PREVALENCE OF MICROVASCULAR COMPLICATIONS AND ASSOCIATED RISK FACTORS AMONG DIABETES MELLITUS PATIENTS ATTENDING NYERI COUNTY REFERRAL HOSPITAL, KENYA

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Prevalence of Microvascular Complications and Associated Risk Factors among Diabetes Mellitus Patients Attending Nyeri County Referral Hospital, Kenya

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2025

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

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This thesis has been submitted for examination with our approval as the University Supervisors

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DEDICATION

I dedicate this work to my family and friends for their support and encouragement. Credit also goes to my beloved husband and children for encouraging me

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ACRONYMS AND ABBREVIATIONS

ADA	American Diabetes Association
BMI	Body mass index
CKD	Chronic Kidney Disease
CVD	Cardiovascular diseases
DALYS	Disability-adjusted life years
DM	Diabetes Mellitus
DM clinic	Diabetes Mellitus Clinic
DOPC	Diabetes Outpatient Clinic
DR	Diabetic retinopathy
DN	Diabetic nephropathy
DPN	Diabetic Peripheral Neuropathy
ESRD	End-stage Renal Disease
GFR	Glomerular filtration rate
HTN	Hypertension
IDF	International Diabetes Federation
NCDs	Non-communicable diseases
MVCs	Microvascular complications

PHC	Primary health care
SDG	Sustainable development goal
T2DM	Type 2 Diabetes Mellitus
T1DM	Type 1 Diabetes Mellitus
USD	United States dollar
WHO	World health organization

DEFINITION OF OPERATIONAL TERMS

Diabetes Mellitus is a group of metabolic disorders characterized by high blood sugar over a prolonged period, resulting from the body's inability to use blood sugar for energy.

Type 2 Diabetes Mellitus the common type of diabetes that consists of an array of dysfunctions characterized by hyperglycemia, resulting from the combination of resistance to insulin action, inadequate insulin secretion, and excessive or inappropriate glucagon secretion.

Hyperglycemia Also called high blood glucose levels. It's a condition where an individual's sugar level or glycemic level deviates from physiological levels to become pathological

Glycemic control- Refers to recommended or optimal blood glucose levels that a person living with diabetes should maintain at any one given point in time. It is determined by a glycated hemoglobin test.

HBIAC Also referred to as Glycated hemoglobin -Is a profile indicator for glycemic control that indicates an average blood sugar level in the body for the last 3 to 4 months with figures < 7 % indicating good glycemic control while > 7 % indicating poor glycemic control.

Microvascular complications Diseases of the smallest blood vessels, such as those found in the eyes, nerves, and kidneys. Makes the walls of the vessels weak, they then bleed, leak protein, and slow the flow of blood to the cells

Diabetes retinopathy Damage of small blood vessels of light-sensitive tissue at the back of the eyes (Retina). May cause mild vision problems and can also lead to vision loss.

Diabetes Nephropathy Disease of the kidneys caused by damage of glomeruli that results in protein leaking out of the kidneys into the urine. Damaged kidneys can no longer remove waste and extra fluids in the bloodstream.

Diabetes peripheral Neuropathy Disease of the nervous system which occurs due to nerve damage, can injure nerves throughout the body but most often affects the legs and feet**.**

Optimal target Recommended levels/ranges of different profiles of glycemic control, GFR, as indicated in ADA guidelines.

Diabetes self-management refers to the activities and behaviors an individual undertakes to control and treat their condition.

ABSTRACT

Diabetes mellitus and its associated microvascular complications is a public health concern globally. In Kenya, Nyeri County has the highest prevalence of DM compared to other counties. More than 50% of admissions to Nyeri County Referral Hospital are the result of Non-communicable Diseases (NCDs), and over 55% of hospital deaths are attributable to NCDs.This study assessed the prevalence of diabetes microvascular complications and associated risk factors among diabetes mellitus patients attending Nyeri County Referral Hospital. A hospital-based cross-sectional study design was conducted among 314 adult patients attending NCRH from August to October 2022. All the recruited patients underwent an extensive examination for the presence of microvascular complications, i.e, neuropathy, retinopathy, and nephropathy. A semi-structured interviewer-administered questionnaire was used to collect data on factors associated with Diabetic peripheral neuropathy, retinopathy, and nephropathy. Data was analyzed using STATA version 17. Descriptive analysis was performed, and the associations between the complications and risk factors were tested using chi-square statistics. Variables with significant associations at univariate analysis were subjected to binomial logistic regression. Differences between parameter estimates were deemed statistically significant at $p<0.05$. More than half of the respondents, 159(50.6%), were recruited from the diabetes clinic (DM), while the rest were from the diabetes outpatient clinic (DOPC). The cumulative diabetes microvascular complications were 36.62%. The prevalence of diabetes neuropathy, retinopathy, and nephropathy was 27.4%, 10.8%, and 8%, respectively. MVCs were more commonly seen in the diabetes outpatient clinic compared to patients seen in the diabetes clinic. Inadequate physical exercise was a risk factor for all MVCs. The odds for non-smokers getting nephropathy are reduced by 98% (OR=0.02, 95% CI 0.002549-0.145117, P-0.0001). Analysis also revealed that the risk of diabetic Retinopathy was reduced by 86% in those who exercise 2-3 times a week compared to those who exercise (OR= 0.18; 95% CI 0.046816-0.690638, P 0.012). daily . Lastly, there is a significant correlation between eating plans and physical exercise with all forms of MVCs.This study illustrates the presence of a major burden of diabetes microvascular complications. It also indicated that the diabetes-related self-care activities were directly linked with diabetes microvascular complications.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Diabetes mellitus comprises a collection of metabolic conditions marked by elevated blood glucose levels and carbohydrate, fat, and protein metabolism disturbances, resulting from impairments in insulin secretion, insulin action, or both (Albitres & Bernabe, 2020). Type 2 diabetes mellitus (T2DM) is the most prevalent form, representing approximately 90% of diabetes cases globally (Ogurtsova *et al*., 2022). Diabetic complications are usually divided into two main categories: macro and microvascular complications. Macrovascular complications include ischaemic heart disease, coronary artery disease, cardiomyopathy, cerebral vascular accident, and others. Microvascular complications include diabetic retinopathy, nephropathy, and neuropathy (Meir *et al*., 2024).

Diabetic retinopathy (DR) is a retinal vascular disorder characterized by signs of retinal ischemia, hemorrhages, intravascular caliber abnormalities, and neovascularization. It is considered the leading cause of blindness in adults and accounts for considerable adult work disability. Diabetics are six times more prone to cataracts and 1.4 times more susceptible to open-angle glaucoma when compared to the general population (Sinclair & Schwartz, 2024). Vision loss results from several mechanisms, including neovascularization leading to vitreous hemorrhage, retinal detachment, macular edema, and retinal capillary non-perfusion (Kropp *et al*., 2023).

Diabetic nephropathy (DN) is one of the long-term complications of diabetes mellitus with the greatest mortality. Clinically, DN is classified into 3 stages: microalbuminuria (MA), macroalbuminuria, and end-stage renal disease (ESRD) (Hu *et al.*, 2023). It has become the common single cause of chronic renal disease (CKD) in diabetic patients. The number of people diagnosed with CKD is progressively increasing annually, and

about 40% of all people diagnosed with diabetes will develop a chronic kidney disease in their lifetime (Selby & Taal, 2020).

Diabetic Peripheral Neuropathy (DPN) refers to the occurrence of symptoms and signs of peripheral nerve dysfunction in individuals with diabetes mellitus, once other potential causes have been ruled out (Zhu *et al*., 2024). Chronic peripheral sensorimotor dysfunction is the major cause of diabetic foot ulcers, which occurs in about 10-30% of diabetes patients (Atmaca *et al*., 2024). Diabetic peripheral neuropathy may present with no symptoms or may present with primary symptoms like numbness, pain, weakness, and loss of sensation in the toes, which extends to involve the feet and legs. Most frequently, the disease progresses insidiously and undetected. If no action is taken, the disease progresses to cause foot callus, ulceration, infection, and eventually develops into distressing and painful impairment (Pfannkuche *et al*., 2020).

Globally, it is estimated that 589 million adults are living with diabetes mellitus, with projections indicating this number could increase to 700 million by 2045. Additionally, 374 million individuals are at risk of developing diabetes mellitus (Ogurtsova *et al*., 2022)The prevalence of diabetes is rising in most countries, with low- and middle-income nations accounting for approximately 79% of adults affected. In 2020, there are more than 4.2 million people were reported to have died from diabetes-related causes (Ogurtsova *et al*., 2022).

Microvascular complications such as diabetic retinopathy, nephropathy, and peripheral neuropathy are the most common complications of diabetes. The global prevalence of these microvascular complications varies considerably. This is attributable to the population characteristics, screening, and treatment methods used in different regions (Saeedi *e*t *al*, 2019).

Diabetic peripheral neuropathy is the most common microvascular complication across all regions. Globally, the prevalence is estimated to be 18.8%, while in Africa, the prevalence is 14.5% (Kosiborod *et al.*, 2018). The prevalence of DR is estimated to be

35%; out of this, 12% are at risk of losing eyesight. Likewise, between 10% and 67% of patients with different levels of renal failure and renal disease are attributed to diabetes. More than 80% of end-stage renal disease (ESRD) is caused by diabetes (Ogurtsova *et al*., 2022).

The African Region has the highest predicted increase in the number of diabetes cases by 48% and 143% in the years 2030 and 2045, respectively. In 2019, 6.8% of mortality was attributable to diabetes, with the majority of deaths reported in people below 60 years of age. Of the total number of deaths attributable to diabetes, large proportions occur in low- and middle-income countries (41.8% and 58.2%, respectively. It is also estimated (3.9% of 19.4 million adults aged 20–79 years have diabetes (IDF,2021). However, more than half (59.7%) of the people living with diabetes are undiagnosed, and this could be the reason for the low prevalence in the region. Out of 19.4 million reported diabetes cases, 8.8% are aged between 65-69 years. Moreover, 5.9% and 2.4% live in urban and rural areas, respectively (Ogurtsova *et al*., 2022).

About 3.0 % of the Kenyan population is diabetic, and a substantial proportion of 44.4% of people with undiagnosed diabetes are at risk of developing complications (Ogurtsova *et al*., 2022). Only 21.3 % of the patients with diabetes reported to be on treatment. Glycemic control was achieved in 7% of the patients on treatment (Mohamed *et al*., 2018). These low glycemic control levels could result in the development of complications and premature deaths. The burden of non-communicable diseases continues to increase in Nyeri County, having a diabetes prevalence of 7.2%, which is almost triple of national prevalence. Almost half of deaths are due to NCDs, i.e., two out of three deaths (Murithi *et al*., 2021). The prevalence of CKD stages 3 to 5 among adults over 30 years old with type 2 diabetes stands at 39.0% (Otieno *et al*., 2020).

As the prevalence of diabetes continues to rise, the burden of diabetic microvascular complications is expected to increase. Individuals with diabetes are at a heightened risk of developing these complications, which, if undetected or untreated, can severely affect the quality of life and impose substantial costs on healthcare systems (Petrović *et al*.,

2024). The risk factors associated with the development of diabetes microvascular complications are classified as modifiable and non-modifiable. Modifiable risk factors include glycemic control, hypertension, hyperlipidemia, and smoking. Non-modifiable risk factors include age at the onset of diabetes, gender, and genetic factors (Antar *et al*., 2023).

Several factors have been linked to the progression and severity of diabetic retinopathy (DR), including the duration of diabetes, glycemic control, hypertension, body mass index (BMI), serum lipid levels, patient age, and gender (Antar *et al*., 2023). Significant relationships have been found between diabetic peripheral neuropathy and age, gender, quality of diabetes control, cigarette smoking, elevated blood pressure, and hyperlipidemia (Pfannkuche *et al*., 2020). Diabetic nephropathy is more likely to develop in patients with poor glycemic control, elevated systolic blood pressure, patients whose duration of diabetes exceeds ten years, and people of black origin. Other factors include age of the patient, high levels of cholesterol and triglycerides (Azagew *Et Al*., 2024).

1.2 Statement of the Problem

Diabetes remains a major public health concern, with many individuals in the pre-diabetic stage or undiagnosed, and its rising prevalence places a substantial economic burden on health systems (Ogurtsova *et al*., 2022). Diabetic retinopathy, nephropathy, and neuropathy are the most prevalent and yet preventable microvascular complications. These three complications are the leading causes of blindness, renal failure, and amputations, respectively (Crasto *et al*., 2021). Globally, only 14 countries are on track to achieve SDG 3.4; insufficient Global action on NCDs is creating the possibility that SDG 3.4 and 3.8 targets will not be met (Taubert & Smith, 2025)

The number of patients who present with complications has increased over the years, and the average life expectancy has decreased as well. This has an impact on financial strain as more resources need to be allocated to public and public health interventions.

