several reasons. Firstly, it will help in the identification of hypertensive patients with undiagnosed DM and allow for early diagnosis. Secondly, it will help in the identification of socio-demographic and behavioral characteristics associated with undiagnosed diabetes

among hypertensive patients. While both diabetes and hypertension independently contribute to the global burden of disease, understanding the prevalence and risk factors for diabetes among hypertensive patients is crucial for targeted interventions and enhanced patient care. Therefore, this research among hypertension patients is essential for early diagnosis of diabetes and identification of risk factors associated with undiagnosed diabetes.

1.4 Research Objectives

1.4.1 Main Objective

The main objective of this study was to assess the prevalence and risk factors associated with undiagnosed diabetes in hypertensive patients visiting St. Orsola Catholic Mission Hospital.

1.4.2 Specific Objectives

The specific objectives for this study were to:

i. To establish the prevalence of undiagnosed diabetes among hypertensive patients visiting St. Orsola Catholic Mission Hospital in Tharaka Nithi County in Kenya.

ii. To identify the socio-demographic characteristics of hypertensive patients associated with undiagnosed diabetes at St. Orsola Catholic Mission Hospital.

iii. To identify the behavioral characteristics of hypertensive patients associated with undiagnosed diabetes at St. Orsola Catholic Mission Hospital.

1.5 Research Questions

i. What is the prevalence of undiagnosed diabetes among hypertensive patients attending St. Orsola Catholic Mission Hospital who have undetected diabetes?
ii. What are the socio-demographic characteristics of hypertensive patients that are associated with undiagnosed diabetes at St. Orsola Hospital?
iii. What are the behavioral characteristics of hypertensive patients that are associated with undiagnosed diabetes at St. Orsola Hospital?

1.6 Research Hypothesis

i. There is no undiagnosed diabetes among hypertensive patients attending St. Orsola Catholic Mission Hospital in Tharaka Nithi County in Kenya.
ii. The socio-demographic and behavioral characteristics of hypertensive patients are not associated with the development of diabetes in patients attending St. Orsola Catholic Mission Hospital in Tharaka Nithi County in Kenya.

1.7 Significance of the Study

Studying the prevalence of undiagnosed diabetes among hypertensive patients is significant due to its potential impact on public health, clinical management, screening strategies, risk assessment, prevention efforts, and addressing health disparities. The findings from this study can contribute to improved health outcomes, and show the risk factors for effective healthcare interventions, and targeted approaches for early detection and management of diabetes in hypertensive individuals. Also, understanding the prevalence and risk factors for diabetes among hypertensive patients holds significance for several stakeholders. Healthcare providers can benefit from insights that inform more

targeted screening and management strategies. Public health policymakers can use this information to design interventions addressing the specific needs of individuals with both conditions, thereby mitigating the broader societal impact of these chronic diseases.

1.8 Scope of the Study

The scope of this research encompasses a detailed investigation into the prevalence of diabetes among hypertensive patients, considering demographic, clinical, and lifestyle factors. By assessing the scope of this study, valuable insights can be gained to improve early detection and management strategies for patients with both hypertension and undiagnosed diabetes. The research involved the collection of data from a sample of hypertensive patients attending the hospital, conducting interviews, questionnaires, and examinations to identify undiagnosed cases of diabetes using random blood sugar and HbA1C as confirmatory tests. Furthermore, risk factors such as age, gender, education, and lifestyle factors were analyzed to establish their association with undiagnosed diabetes in hypertensive patients. The findings will provide a comprehensive understanding of the prevalence and risk factors involved, which can aid in enhancing preventive measures, diagnostic protocols, and treatment strategies for this vulnerable patient population.

1.9 Study Limitations

Due to the cross-sectional nature of this study's design and its hospital setting, it was not possible to extrapolate its results to the general population. The length of time individuals had been diagnosed with hypertension and the specific antihypertensive drugs they were taking were not collected in the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The co-occurrence of hypertension and diabetes is common, with approximately 20-60% of patients with diabetes also having HTN (Mohan et al., 2013). The presence of both conditions can lead to an increased risk of cardiovascular conditions, stroke, kidney disease, and blindness, among other complications.

The pathophysiological mechanisms underlying the co-infection of hypertension and diabetes are complex and multifactorial. Insulin resistance, a hallmark of type 2 diabetes, is closely linked with the development of HTN. Chronic hyperglycemia and oxidative stress in diabetes lead to endothelial dysfunction, inflammation, and vascular remodeling, contributing to elevated blood pressure. Furthermore, shared risk factors such as overweight, sedentary lifestyle, and genetic predisposition contribute to the development of both conditions (WHO, 2012).

Co-occurrence of hypertension and diabetes has several clinical implications, including an aggregated risk of cardiovascular complications. The combination of these conditions amplifies the risk of coronary artery disease, stroke, myocardial infarction, and renal dysfunction. Individuals with both conditions also have a higher risk of microvascular complications, including diabetic retinopathy and nephropathy (Gress et al., 2000).

Effective management of co-occurrence requires a comprehensive approach that targets both hypertension and diabetes. Lifestyle modifications, the management of one's weight, a balanced diet, frequent exercise, and smoking cessation, form the foundation of

management. Pharmacological interventions, such as antihypertensive agents and anti-diabetic medications are commonly prescribed. However, medication selection should consider potential interactions and adverse effects (WHO, 2011).

2.2 Hypertension

The development of an elevated BP (hypertension) in the cardiovascular system involves a complex interplay of various physiological mechanisms. Normally, blood pressure is regulated by the cardiovascular system through a negative feedback loop. When blood pressure rises, the body signals the blood vessels to dilate, allowing blood to flow more easily and reducing blood pressure. When blood pressure drops, the body signals the blood vessels to constrict, increasing blood pressure and maintaining blood flow to vital organs. However, when this feedback mechanism is disrupted, the blood pressure may remain elevated, leading to hypertension (Campbell et al., 2005).

2.3 Epidemiology of Hypertension

Globally, elevated blood pressure is a great health risk for cardiovascular disease, which is the leading cause of death worldwide. The WHO estimates that hypertension is responsible for about 7.5 million deaths per year worldwide. Therefore, preventing and treating hypertension is a critical public health priority, and efforts to reduce its prevalence and associated morbidity and mortality should be a focus of healthcare systems and policy makers (WHO, 2014).

The World Health Organization estimates that 46 percent of those with elevated blood pressure live in Africa and that 40 percent of those with the condition are over the age of 25 globally (Agyei-Mensah & Aikins, 2010). There has been an upsurge in HTN in Sub-

Saharan Africa as a result of physical inactivity, abuse of alcohol, diet, and tobacco use (Hall et al., 2011).

According to a study conducted in 2015, the overall prevalence of Hypertension (HTN) and Diabetes Mellitus (DM) among adults aged 18-69 years in Kenya was approximately 25% and 3.3%. This prevalence is expected to have increased over the years due to various factors such as lifestyle changes and an aging population (Odili et al., 2019).

2.4 Diagnosis of Hypertension

Hypertension does not present with symptoms at an early stage; therefore, it is referred to as a silent killer. The gold standard for diagnosing hypertension is blood pressure measurement using a validated device, such as an automated sphygmomanometer. The American Heart Association and the European Society of Cardiology recommend that blood pressure be measured at least twice on two separate occasions, preferably in a clinical setting, to confirm the diagnosis of hypertension. The threshold for diagnosis is a SBP of 130 mmHg or higher or a DBP of 80 mmHg or higher (Chobanian et al., 2003).

2.5 Causes of Hypertension

Hypertension, or high blood pressure, is a complex condition with multiple causes. Several risk factors have been identified as having the potential to cause hypertension; these factors can be categorized as adjustable and non-adjustable (CDC, 2010; WHO, 2010b). A person's race, genetic susceptibility, age, and family history of HTN are examples of non-modifiable characteristics that cannot be altered by any intervention (Geller, 2004; Kato, 2012). On the other hand, the adjustable risk factors can be changed by applying an

intervention such as poor eating habits, cigarette usage, inactivity, and alcohol abuse (Ôunpuu, et al., 2001).

2.6 Hypertension Management

The control of hypertension involves a combination of lifestyle modifications and medication therapy, with regular monitoring and follow-up. Identifying and managing hypertension early and effectively is crucial for preventing cardiovascular complications and improving long-term outcomes (Almas et al., 2012).

Lifestyle changes, including weight control, nutritional changes, physical exercise, and smoking cessation, are recommended as the initial line of treatment for individuals with HTN. Antihypertensive medications are typically prescribed when lifestyle change alone are not sufficient to control blood pressure. Several classes of medications are available for the management of hypertension, including diuretics, Angiotensin-Converting Enzymes (ACE) inhibitors, angiotensin II receptor blockers, beta-blockers, calcium channel blockers, and renin inhibitors (Sekokotla et al., 2003).

2.7 Hypertension Complication

HTN is a leading cause of health care expenditure worldwide and it affects all organs in the body (WHO, 2014). It is a major risk factor for the development of cardiovascular conditions, including coronary artery disease, heart failure, and stroke. It also causes kidney disease, eye disease, cognitive impairment, and erectile dysfunction. Early diagnosis and effective management of hypertension are crucial for preventing these complications and improving long-term outcomes (Ong et al., 2007).

2.8 Hypertension Prevention

Following a balanced and nutritious diet is essential for maintaining healthy blood pressure levels. The Dietary Approaches to Stop Hypertension (DASH) diet is often recommended, which emphasizes fruits, vegetables, whole grains, lean proteins, and low-fat dairy products while limiting saturated fats, cholesterol, and sodium. High sodium consumption has been linked to hypertension. Lowering the amount of salt in a diet is important for preventing and managing hypertension. Avoid processed foods, canned soups, fast food, and condiments high in sodium. Instead, opt for fresh ingredients and season meals with herbs and spices (NIH, 2002).

Being overweight or obese increases the risk of hypertension. Regular physical exercise and a nutritional diet can help maintain a healthy weight or promote weight loss if necessary. Therefore, one should have a minimum of 150 minutes of medium-intensity aerobic exercise a week, such as brisk walking, cycling, or swimming. Engaging in regular physical activity not only helps with weight management but also contributes to overall cardiovascular health. Exercise improves blood circulation, strengthens the heart, and reduces the risk of hypertension (Almas et al., 2012).

Excessive alcohol consumption can raise blood pressure. Men should aim for no more than two standard drinks per day, while women should limit themselves to one standard drink per day. It's important to note that excessive alcohol intake can also lead to other health issues, so moderation is key. Smoking damages blood vessels and raises blood pressure (Kumar et al., 2021).

2.9 Diabetes Mellitus

DM, also referred to as diabetes, is a chronic condition that affects the body's ability to produce or use insulin, a hormone that regulates blood sugar levels. There are three main types of diabetes - type 1, type 2, and gestational diabetes (WHO, 2010b).

As an autoimmune disease, type 1 diabetes is a condition where the body attacks the cells that produce insulin. Type 2 DM is a metabolic disorder in which the cells become non-adherent to insulin or do not excrete the required level of insulin. Gestational diabetes occurs during pregnancy and usually resolves postpartum. Common symptoms of diabetes include frequent urination, increased thirst, hunger, fatigue, blurred vision, and slow wound healing (WHO, 2006).

According to the World Health Organization (WHO, 2015), diabetes is a major cause of blindness, kidney failure, heart attacks, stroke, and lower limb amputations. WHO data indicate its prevalence has been rising more rapidly in middle and low-income countries. Prevalence in Kenya is 3.3%, according to the 2015 STEP-wise survey for non-communicable diseases. About 537 million are affected worldwide, while only 24 million are affected in Africa.

2.9.1 Causes of Diabetes Mellitus

Type 2 diabetes is the most common form of diabetes where the body's cells become resistant to the action of insulin, a hormone excreted by the beta cells. Insulin is responsible for allowing glucose to enter the cells and be used for energy generation. When cells fail to adhere to the insulin, glucose piles up in the bloodstream, causing high level of blood sugar.