The African Region has the highest predicted increase in diabetes cases by 48% in the year 2030. In 2019, 6.8% of mortality attributable to diabetes was reported globally. The majority of deaths occurred in low-income countries (41.8%) and middle-income countries (58.2%). A large proportion of deaths were directly related to diabetes complications and were reported in people below 60 years old (Ogurtsova *et al.*, 2022).

In Kenya, Non-communicable diseases, including diabetes, account for more than 50% of total hospital admissions (Mwenda *et al*., 2018) . NCDs are estimated to account for 27% of all deaths, with diabetes and related complications responsible for 50% of these deaths. It is reported that 805/1000 DALYs are lost as a result of premature mortality and disability resulting from diabetes (Karugu *et al*., 2024; Muthuri & Kirigia, 2020)

These complications result in increased medical and surgical costs incurred by patients and the demand increases as other co-morbidities sets in. The health costs of detection and treatment of diabetes-related complications are high. This relates both to direct costs, for which the costs of hospitalization for diabetes complications are a major driver, and to indirect costs since complications are the most significant contributors to premature mortality, disability, and absenteeism (Karugu *et al*., 2024). In Kenya, It is estimated that the total cost of managing diabetes is approximately Kenyan shillings 56,000 per annum (approximately USD 560 per patient per annum). Total direct costs accounted for 43% while indirect cost was 57% (Muthuri & Kirigia, 2020). Management of diabetes faces a greater challenge as most of the patients have poor glycemic control (Kimando *et al*., 2017). This could be attributable to a lack of proper knowledge and self-empowerment on glycemic management, inadequate primary health care workers, inappropriate drugs, inaccessibility to tests, and lack of social support (Ceriello & Prattichizzo, 2021).

Diabetes is the 2nd commonest cause of admissions and death in Nyeri County. Moreover, 2 out of 3 people in Nyeri County die of an NCD (Murithi *et al*., 2021). Diabetes is a major cause of blindness, kidney failure, heart attacks, stroke, and lower limb amputation in Nyeri (Murithi *et al.*, 2021). Complications arising from diabetes

have led to reduced economic productivity and high financial implications. The rising burden of DM, CVD, and certain cancers is closely linked to dietary practices and physical inactivity. However, a clear understanding of the specific drivers of these behaviors within local populations remains limited, hindering the development of effective, targeted, and affordable prevention strategies. Therefore, this study seeks to determine the prevalence of diabetes microvascular complications and associated risk factors among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya.

1.3 Justification for the Study

The management of diabetes and its risk factors is reasonably simple and inexpensive. Treating complications, however, is costly, requiring providers with a high level of skill and specialized equipment. Prevention of diabetic complications is the most effective intervention that might result in improved quality of life, increased average life expectancy, and substantial long-term savings in healthcare costs. Intensive management and monitoring of diabetic complications is crucial with matched diagnostic and medical availability (Karugu *et al*., 2024).

Diabetes Complications are responsible for a higher risk of death in low and middle-income countries. Substantial reduction of complications mortality requires policies that considerably address prevention of diabetes microvascular complications, and accessible and effective treatment (Ogurtsova *et al.,* 2022). Producing periodic prevalence estimates will give future projections for possible diabetes microvascular complications. This is essential to promote the prevention of microvascular complications and to encourage improvements in care for all who live with diabetes. Also, raise the priority accorded to prevention and control of diabetes complications within the national SDG response, and incorporate the targets set for 2030.

Nyeri County is experiencing an increase in the prevalence of diabetes due to various factors that are not documented. Understanding local evidence on the burden of MVCs

allows for more targeted Public health planning. It also provides valuable insights for bridging gaps in surveillance, screening, and early detection strategies.

The findings of this study will help to achieve the goal of SDG 3.4, which is to reduce by one-third pre-mature mortality from non-communicable diseases (NCDs) through prevention and treatment and promote mental health and wellbeing. The study will provide valuable insights for healthcare providers to optimize patient care and management strategies. clinicians will also be able to implement targeted screening programs, early interventions, and preventive measures to mitigate the progression of complications and improve patient outcomes. Lastly, it will open up opportunities to develop and implement coordinated and multisectoral strategies to tackle the prevention, screening, and management of microvascular complications, encourage public-private partnerships, and mobilize patients to participate in self-management.

1.4 Study Objectives

1.4.1 Broad Objective

To determine the prevalence of diabetes microvascular complications and associated risk factors among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya.

1.4.2 Specific Objectives

1. To determine the prevalence of Diabetes retinopathy, nephropathy, and neuropathy complications among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya.
2. To determine the risk factors associated with diabetes retinopathy, nephropathy, and neuropathy among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya.

3. To determine the correlation between diabetes self-management and progression of Diabetic retinopathy, nephropathy, and peripheral neuropathy among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya.

1.5 Research Questions

1. What is the prevalence of Diabetes retinopathy, nephropathy, and neuropathy complications among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya?
2. What are the risk factors associated with diabetes retinopathy, nephropathy, and neuropathy among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya?
3. What is the correlation between diabetes self-management and progression of Diabetic retinopathy, nephropathy, and peripheral neuropathy among diabetes mellitus patients attending Nyeri County Referral Hospital, Kenya?

1.6 Theoretical Framework (Health Belief Model)

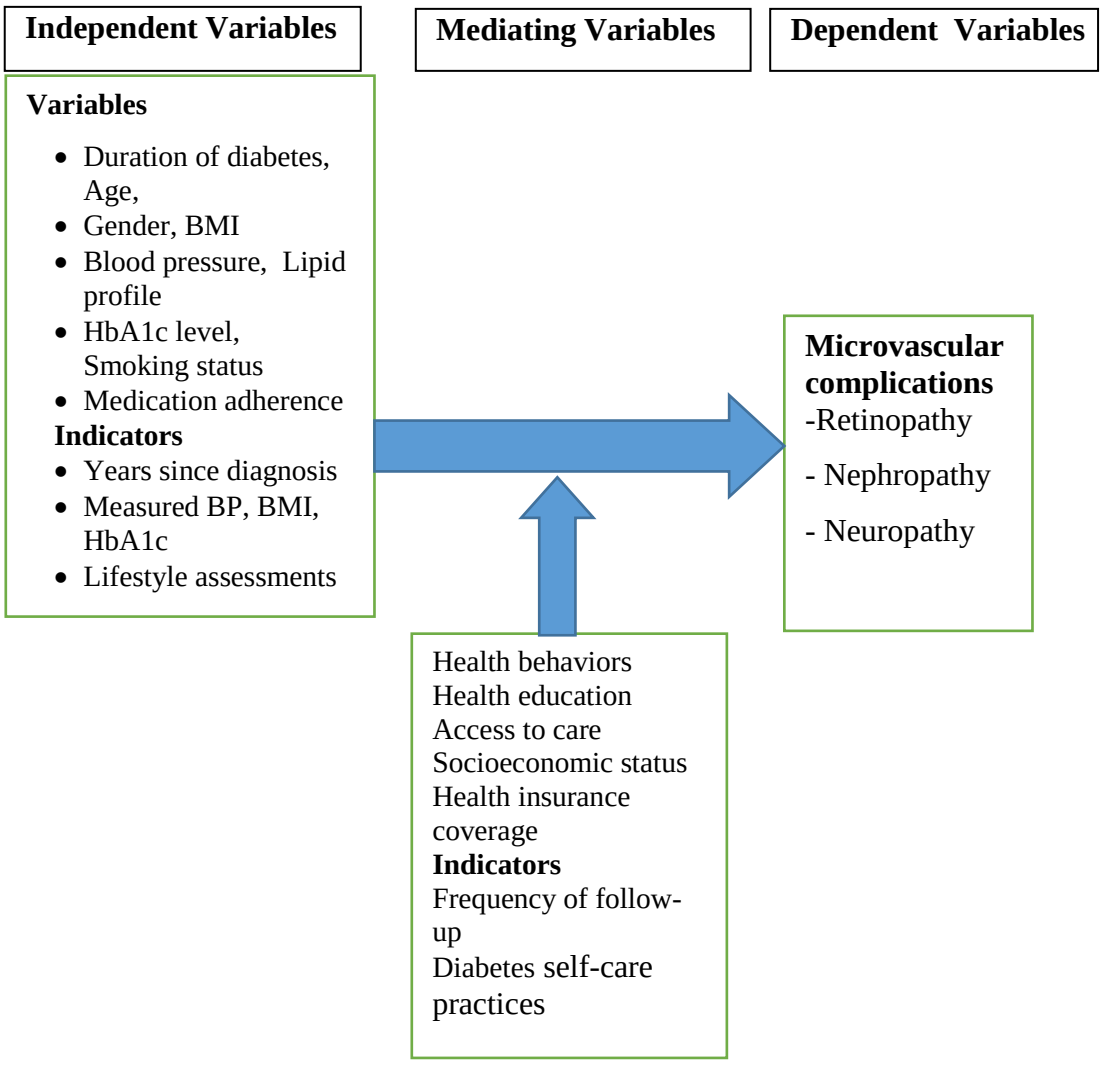

Figure 1.1: Theoretical Framework

1.7 Conceptual Framework

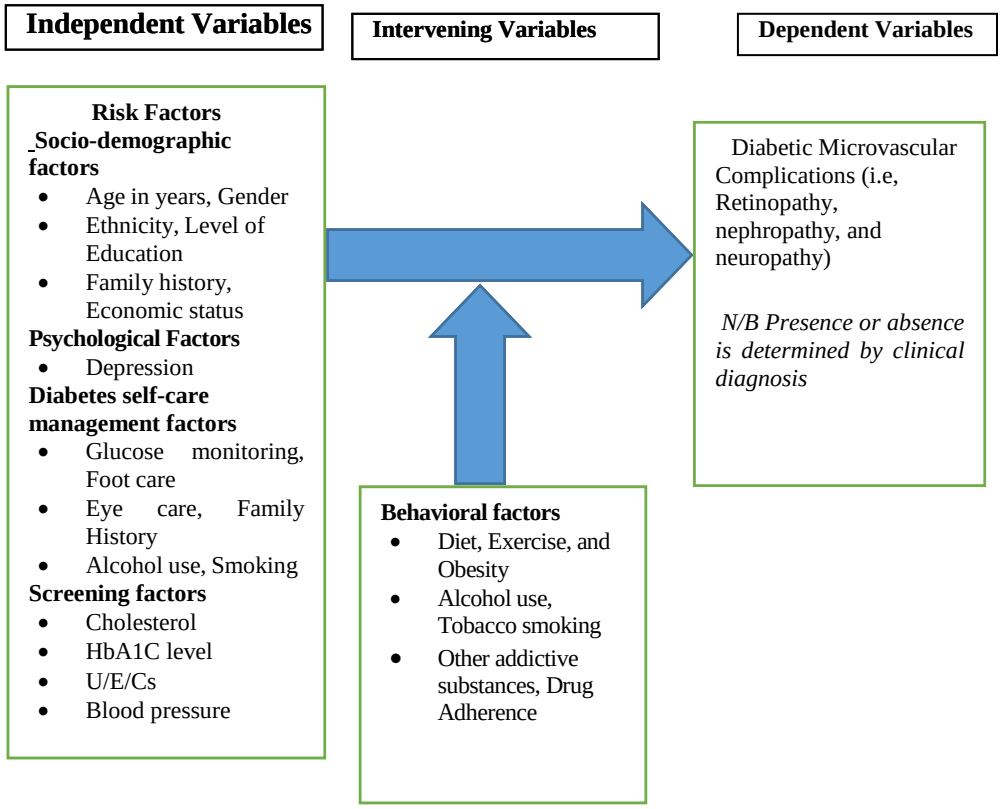

Figure 1.2: Conceptual Framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Global Prevalence of Diabetes Mellitus

Diabetes mellitus is a long-term condition that arises when the pancreas produces insufficient insulin or when the body is unable to effectively utilize the insulin it generates. Insulin, a hormone produced by the pancreas, regulates blood glucose by enabling it to move from the bloodstream into the body's cells (ElSayed *et al*., 2025). Diabetes may not be diagnosed until years after its onset, often when complications have already developed. Type 2 diabetes mellitus (T2DM) represents approximately 90% of all diabetes cases worldwide (Ogurtsova *et al*., 2022).

Since 2009, there has been an increasing trend in diabetes prevalence. It is estimated that globally, 537 million adults aged 20-79 years are living with diabetes, with this number expected to increase by 25%, reaching 573 million by 2030 (Ogurtsova *et al*., 2022). The majority, about 67%, of individuals with diabetes reside in urban areas. Additionally, 374 million people are at risk of developing diabetes. Over half of those living with diabetes remain undiagnosed. About 4.2 million people were reported to have died from diabetes-related causes in 2019. Almost half of the deaths occurred in persons below 60 years of age (42.6%) (Ogurtsova *et al.*, 2022).

The increasing incidence rates pose a great increase in global economic expenditure.WHO terms diabetes as an epidemic, which is among the top ten causes of death. Premature death and disability due to diabetes are associated with negative economic impacts as they increase indirect costs of health care. In 2017, the global health expenditure on diabetes was estimated to be USD 727 billion, and this expenditure is expected to rise with increasing prevalence (Saeedi, *et al*., 2019).

2.2 African and Sub-Saharan Africa Diabetes Mellitus Perspective

The proportion of people with diabetes is rising in most countries, with low- and middle-income countries accounting for approximately 79.4% of adults with diabetes (Ogurtsova *et al.*, 2022). It is estimated that 24 million in Africa's population are living with diabetes. Of these, 45.9% are in low-income countries, while 54.1% are in middle-income countries. More than half (59.7%) of individuals with diabetes in Africa are unaware of their condition, contributing to the relatively low prevalence reported in the region. Sub-Saharan Africa has the highest prevalence. Among the top 3 countries with high DM Prevalence are from this region (Ogurtsova *et al*., 2022).

Almost three-quarters of deaths reported each year are due to diabetes and its complications. In 2019, 6.8% of deaths were attributable to diabetes, with the highest mortality due to diabetes being in adults aged 30-39 years. Furthermore, increased mortality occurred in people aged below 60 years, which is 73.1%. Health expenditure, including both direct and indirect costs, was USD 9.5 billion in 2019; this is projected to rise to USD 12.7 billion by 2030 *(Ogurtsova et al.*, 2022).

2.3 Kenyan Situation on Diabetes Mellitus

Kenya, which is a middle-income country, has not been spared by this global pandemic. The country faces an epidemiological transition due to technological advancements affecting and changing the lifestyle behaviors of the population. In Kenya, diabetes is still on the rise, and the majority of people (52.2%) living with diabetes are undiagnosed and are at risk of developing complications. It is estimated that 3.0 % of the Kenyan population is diabetic, and 3.1% are prediabetic (Mwenda *et al*., 2018). Out of the people diagnosed with diabetes, only 21.3% are on treatment. Glycemic control is achieved in 7% of patients on treatment (Mohamed *et al.,* 2018). The burden of non-communicable diseases continues to increase in the country, and Nyeri County is the most affected county with a diabetes prevalence of 7.2%, which is almost triple the

national prevalence. Furthermore, almost half of the deaths are due to NCDs, i.e., two out of three deaths (Murithi *et al*., 2021).

2.4 Diabetes Complications

People living with diabetes are at risk of developing several serious and life-threatening complications. This heightens their need for medical care, diminishes their quality of life, and places added stress on their families (Karugu *et al*., 2024). It is estimated that around half of diabetes patients are unaware of their condition, making them more susceptible to developing diabetic complications. Diabetes complications account for increased morbidity, disability, and mortality (Cole & Florez, 2020). Diabetes complications are generally categorized into microvascular and macrovascular types. Macrovascular complications include cardiovascular disease, stroke, and peripheral artery disease. In divergence, microvascular complications include neuropathy, nephropathy, and retinopathy (Papatheodorou *et al*., 2018).

Microvascular Complications, such are diabetes retinopathy, nephropathy, and peripheral neuropathy, are the most prevalent complications and leading cause of hospital admissions in diabetic patients. Additionally, they are the major cause of morbidity and mortality among individuals with diabetes (Molinaro & Carole, 2017). Microvascular complications (MVCs) are triggered by chronic and persistent hyperglycemia through various mechanisms, including the formation of advanced glycation end products, the induction of oxidative stress, and the creation of a pro-inflammatory microenvironment (Avogaro & Fadini, 2019).

Diabetic retinopathy is the leading cause of blindness among adults and significantly contributes to adult work disability. Individuals with diabetes are six times more likely to develop cataracts and 1.4 times more susceptible to glaucoma compared to the general population (Kropp *et al.*, 2023) The overall prevalence of diabetic retinopathy among people with diabetes is estimated at 35%, with vision-threatening diabetic retinopathy affecting 12% of individuals (Ogurtsova *et al*., 2022).

Globally, more than 80% of end-stage renal disease (ESRD) is caused by diabetes, hypertension, or a combination of both. The proportion of end-stage renal disease (ESRD) linked to diabetes ranges from 10% to 67%. Individuals with diabetes are up to 10 times more likely to develop ESRD compared to those without the condition. The incidence of chronic kidney disease (CKD) is rising each year, with approximately 40% of individuals diagnosed with diabetes expected to develop CKD over their lifetime (Ogurtsova *et al*., 2022).

Peripheral neuropathy is the most prevalent type of neuropathy associated with diabetes. Its reported prevalence among individuals with diabetes ranges from 16% to 87%. Painful diabetic neuropathy affects approximately 26% of adults with diabetes. People with diabetes are 10 to 20 times more likely to undergo lower limb amputation compared to those without the condition. Globally, it is estimated that a lower limb is amputated every 30 seconds due to diabetes-related complications (Pfannkuche *et al.*, 2020).

2.5 Microvascular Complications

Chronic exposure to hyperglycemia affects microvasculature, eventually leading to diabetic nephropathy, retinopathy, and neuropathy.

2.5.1 Diabetic Retinopathy

Diabetic retinopathy is a vascular complication of type 2 diabetes, with its prevalence closely related to the duration of diabetes and the level of glycemic control. It is marked by signs such as retinal ischemia, hemorrhages, abnormalities in venous caliber, and neovascularization (Flores & Ortiz, 2020). Diabetic retinopathy is the leading cause of new blindness cases among adults aged 20–74 years in developing countries. Other significant ocular complications associated with diabetes include cataracts, glaucoma, ischemic optic neuropathy, cranial nerve palsies, and recurrent corneal erosion syndrome. These conditions occur earlier and more frequently in individuals with

diabetes. Once retinal lesions become clinically visible, reversing the damage is challenging, and the risk of progression of diabetic retinopathy increases (Zeng *et al*., 2019).

2.5.2 Diabetic Nephropathy

Chronic kidney disease (CKD) is diagnosed through persistent elevated levels of albumin in the urine, reduced estimated glomerular filtration rate (eGFR), and other symptoms such as the accumulation of urea and swelling in the lower limbs. In individuals with type 2 diabetes, CKD can either be present at diagnosis or develop later in life (Selby & Taal, 2020). CKD can advance to end-stage renal disease (ESRD), necessitating dialysis or kidney transplantation. Additionally, the presence of CKD increases the risk of cardiovascular diseases. Acute kidney injury (AKI) is typically identified by a rapid rise in serum creatinine and a corresponding sharp decline in eGFR over a short period. Individuals with diabetes are more likely to experience AKI compared to those without diabetes (Hu *et al*., 2023). Diabetic kidney disease is usually a clinical diagnosis made based on the presence of albuminuria and/or reduced eGFR in the absence of signs or symptoms of other primary causes of kidney damage. The typical presentation of diabetic kidney disease is considered to include a long-standing duration of diabetes, retinopathy, albuminuria without hematuria, and gradually progressive kidney disease. However, signs of CKD may be present at diagnosis or without retinopathy in type 2 diabetes and reduced eGFR without albuminuria (Selby & Taal, 2020).

2.5.3 Diabetic Peripheral Neuropathy

Diabetic neuropathies encompass a diverse range of disorders with various clinical manifestations. Early detection and proper management of neuropathy in diabetic patients are crucial, as it can affect multiple nerves throughout the body. Diagnosing diabetic neuropathy often involves ruling out other potential causes of neuropathy. Up to

50% of diabetic peripheral neuropathy (DPN) may be asymptomatic (Atmaca *et al*., 2024).

It is recommended that all patients with type 2 diabetes undergo annual assessments for DPN using medical history reviews and simple clinical tests. Symptoms of neuropathy can differ based on the type of sensory fibers affected. Small fiber involvement often leads to early symptoms such as pain, burning, and tingling sensations. Large fiber involvement may result in numbness and loss of protective sensation (LOPS), which indicates distal sensorimotor polyneuropathy and increases the risk of diabetic foot ulcers (Nkonge *et al*., 2023).

2.6 Risk Factors for Microvascular Complications

The increasing prevalence of diabetes microvascular complications worldwide is driven by an interplay between socioeconomic, demographic, environmental, and genetic factors (Ceriello & Prattichizzo, 2021). High prevalence in low and middle-income countries is attributable to massive health inequalities that persist across many populations. Despite enhanced interventions, individuals with diabetes remain at a higher risk of developing microvascular complications (MVC) compared to those without diabetes (Armengol *et al.*, 2021). Microvascular complications are among the most common and significant causes of morbidity and mortality in individuals with type 2 diabetes. Additionally, MVCs also contribute to the development of macrovascular complications (Sękowski *et al*., 2022)

The eyes are considered a primary target for damage by chronic and uncontrolled hyperglycemia in DM. The overall impact of diabetes on visual outcomes has been observed to increase in recent years (Zeng *et al*., 2019). DR is divided into incipient stages of vasoprogression and subsequent stages of angiogenesis, which lead to increased permeability and macular edema. Both early and severe stages of DR have similar risk factors (Amer *et al*., 2021). Modifiable risk factors for DR include smoking, obesity, and diabetic kidney disease, which worsen the progression of retinopathy

(Hasan *et al.,* 2023). Other factors associated with DR include hypertension, duration of diabetes, poor glycemic control, dyslipidemia, and the presence of microalbuminuria (Vu *et al*., 2023)

Diabetic peripheral neuropathy (DPN) is one of the most common complications of DM. It is considered a serious complication of DM. It poses a major medical and economic threat as it is the main cause of diabetic foot (Pfannkuche *et al.,* 2020). Identifying DPN and setting early interventions is the best intervention. Diabetes patients with diabetic foot patients have an increased mortality rate compared with diabetic counterparts without foot complications and the general population (Nkonge *et al*., 2023) Early interventions to prevent foot ulcers in diabetics are a hallmark of preventing amputations and reducing related mortality. The risk of ulceration and amputation among diabetics increases with the progression of age and duration of diabetes. Other risk factors associated with the development of DPN include the presence of other microvascular and macrovascular complications, poor glycemic control, use of oral hypoglycemics, and the presence of atherosclerosis. Furthermore, Dyslipidemia and unemployment have also been associated with DPN (Purwanti *et al.*, 2024)

Diabetic Nephropathy (DN) is the leading cause of chronic Kidney disease and a cause of cardiovascular mortality.DN results in the deterioration of kidney function. The progression of the disease occurs in a series of stages and is linked to glycemic control and blood pressure control (Sulaiman, 2019). Despite aggressive blood control, the prevalence of DN and CKD is underestimated and continues to increase. Prevalence also varies in different regions, which is attributable to a shortage of screening programs (Selby & Taal, 2020). Previous studies have also shown that non-modifiable risk factors for DN include male gender, diabetes duration, and age above 45 years. Most of the risk factors of DN are modifiable and they include: nutrition, which influences process and outcome, Obesity, overweight, hypertension, poor glycemic control, dyslipidemia, retinopathy, and nephropathy (Azagew *et al*., 2024). Additionally, cigarette smoking is an associated risk factor, but it is dose-dependent (Zhang *et al*., 2024). Compared to healthy individuals, people with T2DM are more susceptible to non-fatty alcoholic liver

diseases, which are closely associated with the development of DN. This is because elevated liver fats cause kidney dysfunction and damage (Zhang *et al*., 2024).

2.6.1 Social Demographic Characteristics and Microvascular Complications

Socio-demographic factors are known to affect the time to microvascular complications and survival probabilities of diabetes mellitus patients. Age and duration of diabetes illness are among the key indicators of the development of MVCs (Dey *et al.*, 2022). Patients over the age of 50 and those with diabetes lasting more than 10 years are at a higher risk of developing various diabetes-related complications. Individuals over 60 years old are more likely to experience multiple complications compared to their younger counterparts. Besides, patients with an early onset of diabetes are more likely to develop severe complications. This is attributable to genetic determinants such as a family history of diabetes (Khoiry *et al*., 2023; Yaya *et al.*, 2021).