In type 1 DM, the immune system mistakenly attacks and destroys the cells producing insulin in the pancreas. This results in a total deficiency of insulin, leading to uncontrolled glucose levels. The exact cause of this autoimmune reaction is not fully understood, but genetic and environmental factors are believed to play a role (WHO, 2015).

Certain genetic factors can predispose individuals to develop diabetes. People with a history of diabetes in a family, especially type 2, have a higher danger of developing the condition. However, having a genetic issue doesn’t guarantee that an individual will end up having DM, as other factors like lifestyle and environmental factors also have a significant role. Unhealthy lifestyle choices can significantly increase the risk of developing type 2 diabetes. Lack of physical exercise, poor diet (high in processed foods, sugar, and unhealthy fats), and obesity are major contributors. Excess weight, particularly abdominal obesity, increases insulin resistance and the likelihood of developing diabetes (Agyei-Mensah & Aikins, 2010).

The risk of having DM rises with age. Type 2 diabetes is more common in older age, although it is becoming more prevalent in younger age groups due to the rise in obesity rates. Certain ethnic groups, such as African Americans, Hispanic/Latino Americans, Native Americans, and Asian Americans, have a higher predisposition to diabetes compared to others. Certain medical conditions and hormonal disorders, like polycystic ovary syndrome (PCOS), Cushing's syndrome, and acromegaly, can elevate the chance of developing diabetes. These conditions can affect hormone levels and insulin sensitivity, leading to impaired glucose metabolism (WHO, 2014).

2.9.1.1 Smoking.

Smoking can cause insulin resistance, a condition in which the body's cells become less responsive to insulin. Insulin is a hormone that controls blood sugar levels, and when cells become resistant to insulin, blood sugar levels can rise, increasing the risk of developing diabetes (WHO, 2010b). In addition, smoking can increase cortisol levels, a hormone that can increase blood sugar levels. This can contribute to insulin resistance and increase the risk of developing diabetes.

2.9.1.2 Weight.

Being overweight or obese can cause the body's cells to become resistant to insulin, a hormone that regulates blood sugar levels. Insulin resistance can lead to elevated blood sugar levels, which can eventually lead to type 2 diabetes. Also, the fat cells release chemicals that can cause chronic inflammation in the body. Inflammation can impair the body's ability to use insulin effectively, leading to insulin resistance and a raised chance of contracting diabetes (WHO, 2010b).

2.9.1.3 Physical Activity.

Regular physical exercise helps the body to use insulin more efficiently, reducing insulin resistance. When one engages in exercise, the muscles require more glucose for energy. As a result, the cells become more sensitive to insulin, allowing them to take up glucose from the bloodstream more effectively. Physical activity can lower blood sugar levels, especially during and after exercise. Exercise stimulates glucose uptake by the muscles, leading to a reduction in blood sugar levels. This effect can last for several hours after exercise, depending on the intensity and duration of the activity (Barboi, 2022).

Physical exercise is instrumental in achieving and maintaining a healthy weight. Regular exercise helps burn calories, promotes fat loss, and builds muscle mass. By achieving a healthy weight or losing excess weight, the risk of developing type 2 diabetes decreases significantly. Furthermore, weight management through physical activity is crucial for individuals with DM to better control their level of blood sugar. Diabetes increases the risk of cardiovascular diseases, such as heart disease and stroke. Physical activity plays a crucial role in maintaining cardiovascular health by improving blood pressure, reducing LDL cholesterol levels (the "bad" cholesterol), increasing HDL cholesterol levels (the "good" cholesterol), and enhancing overall heart function (Alqahtani et al., 2013).

Regular physical exercise can help in lowering stress levels. Stress can contribute to elevated blood sugar levels in people with diabetes, so managing stress through exercise can have a positive impact on blood sugar control. Engaging in physical activity releases endorphins, which are natural mood-boosting chemicals. Exercise can improve sleep quality, increase energy levels, and reduce the risk of depression and anxiety, all of which contribute to overall well-being. Managing mental health is particularly important for individuals with diabetes, as the condition can be demanding and stressful (WHO, 2015).

2.9.1.4 Diet.

Consuming more calories than the body's needs can lead to weight gain and obesity, which is a significant risk factor for type 2 diabetes. Being overweight or obese increases insulin resistance and makes it more difficult for the body to regulate blood sugar levels. Foods and drinks that are high in added sugars and refined carbohydrates can cause a rapid spike in blood sugar levels. Over time, repeated spikes in blood sugar can lead to insulin resistance and contribute to the occurrence of type 2 DM. Sugary beverages, candies,

pastries, and processed foods are examples of sources of added sugars and refined carbohydrates (Sánchez-Pimienta et al., 2016).

A diet low in fiber, particularly soluble fiber, can increase the risk of type 2 diabetes. Fiber helps slow down the absorption of sugars, preventing rapid spikes in blood sugar levels. Additionally, high-fiber foods can help with weight management and promote overall metabolic health (Mwendwa, 2001). Consuming excessive amounts of unhealthy fats, such as saturated fats and trans-fats, can increase the risk of insulin resistance and type 2 diabetes. These fats are commonly found in fried foods, fatty cuts of meat, full-fat dairy products, and processed snacks (Kumar & Bansali, 2010).

Diets that lack a variety of nutrients, including vitamins, minerals, and antioxidants, can impair the body's ability to regulate blood sugar levels and maintain optimal metabolic function. Consuming a balanced and diverse diet is essential for overall health, including diabetes prevention (Zemlin et al., 2011).

2.9.1.5 Alcohol.

Chronic alcohol consumption can damage the beta cells of the pancreas which is responsible for excreting insulin. This can impair the pancreas's ability to produce and secrete insulin, leading to an elevated chance of contracting diabetes (Yu et al., 2012). Also, chronic alcohol consumption can lead to nutrient deficiencies, including deficiencies in B vitamins, which are important for glucose metabolism. These deficiencies can contribute to insulin resistance and an increased risk of developing diabetes (Unwin et al., 2002).

2.9.2 Association Between Diabetes, Hypertension and Risk Factors

Hypertension is a common comorbidity in individuals with diabetes, and vice versa. This bi-directional relationship poses challenges for healthcare systems, as the management of one condition may influence the progression or onset of the other. Despite the recognized interplay between diabetes and hypertension, there is a need for a focused investigation into the prevalence of diabetes among hypertensive patients and the identification of the specific risk factors contributing to this co-occurrence. The prevalence of co-occurring hypertension and diabetes is significant. According to the International Diabetes Federation, approximately 50% of individuals with diabetes also have hypertension (Selvin et al., 2013).

This high prevalence underscores the frequent overlap of these conditions in clinical practice. However, it's essential to recognize that prevalence rates may vary by region, age, sex, and other demographic factors. The global prevalence of co-occurring hypertension and diabetes demonstrates considerable variation. Regions with a high burden of non-communicable diseases, including cardiovascular diseases and diabetes, tend to exhibit higher rates of this co-occurrence. Southeast Asia, the Middle East, and Africa have seen rising prevalence rates, partly due to changing dietary habits, sedentary lifestyles, and increasing obesity rates (Kato, 2012)

Age is a critical determinant of the co-occurrence of hypertension and diabetes. Both conditions are more common in older adults, and as the global population ages, the prevalence of co-occurring conditions is likely to increase. Additionally, men appear to be at a higher risk of experiencing this comorbidity compared to women. In recent decades,

there has been a steady increase in the prevalence of co-occurring hypertension and diabetes. This upward trend is largely attributed to lifestyle changes, including poor dietary habits, sedentary behavior, and the growing rates of obesity. Notably, there is a concerning increase in the co-occurrence of these conditions among younger populations, primarily due to the rising prevalence of childhood and adolescent obesity (Vijver & Oti, 2013).

Socio-economic status plays a significant role in the epidemiology of co-occurring hypertension and diabetes. Lower socio-economic status is associated with a higher risk of both conditions. Individuals with limited access to healthcare, education, and resources for managing these conditions are more vulnerable to this comorbidity. Racial and ethnic disparities exist in the prevalence of co-occurring hypertension and diabetes. Certain population groups, such as African Americans, Hispanics, and indigenous communities, have a higher risk of experiencing this comorbidity. Genetic and environmental factors may contribute to these disparities, emphasizing the need for targeted interventions and culturally sensitive care (Wang et al., 2014)

Diabetes and hypertension share several common risk factors, including obesity, a sedentary lifestyle, an unhealthy diet, age, family history, race and ethnicity, and other health conditions. Addressing these risk factors through lifestyle modifications, such as regular exercise, healthy eating, and weight management, can help prevent the development of both conditions and reduce the risk of complications (WHO, 2010b).

Overweight is a significant risk factor for both diabetes and hypertension. Excess weight can lead to insulin resistance and high blood pressure, increasing the risk of developing both conditions (Pastakia et al., 2013). Lack of physical activity is another risk factor for

both DM and elevated blood pressure. Adults should engage in not less than two hours of medium-intensity exercise each week. This helps in controlling the level of blood sugar and lowers blood pressure hence reducing the risk of HTN, DM, and cancer-related mortality (WHO, 2013).

A diet high in saturated and trans-fats, salt, and sugar is a risk factor for both diabetes and hypertension. A healthy diet, rich in fruits, vegetables, whole grains, and lean protein, can help prevent both conditions. The risk of developing both diabetes and hypertension increases with age. Older adults are more likely to have high blood pressure and impaired glucose tolerance (Wang et al., 2012; WHO, 2014).

The breakdown of glucose is affected differently by several anti-hypertensive medications, where diuretics such as thiazides may increase blood glucose levels by reducing insulin sensitivity and impairing insulin secretion (Rizos & Elisaf, 2014). However, loop diuretics like furosemide are less likely to have this effect while Beta-blockers may decrease insulin sensitivity and impair insulin release, which may cause increased blood glucose levels. This effect may be more pronounced in non-selective beta-blockers like propranolol than in selective beta-blockers like atenolol (Eleftheriadou et al., 2011).

2.9.3 Diabetes Screening in Hypertensive Patients

All hypertensive patients should be screened for diabetes, regardless of age, gender, or race. Screening is particularly important for patients who have additional risk factors for diabetes, such as obesity, a family history of diabetes, or a history of gestational diabetes (Njihia, 2014).

The American Diabetes Association (ADA) recommends that hypertensive patients be screened for diabetes at the time of diagnosis of hypertension and annually thereafter. However, some healthcare providers may choose to screen more frequently, particularly in patients with additional risk factors. The ADA recommends using either a fasting plasma glucose test, an oral glucose tolerance test, or a hemoglobin A1C test to screen for diabetes. However, the preferred screening method may vary depending on individual patient factors and local laboratory resources (WHO, 2012).

The hemoglobin A1C (HbA1C) test is a commonly used blood test that provides valuable information about a person's average blood glucose levels over a period of approximately three months. It is primarily used in the diagnosis and management of diabetes mellitus. The HbA1C test measures the percentage of glycated hemoglobin (hemoglobin molecules bound to glucose) in the bloodstream. Hemoglobin, the oxygen-carrying protein in red blood cells, undergoes a non-enzymatic glycation process when exposed to high blood glucose levels. This glycation occurs over the lifespan of red blood cells, which is around 120 days on average. Consequently, the HbA1C test provides an estimation of long-term glucose control (Sánchez-Pimienta et al., 2016).