2.6.2 Physical Activity and Microvascular Complications

It is widely accepted that regular physical exercise is one of the therapeutic measures that helps diabetic patients control blood glucose, and reduce and prevent other related complications. Physical activity is believed to control hyperglycemia through the improvement of peripheral insulin sensitivity, particularly in skeletal muscle (Bukht *et al*., 2019). In addition, it is also a countermeasure against many abnormalities observed in diabetic patients, such as hyperlipidemia, hypertension, and a tendency for hypercoagulation, which are considered to increase the risk of macro- and microvascular complications (Dolenc *et al*., 2020).

2.6.3 Glycemic Control and Microvascular Complications

Glycemic control is a key goal in DM patients. Capillary blood glucose can be done by patients to monitor their glucose level and adjust treatment while at home. Improved glycemic control is linked to reduced rates of chronic complications; Conversely, poor glycemic control is linked to all three types of microvascular complications (Dai *et al*.,

2021). Glycated hemoglobin (HbA1c) is used to monitor blood glucose control over three months. It also helps assess treatment efficiency. Careful diabetic control is a worthwhile and achievable goal for minimizing the disability and costs associated with microvascular complications (P. Kumar et al., 2021).

2.6.4 Smoking and Microvascular Complications

Smoking has been associated with a high prevalence of diabetes complications. According to studies, there are more men than women smokers (Cho *et al.,* 2024). Poor glycemic control among men smokers has been reported. Other effects reported in smokers included coronary artery disease and ketoacidic episodes, which are likely to trigger other complications. Moreover, macroalbuminuria and proliferative retinopathy have been reported in ex-smokers. Cessation of smoking has proven a greater benefit in the reduction of vascular complications (Durlach *et al*., 2022).

2.7 Diabetes Self-Management

Self-management has received growing attention as an effective approach to managing chronic conditions. Supported self-management is the best approach, which yields greater and positive outcomes for patients, families, and healthcare professionals (Maina *et al*., 2023). Controlling blood glucose and establishing euglycemia in diabetics is the most important factor in patients' self-management of the condition. Since poor glycemic control contributes greatly to the risk of microvascular complications, the improvement of self-management behaviors is important to improve prognosis and reduce the risk of developing long-term complications (Hurst *et al.,* 2020).

Diabetes self-management is the cornerstone of diabetes care. Effective self-management has been linked to good glycemic control and reduced risk of developing long-term complications. Despite recommendations for self-management among T2DM patients, the performance and practice are still suboptimal in Africa and many developing countries (Kumar & Mohammadnezhad, 2022). Besides, diabetes self-

management improves diabetes management self-efficacy and diabetes knowledge; thus improving the patients' ability and confidence to perform a goal-directed behavior intervention. This improves the patient's confidence in managing and monitoring their diseases (Alodhayani *et al.*, 2021). This practice helps to improve the clinical targets and outcomes. However, there is strong evidence that diabetes self-management is linked to glycemic control. Some studies have demonstrated that many patients exhibit poor diabetes self-management (Woodward *et al*., 2024).

Diabetes self-management is evaluated using tools such as the Summary of Diabetes Self-Care Activities (SDSCA) or the Diabetes Self-Management Questionnaire (DSMQ). Both tools assess various aspects of self-care, including diet, physical activity, and blood glucose monitoring (Schmitt *et al*., 2016). The SDSCA, in particular, asks for the number of days in the past week on which specific behaviors or activities were carried out.

The appraisal of self-management depends on the health professional and the patient's regimen of treatment (Schmitt *et al.*, 2016). On the other hand, DSMQ involves self-rating of self-management by the patient. The period under review is usually eight weeks and may be prone to recall bias. In addition, DMSQ comprises items like medication intake and contact with one’s health care provider, which are key aspects in determining glycemic control. On the other hand, SDSCA includes items of foot care and smoking behavior (Özkan *et al.*,, 2020).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Site

The study was carried out in Nyeri County Referral Hospital (NCRH), located in the Central region of Kenya. NCRH is a Level 5 Hospital and the only county referral hospital in the county. The Central Region of Kenya has the highest prevalence of DM; Nyeri County has been identified through epidemiological surveys as the area with the highest prevalence of Diabetes Mellitus compared to other counties (Murithi *et al*., 2021)The County has a diabetes prevalence of 7.2 %, which is almost triple the national prevalence. More than 50% of hospital admissions and deaths are due to non-communicable diseases (Murithi *et al.*, 2021). From the hospital health records department, there are about 2000 patients who are known to have DM and are on follow-up. The Diabetes Outpatient Clinic (DOPC) runs every Friday from 9:00 am to 12:00 noon each week, while the Diabetes clinic operates daily, except on public holidays**.** Adult patients, i.e., 18 years and above, with either type 1 or type 2 diabetes mellitus, are seen at either DOPC or Diabetes Clinic. Children below 18 years old are seen by a pediatrician during a pediatric outpatient clinic (POPC) that runs on Wednesdays.

3.2 Study Design

A hospital-based cross-sectional study was conducted to collect quantitative data over five months from adult patients with diabetes mellitus attending the outpatient department.

3.2.1 Study Population

Adults diagnosed with diabetes mellitus who attended outpatient clinics or outpatient departments for three months or more and were undergoing anti-diabetic treatment.

3.3 Selection Criteria for Participants

3.3.1 Inclusion Criteria

1. DM patients aged 18 years and above who consented to the study.
2. DM patients on follow-up for 3 months or longer
3. DM patients on anti-diabetic treatment for 3 months or longer

3.3.2 Exclusion Criteria

1. DM patients requiring emergency treatment and referral on the date of the study.
2. Patients with gestational diabetes

3.4 Study Variables

3.4.1 Independent Variables

The independent variables of interest were:

- Social-economic factors (age, gender, education levels, occupation, area of residence, level of income, marital status)
- Screening-related factors (Duration of diabetes, glycemic control, blood glucose monitoring, lipid profile, Renal function tests, urinalysis, current treatment regimen, body mass index)
- Lifestyle factors (smoking, use of alcohol, diet, foot care), among others

3.4.2 Dependent Variables

Microvascular complications.

3.5 Sample Size Determination

The minimum sample size was determined using Cochran's formula for a single population proportion (Naing *et al*., 2006,)

$$n = \frac{Z^2 pq}{d^2}$$

Where

n = minimum sample size

Z = 1.96 standard deviation correspondence to 95% CI)

P= Prevalence of microvascular complications in Kenya. The prevalence of neuropathy, retinopathy, and nephropathy is 41, 33, and 0.9%, respectively.

d = 0.05 (Level of precision at 5%)

Based on the following assumptions:

A report of an audit of clinical care delivered to the patients in various outpatient departments at Nyeri Level 5 Hospital indicated that about 2000 patients are registered for follow-up for diabetes and its related complications. Every week, about 100 diabetes patients visit both the DOPC and DM clinic, which makes a total of 400 patients per month.

The prevalence of reported neuropathy, retinopathy, and nephropathy in other areas in Kenya is 41, 33, and 0.9%, respectively (Kaitany *et al.*, 2017). Based on this finding from previous studies 41% prevalence rate (p) of diabetic neuropathy complication was used in a margin of error (d 0.05), and a 95% confidence interval.

A 41% prevalence rate was used.

Therefore:

$$n = \frac{1.96^2 (0.41(1-0.41))}{0.05^2} = 372$$

Since the target population is below 10,000, a finite correction formula was applied to get a working sample size (Naing et al., 2006). $f = \frac{n}{1+\frac{n}{N}}$

Where:

Nf desired sample size when the population is less than 10,000

n the desired sample size when the population is more than 10,000

N the estimation of the study population

A working sample size then:

$$nf = \frac{372}{1+\frac{372}{2000}} = 313.6593.960 = 314$$

Since human beings can only be calculated in whole numbers the sample was rounded to the nearest whole number. That makes the sample size of 314.

Therefore, the final sample size was 314.

3.6 Sampling Procedure

Nyeri County was selected purposively to represent regions with a high prevalence of diabetes (Murithi *et al.*, 2021). The county has a diabetes prevalence of 7.2%, which is almost triple the national prevalence. More than 50% of hospital admissions are due to non-communicable diseases. Additionally, two out of three deaths reported in the hospital are attributable to NCDs (Murithi *et al.*, 2021). Systematic random sampling was used to collect data from the patients. Where the first subject was selected randomly, and then every sixth subject was selected for the study till the sample size was achieved. Data was collected on all clinic days for five months. All the recruited patients underwent extensive examination for the presence of microvascular complications like neuropathy, retinopathy, and nephropathy.

3.7 Data Collection and Instruments

A semi-structured interviewer-administered manual paper-based questionnaire was used to collect data from the patients. The questionnaire was administered face-to-face by the interviewer. The principal investigator and research assistant (a qualified clinical

officer, medical officer, or nursing officer) read out the question as it is from the questionnaire, interpreted by the participant, and then documented the findings. The microvascular complications were diagnosed based on the physical, clinical, laboratory, and other requested findings. The results were interpreted by the clinician. Fundus ophthalmoscopy examination (the presence of neovascularization, hemorrhage spot, vitreous hemorrhage, microaneurysm, macular lesion, and cotton wool spot) was done to diagnose diabetic retinopathy. For neuropathy, clinical assessment, like history of numbness, paresthesia, tingling sensation, and tests for vibration sensation, was used. Likewise, symptoms such as swelling of feet, hands, or eyes, urinary frequency and urgency, BP measurement, and tests like protein in the urine, renal function tests, and ultrasound were used to diagnose diabetic nephropathy.

3.8 Data Management

Data quality was assured by training research assistants before data collection they were supervised. The data collected was verified and accurately entered into a database using MS Excel. Regular backup copies are stored on hard discs. Files containing the data were password-encrypted and accessible to only authorized persons. Hard copies of the questionnaires were kept in locked safe storage. The electronic data in Excel and STATA, plus the hard copy questionnaires from this study, will be stored in safe custody for three years, after which they will be destroyed.

3.9 Reliability and Validity

Before data collection, we pre-tested the questionnaire for consistency and suitability at a non-participating hospital, i.e., Murang'a County referral hospital. The test-retest pre-reliability method was used to ascertain the consistency of the research tools by administering them to 10% of the expected sample size twice. The comments and suggestions from the pilot study were used to revise the tool and ensure questions were understandable.

All the research assistants were trained a month before the commencement of the study. Additionally, they were involved in a pre-testing study three weeks before the actual study. During data collection, debriefing meetings were held at the end of each day to review data and identify any omissions and errors. Besides the Blood pressure machines, and laboratory equipment was calibrated every day by the technician who was part of the research team.

3.10 Data Analysis

The completed questionnaires were examined by the principal investigator to ensure completeness and consistency of the data collected. The data were then coded, cleaned, and entered into Microsoft Excel and backed up on an external hard drive. It was then exported into STATA version 17 for statistical analysis. Frequency tables with percentage, median, and interquartile range (IQR) were used to describe study findings. Variables with p-value ≤ 0.05 in the binary logistic regression (age, marital status, residence, educational level, occupation, duration of diabetes, medication regimen, physical activity, alcohol intake, and smoking) were entered into multivariable logistic regression analysis. We used the odd-adjusted odds ratio (AOR) at 95% to determine the strength of association. The level of significance will be set at $p<0.05$.

3.11 Pretesting

Content validity was ensured by pre-testing the data collection tool on 10% of the diabetes patients. The tool was modified based on the observed findings from the pre-test results. Some questions having an ambiguous meaning were rewritten for a better understanding of the study participants. The pre-testing was conducted at Murang'a County Referral Hospital, which is located in the same geographical location. The population in Murang'a and Nyeri has similar characteristics, such as socioeconomic activities and cultural practices. Besides, Muranga County Referral Hospital shares similarities with Nyeri County Referral Hospital. Data analysis of the pretest was analyzed so that to guide the final data analysis.

3.12 Ethical Considerations

This study was conducted according to the research guidelines in the Declaration of Helsinki, and all procedures involving human subjects study participants. The study received approval from the Ethical Review Committee of Jomo Kenyatta University of Agriculture and Technology (JKU/2/4/896B), the National Commission for Science, Technology and Innovation (NACOSTI/P/22/18990), and the County Director of Health Services in Nyeri County (CGN/HEALTH/HRM/5/VOL.II).

Informed consent, both written and oral, was obtained from all participants. All study participants were presented with information regarding the purpose of the study, the right to withdraw, and measures put in place to ensure confidentiality, and gave their written informed consent.

Written consent was obtained through signatures on the consent form included in the questionnaire, while verbal consent was witnessed by either the nurse or clinical officer overseeing the clinic.

CHAPTER FOUR

RESULTS

4.1 Socio-Demographic Characteristics of the Study Participants

Out of the 314 participants enrolled in this study, 182 (58%) were female and 132 (42%) were male. The average age of the participants was 58.49 ± 17.43 years. A large majority of participants had attained at least a primary level education 90.5%), and 79% resided in rural areas.

In terms of marital status, 209 participants (66.6%) were married, while only 12 (3.8%) were divorced or separated. Christians constituted 99% (311) of the participants, and the Kikuyu ethnic group was the dominant ethnicity, making up 93.6% (294) of the total participants.

Regarding occupation, farmers were the majority at 58.3% (183), followed by the unemployed at 16.9% (53). Only 7 participants (2.2%) were employed in the government sector. A significant proportion, 58.3% (183), reported earning less than KES 5,000 per month. (Table 4.1)

Table 4.1: Socio-Demographic Characteristics of Study Participants

Characteristic	Description	Freq, N(%)
Follow Up Clinic	DOPC	155(49.4)
	DM Clinic	159(50.6)
Age Group	<=30 Years	26(8.3)
	31-45 Years	42(13.4)
	46-60 Years	90(28.7)
	>=61 Years	156(49.7)
Gender	Male	132(42)
	Female	182(58)
Marital Status	Married	209(66.6)
	Single	43(13.7)
	Divorced/Separated	12(3.8)
	Widowed	50(15.9)
Religion	Christian	311(99)
	Muslim	2(0.6)
	Hinduism	1(0.3)
Level Of Education	Primary	158(50.3)
	Secondary	90(28.7)
	Tertiary	36(11.5)
	None	30(9.6)
Occupation	Government Employee	7(2.2)
	Private Employment	19(6.1)
	Business	52(16.6)
	Farmer	183(58.3)
	Unemployed	53(16.9)
Residence	Rural	248(79)
	Urban	66(21)
Ethnicity	Kikuyu	294(93.6)
	Embu	9(2.9)
	Meru	4(1.3)
	Others	7(2.2)
Income	Less Than 5000	183(58.3)
	5001-10000	64(20.4)
	10001-15000	29(9.2)
	15001-20000	12(3.8)
	20001-25000	12(3.8)
	Above 25001	14(4.5)

4.2 Overall Prevalence of Diabetes Microvascular Complications

Figure 4.1 shows that more than a third of the study participants (36.62%) had microvascular complications.

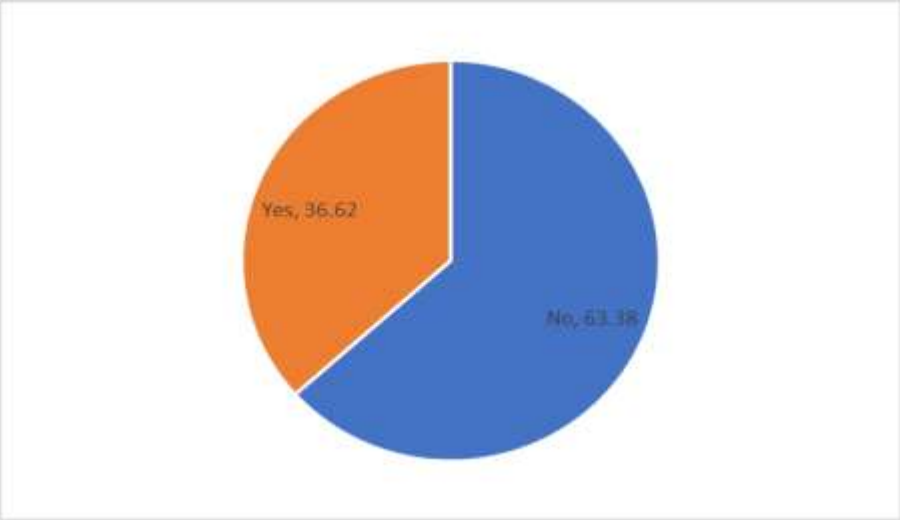

Figure 4.1: Prevalence of Microvascular Complications(N=314)

4.2.1 Distribution of Microvascular Complications by Socio-demographic Characteristics of the Study Participants

Most of the participants on follow-up at DOPC 68(43.9%) had microvascular complications compared to those from the DM clinic 47, 29.6%). Almost half, 73(46.8%) of the participants aged >=61 years old had microvascular complications. Those aged <=30 years old were the least affected, 4(15.4%). Females, widows, and those with no formal education were the most affected, 71 (39%), 28(56%), and 18(60%), respectively. (Table 4.2)

Table 4.2: Distribution of Microvascular Complications by Socio-Demographic Characteristics of Participants

Variable	Description	Participants with MVCs Freq (n %)	Participants without MVCs freq (n %)	Total
Follow Up Clinic	DOPC	68(43.9)	87 (56.1)	155
	DM Clinic	47(29.6)	112 (70.4)	159
Age Group	<=30 Years	4(15.4)	22 (84.6)	26
	31-45 Years	13(31)	29 (69)	42
	46-60 Years	25(27.8)	65 (72.2)	90
	>=61 Years	73(46.8)	83 (53.2)	156
Gender	Male	44(33.3)	88 (66.7)	132
	Female	71(39)	111 (61)	182
Marital Status	Married	78(37.3)	131 (62.7)	209
	Single	7(16.3)	36 (83.7)	43
	Divorced/Separated	2(16.7)	10 (83.3)	12
	Widowed	28(56)	22 (44)	50
Religion	Christian	114(36.7)	197 (63.3)	311
	Muslim	1(50)	1(50)	2
	Hinduism	0(0)	1(100)	1
Level Of Education	Primary	58(36.7)	100 (63.3)	158
	Secondary	26(28.9)	64 (71.1)	90
	Tertiary	13(36.1)	23 (68.9)	36
	None	18(60)	12 (40)	30
Occupation	Government Employee	0(0)	7 (100)	7
	Private Employment	9(47.4)	10 (52.6)	19
	Business	21(40.4)	31(59.6)	52
	Farmer	63(34.4)	120(65.6)	183
	Unemployed	22(41.5)	31(58.5)	53
Residence	Rural	94(37.9)	154 (62.1)	248
	Urban	21(31.8)	45 (68.2)	66
Ethnicity	Kikuyu	108(36.7)	186(63.3)	294
	Embu	3(33.3)	6(66.7)	9
	Meru	0(0)	4 (100)	4
	Others	4(57.1)	3 (42.9)	7

4.3 Prevalence of Retinopathy, Nephropathy, and Neuropathy Complications among Diabetes Mellitus Patients

Neuropathy was the most common complication, affecting 86(27.4%) of the participants. Retinopathy was less common at 34(10.8%), while nephropathy was the least 25(8%). (Figure 4.2)

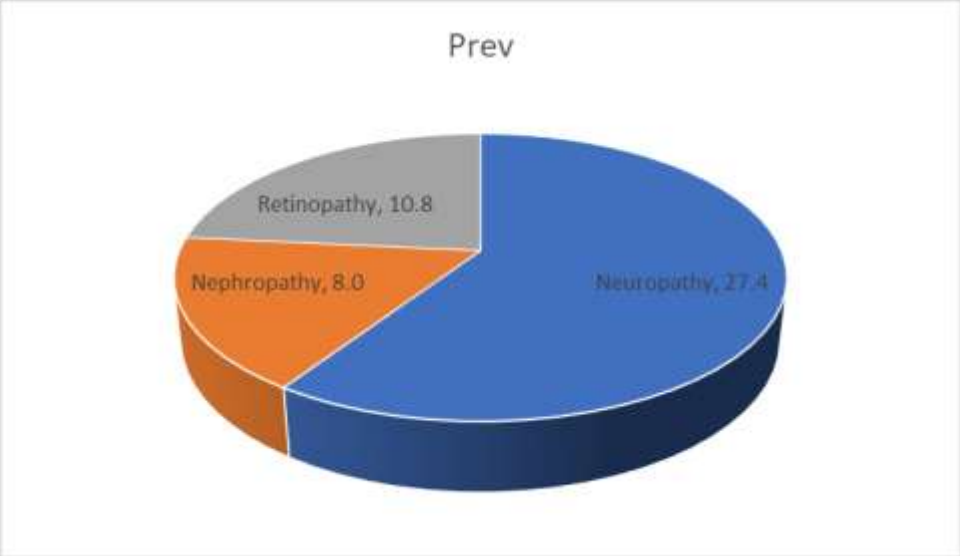

Figure 4.2: Prevalence of Diabetic Complications

4.3.1 Prevalence of Diabetes, Microvascular Complications, and Distribution of Prevalence by Demographic Characteristics

The overall prevalence of microvascular complications (MVCs) is 36.62%. Peripheral neuropathy was the most common complication affecting 86(27.4%) of the participants, while retinopathy was at 34(10.8%), and nephropathy was the least 25(8%).

The majority of the participants with diabetic neuropathy complications were from the DOPC clinic, 49(31.6%), compared to 37(23.3%) from the DM clinic. The condition was most common among those aged ≥61 years, 56(35.9%), and least prevalent among participants aged ≤30 years.

Diabetic neuropathy was more frequent among widowed participants 23(46%), and least common among the divorced/separated. In terms of education, slightly more than half of the affected participants, 16(53.3%), had no formal education and were rural residents.

Diabetic nephropathy was reported in 14(9%) from the DOPC clinic and 11(6.9%) from the DM clinic. It was most prevalent among those aged ≥61 years, and males were more affected, 14(10.6%), compared to females, 11(6%).

Nephropathy was more prevalent among respondents with no formal education and widows, 16.7% and 16% respectively. The condition was more common among rural residents (8.9%) and those in business (9.6%)

The DOPC clinic recorded a higher number of diabetic retinopathy cases, 23(14.8%), compared to the DM clinic, 11(6.9%). Retinopathy was most common among participants aged ≥61 years and least prevalent among those aged ≤30 years.

Participants with no formal education and widows accounted for the majority of cases (20%) of all cases. Additionally, the condition was common among rural residents and those in private employment. (Table 4.3).

Table 4.3: Prevalence of Diabetes Microvascular Complications by Demographic Characteristics

Characteristic	Variable	Type of MVCs			n	Total N
		Neuropathy (%)	Nephropathy (%)	Retinopathy (%)		
Follow Up Clinic	DOPC	49(31.6%)	14(9%)	23(14.8%)	155	314
	DM Clinic	37(23.3%)	11(6.9%)	11(6.9%)	159	
Age Group	<=30 Years	1(4%)	2(8%)	1(4%)	26	314
	31-45 Years	8(19%)	3(7.1%)	4(9.5%)	42	
	46-60 Years	21(23.3%)	2(2.2%)	8(8.9%)	90	
	>=61 Years	56(35.9%)	18(11.5%)	21(13.5%)	156	
Gender	Male	33(25%)	14(10.6%)	10(7.6%)	132	314
	Female	53(29.1%)	11(6%)	24(13.2%)	182	
Marital Status	Married	57(27.3%)	14(6.7%)	23(11%)	209	314
	Single	5(11.6%)	2(4.7%)	1(2.3%)	43	
	Divorced/Separated	1(10%)	1(10%)	0(0%)	12	
	Widowed	23(46%)	8(16%)	10(20%)	50	
Religion	Christian	85(27.3%)	25(8%)	34(10.9%)	311	314
	Muslim	1(50%)	0(0%)	0(0%)	2	
	Hinduism	0(0%)	0(0%)	0(0%)	1	
Education	Primary	42(26.6%)	15(9.5%)	16(10.1%)	158	314
	Secondary	21(23.3%)	3(3.3%)	6(6.7%)	90	
	Tertiary	7(19.4%)	2(5.6%)	6(16.7%)	36	
	None	16(53.3%)	5(16.7%)	6(20%)	30	
Occupation	Government Employee	0(0%)	0(0%)	0(0%)	7	314
	Private Employment	7(36.8%)	0(0%)	4(21.1%)	19	
	Business	15(28.8%)	5(9.6%)	4(7.7%)	52	
	Farmer	50(27.3%)	12(6.6%)	19(10.4%)	183	
	Unemployed	14(26.4%)	8(15.1%)	7(13.2%)	53	
Residence	Rural	71(28.6%)	22(8.9%)	27(10.9%)	248	314
	Urban	15(22.7%)	3(4.5%)	7(10.6%)	66	

4.4 Risk Factors Associated with Diabetes Microvascular Complications (Retinopathy, Nephropathy, and Neuropathy)

The Chi-square test was performed to assess the significance of risk factors for diabetic neuropathy, nephropathy, and retinopathy. In cases where cell counts are less than 5, Fisher's exact method was used. The significance level was set at 0.05.

Analysis revealed that physical exercise, age cohort, marital status, and level of education had a significant relationship with neuropathy complications, with p values of 0.002, 0.001, 0.002, and 0.007, respectively.