2.9.4 Pathophysiology of the Co-occurrence of Hypertension and Diabetes

One of the central pathophysiological links between hypertension and type 2 diabetes is insulin resistance. Insulin resistance occurs when the body's cells do not respond effectively to insulin, a hormone that regulates blood glucose levels. In this condition, the pancreas produces more insulin to compensate, leading to higher circulating insulin levels. This, in turn, can contribute to various pathophysiological changes, including Endothelial

Dysfunction where insulin resistance can impair the function of the endothelium, the inner lining of blood vessels. This leads to reduced nitric oxide production, affecting blood vessel dilation and contributing to increased blood pressure, as well as Increased Sympathetic Nervous System Activity where insulin resistance can stimulate the sympathetic nervous system, which regulates blood pressure. Increased sympathetic activity can result in elevated heart rate and vasoconstriction, raising blood pressure (WHO, 2018).

Both hypertension and type 2 diabetes are associated with chronic low-grade inflammation. Inflammation can lead to endothelial dysfunction, vasoconstriction, and oxidative stress. Inflammatory mediators such as cytokines and chemokines are elevated in individuals with these conditions, creating a pro-inflammatory environment that contributes to both hypertension and diabetes. Oxidative stress, an imbalance between reactive oxygen species (ROS) and the body's antioxidant defenses, is a shared pathophysiological mechanism. Excess ROS can damage blood vessels, impair vasodilation, and promote inflammation, all of which can contribute to both hypertension and diabetes (Kato et al., 2012).

In both hypertension and diabetes, there is often an over-activation of the Renin-Angiotensin-Aldosterone System (RAAS). This system leads to vasoconstriction and fluid retention, which can raise blood pressure and worsen insulin resistance. The interactions between the RAAS and these conditions create a positive feedback loop that perpetuates their coexistence. Dyslipidemia, characterized by abnormal lipid profiles, is common in both hypertension and diabetes. Dysregulated lipid metabolism, including elevated triglycerides and low-density lipoprotein (LDL) cholesterol, can contribute to endothelial dysfunction, inflammation, and the development of atherosclerosis, all of which are linked to both conditions (Alqahtani et al., 2013).

2.9.5 Clinical Management and Treatment Strategies for the Co-occurrence of Hypertension and Diabetes

One of the cornerstones of managing hypertension and diabetes is lifestyle modification. A healthy diet is fundamental, with recommendations to reduce sodium intake, limit saturated fats and added sugars, and increase the consumption of whole grains, fruits, vegetables, lean proteins, and healthy fats. Special attention is given to diets like the Dietary Approaches to Stop Hypertension (DASH) and diabetes-friendly eating plans, which emphasize nutrient-rich foods to control blood pressure and blood glucose. Weight management is also a priority, especially targeting abdominal obesity. Achieving and maintaining a healthy weight is encouraged, with a focus on gradual and sustainable weight loss through caloric restriction and increased physical activity. Regular exercise, including a combination of aerobic and resistance training, is integral to improving insulin sensitivity and lowering blood pressure. Individualized exercise plans are tailored to the patient's fitness levels and medical conditions (Eleftheriadou et al., 2011).

Pharmacological interventions play a significant role in managing hypertension and diabetes. Antihypertensive medications, such as ACE inhibitors, angiotensin receptor blockers (ARBs), beta-blockers, diuretics, and calcium channel blockers, are prescribed based on individual patient characteristics and blood pressure control goals. Oral antidiabetic drugs, including metformin, sulfonylureas, dipeptidyl peptidase-4 (DPP-4) inhibitors, and sodium-glucose cotransporter-2 (SGLT-2) inhibitors, are chosen according to the type of diabetes and patient-specific factors. The selection of antidiabetic medications is individualized, considering efficacy, tolerability, and potential side effects. Insulin therapy may be required when glycemic control cannot be achieved with oral

medications. Various insulin regimens, such as basal insulin, bolus insulin, or combination therapies, are used to tailor treatment to the patient's needs (CDC, 2010).

Patient education is a critical component of clinical management. Individuals must understand both conditions, their interrelationship, and the significance of adhering to treatment plans. Education encompasses dietary guidance, self-monitoring techniques, medication management, and lifestyle changes. Finally, support services are provided to complement patient education. These services may include diabetes education programs, self-management classes, and counseling for behavior change. The goal is to engage patients in shared decision-making regarding their care, empowering them to take an active role in managing their health. Also, the integrated care model is crucial for managing the co-occurrence of hypertension and diabetes. This approach involves a team of healthcare professionals, including physicians, nurses, dietitians, pharmacists, and other specialists. The care team collaborates to provide comprehensive and coordinated care that addresses both conditions simultaneously (Chatterjee et al., 2013).

2.9.6 Public Health Implications of the Co-occurrence of Hypertension and Diabetes

One of the primary public health implications of this co-occurrence is the increased burden on healthcare systems. Individuals living with both hypertension and diabetes often require more intensive medical care, including frequent check-ups, a variety of medications, and ongoing monitoring. This results in higher healthcare costs and resource utilization, straining already overstretched healthcare systems. This co-occurrence of hypertension and diabetes also significantly elevates the risk of complications. Individuals with both conditions are at a heightened risk of cardiovascular diseases, kidney disease, retinopathy,

neuropathy, and other diabetes-related complications. This not only affects the health and quality of life of the affected individuals but also adds to the healthcare burden. Preventing these complications becomes a critical public health goal (Mohan et al., 2013).

Health disparities are a concerning public health implication of the co-occurrence of hypertension and diabetes. Certain population groups, including racial and ethnic minorities and individuals with lower socio-economic status, are more likely to experience this comorbidity. Addressing health disparities is imperative to achieve health equity. Public health organizations must implement interventions that ensure access to quality care and resources for all individuals, regardless of their background or socio-economic status. The economic implications of managing individuals with both conditions are substantial. The cost of care includes medication expenses, hospitalizations, long-term management, and indirect costs such as lost productivity. As the prevalence of these comorbid conditions continues to rise, healthcare budgets must accommodate the growing financial burden (Pétursson, 2012).

2.10 Conceptual Framework

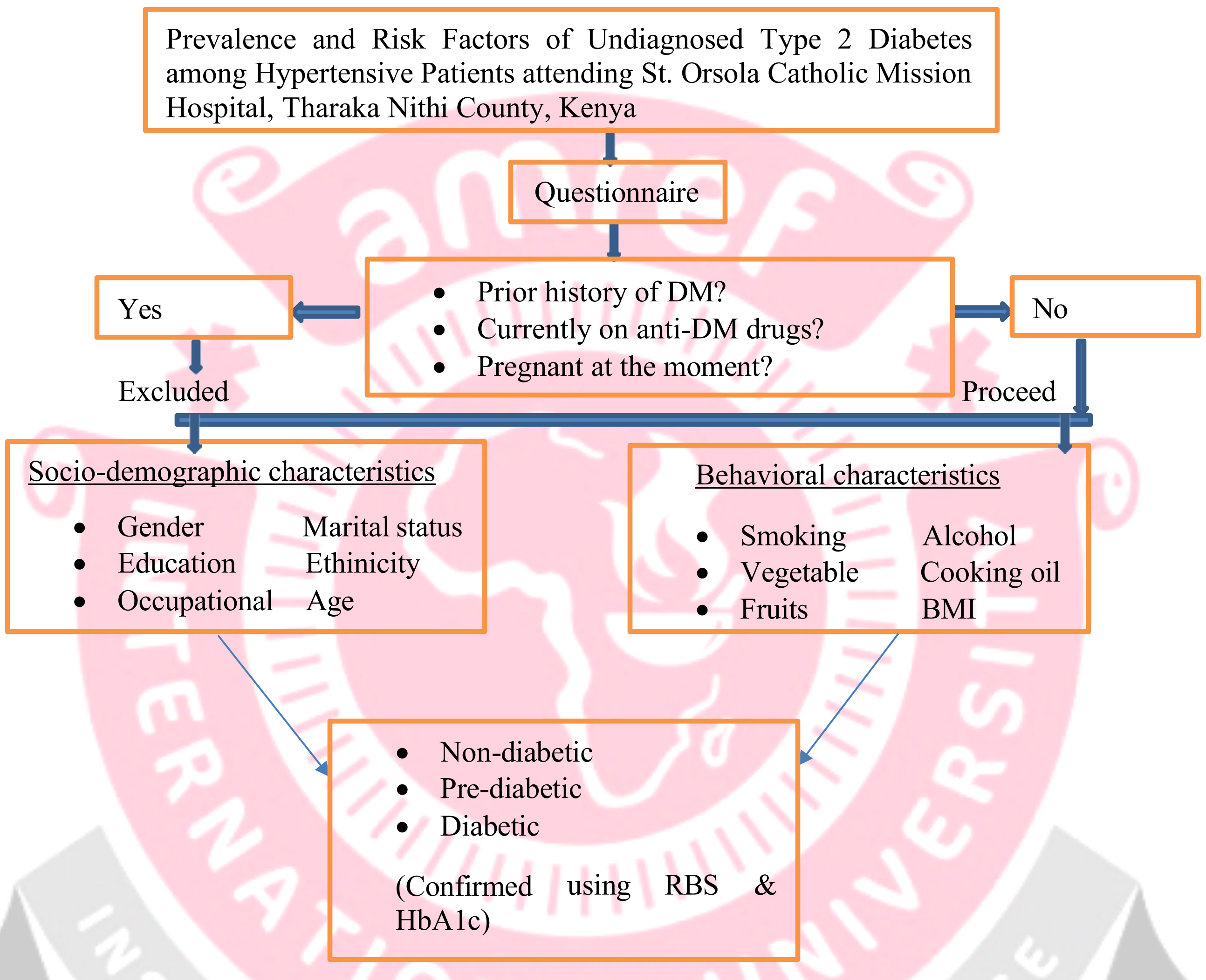

Figure 1: Conceptual Framework

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Study Area

This study was conducted at St. Orsola Catholic Mission Hospital hypertensive outpatient clinic. The hospital is located in Tharaka South sub-county with a catchment population of 100,000 and serves an average patients population of 10,000 patients per month and has a bed capacity of 216. The facility is a level 4 hospital serving three neighboring counties, Embu, Meru, and Kitui. It has specialized out-patient medical clinics where HTN patients are enrolled (an average of 350 HTN per month).

Patients are seen at their planned appointments based on their health status, and they come after every 2-3 months for drug refills and routine checkups. During the patient visit, regular evaluation tests like BP and BMI are taken before entering to physician's room. Any further tests e.g., Random Blood Sugar (RBS) and HbA1c are requested by a physician based on the patient's clinical presentation at the time of visit, hence not all visiting patients are screened.

Therefore, for the facilitation of data collection during the patient visit, I provided the testing material where all patients visiting HTN clinic were screened for random blood sugar irrespective of their clinical presentation, and those with higher levels were tested for HbA1c test to determine the average blood sugar for the last four months before physician visit.

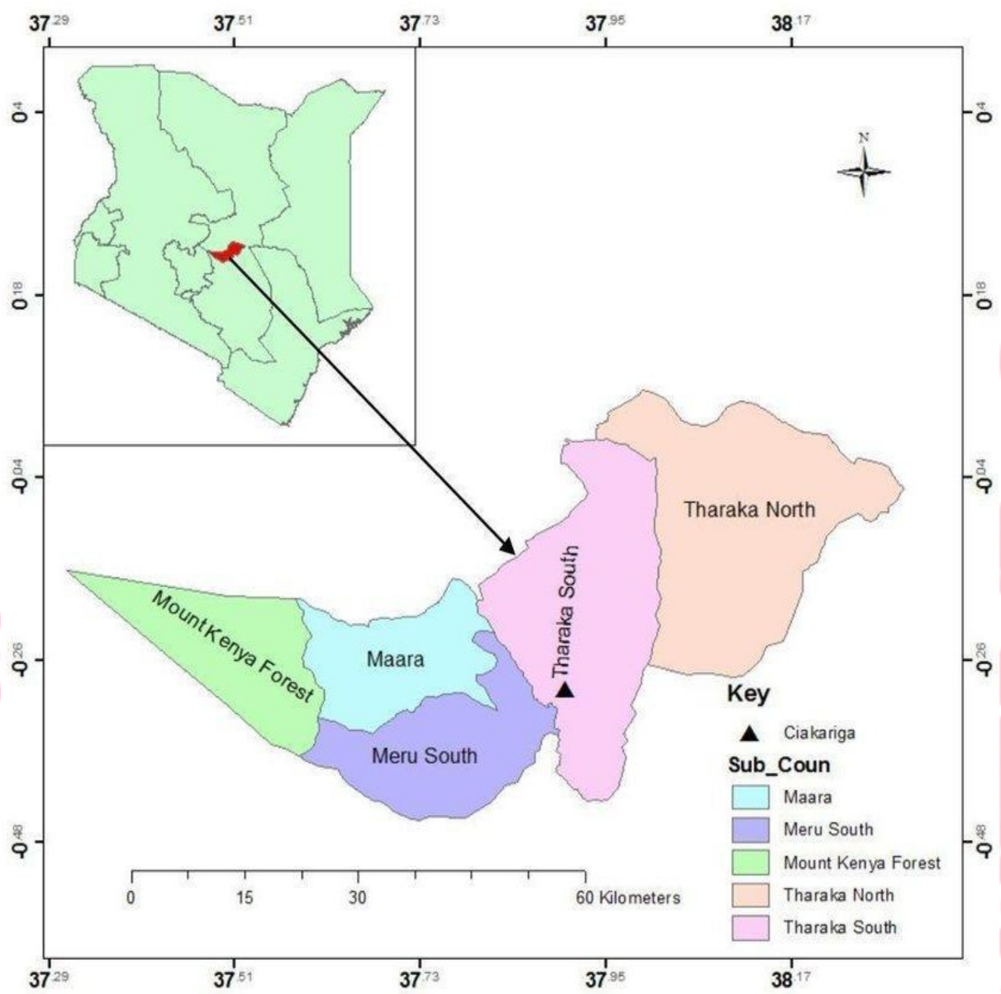

***Figure 2**: A Kenyan Map Highlighting the Research Area*

3.2. Study Design

This study employed a cross-sectional design to investigate the prevalence and risk factors of undiagnosed Type 2 diabetes among 384 hypertensive patients.

3.3 Sampling

The study population (hypertensive patients) was sampled through systemic random sampling (every 2nd patient was sampled).

3.4 Study Population

The study population was hypertensive patients (patients on anti-hypertensive medication) attending St. Orsola Catholic Mission Hospital were the target population.

3.5 Study Variables

i) Dependent variable

The occurrence of Diabetes mellitus (tested by RBS and confirmed by HbA1c test) among hypertensive patients attending St. Orsola Catholic Mission Hospital was the dependent variable.

ii) Independent variables

Age, sex, education, marital status, occupational, hypertension, smoke, BMI, Nutritional status.

3.6 Sampling Procedures

Respondents to this study were identified following the inclusion criteria below.

3.6.1 Inclusion Criteria

The patients who are already under anti-hypertensive medication or confirmed as hypertensive were included in this study.

3.6.2 Exclusion Criteria

i. The hypertensive patients who were known to be diabetic or under anti-diabetic medication during the study period were excluded from the study.

ii. Expectant mothers due to gestation-related diabetes and HTN which may disappear after delivery.

3.7 Sample Size

The formula below was used to get the sample size (Fisher`s formula)

$N = (z)^{2} p (1-p)$

d^{2} $\qquad N \quad = \quad 1.96^{2 \times 0.5 (1-0.5)}$

0.052

n = desired sample size;

z = standard normal distribution value (1.96)

p = known prevalence rate for the factor of interest under study (50%)

d = the level of desired precision (0.05).

A prevalence of 50% will be used as the assumed prevalence of undiagnosed diabetics' state among hypertensive patients.

d = 0.05, z = 1.96, p = 0.5 n =384.

3.8 Collection of Data

3.8.1 Questionnaire

Patients were given a questionnaire that asked about their demographics and behavioral traits such as their use of alcohol, smoking, diet, and physical exercise, as well as their medical history and prior assessment for high blood pressure and diabetes. The initial questions contained a screening section that gave an opportunity to the participant to decide

whether to or not to enroll as a participant in the research, where all patients with known diabetes, pregnant or under diabetes medication were excluded from study participation.

3.8.2 Validity

Data validity was achieved by ensuring that the data collection tool was formulated based on the study objectives with an adequate number of questions addressing each of the study variables. The questionnaires were numbered in a sequential order before being dispatched to the field and the study was limited to the area of study.

3.8.3 Reliability

Reliability was ensured through the use of a standard well-designed questionnaire and; proper selection, training, and supervision of research assistants on interview techniques. The research assistants were also involved in pre-testing to ensure they administered the questionnaires correctly during the actual data collection. Completed questionnaires were checked at the end of each day of data collection.

3.8.4 Biochemical Data Collection

During the patient visit, regular evaluation tests like BP and BMI are taken before entering to physician's room. Any further tests e.g., Random Blood Sugar (RBS) and HbA1c are requested by a physician based on the patient's clinical presentation at the time of visit, hence not all visiting patients are screened. Therefore, for the facilitation of data collection during the patient visit, I provided the testing material where all patients visiting the HTN clinic were screened for random blood sugar irrespective of their clinical presentation, and

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those with higher levels were tested for HbA1c test to determine the average blood sugar for the last four months (120 days) before entering the physician room.

Briefly, when patients entered the HTN clinic, the nurse located at the clinic took the BP and BMI of the patient, then the patient proceeded to the laboratory where the Random blood sugar (RBS) was tested and entered into the patient's card and those with high RBS were tested for HbA1c test. The patient's diabetes results were classified based on WHO revised criteria of diabetic, pre-diabetic, and non-diabetic (HbA1c of greater than 6.5 %, between 6.1 % and 6.4% and less than 6.1%) (WHO 2011b). Finally, the patients take the results back to the nurse who documents the results in the clinical book. Then the patients proceeded to the physician's room with BP, RBS, BMI, and some with HbA1c test results.

3.9 Analysis of Data

The analysis of data was done using SPSS Version 20.0, performing bivariate correlation and Chi-square analysis, and looking at statistical significance at a p-value less than 0.05 at a 95% confidence interval.

3.10. Ethical Considerations

The study received endorsements from the management committees of St. Orsola Catholic Mission Hospital, the Scientific and Ethical Review Committee of Amref International University, and the National Commission for Science Technology and Innovation (NACOSTI). Through the use of a standard consent form created specifically for this investigation, participants gave their informed consent to take part in the study after induction. Participants who qualified for the study were given a questionnaire after an interview.

CHAPTER 4: RESULTS

4.1 Introduction

This section provides the data analysis where the results were analyzed using univariate, bivariate correlation, and Chi-square analysis. The study involved 384 patients who were all screened for diabetes for the first time during HTN clinic visits. The chapter is organized as follows: First, it presents the socio-economic characteristics of respondents. This is followed by a summary of the behavioral characteristics of the respondents; then the prevalence of undiagnosed diabetes; the influence of socio-demographic characteristics on patients with undiagnosed diabetes. The next section presents the influence of behavioral characteristics on patients with undiagnosed diabetes. The chapter concludes with a presentation of a model explaining the factors that influence undiagnosed diabetes.

4.2 Socio-demographic Characteristics of Respondents

4.2.1 Gender

The respondents were asked to indicate their gender. From Figure 3, the majority of the respondents (66%) were female while 34% were male. Figure 3 shows the distribution of respondents by gender.

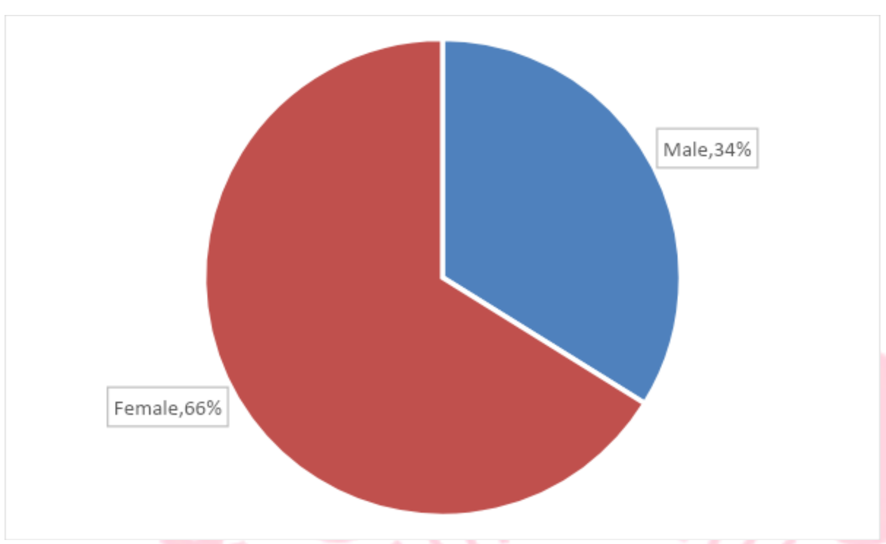

Figure 3: Distribution of Respondents by Gender

4.2.2 Age

The researcher sought to find out the age category of the respondents. Figure 4 shows that the majority of the respondents (43%) were aged between 30 to 59 years. This was followed by 37% who were aged 60 years and above, while only 19% were aged under 30 years. The summary is presented in Figure 4.

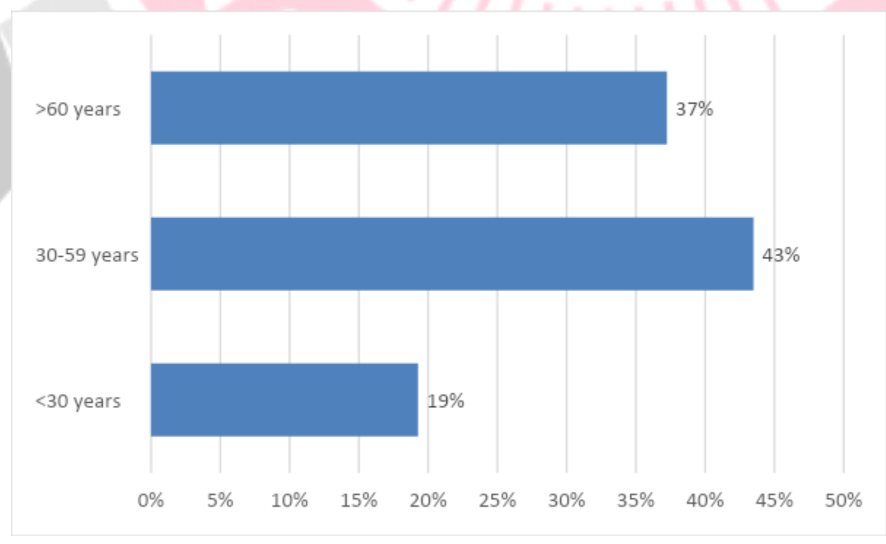

Figure 4: Distribution of Respondents by Age

4.2.3 Education Level

The respondents were asked to indicate their highest education level. The results are presented in Table 1.

Table 1: Respondents Distribution by Education

Highest education level	Frequency	Percent
No formal education	105	27.3
Primary school	148	38.5
Secondary school	90	23.4
College	34	8.9
Postgraduate	7	1.8
Total	**384**	**100.0**

Table 1 shows that the majority of the respondents 65.8% had either primary or less than primary level of education, 23.4% had secondary school education level, and 8.9% had college education. Only 1.8% had postgraduate education.

4.2.4 Ethnicity

The research sought to find out the ethnic group where the participants came from. Table 2 shows that most (33.9%) of the respondents were from the Meru community followed by 28.1% who were from the Embu community while 21.9% came from the Kikuyu community. Table 2 shows the distribution of respondents by their ethnic groups.