Further, it displayed that a significant relationship exists between nephropathy complications and smoking, history of alcohol intake, physical exercise, and HBIAC test with p-values of 0.001, 0.001, 0.0002, and 0.011, respectively.

Additionally, a significant relationship with retinopathy complications was physical exercise and marital status, with p-values of 0.013 and 0.033, respectively.

The other factors, such as BMI, smoking status, gender, religion, and current treatment regimen, showed no significant association. (Table 4.4)

Table 4.4: Risk Factors Associated with Diabetes Retinopathy, Nephropathy, and Neuropathy among Diabetes Mellitus Patients

Variable	Variable choices	Type of Complication and P Value					
		Neuropathy Yes, n (%)	P value	Nephropathy Yes, n (%)	P value	Retinopathy Yes, n (%)	P value
BMI	Normal	37(29.6)	0.236	10(%yes)	0.633	15(12)	0.864
	Under weight	0(0)		0(0)		0(0)	
	Over weight	40(29.9)		13(9.7)		15(11.2)	
	Obese	9(17.6)		2(3.9)		4(7.8)	
Smoke	Yes	3(17.6)	0.267	5(29.4)	0.001	0(0)	0.233
	No	83(27.9)		20(6.7)		34(11.4)	
History of alcohol intake	Yes	4(23.5)	0.481	5(29.4)	0.001	1(5.9)	0.705
	No	82(27.6)		20(6.7)		33(11.1)	
Physical Exercise	Yes	62(23.8)	0.002	15(5.8)	0.002	23(8.8)	0.013
	No	24(44.4)		10(18.5)		11(20.4)	
Age group	<=30 years	1(3.8)	0.001	2(7.7)	0.078	1(3.8)	0.494
	31-45 years	8(19)		3(7.1)		4(9.5)	
	46-60 years	21(23.3)		2(2.2)		8(8.9)	
	>=61 years	56(35.9)		18(11.5)		21(13.5)	
Gender	Male	33(25)	0.249	14(10.6)	0.14	10(7.6)	0.114
	Female	53(29.1)		11(6)		24(13.2)	
Marital status	Married	57(27.3)	0.002	14(6.7)	0.142	23(11)	0.033
	Single	5(11.6)		2(4.7)		1(2.3)	
	Divorced/separated	1(8.3)		1(10)		0(0)	
	Widowed	23(46)		8(16)		10(20)	
Level of education	Primary	42(26.6)	0.007	15(9.5)	0.078	16(10.1)	0.134
	secondary	21(23.3)		3(3.3)		6(6.7)	
	Tertiary	7(19.4)		2(5.6)		6(16.7)	
	None	16(53.3)		5(16.7)		6(20)	
Employment status	government employee	0(0)	0.497	0(0)	0.206	0(0)	0.482
	Private	7(36.8)		0(0)		4(21.1)	
	Business	15(28.8)		5(9.6)		4(7.7)	
	Farmer	50(27.3)		12(6.6)		19(10.4)	
	Unemployed	14(26.4)		8(15.1)		7(13.2)	
Current treatment	Metformin 500mg	17(24.6)	0.784	2(2.9)	0.191	12(17.4)	0.141
	Metformin 500mg and Glibenclamide	8(28.6)		2(7.1)		1(3.6)	
	Metformin 850/1000mg	28(29.5)		7(7.4)		11(11.6)	
	Metformin+Glibenclamide+ Insulin	20(31.7)		5(7.9)		8(12.7)	
	Insulin only	13(22.8)		9(15.8)		2(3.5)	
	Others	0(0)		0(0)		0(0)	
HBIAC Test	Normal	37(29.6)	0.475	4(3.2)	0.011	17(13.6)	0.199
	Abnormal	49(25.9)		21(11.1)		17(9)	

4.4.1 Regression Analysis for Risk Factors for Diabetic Complications

Binomial logistic regression was conducted on risk factors with p-values less than 0.1 from the chi-square analysis.

4.4.1.1 Regression Analysis for Risk Factors for Diabetic Neuropathy

Controlling for age cohorts, marital status, and level of education, frequency of exercise was not significantly associated with neuropathic complications. Similarly, controlling for frequency of exercise, marital status, and level of education, age cohorts were not significantly associated with neuropathic complications. (Table 4.5)

Table 4.5: Regression Analysis for Risk Factors for Diabetic Neuropathy

	Multivariate Analysis	
Independent Variable	**OR (95% CI)**	**P value**
Age cohorts (Base-<= 30 years)		
<=30 years	1	1
31-45 years	0.452(0.158- 1.30)	0.14
46-60 years	0.731 (0.356-1.40)	0.392
>=61 years	1	1
Marital status (Base-Married)		
Single	0.833(0.251-2.764)	0.765
Divorced/Separated	0.376(0.044-3.189)	0.37
Widowed	1.49(0.635-3.492)	0.359
level of education (Base-Primary)		
Secondary	1.384 (0.665-2.88)	0.359
Tertiary	1.183 (0.402-3.475)	0.76
None	1.89 (0.635-5.645)	0.252
Frequency of exercise (Base-Daily)		
Once weekly	0.812 (0.34-1.94)	0.252
2-3 times a week	0.537 (0.254-1.133)	0.639
2 weeks to one month	1	1
Only when recommended by HC person	0.768 (0.072-8.22)	0.827

4.4.1.2 Regression Analysis for Risk Factors for Diabetic Nephropathy

Controlling for age cohorts, frequency of exercise, and level of education, the odds of those who are not smoking getting nephropathy reduce by 98% compared to smokers (OR=0.02, 95% CI 0.002549-0.145117, P ≥0.0001). (Table 4.6).

Table 4.6: Regression Analysis for Risk Factors for Diabetic Nephropathy

Multivariate Analysis		
Independent Variable	**OR (95% CI)**	**P value**
Age cohorts (Base-<= 30 years)		
<=30 years	1	1
31-45 years	1	
46-60 years	0.226 (0.005-9.509)	0.435
>=61 years	4.505 (0.163-124.742)	0.374
level of education (Base-Primary)		
Secondary	0.278 (0.027-2.827)	0.279
Tertiary	1.613 (0.203-12.84)	0.652
None	0.568 (0.078-4.13)	0.576
Frequency of exercise (Base-Daily)		
Once weekly	4.176 (0.635-27.461)	0.137
2-3 times a week	0.687 (0.108-4.378)	0.692
2 weeks to one month	1	
Only when recommended by HC person	1	
Smoking (Base-Yes)		
No	0.024 (0.003-0.192)	0.0001
HB1ac	2.217 (0.509-9.653)	0.289

4.4.1.3 Regression Analysis for Risk Factors for Diabetic Retinopathy

Controlling for marital status, the odds of those who do exercise once weekly getting retinopathic complications reduce by 83% compared to those who do exercise daily (OR= 0.18; 95% CI 0.046816-0.690638, P 0.012). Controlling for marital status, the odds of those who are who do exercise 2-3 times a week reduce by 86% compared to those who do exercise daily (P 0.0001; CI 0.049133-0.397895) (Table 4.7).

Table 4.7: Regression Analysis for Risk Factors for Diabetic Retinopathy

Complication retinopathy	Odds Ratio	Std. Err.	z	P>z	[95% Conf. Interval]	
Frequency of exercise (Base-Daily)						
Once weekly	0.179814	0.123459	-2.5	0.012	0.046816	0.690638
2-3 times a week	0.139821	0.074608	-3.69	0.0001	0.049133	0.397895
2 weeks to one month	2.87246	4.190182	0.72	0.469	0.164653	50.11163
Only when recommended by HC person	1	(empty)				
Marital status (Base-Married)						
Married	1	(base)				
Single	0.149677	0.160029	-1.78	0.076	0.018411	1.216815
Divorced/Separated	1	(empty)				
Widowed	1.599709	0.933347	0.81	0.421	0.509811	5.019643
_Cons	0.348134	0.124519	-2.95	0.003	0.1727	0.701779

4.5 Correlation between Diabetes Self-Management and Progress of Diabetic Retinopathy, Nephropathy, and Peripheral Neuropathy

A Spearman's correlation was run to assess the relationship between diabetes self-management and progression of Diabetic neuropathy, nephropathy, and retinopathy. A Spearman's correlation was preferred for its robustness when dealing with outliers. Further, Bonferroni-adjusted p-values were obtained on diabetic self-management factors for each arm of diabetic retinopathy, nephropathy, and retinopathy. Study results show progress of 156, 39, and 68 for diabetic neuropathy, nephropathy, and retinopathy, respectively. Below is a guide for the interpretation of correlation coefficients. Bonferroni P values have been indicated below each row of self-management practice variables. The significant ones have been marked with an asterisk (*).

Table 4.8: Correlation Table Interpretation

Size of Correlation	Interpretation
.90 to 1.00 (−.90 to −1.00)	Very high positive (negative) correlation
.70 to .90 (−.70 to −.90)	High positive (negative) correlation
.50 to .70 (−.50 to −.70)	Moderate positive (negative) correlation
.30 to .50 (−.30 to −.50)	Low positive (negative) correlation
.00 to .30 (.00 to −.30)	negligible correlation

4.5.1 Correlation between Diabetes Self- Management and Progress of Diabetic Neuropathy

For patients who showed progress with diabetic neuropathy(N=156), study results reveal a strong positive correlation exist between average eating plan and healthful eating plan (0.8673), serving of fruits and vegetables and healthy eating plan (0.6193), high fat feeds and healthy eating plan (0.7097), carbohydrates and healthy eating plan (0.6606), serving of fruits and vegetables and average eating plan (0.6328), high fat feeds and average eating plan (0.7070), carbohydrates and average eating plan (0.6697), high fat feeds and serving of fruits (0.7234), carbohydrates and serving of fruits (0.7029) and between carbohydrates and high fat feeds (0.7095) (Table 4.9).

Table 4.9: Correlation between Diabetes Self- Management and Progress of Diabetic Neuropathy

	Healthful eating plan	Average eating plan	Serving of fruits and vegetables	High fat feeds	Carbohydrates	Participating in exercise	Specific exercise	Blood sugar testing	Test sugar recom times	Checking feet	Inside shoes	Wash feet	Soak feet	Dry between toes	Diabetes medication	Insulin injections	Dm pills
Healthful eating plan	1.0000																
Average eating plan	0.8673*	1.0000															
p value	0.0000																
Serve fruits & veges	0.6193*	0.6328*	1.0000														
p value	0.0000	0.0000															
High fat feeds	0.7097*	0.7070*	0.7234*	1.0000													
p value	0.0000	0.0000	0.0000														
Carbohydrates	0.6606*	0.6697*	0.7029*	0.7095*	1.0000												
p value	0.0000	0.0000	0.0000	0.0000													
Participate in exerc	-0.0579	-0.018	0.0149	-0.0769	-0.0354	1.0000											
p value	1.0000	1.0000	1.0000	1.0000	1.0000												
Specific exercise	-0.3259*	-0.2601	-0.2969*	-0.3762*	-0.3335*	0.5513*	1.0000										
p value	0.0000	0.1414	0.0228	0.0000	0.0028	0.0000											
Bld sugar test	0.1418	0.1313	0.0453	0.0662	0.0905	0.1729	0.177	1.0000									
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000										
Test rec times	0.069	0.1093	-0.0561	-0.0371	0.0333	0.0348	0.2517	0.7323*	1.0000								
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.2074	0.0000									
Checking feet	0.4448*	0.3948*	0.3909*	0.3839*	0.3398*	0.1882	-0.1682	0.0397	0.0139	1.0000							
p value	0.0000	0.0000	0.0001	0.0001	0.0019	1.0000	1.0000	1.0000	1.0000								
Inside shoes	0.3298*	0.2729	0.214	0.2723	0.2545	0.1035	-0.0679	0.0277	0.0460	0.7825*	1.0000						
p value	0.0000	0.0773	0.9929	0.0793	0.1828	1.0000	1.0000	1.0000	1.0000	0.0000							
Wash feet	0.4619*	0.3976*	0.4490*	0.4612*	0.3850*	0.1705	-0.2024	0.0289	-0.0451	0.8655*	0.6906*	1.0000					
p value	0.0000	0.0000	0.0000	0.0000	0.0001	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000						
Soak feet	0.0691	0.017	0.007	0.0612	0.0155	0.05	0.119	0.0652	0.1578	0.1955	0.2595	0.0944	1.0000				
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.1459	1.0000					
dry btw toes	0.4233*	0.3342*	0.4116*	0.4553*	0.3139*	0.0993	-0.206	0.0683	-0.0210	0.8245*	0.6483*	0.9167*	0.19	1.0000			
p value	0.0000	0.0027	0.0000	0.0000	0.009	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	1.0000				
Diabetes medic	-0.0716	-0.1059	-0.1243	-0.0193	-0.0984	0.0217	-0.0069	-0.0532	-0.1495	0.0549	0.0385	0.0454	-0.0328	0.043	1.0000		
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000			
Insulin injs	-0.1358	-0.1148	-0.1019	0.0178	0.028	-0.1507	-0.0824	-0.0909	0.0216	-0.0642	-0.0123	-0.0309	-0.1153	-0.0367	0.0142	1.0000	
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		
dm pills	0.0256	-0.0191	-0.0064	0.0605	0.0000	0.0571	0.0331	-0.0580	-0.1078	0.0400	0.0293	0.0433	-0.022	0.0394	0.5811*	-0.076	1.0000
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	

4.5.2 Correlation between Diabetes Self- Management and Progress of Diabetic Nephropathy

For those patients which showed progress with diabetic nephropathy(N=39), study results show a strong positive correlation exist between average eating plan and healtyl eating plan (0.7199), serving of fruits and vegetables and healthy eating plan (0.6351), carbohydrates and healthy eating plan (0.5540), serving of fruits and vegetables and average eating plan (0.5508), high fat feeds and serving of fruits (0.6910), specific exercise and participate in exercise (0.9414), testing blood sugar for recommended number of times and blood sugar testing (0.8188), inspect inside shoes and check feet (0.6667) and between wash feet and check feet (0.6868) (Table4.10).