Table 2: Respondents Distribution by Ethnic Group

Ethnicity	Frequency	Percent
Kikuyu	84	21.9
Embu	108	28.1
Meru	130	33.9
Other	62	16.1
Total	**384**	**100.0**

4.2.5 Marital Status

The research sought to find out the marital status of the participants. A majority (63%) of the respondents were married, followed by 29.4% who were single. Only 7.6% of the respondents were divorced. Table 3 shows the respondent's distribution by marital status.

Table 3: Respondents Distribution by Marital Status

Marital status	Frequency	Percent
Married	242	63.0
Divorced	29	7.6
Single	113	29.4
Total	**384**	**100.0**

4.2.6 Employment Status

The research sought to establish the employment status of the respondents. The highest population (41.4%) of the respondents were employed while 36.5% were casual workers. 6.5% were housewives, 6.5% were in business and 9.1% were students. They were asked

to indicate the main type of work they do. Table 4 shows the respondent's distribution by employment status.

Table 4: Respondents Distribution by Employment Status

Occupation	Frequency	Percent
Employed	159	41.4
Housewife	25	6.5
Business	25	6.5
Casual worker	140	36.5
Student	35	9.1
Total	**384**	**100.0**

4.3 Behavioral Characteristics of the Participants

4.3.1 Cigarette Smoking

The study sought to establish whether the respondents smoked cigarettes. They were asked whether they currently smoke. A majority (80%) of the respondents were non-smokers while only 20% smoked at the time of the study. Figure 5 shows the distribution of respondents by smoker status.

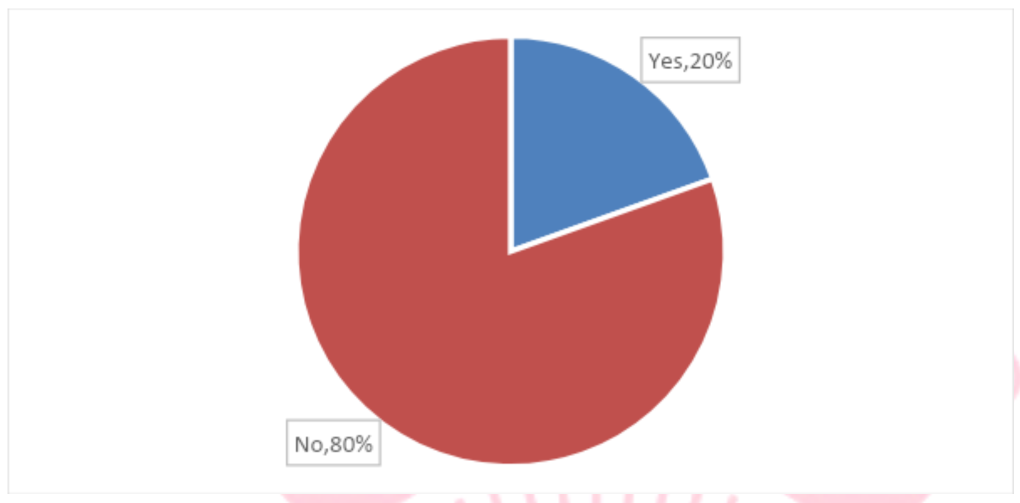

Figure 5: Distribution of Respondents by Cigarette Smoking Status

4.3.2 Alcohol Consumption

The study sought to find out whether the respondents consumed alcohol at the time of carrying out the study. A majority (64.1%) of the respondents had never consumed alcohol while 35.9% had a history of alcohol consumption. Table 5 shows the distribution of respondents by whether or not they were alcohol users.

Table 5: Distribution of Respondents by Alcohol Consumption History

Alcohol consumption	Frequency	Percent
Yes	138	35.9
No	246	64.1
Total	**384**	**100.0**

4.3.3 Type of Cooking Oil

The study sought to find out the type of oil that the respondents used for cooking. A majority of the respondents (70%) used liquid oil while 26% used solid fat. Only 4% did not use any cooking oil. Figure 6 shows the summary of the results.

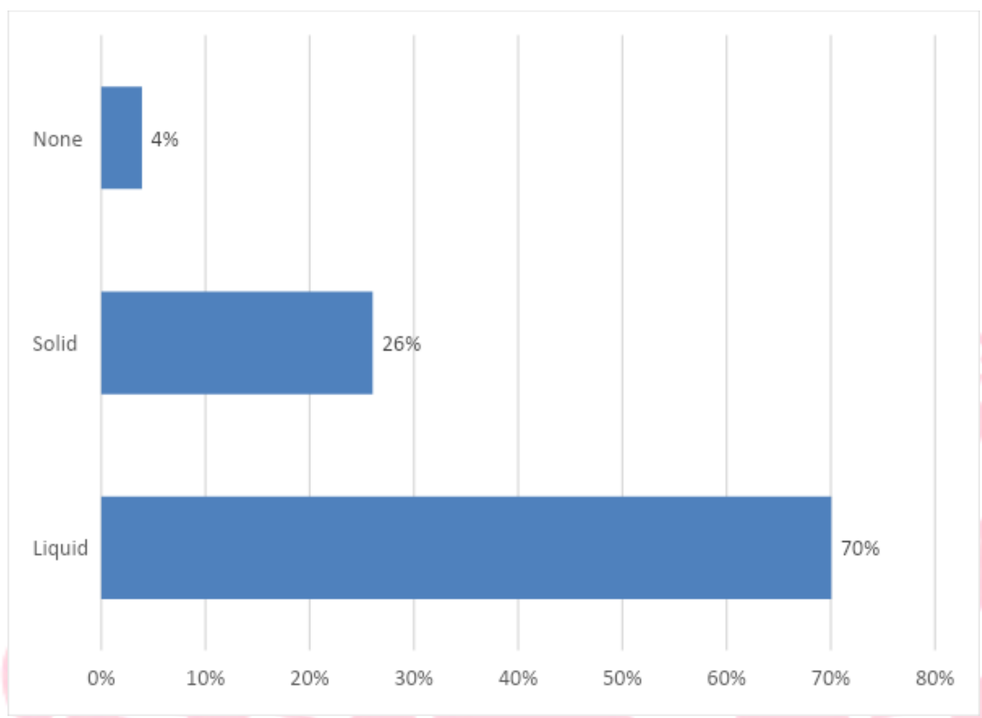

Figure 6: Distribution of Respondents by Type of Cooking Oil

4.3.4 Frequency of Consumption of Fruits

The study sought to establish how frequently the respondents consumed fruits. The respondents were asked to indicate the average number of days during which they consumed fruits weekly. Most respondents (49.5%) consumed fruits for 2 days weekly, followed by 23.2% who consumed fruits for 3 days every week and 13.3% who consumed fruits once every week. Only 1% of the respondents indicated they did not consume any fruits at all. Table 6 below shows the results.

Table 6: ***Distribution of Respondents by Fruit Consumption***

Number of days in a week	Frequency	Percent
0	4	1.0
1	51	13.3
2	190	49.5
3	89	23.2
4	25	6.5
5	10	2.6
6	3	.8
7	12	3.1
Total	**384**	**100.0**

4.3.5 Frequency of Consumption of Vegetables

The respondents were asked to indicate the frequency of their vegetable consumption weekly. The highest proportion of the respondents (35.2%) indicated that they consumed vegetables for an average of 2 days weekly. This was followed by 27.3% who consumed vegetables for an average of one day weekly. Only 0.5% indicated they never consumed any vegetables. Table 7 shows the distribution of respondents by frequency of consumption of vegetables weekly.

Table 7: Distribution of Respondents by Frequency of Consumption of Vegetable Weekly

Number of days in a week	Frequency	Percent
0	2	.5
1	105	27.3
2	135	35.2
3	73	19.0
4	40	10.4
5	17	4.4
6	3	.8
7	9	2.3
Total	**384**	**100.0**

4.4 Diabetes Status of Respondents

The study sought to establish the diabetes status among the respondents. Three-quarters of the respondents (75%) were non-diabetic while 19.5% were pre-diabetic but 5.5% were found to be diabetic. Table 8 shows the respondent's distribution by diabetes status.

Table 8: Distribution of Respondents by Diabetes Screening Results

Diabetes Status	Frequency	Percent
Non-diabetic	288	75.0%
Pre-diabetic	75	19.5%
Diabetic	21	5.5%
Total	**384**	**100.0%**

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4.5 Association Between Socio-Demographic Characteristics and Occurrence of Diabetes Among Hypertensive Patients

4.5.1 Gender and Diabetes Status

The study sought to examine the relationship between gender and diabetes status. Chi-square was used to assess the relationship and the results were as presented in Table 9.

Table 9: Association of Gender and Occurrence of Diabetes Status among Hypertensive Patients

		Diabetes status			
		Non-diabetic	**Pre-diabetic**	**Diabetic**	**Total**
Gender	Male	70.8%	22.3%	6.9%	100.0%
	female	77.2%	18.1%	4.7%	100.0%
Total		75.0%	19.5%	5.5%	100.0%
Pearson Chi-Square	2.005[a]	df =2	Ass. Significance	.367	

Table 9 shows that among the male sample, 70.8% were non-diabetic, 22.3% were pre-diabetic and 6.9% were diabetic. Among the females, 77.2% were non-diabetic, 18.1% were pre-diabetic and 4.7% were diabetic. The Chi-square results indicate that there is no significant association between gender and diabetes status (Chi-Square 2.005, $p>.05$).

4.5.2 Association Between Age and Diabetes Status Among Hypertensive Patients

To assess the relationship between age and diabetes status, a chi-square was generated for the two variables and the results were as presented in Table 10.

Table 10: Association of Age and Diabetes Status among Hypertensive Patients

		Diabetes status			
		Non-diabetic	**Pre-diabetic**	**Diabetic**	**Total**
what is your age	<30	85.1%	14.9%		100.0%
	30-59	71.9%	25.7%	2.4%	100.0%
	>60	73.4%	14.7%	11.9%	100.0%
Total		75.0%	19.5%	5.5%	100.0%
Pearson Chi-Square	24.837[a]	df =4	Ass. Significance	.000	

From Table 10, 85.1% of those aged under 30 were non-diabetic, while 14.9% were pre-diabetic and none were diabetic. Among those aged between 30 and 60, 71.9 % were non-diabetic, 25.7% were pre-diabetic and 2.4% were diabetic. Among those aged over 60, 73.4% were non-diabetic, 14.7% were pre-diabetic and 11.9% were diabetic. Older people above 60 years had a significantly higher risk of diabetes than those between 30-59 years. The chi-square result confirms that there exists an association between age and diabetes status (Chi-Square 24.837, $p<.05$).

4.5.3 Association of Education Level and Diabetes Status Among Hypertensive Patients

The study sought to evaluate the relationship between education level and diabetes status. Chi-Square was employed to assess the relationship and the results are presented in Table 11.

Table 11: Association of Education Level and Diabetes Status among Hypertensive Patients

		Diabetes status			
		Non-diabetic	**Pre-diabetic**	**Diabetic**	**Total**
Education level	No formal education	72.4%	19.0%	8.6%	100.0%
	Primary school	71.6%	23.6%	4.7%	100.0%
	Secondary school	82.2%	14.4%	3.3%	100.0%
	College	82.4%	11.8%	5.9%	100.0%
	Postgraduate	57.1%	42.9%		100.0%
Total		75.0%	19.5%	5.5%	100.0%
Pearson Chi-Square	10.120[a]	df =8	Ass. Significance	.257	

Table 11 shows that among those with non-formal education, 72.4% were non-diabetic, 19.0% were pre-diabetic and 8.6% were diabetic. Among those with primary-level education, 71.6% were non-diabetic, 23.6% were pre-diabetic and 4.7% were diabetic. Among those with secondary education level, 82.2%% were non-diabetic, 14.4% were pre-diabetic and 3.3% were diabetic. Among the college-educated, 82.4% were non-diabetic, 11.8% were pre-diabetic and 5.9% were diabetic. Among those with postgraduate education level, 57.1% were non-diabetic, 42.9% were pre-diabetic and none were diabetic. The chi-square result shows that there is no significant association between education level and diabetes status (Chi-Square 10.120, p>.05).

4.5.4 Association of Marital Status and Diabetes Status Among Hypertensive Patients

A Chi-Square of marital status and diabetes status was generated to evaluate the relationship between the two variables. The results are shown in Table 12.

Table 12: Association of Marital Status and Diabetes Status among Hypertensive Patients

		Diabetes status			
		Non-diabetic	**Pre-diabetic**	**Diabetic**	**Total**
Marital status	Married	70.6%	24.0%	5.4%	100.0%
	Divorced	69.0%	24.1%	6.9%	100.0%
	Single	85.9%	8.8%	5.3%	100.0%
Total		75.0%	19.5%	5.5%	100.0%
Pearson Chi-Square	11.992[a]	df =4	Ass. Significance	.017	

Table 12 shows that among the respondents who were married, 70.7% were non-diabetic, 24.0% were pre-diabetic and 5.4% were diabetic. Among those who were divorced, 69.0 % were non-diabetic, 24.1% were pre-diabetic and 6.9% were diabetic. Among those who were single, 85.8 % were non-diabetic, 8.8% pre-diabetic and 5.3% diabetic. This suggests an uneven distribution of diabetes status across marital status. The chi-square result confirms that there is a dependence between marital status and diabetes status (Chi-Square 11.992, $p<.05$).

4.5.5 Association of Ethnicity and Diabetes Status Among Hypertensive Patients

The goal of the study was to determine the relationship between ethnicity and the status of diabetes. Chi-Square was used to assess the relationship and the results were as presented in Table 13.

Table 13: Association of Ethnicity and Diabetes Status among Hypertensive Patients

		Diabetes status			
		Non-diabetic	**Pre-diabetic**	**Diabetic**	**Total**
Ethnic group	Kikuyu	69.0%	26.2%	4.8%	100.0%
	Embu	71.3%	22.2%	6.5%	100.0%
	Meru	75.4%	16.9%	7.7%	100.0%
	Other	88.7%	11.3%		100.0%
Total		75.0%	19.5%	5.5%	100.0%
Pearson Chi-Square	11.912[a]	df =6	Ass. Significance	.064	

From Table 13 among the Kikuyu respondents, 69.0% were non-diabetic, 26.2% were pre-diabetic and 4.8% were diabetic. Among the Embu, 71.3% were non-diabetic, 22.2% were pre-diabetic and 6.5% were diabetic. Among the Meru, 75.4% were non-diabetic, 16.9% were pre-diabetic and 7.7% were diabetic. Among the other communities, 88.7% were non-diabetic, 11.3% were pre-diabetic and none were diabetic. The Chi-square result shows that there was no significant association between ethnicity and diabetes status (Chi-Square 11.912, p>.05).

4.5.6 Association Between Employment Status and Diabetes Status Among Hypertensive Patients

The study sought to examine the relationship between employment status and diabetes status. Chi-Square was used to assess the relationship and the results were as presented in Table 14.

Table 14: Association Between Employment Status and Diabetes Status Among Hypertensive Patients

		Diabetes status			
		Non-diabetic	**Pre-diabetic**	**Diabetic**	**Total**
Main work	Employed	67.3%	26.4%	6.3%	100.0%
	Housewife	84.0%	8.0%	8.0%	100.0%
	Business	84.0%	8.0%	8.0%	100.0%
	Casuals	77.9%	17.1%	5.0%	100.0%
	Student	85.7%	14.3%		100.0%
Total		75.0%	19.5%	5.5%	100.0%
Pearson Chi-Square	13.402[a]	df =8	Ass. Significance	.099	

From Table 14, among those employed, 67.3% were non-diabetic, 26.4% were pre-diabetic and 6.3% were diabetic. Among the housewives and business people, 84.0% were non-diabetic, 8.0% were pre-diabetic and 8.0% were diabetic. Among the casuals' respondents, 77.9% were non-diabetic, 17.1% were pre-diabetic and 5.0% were diabetic. Among the student respondents, 85.7% were non-diabetic, 14.3% were pre-diabetic and none were diabetic. The Chi-square result indicates that there is no association between employment status and diabetes status (Chi-Square 13.402, $p>.05$).

4.5.7 Association Between BMI Status and Diabetes Status Among Hypertensive Patients

A chi-square of BMI status and diabetes status was generated to establish the relationship between the two variables. The results are shown in Table 15.

Table 15: Association Between BMI Status and Diabetes Status Among Hypertensive Patients

BMI status	**Diabetes status**			**Total**
	Non-diabetic	**Pre-diabetic**	**Diabetic**	
18.5-24.5	96.0%	4.0%	0.0%	6.5%
25-29.5	90.2%	7.8%	2.0%	39.8%
≥30	61.2%	30.1%	8.7%	53.6%
Total	75.0%	19.5%	5.5%	100.0%
Pearson Chi-Square	45.838	df =4	Ass. Significance	.000

From Table 15, 61.2% of those with a BMI above 30 were non-diabetic, while 30.1% were pre-diabetic and 8.7% were diabetic. Among those with a BMI between 25 and 29.5, 90.2 % were non-diabetic, 7.8 % were pre-diabetic and 2.0% were diabetic. Among those with a BMI between 15.5 and 24.5, 96% were non-diabetic, 4% were pre-diabetic and none were diabetic. A BMI above 30 had a significantly higher risk of diabetes than those with a BMI between 25 and 29.5. The chi-square result confirms that there exists an association between BMI and diabetes status (Chi-Square 45.838, p<.001).

4.6 Influence of Behavioral Characteristic on Patients with Undiagnosed Diabetes

The study sought to establish the relationship between behavioral characteristics of the respondents and undiagnosed diabetes.

Table 16: Association Between Behavioral Status and Diabetes Status Among Hypertensive Patients

	Model Fitting Criteria	Likelihood Ratio Tests		
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	284.525[a]	0.000	0	
Fruits	286.798	2.273	2	.321
Vegetables	289.032	4.507	2	.105
Smoke	287.256	2.731	2	.255
Alcohol	285.676	1.151	2	.562
Fat	290.886	6.361	2	.174

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

From Table 16, all behavioral characteristics, namely frequency of taking fruits (Chi-square 2.273, $p>.05$), frequency of eating vegetables (Chi-square 4.507, $p>.05$), smoking status (Chi-square 2.731, $p>.05$) and alcohol status (Chi-square 1.151, $p>.05$) were found to have no significant effect on health status ($p>.05$).

CHAPTER 5: DISCUSSIONS

5.1 Introduction

This section discusses the results presented in chapter four. The chapter is organized as follows, first, it discusses the respondents' socio-demographic, behavioral, and physical characteristics; then prevalence of undetected diabetes and pre-diabetes and finally the risk factors associated with undiagnosed diabetes among hypertensive patients.

5.1 Respondents Socio-Demographic, Behavioral and Physical Characteristics

From the study, a majority (62%) of the study participants with undetected DM were women while men were 38%. Similar research was done in Uganda at Mulago Hospital where seventy-three percent of the HTN individuals with undetected DM were women (Mutebi et al., 2012). From the research, the majority of participants 158 (41.1%) had secondary education while 33 (8.6%) had no formal education, among whom 38% were diabetes while 31% were pre-diabetic. Those with tertiary education level had the lowest prevalence of undiagnosed DM, similar to another study's findings where the majority of HTN participants with undetected DM had no formal education (Mayega et al., 2013). Therefore, this research shows that education has an influence on patient diabetes status, similar to what was shown by Shang et al (2013).

Among the study participants, usage of alcohol and tobacco use was not a widespread habit as 309 (80.5%) didn't engage in tobacco smoking and 240 (64.1%) had never consumed alcohol during the study period. This was in line with a study done in Nigeria, where 66 percent of undetected DM hadn't consumed alcohol while 80% hadn't smoked tobacco (Iloh et al., 2013).

From the study, fifty-three percent 206 (53.6%) of the participants were categorized as obese, and 8.7% among them were undiagnosed DM while 30.1% were pre-diabetic. Similar study findings were reported in Nigeria where six percent of HTN individuals with undetected DM were obese (Iloh et al., 2013). Similar study findings were reported in Uganda and Germany where more than half of the study participants had obesity (Mayega et al., 2013; Lüders et al., 2005). Consequently, obesity is a controllable risk factor for DM development (WHO, 2014). According to Chatterjee et al. (2013), pre-diabetes increases the chance of later acquiring DM and its related consequences. To lower their BMI, people with a BMI of 25 kg/m2 and more should receive counseling and education.

5.2 Prevalence of Undiagnosed Diabetes

The goal of the research was to determine the prevalence and associated risk factors for undiagnosed diabetes among individuals with HTN at St. Orsola Hospital. From the study, a quarter 96, (25%), of the study respondent were confirmed to have AGR (pre-diabetes and diabetes), where 21 (5.5%) were diagnosed with diabetes, while 75 (19.5%) were pre-diabetic.

Evidence from literature shows that patients with cardiovascular diseases like hypertension are more likely to have an abnormal AGR. A study conducted in Uganda with 320 HTN patients found that half of the individual participants were pre-diabetic while 77 (24%) had undetected diabetes. In Nigeria, screening of 320 HTN individuals in a healthcare facility was done and 105 (33%) had undetected DM (Iloh et al., 2013).

In Minnesota, Kidney et al. (2014) study showed that of 3847 HTN individuals, 19.6% had undiagnosed diabetes while 10.7% had pre-diabetes. The Euro Heart Study on DM and the cardiovascular system showed that patients with coronary artery diseases and HTN had AGR, 36% of participants were pre-diabetic, and 22% percent had DM (Bartnik, 2004).

According to Luders et al. (2005), 12% of 260 HTN individuals in Germany had untreated diabetes, whereas 39% were pre-diabetic The finding of undetected DM and pre-diabetes among HTN patients illustrated the urgent need for monitoring for DM in all HTN patients in a clinical setting for early management.

5.3 Factors Associated with Undiagnosed AGR among Participants

From the study, 85.1% of those aged under 30 were non-diabetic, while 14.9% were pre-diabetic and none were diabetic. Among those aged between 30 and 60, 71.9 % were non-diabetic, 25.7% were pre-diabetic and 2.4% were diabetic. Among those aged over 60, 73.4% were non-diabetic, 14.7% were pre-diabetic and 11.9% were diabetic. From research findings, the AGR is significantly associated with age increases. This is primarily attributed to age-related changes in the body, such as decreased insulin sensitivity and impaired glucose regulation. The prevalence of diabetes tends to rise steadily after the age of 45. Type 2 diabetes, which accounts for the majority of diabetes cases worldwide, has a strong association with age. As individuals get older, their risk of developing Type 2 diabetes increases.

This can be partly attributed to several factors. First, the lifestyle factors accumulated over time, such as poor diet, sedentary behavior, and weight gain (Mutebi et al., 2012). Secondly, the body's cells become less responsive to insulin and changes in body

composition, including an increase in body fat and a decrease in muscle mass. These changes contribute to insulin resistance, making older individuals more susceptible to developing diabetes and finally, the pancreas may become less efficient at producing insulin, leading to impaired glucose control and an elevated chance of developing diabetes (Lüders et al., 2005).