Table 4.10: Correlation between Diabetes Self- Management and Progress of Diabetic Nephropathy

	Healthful eating plan	Average eating plan	Serving of fruits and vegetables	High fat feeds	Carbohydrates	Participating in exercise	Specific exercise	Blood sugar testing	Test sugar recom times	Checking feet	Inside shoes	Wash feet	Soak feet	Dry between toes	Insulin injections
Healthful eating plan	1.0000														
Average eating plan	0.7199*	1.0000													
p value	0.0000														
Serve fruits & veges	0.6351*	0.5508*	1.0000												
p value	0.0019	0.038													
high fat feeds	0.3616	0.2762	0.6910*	1.0000											
p value	1.0000	1.0000	0.0002												
Carbohydrates	0.5540*	0.5326	0.2183	0.3321	1.0000										
p value	0.0344	0.0657	1.0000	1.0000											
Participate in exerc	-0.4641	-0.3515	-0.4159	-0.4133	-0.378	1.0000									
p value	0.3973	1.0000	1.0000	1.0000	1.0000										
Specific exercise	-0.4918	-0.3501	-0.5414	-0.4932	-0.3579	0.9414*	1.0000								
p value	0.2004	1.0000	0.0506	0.1932	1.0000	0.0000									
Blood sugar testing	0.1522	0.3783	-0.0397	0.0126	0.1404	0.1416	0.2718	1.0000							
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000								
Test recom times	-0.0182	0.1565	-0.2083	0.0000	0.034	0.1527	0.2812	0.8188*	1.0000						
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000							
Checking feet	0.1665	0.3536	0.2231	0.0802	0.1684	0.0586	0.0907	0.2757	0.1773	1.0000					
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000						
Inside shoes	0.0643	0.0807	-0.0101	-0.1036	0.1294	0.1291	0.1599	-0.0175	0.0335	0.6667*	1.0000				
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0005					
Wash feet	0.3309	0.2596	0.3811	0.2871	0.1555	-0.3062	-0.2814	0.0142	0.0434	0.6868*	0.5976*	1.0000			
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0002	0.008				
Soak feet	0.0319	0.0046	-0.1749	-0.059	0.0769	-0.0227	0.0482	0.0631	0.0747	0.1118	0.1456	0.0408	1.0000		
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000			
Dry between toes	0.1732	0.2965	0.2055	0.2012	0.2184	-0.1447	-0.1187	0.0771	0.0995	0.7100*	0.6364*	0.8945*	0.0534	1.0000	
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0001	0.0018	0.0000	1.0000		
Insulin injections	-0.0256	-0.0186	-0.0841	0.3551	0.063	-0.1688	-0.0983	0.2955	0.3089	-0.0023	-0.0258	0.1566	-0.088	0.1716	1.0000
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	

4.5.3 Correlation between Diabetes Self-Management and Progress of Diabetic Retinopathy

For those patients which showed progress with diabetic retinopathy(N=39), study results show a strong positive correlation exist between average eating plan and healthy eating plan (0.7199), serving of fruits and vegetables and healthy eating plan (0.6351), high fat feeds and serving of fruits and vegetables (0.6910), specific exercise and participate in exercise (0.9414), blood sugar testing and testing blood sugar number of recommended times by health care provider (0.8188) (Table 4.11).

Table 4.11: Correlation between Diabetes Self- Management and Progress of Diabetic Retinopathy

	Healthful eating plan	Average eating plan	Serving of fruits and vegetables	High fat feeds	Carbohydrates	Participating in exercise	Specific exercise	Blood sugar testing	Test sugar recom times	Checking feet	Inside shoes	Wash feet	Soakfeet	Dry between toes	Diabetes medication	Insulin injections
Healthful eating plan	1.0000															
Average eating plan	0.6141*	1.0000														
p value	0.0000															
Serving of fruits & veges	0.6197*	0.6849*	1.0000													
p value	0.0000	0.0000														
High fat feeds	0.6827*	0.6509*	0.7152*	1.0000												
p value	0.0000	0.0000	0.0000													
Carbohydrates	0.5522*	0.7467*	0.6879*	0.7034*	1.0000											
p value	0.0001	0.0000	0.0000	0.0000												
Participating in exercise	-0.1200	-0.228	-0.1159	-0.2108	-0.0624	1.0000										
p value	1.0000	1.0000	1.0000	1.0000	1.0000											
Specific exercise	-0.2708	-0.0598	-0.3648	-0.4089	-0.2389	0.5478*	1.0000									
p value	1.0000	1.0000	0.3028	0.0729	1.0000	0.0002										
Blood sugar testing	0.0804	0.0794	0.0392	0.0184	-0.0670	0.3186	0.2471	1.0000								
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000									
Test sugar recom times	0.0008	0.1386	-0.1179	-0.0692	-0.0903	0.087	0.4420*	0.6991*	1.0000							
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0219	0.0000								
Checking feet	0.4856*	0.3938	0.5265*	0.4856*	0.4825*	0.2524	-0.1865	0.1424	-0.0826	1.0000						
p value	0.0037	0.1213	0.0005	0.0037	0.0042	1.0000	1.0000	1.0000	1.0000							
Inside shoes	0.3278	0.3044	0.2579	0.3079	0.3694	0.2	-0.0568	0.0964	0.0231	0.6742*	1.0000					
p value	0.8651	1.0000	1.0000	1.0000	0.2631	1.0000	1.0000	1.0000	1.0000	0.0000						
Wash feet	0.5258*	0.3539	0.5701*	0.5400*	0.4719*	0.1776	-0.2612	0.1344	-0.1089	0.9317*	0.6132*	1.0000				
p value	0.0006	0.418	0.0001	0.0003	0.0066	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000					
Soak feet	0.1737	0.0833	0.0779	0.1332	0.0259	0.1856	0.2216	0.0555	0.1346	0.1599	0.2496	0.1206	1.0000			
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000				
Dry between toes	0.5038*	0.3739	0.4383*	0.4765*	0.3941	0.1589	-0.1568	0.206	-0.0281	0.8823*	0.5660*	0.8842*	0.1928	1.0000		
p value	0.0016	0.2292	0.0252	0.0054	0.1203	1.0000	1.0000	1.0000	1.0000	0.0000	0.0001	0.0000	1.0000			
Diabetes medication	-0.0415	-0.0541	-0.1435	-0.0221	-0.0666	0.144	0.1216	0.0956	-0.0753	0.2210	0.2027	0.1924	0.1379	0.1836	1.0000	
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		
Insulin injections	-0.1214	-0.0681	-0.0795	-0.0988	-0.0216	-0.1781	-0.0596	-0.2006	-0.1066	-0.1438	-0.0774	-0.0585	-0.1987	-0.1337	0.0902	1.0000
p value	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	

CHAPTER FIVE

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Discussion

Diabetes mellitus is the most prevalent metabolic disorder in low and middle-income countries, with its prevalence steadily rising. As diabetes rates continue to climb, the burden of its complications is also expected to increase. Globally, the prevalence of microvascular complications varies by region. Approximately 18.8% of individuals with type 2 diabetes mellitus experience microvascular complications; this proportion has increased to 45% in the Middle East and 47.8% in Africa (Aschner *et al*., 2021).

The prognosis of diabetic patients largely depends on the complications seen in the natural course of illness. People with diabetes have an increased risk of developing microvascular complications: diabetic retinopathy, diabetic nephropathy, and diabetic neuropathy. If undetected or left untreated, MVCs can have a devastating impact on quality of life and place a significant burden on healthcare costs (Aikaeli *et al*., 2022). Additionally, diabetic microvascular complications are a leading cause of morbidity and mortality in both type 1 and type 2 diabetes. Even with effective long-term management of blood glucose and blood pressure, diabetes continues to be a major contributor to blindness, renal failure, and amputations (Lovic *et al.,* 2020).

The overall prevalence of microvascular complications in our study population was 36.62%. Among the microvascular complications, peripheral neuropathy (27.4%) had the highest prevalence, followed by retinopathy (10.8%) and nephropathy (8 %). The findings in this study are within the same range of proportion as studies conducted in other low-income countries such as Ethiopia, Tanzania, and India (Hafidh *et al*., 2022; Negussie *et al.*, 2024) However, these findings might differ in specific percentages of proportions, the difference might be related to the accessibility and advancement of

health institutions and patients' adherence to medication and practice in different regions.

The analysis revealed that factors such as lower education levels, occupations such as farming, and rural residence were significantly associated with peripheral neuropathy ($P < 0.05$). Lower education levels, unemployment, smoking, and rural residence were significantly linked to nephropathy ($P < 0.05$), while lower education levels, infrequent exercise, and private employment were significantly associated with retinopathy ($P < 0.05$). The prevalence of all three microvascular complications (MVCs) was notably higher among patients seen in the Diabetes Outpatient Clinic (DOPC) compared to those in the general diabetes clinic. This disparity in prevalence rates in the DOPC could be attributed to delayed diagnosis, inadequate self-care practices, and suboptimal health-seeking behaviors, as the DOPC operates only once per week with longer appointment intervals, whereas the general diabetes clinic operates daily with shorter review dates (Chalie *et al., 2024;* Mahbub *et al.,* 2024).

Lower education status was an independent and commonly encountered risk factor for all the MVCs. Educational status influences the awareness about diabetes, compliance with drugs, and the health-seeking behavior of an individual. Studies have observed that the lower the education, the higher the risk of developing diabetes complications(Amr et al., 2024; M. J. F. Duan et al., 2022) Agriculture is the major occupation in rural areas in Kenya. Farmers are more prone to foot injuries during work, which could be the reason for the high prevalence of neuropathy(Muyambi *et al.,* 2025)

The presence of DPN and Nephropathy was associated with the rural sector of residence and lower household income. The heightened risk observed among rural residents might be attributed to limited access to superior healthcare facilities that are more readily available in urban areas. DM. Previous studies have reported that metabolic control of DM was worse in patients in the rural sector due to a lack of access to the better healthcare facilities available to residents in urban areas (Duan *et al.,* 2019) .

Multivariate analysis revealed that the risk of diabetic Retinopathy reduces by 86% in those who exercise 2-3 times a week compared to those who exercise daily ($p \leq 0.0001$; CI 0.049133-0.397895. In this study, physical activity was defined as any body movement that is above resting conditions, whereas exercise was planned or structured movement with specific intent on gains in aerobic and/or muscular fitness. We focused on frequency, intensity, including volume, and the duration/repetitions of the exercise being completed.

Even though there is strong evidence for the correlation between physical activity and disease status, the number of people who partake in the minimum requirement for physical activity as prescribed by the American College of Sports Medicine (ACSM) and other Public Health and Exercise Authorities remains low around the world. Physical activity (PA) is a critical component of lifestyle intervention in diabetes management. This study agrees with other studies, which revealed that total physical activity was decreased in patients with severe to very severe non-proliferative and proliferative diabetic retinopathy (AlQabandi *et al.*, 2022; Yan *et al*., 2021).