From the study, fifty-three percent 206 (53.6%) of the participants were categorized as obese, and 8.4% among them were undiagnosed DM while 30.1% were pre-diabetic. A similar study finding was observed in Nigeria where six percent of HTN individuals with undetected DM were obese (Iloh et al., 2013). Similar study findings were reported in Uganda and Germany where more than half of the study participants had obesity (Mayega et al., 2013; Lüders et al., 2005). Consequently, obesity is a controllable risk factor for DM development (WHO, 2014). According to Chatterjee et al. (2013), pre-diabetes increases the chance of later acquiring DM and its related consequences. This can be attributed to the fact that excess body weight, especially in the form of visceral fat (fat around the organs), can lead to insulin resistance, where the body's cells become less responsive to insulin (Shang et al., 2013). Also, this high BMI can generally be associated with reduced insulin sensitivity resulting in higher blood glucose levels and an increased risk of developing diabetes (Iloh et al., 2013).

From the study, marital status has a significant association with diabetes. There are no other known studies conducted that showed similar results but several studies have suggested that being married is associated with a lower risk of developing diabetes compared to individuals who are single, divorced, or widowed. And suggestion is that married individuals may have better social support, healthier lifestyles, and greater access to

resources that promote overall well-being, including healthy eating habits, physical activity, emotional support, companionship, and a shared responsibility for health. The above suggestion has no supportive research documents to show that.

In this study, AGR was not significantly associated with alcohol consumption or smoking where 309 (80.5%) of the participants did not smoke tobacco and 240 (64.1%) hadn't consumed alcohol. The evidence regarding smoking and the risk of type 2 diabetes is inconsistent. Some studies have suggested a modest association between smoking and an elevated chance of contracting type 2 diabetes, while others have found no significant association (USPSTF, 2008).

The relationship may be influenced by other factors such as age, body weight, and genetic predisposition. Smoking has been associated with weight loss or weight suppression in some individuals. This weight-suppressing effect of smoking may lead to a lower risk of developing type 2 diabetes in certain populations. However, the overall negative health effect of smoking significantly outweighs any potential benefits related to weight suppression (Agardh et al., 2011).

Research has shown that moderate alcohol consumption may have a neutral or even slightly beneficial effect on the risk of developing Type 2 DM. Some studies suggest that moderate alcohol consumption, particularly red wine, may improve insulin sensitivity and lower the chance of Type 2 DM. However, it is crucial to note that excessive alcohol consumption can increase the risk of various health problems, including liver disease, pancreatitis, and certain types of cancer (Pastakia et al., 2013).

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The co-occurrence of hypertension and diabetes presents a complex and multifaceted challenge. While current challenges include limited awareness, health disparities, complex treatment regimens, and healthcare system limitations, future directions should focus on preventive strategies, integrated care models, telehealth solutions, patient-centered care, community health initiatives, improved health literacy, research and innovation, and health equity initiatives. By addressing these challenges and embracing these future directions, healthcare systems and public health organizations can provide more effective care and support for individuals facing the co-occurrence of hypertension and diabetes, ultimately improving patient outcomes and reducing the overall public health burden Preventive measures play a crucial role in managing these conditions effectively. Lifestyle modifications such as regular exercise, maintaining a healthy weight, adopting a balanced diet, limiting salt and sugar intake, and avoiding tobacco and excessive alcohol consumption are key preventive strategies. Additionally, early detection through regular screenings and prompt management of hypertension and diabetes are essential to prevent complications and improve outcomes.

6.2 Conclusions

6.2.1 Prevalence of Undiagnosed Diabetes

Despite the follow-up of participants for anti-hypertensive medication at the outpatient care center, the study revealed a high frequency of undetected DM where 5.5% of the

participants were diabetic and 19.5% pre-diabetes, hence emphasizing missed chance for detection.

6.2.2 Socio-Demographic Characteristics

From the study, it can be concluded that the socio-demographic characteristics are correlated factors for undiagnosed diabetes among the study participants.

6.2.3 Behavioral Characteristics

From the study, it can be concluded that all behavioral characteristic had no effect on the development of diabetes among hypertension patients.

6.3 Recommendations

Due to the increase in the prevalence of diabetes among hypertensive patients attending HTN clinics, all patients should be screened for diabetes irrespective of clinical presentation during HNT clinics.

A multidisciplinary approach involving healthcare professionals, including doctors, nurses, dietitians, and psychologists, can provide comprehensive awareness campaigns to educate hypertensive patients about the risk factors (both socio-demographic and behavioral characteristics), symptoms, and consequences of diabetes. These campaigns can also promote healthy lifestyle choices and encourage regular screenings.

Continued research is necessary to develop technologies for the prevention and management of hypertension and diabetes. Investments in research can lead to improved diagnostic tools, more effective therapies, and a better understanding of the underlying mechanisms of these conditions.

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APPENDICES

Appendix I: Informed Consent Form

Study title	PREVALENCE AND FACTORS ASSOCIATED WITH UNDIAGNOSED DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA HOSPITAL IN THARAKA NITHI COUNTY, KENYA.
Investigator(s)	a) Name: Father Emilio (Principal investigator) Contact: 0700433220
Study sponsor	No study sponsor
Collaborators	a) Name: Dr. Josephat Nyagero (supervisor) Contact 0722301689 b) Name: Dr. Rumishael Shoo (supervisor) Contact +255 75686501

This informed consent form has two parts

Information Sheet (to share information about the study with you)

Certificate of Consent (for signatures if you choose to participate)

You will be given a copy of the full Informed Consent Form

Part i: information sheet

Diabetes and hypertension pose significant public health challenges individually, and their co-occurrence further complicates the health landscape. Understanding the factors influencing their simultaneous presence is crucial for effective management and preventive strategies. This thesis is driven by a commitment to ethical research practices, with voluntary participation as a cornerstone.

You are welcome in this research study participation. The main objective of this study is to determine the prevalence and risk factors of diabetes among hypertensive patients attending St. Orsola Hospital. You have been selected as a participant. Kindly read the explanation of the study and feel free to ask questions that you may have. The gathered information from this study will be used to inform policy and guide in developing strategic interventions for Non-Communicable Diseases like hypertension.

The participate

The patients who are already under antihypertensive medication or confirmed as hypertensive will be included in this study. The hypertensive patients who were known to be diabetes or under anti-diabetic medication during study period will be excluded from the study and also the expectant mothers due to gestation related diabetes and HTN which may disappear after delivery. Those to participate in this study will also need to be over 18 years and have been diagnosed as having hypertension.

Voluntary participation

The participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled, and you may discontinue participation at any time without penalty or loss of benefits, to which you are otherwise entitled.

Purpose of the study

If you agree to take part in this study, a pre-coded questionnaire consisting of questions that cover demographic, medical history and behavioral characteristics will be issued to you to answer the questions that will take around 10 minutes. The initial questions will comprise a screening section to address the selection criteria to determine whether to enroll

you as a participant who gave consent into the study or not, where all patient with known diabetes, pregnant, under diabetes medication or below 18 years will be excluded from the study.

Duration of study

This study will take place for a period of 3 months from September to December.

The risks

There will be no risk in participating in this study, since data concerning your blood sugar levels shall be extracted from your clinical book and HTN Clinic Record Book. The hospital laboratory is registered, licensed and under mentorship of HUQAS for accreditation, while it participates in external quality control to ensure the quality of results produced and it has an appropriate measure of disposing the waste as guided by NEMA and public health.

The benefits

There will be an individual benefit in participating in this study, since the results of HbA1c test will be recorded in the HTN Clinic Record Book, and if abnormal, the clinician will take the necessary measure.

Information protects and confidentiality

All information from this study will be kept private and confidential. Records will be stored in a lockable drawer with restricted access. All communication regarding the research, including discussions of sensitive information, will take place through secure channels. Email correspondence will be encrypted, and any physical documents shared will be

password-protected. In the reporting of results, data will be presented in aggregate form to prevent the identification of individual participants. Descriptive statistics and general trends will be emphasized to maintain the anonymity of the study population. Your name will not be used in any report of this study, or in any publications or presentations. This information will strictly be reviewed only by authorized persons. The research team will adhere to a predefined data retention period, after which all identifiable information will be permanently deleted or destroyed. The research plan, including the measures to protect participant information, has received ethical approval from the Amref Review Board/Ethics Committee and NACOSTI. This approval ensures that the research adheres to ethical guidelines and regulations governing participant confidentiality.

The results

The information gathered in this study will be used to inform policy and in the development of guidelines for screening of individuals at risk of developing hypertension. The results of this study on the co-occurrence of diabetes and hypertension has the potential to make meaningful contributions to healthcare knowledge, patient care, and public health strategies. It addresses a significant health challenge and provides a platform for generating insights that can positively impact both clinical practice and policy development.

Refusal to participate or withdraw from the study

Participation in this study is entirely voluntary and if at any time you wish to withdraw from participating in the study, you are free to do so and you shall not be penalized or the study affect the services delivery to you. You may contact any of above contacts provided

if withdrawal is after data collection, and also provide information on how you would like your collected data to be treated.

Compensation

There will be no monetary gain to you if you accept to participate in this study but you will get information on your diabetes status at the end of the study and you will receive further management in case the blood sugar are high.

Whom to contact

If you have any questions, you can ask anyone from our team now or later. If you have questions later, you may contact, **Father Emilio, 0700433220, padreemilio@yahoo.com**. If you have questions about your rights as a study subject, you may contact:

The Research Officer
Amref Health Africa in Kenya
Wilson Airport, Lang'ata Road
Office Tel: +254 20 6994000
Mobile No: 0795746777
Fax: +254 20 606340
P.O Box 30125-00100
Nairobi, Kenya

Part ii: certificate of consent

I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study.

Print name of Subject

Signature of Subject

DD/MM/YYYY

If visually impaired, physically impaired, mentally impaired or illiterate

I have witnessed the accurate reading of the Consent Form to the potential study subject, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print Name of Subject

Thumb/Foot print of Subject

Signature of Witness

DD/MM/YYYY

I confirm that the study subject was given an opportunity to ask questions about the study, and all the questions asked by the study subject 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.

A copy of this Informed Consent Form has been provided to the study subject.

Print Name of researcher/person taking the consent

Signature of researcher/person taking the consent

DD/MM/YYYY

Appendix II: Questionnaire

Research Question: **PREVALENCE OF DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA MISSION HOSPITAL IN THARAKA NITHI COUNTY, KENYA.**

Questionnaire number

Interview date___/______/________

Health Facility__________________________________

Patient number___________________________________

Introduction part

The co-occurrence of diabetes mellitus (DM) and hypertension represents a common and complex health challenge with far-reaching implications for individuals and healthcare systems globally. Diabetes and hypertension are two prevalent chronic conditions, each independently contributing to the burden of non-communicable diseases. When present together, they can significantly exacerbate health risks, leading to increased morbidity and mortality.

SCREENING SECTION

Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes? Yes □ No □

Are you on any prescribed anti-diabetic medication? Yes □ No □

If Female, Are you pregnant? Yes □ No □

(NB: If "Yes" to any of the above questions, do not proceed with interview.)

Demographic information

1) Sex Male □ Female □

2) How old are you? □□

3) What is the highest level of education you have completed?

1-No formal schooling □ 2-Less than primary school □

3-Primary School □ 4-Secondary School □

5- College/University completed □ 6- Post graduate degree □

4) What is your ethnic group? Kikuyu □ Embu □ Meru □

Other (specify................)

5) What is your marital status?

a) Married □ b) Divorced □

c) Single □ d) Polygamous □

6) Which of the following best describes your main work status?

a) Employed/ skilled □ b) Housewife □ c)-Retired □

d) Unemployed □ e) Student □

7) Do you currently smoke any tobacco products, such as cigarettes? Yes □ No □

8) Have you ever consumed an alcoholic drink? Yes □ No □

9) In a typical week, on how many days do you eat fruit? □

10) In a typical week, on how many days do you eat vegetables? □

11) What type of oil or fat is most often used for meal preparation in your household?

a) Liquid oil □ b) solid fat □ c) Margarine □

12) Does your work involve vigorous-intensity activity ***[carrying or lifting heavy loads, digging or construction work]*** that causes large increases in breathing or heart rate like for at least 10 minutes continuously? Y □ No □

13) In a typical week, on how many days do you do vigorous-intensity activities as part of your work? a) Number of day b) Hours per day

History of Diabetes

14) Have you ever had your blood sugar measured? Yes □ No □

15) Has your blood sugar been measured in the past 12 months?

Yes □ No □

16) Do you have a family member with diabetes? Yes □ No □

Physical measurements

17) Height in Centimeters (cm) ________

18) Weight in Kilorams (kg) ________

19) BMI ________

20) BP Reading 1 Systolic (mmHg) ______Diastolic (mmHg) ________

21) Blood sugar results (RBS) ________

22. HBA1C test results if RBS high

Appendix III: Hospital Approval Letter

P.o Box 41 (60200) Matiri Meru-TharakaNithi county, Kenya, E.Africa
Tel. +254,703983686,+ 254 733 404 161 +254700433220

Ref. ERC-ST.OCMH/MSc/VOL.1/12 **Date: 10TH JUNE, 2022**

GERRALD NJERUH EMILIOH

RE: PREVALENCE AND RISK FACTORS OF UNDIAGNOSED DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA CATHOLIC MISSION HOSPITAL, THARAKA NITHI COUNTY, KENYA

This is to inform you that the Ethics Review Committee reviewed the document submitted and is satisfied that the issues raised at the meeting of Ethics Review Committee on 10th June, 2022 have been adequately addressed.

The study is granted approval for implementation effective from the date of this letter. Please note that authorization to conduct this study will automatically expire on 10th June 2023. If you plan to continue with data collection and analysis beyond this date, please submit an application for continuing approval to the ethical Review Committee-ST. Orsola Catholic Mission Hospital in appropriate time.

Any unanticipated problem resulting from the implementation of this protocol should be brought to the attention of ERC-ST.OCMH.

The ERC-ST.OCMH looks forward to receiving a summary of the research finding upon completion of the study to be part of the data base to be consulted when processing related researches to minimize duplication.

DR. Beppe Gaido
Medical superintendent

ST. ORSOLA HOSPITAL - MATIRI
10 JUN 2022
P.O. BOX 41 - 60200 MERU

Incorporating services rendered: laboratory, theater, x-ray, dental, maternity, pediatric, V.C.T, orthopediatric surgery, aesthesia, counseling, spiritual healing, biblical exorcism. **Personnel**: highly qualified, harmonized from within and without the county.
Machineries up to date, modernized and computerized.

Appendix IV: Amref Approval Letter

Amref International University

OFFICE OF THE DEAN SCHOOL GRADUATE STUDIES

2nd May 2022

GERRALD NJERUH EMILIOH SHS/MPH/3637-2/2020

PROPOSAL TITLE: PREVALENCE AND RISK FACTORS OF UNDIAGNOSED DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA CATHOLIC MISSION HOSPITAL, THARAKA NITHI COUNTY, KENYA.

Following your full proposal presentation on 27th January 2022 and subsequent review of your revised proposal, Graduate School has approved your work for submission for ethical review before the commencement of fieldwork.

You are advised to update the Graduate School of your progress every three months by submitting progress reports using the forms attached.

Dr Alice Lakati

Director, Research and Dean, Graduate School

CC: HOD Community Health

Appendix V: Ethical Approval Letter

Amref Health Africa in Kenya

REF: AMREF – ESRC P1174/2022

October 18, 2022

Gerrald Njeruh
Amref International University
P.O. Box 27691 – 00506
Nairobi, Kenya
Tel: +254700433200
Email: padreemelio@yahoo.com

Dear Gerrald Njeruh,

RESEARCH PROTOCOL: PREVALENCE AND RISK FACTORS OF UNDIAGNOSED DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA CATHOLIC MISSION HOSPITAL, THARAKA NITHI COUNTY, KENYA.

Thank you for submitting your protocol to the Amref Ethics and Scientific Review Committee (ESRC).

This is to inform you that the ESRC has reviewed and approved your protocol. Your application approval number is ESRC P1174-2022. The approval period is from October 18, 2022, to October 17, 2023, and is subject to compliance with the following requirements:

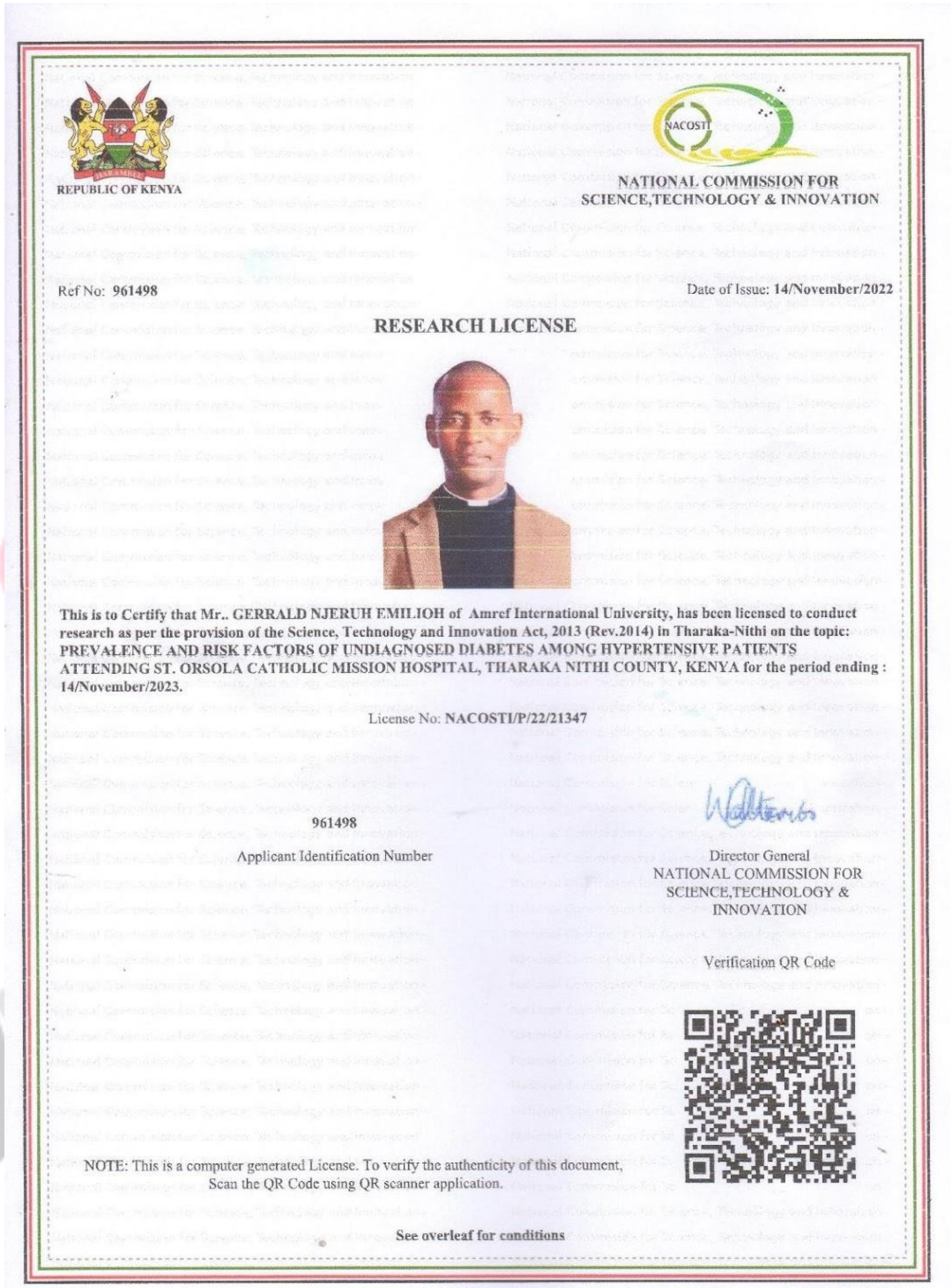
a) Only approved documents (including informed consents, study instruments, advertising materials, material transfer agreements, etc.) will be used.
b) All changes including (amendments, deviations, violations, etc.) are submitted for review and approval by Amref ESRC before implementation.
c) Death and life-threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the Amref ESRC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to Amref ESRC within 72 hours.
e) Clearance for export of biological specimen must be obtained from the relevant government authorities for each batch of shipment/export.
f) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
g) In case of late renewal, the Amref ESRC shall not be held responsible for any severe adverse events (SAEs) that may occur as a result of research activities that were carried out after the expiry of approval.
h) Submission of an executive summary report within 90 days upon completion of the study to the Amref ESRC.
i) All government regulations for prevention and control of the spread of COVID-19 including social distancing, provision of personal protective equipment for participants and research assistants should be adhered to during data collection. All research assistants should be monitored for COVID 19 symptoms and referred for testing in case they present with symptoms.

Board Members: Mr P Kasimu | Mrs E Mathu | Prof P Kiama | Mrs M Kuyoh | Prof Z Qureshi | Prof J Wang'ombe | Dr D Soti | Dr G Gitahi

P O Box 30125-00100 Nairobi, Tel: +254 (0)20 699 4000, Fax: +254 (0)20 699 2531. www.amref.org

Winner of the Gates Award for Global Health

Appendix VI: NACOSTI Letter



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 961498

Date of Issue: 14/November/2022

RESEARCH LICENSE

This is to Certify that Mr.. GERRALD NJERUH EMILIOH of Amref International University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Tharaka-Nithi on the topic: PREVALENCE AND RISK FACTORS OF UNDIAGNOSED DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA CATHOLIC MISSION HOSPITAL, THARAKA NITHI COUNTY, KENYA for the period ending : 14/November/2023.

License No: NACOSTI/P/22/21347

961498
Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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See overleaf for conditions

Appendix Vi: Plagiarism Report

Predictors and risk factors for undiagnosed diabetes

ORIGINALITY REPORT

13%	11%	4%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

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1	hdl.handle.net	Internet Source	<1%
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4	Nkatha Meme, Samuel Amwayi, Ziporrah Nganga, Esther Buregyeya. "Prevalence of undiagnosed diabetes and pre-diabetes among hypertensive patients attending Kiambu district Hospital, Kenya: a cross-sectional study", Pan African Medical Journal, 2015	Publication	<1%
5	www.coursehero.com	Internet Source	<1%
6	era.ed.ac.uk	Internet Source	<1%
7	ir.jkuat.ac.ke	Internet Source	<1%

Appendix VII: Evidence of Publication

From: **Editor - Manuscript Hut Pan African Medical Journal** <editor@panafrican-med-journal.com>
Date: Mon, Jun 24, 2024 at 8:45 PM
Subject: Pan African Medical Journal - Editorial decision: Major revision [Manuscript ID 44119]
To: GERRALD E <gerraldnjeru017@gmail.com>
Cc: Jean Jacques Noubiap <jjnoubiap@panafrican-med-journal.com>, Gladwel Muthoni <gladwel.muthoni@panafrican-med-journal.com>, <editor@panafrican-med-journal.com>

PREVALENCE AND RISK FACTORS OF UNDIAGNOSED TYPE 2 DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING ST. ORSOLA CATHOLIC MISSION HOSPITAL, THARAKA NITHI COUNTY, KENYA (44119)

Dear Dr Gerrald Emilioh,

Thank you for submitting your manuscript to the Pan African Medical Journal (PAMJ). We have completed its evaluation. We invite you to submit a revised version after addressing the concerns raised in the editorial report.

During the resubmission of your manuscript, please make sure you provide:

- **Your revised manuscript** with all changes made in a different font color (blue for instance). Please do not use track changes.
- **A cover letter** detailing the changes that have been made in the revised manuscript and a point-by-point response to the comments made above. This should be appended at the end of the manuscript under the heading "Cover letter"