Adjusting for age cohorts, frequency of exercise, and level of education, the odds of those who are not smoking getting nephropathy reduced by 98% compared to smokers (P-0.0001; CI 0.002549-0.145117). Smoking is a well-known and preventable risk factor for many diseases. cigarette smoking in diabetes has been repeatedly confirmed as an independent risk factor for the onset and progression of diabetic nephropathy. This study demonstrates a strong association between chronic cigarette smoking and diabetic nephropathy. This is consistent with various studies that suggest smoking is a major factor in the development of high oxidative stress and subsequently, hyperlipidemia, and Rho-kinase, which are observed to play a pathogenic role in the progression of diabetic nephropathy. Furthermore, cigarette smoking in diabetic patients with vascular complications produces a variety of pathological changes in the kidney, such as thickening of the glomerular basement membrane and mesangial expansion with progression in glomerulosclerosis and interstitial fibrosis, which ultimately results in end-stage renal failure (Liao *et al*., 2019).

After adjusting for potential confounders, a strong positive correlation was found between an average eating plan and a healthy eating plan and progress with diabetic neuropathy(N=156), (0.8673), progress with diabetic nephropathy(N=39), (0.7199), and progress with diabetic retinopathy(N=39), (0.7199). Patients who observed an average eating plan were more likely to progress to develop MVC compared to the patients who observed a healthy eating plan and consumed more vegetables and fruits. The findings in this study agree with other studies that illustrate that a diet that includes plenty of vegetables, fruits, and lean proteins is important for diabetes management (Sami *et al*., 2017; Sarmento *et al*., 2018). Consuming a diet with high fat was 71.99% more likely to progress to peripheral neuropathy compared to a person who was consuming a healthful eating plan, carbohydrates, vegetables, and fruits. A high-fat diet is a risk factor for dyslipidemia. This study agrees with other studies that indicate that excess lipids destroy peripheral nerves (Rumora *et al*., 2022; Sarmento *et al*., 2018).

Patients who engaged in specific exercises (0.9414) were more likely to develop nephropathy and retinopathy compared to those who participated in regular, general exercise. Most of the people who perform specific exercises are involved in low-intensity physical activity since they are limited to engaging in other safe exercise participation because of the presence of diabetes-related health complications, such as CVD and hypertension. This explains why they are more likely to progress to develop complications. To enhance diabetes management and improve insulin sensitivity, it is recommended to engage in moderate-intensity physical exercise with increased frequency and duration over time. Our study supports the benefits of physical activity in reducing microvascular complications in patients with diabetes (Makura *et al*., 2013).

5.2 Conclusions

The study found that the overall prevalence of microvascular complications among diabetes patients at Nyeri County Referral Hospital was 36.62%. Diabetic peripheral neuropathy was the most common complication, affecting 27.4% of the patients.

Key risk factors identified included inadequate physical exercise, age, marital status, level of education, smoking, and alcohol intake.

The findings from this study underscore the importance of lifestyle modifications such as regular physical exercise, emphasis on diabetes self-management, and prevention of microvascular complications in diabetic patients

5.3 Recommendations

It is therefore recommended that Measures to prevent the development of complications and prolong the quality of life among patients be put in place; such measures should include early screening and intervention during routine follow-up of patients

Engaging and encouraging patients to observe diabetes self-care activities this should be offered as health education and behaviour change counselling during all visits in the hospital

Any behavior change activity should be fully documented in the patient's medical records, as it will facilitate provider-patient communication and help in the assessment of compliance.

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APPENDECES

Appendix I: Participant Information and Consent Form

Title of the study: Prevalence of Microvascular Complications and Associated Risk Factors Among Type 2 Diabetes Patients attending Nyeri County Referral Hospital, Kenya.

Investigators

Rachael Ireri (Principal Investigator)
Jomo Kenyatta University of Agriculture and Technology
Email: ireririachaelw@yahoo.com
Professor Gideon Kikuvi
Jomo Kenyatta University of Agriculture and Technology
Email: kikuvi@itromid.jkuat.ac.ke
Dr. Susan Mambo
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Ms. Betsy C.Rono Cheriro
Jomo Kenyatta University of Agriculture and Technology
Email: bcheriro@jkuat.ac.ke

This informed consent form has two parts: Part A- Information sheet (to share information about the study with you) and Part B- Signature sheet (to indicate whether you agree to participate or not).

Part A: Information sheet

Introductory statement

My name is Rachael Ireri, a Master's of Science in Epidemiology Student from the School of Public Health at Jomo Kenyatta University of Agriculture and Technology. I

am the principal investigator in this study. I am undertaking a research project to determine the Prevalence of Microvascular Complications and Associated Risk Factors Among Type 2 Diabetes Patients attending Nyeri County Referral Hospital, Kenya.

The reason for giving you this information is that you have been selected as a possible participant in this study. I will read and explain this form to you, as you ask any questions that you may have, before agreeing to participate. If you agree to participate, you will be required to sign the signature sheet provided as a sign of your consent. If you prefer not to participate, you are free to do so. If there is anything that you do not understand in the questionnaire, you are free to seek clarification from the investigator.

Importance of the study: This study is aimed at determining the Prevalence of Microvascular Complications and Associated Risk Factors Among Type 2 Diabetes Patients attending Nyeri County Referral Hospital, Kenya.The prevalence and risk factors identified in the study will help in making recommendations to further address screening of microvascular complications, initiating support programs for diabetes self management andimplementation of set guideline for prevention of diabetes complications

Who can participate? All persons above 18 years with a diagnosis of Diabetes and on follow-up in the hospital, who will agree and consent to participate in this study. The study targets household Participation is voluntary.

Permission and ethical approval: Permission to conduct this study has been granted by the Nyeri County Research Committee and the Ethical Review Committee of Jomo Kenyatta University of Agriculture and Technology. The Hospital administration has been informed and has allowed the study to be conducted.s. A research permit has been obtained from the National Commission of Science, Technology and Innovation (NACOSTI).

Study procedures: If you agree to take part in this study, you will be interviewed on various issues such as socio-economic and demographic characteristics, and diabetes self-management. You will also be examined for any diabetes microvascular complications. Your routine blood and urine samples will also be collected for laboratory examination.

What the study involves: This study will take three months, starting from the day data collection commences. Participants will be recruited randomly from the Diabetic clinic. If you agree to participate in the study, you will be required to sign an informed consent form. You will be issued with a structured questionnaire requesting you to give information to your diabetes status. Participants will be required to provide the information required by filling in the questionnaire as truthfully as possible.

Confidentiality: Any information collected from you will have a number and you are not required to indicate your name on the questionnaires. The number will only be known to the investigator, and no information should be shared among participants. Ever information given will be treated with confidence, and there will be no victimization.

Handling of the results: The results of the research will be shared with you upon request and the stake holders. The results will then be published so that those interested can learn or do further research in the field.

Costs :There is no cost to participate in this research study.

Risks and benefits of participation: There are minimal risks associated with participating in this research and confidentiality is guaranteed. Any issues arising in the process of the study will be appropriately addressed where possible and confidentiality guaranteed. There are no direct benefits to you as a participant and you will not be given any compensation. The study may however benefit the Nyeri Residents.

Rights of the participants: Your participation is voluntary and you may agree or refuse to participate in the research. You are at liberty to withdraw at any stage without any coercion or victimization.

Contact person: For further clarification or if in doubt kindly contact:
Dean School of Public Health
Jomo Kenyatta University of Agriculture and Technology.
P.O. Box 62000 – 02000
Nairobi, Kenya.

Part B: Consent Form

Participant Declaration

This is to certify that I, Mr/Ms/Mrs/Dr/Prof/Rev…… ……... (participant name) have read and understood the contents and implications of the consent I am required to give and do agree to participate in the study. I understand the aim of the study and what will be required of me if I take part in the study. The risks and benefits, if any, have been explained to me. I understand that at any time that I may wish to withdraw from this study, I can do so without giving any reason and without affecting my work. I realise that I will be interviewed once. I also understand there is no compensation for participating, and no risks I will be involved in the study. I consent voluntarily to participate in this study. I hereby append my signature as a sign of my agreement to participate in this study.

Signature of the participant Date

Appendix II: Questionaire

Date……

Respondent's code……

Instructions

a) Don't write your name on this form
b) Answer all questions to the best of your knowledge in the space provided
c) Place a tick in the box provided or where necessary
d) All questions are purely for academic purpose and this information will be treated with a lot of confidentiality

SECTION A- SOCIO-DEMOGRAPHIC DATA

1.Department the ptient is on followup

Department seen	**Tick (√)**	**Code**
DOPC		1
DM clinic		2

2.Age cohort

Age cohort in years	**Tick (√)**	**Code**
16-30		1
31-45		2
46-60		3
61 and above		4

3.Age in years……

4. What is your Sex

Sex	**Tick (√)**	**Code**
Male		1
Female		2

5.Marital status?

Marital status	**Tick(√)**	**Code**
Married		1
Single		2
Divorced		3
Separated		4
Widowed		5
Cohabiting		6

6.Religion

Religion	**Tick(√)**	**Code**
Christian		1
Muslim		2
Hinduism		3

7.Level of education

Education level	**Tick(√)**	**Code**
Primary		1
Secondary		2
Tertiary		3
None		4

8.Occupation

Occupation	**Tick(√)**	**Code**
Government employee		1
Private employment		2
Business		3
Farmer		4
Unemployed		5

9.Where is your residence?

Residence	**Tick (√)**	**Code**
Rural		1
Urban		2

10.What is your Ethnic Group?

Ethnic Group	**Tick(√)**	**Code**
Kikuyu		1
Embu		2
Meru		3
Others (specify)		4

11. What is your gross income per month

Household income	**Tick(√)**	**Code**
Less than 5,000		1
5,001-10,000		2
10,001-15,000		3
15,001-20,000		4
20,001-25,000		5
More than 25,001		6

12. Is there other family history of diabetes in your family apart from you

DM family History	**Tick(√)**	**Code**
Yes		1
No		2

13.What type of diabetes mellitus

Type of DM	**Tick(√)**	**Code**
Type 1 DM		1
Type 2 DM		2

14.For how long have you been having Diabetes?

Duration of Diabetes	**Tick(√)**	**Code**
1-3 years		1
4-6 years		2
7-9 years		3
10-12 years		4
13-15 years		5
16-18 years		6
19-21 years		7
22-24 years		8
25 and above years		9

SECTION B: ASSESSING MICROVASCULAR COMPLICATION

15.Apart from Diabetes do you have any other chronic conditions

Other chronic Conditions	**Tick(√)**	**Code**
Yes		1
NO		2

16.If the Answer to 13 is Yes indicate which other condition?

Other chronic Conditions	**Tick(√)**	**Code**
Hypertension		1
Asthma		2
Epilepsy		3
Cancer		4
Stroke		5
Heart Failure		6
Chronic Kidney disease		7
Others (specify)		8

17.If answer to 13 and 14 is yes. Are you on treatment for above condition

Treatment for other conditions	Tick **(√)**	Code
Yes		1
NO		2

18.Do you have any known diabetes complications?

Presence of Complications	**Tick(√)**	**Code**
Yes		1
NO		2

19.If Yes to 13 above indicate the type of complication

Type of complication	**Tick(√)**	**Code**
Neuropathy		1
Nephropathy		2
Retinopathy		3
Erectile dysfunction		4
Coronary artery disease		5
Stroke		6
Others (specify)		7

If no to 13, above Examine the patient for any micro-vascular complications.

If yes to 13, Examine for other microvascular complications not indicated in **17 above**

	System/Organ	**Standard Normal Ranges**	**Normal Result (√)**	**Abnormal Result (√)**
	Cardiovascular System			
	Tick appropriately		**1**	**2**
20..	Blood Pressure	Systolic 100-120 mm/Diastolic 60-80mm/Hg		
	Examine for clinical features of the following conditions		**1 features present**	**2 no features present**
21.	Angina			
22.	Chronic Heart Failure			
23.	Peripheral Vascular Disease			
24.	Stroke			
25.	Transient Ischemic Attack			
	Neurological			
26.	Neuropathy Tuning folk/monofilament			
27.	Reflexes			
	Skin			
28.	Diabetic Dermopathy			
29.	Skin Infection			
	Foot/ upper limbs			
30.	Neuropathy (Monofilament)			
31.	Amputation			
32.	Diabetic Foot			
	EYE			
33.	Retinopathy (eye examination)			
34.	**Renal**			

Clinical Tests

	Clinical Test	Normal Ranges	**Normal Result (√) (1)**	**Abnormal Result (√) ((2)**
35.	HBIAC	6.5% or below or 48mmol/mol		

36.	RBS	7.8-11.0mmol/L		
37.	Urinalysis	Color-amber/clear Ph 4.5-8 Clarity-clear Glucose-nil Ketones-nil Nitrites-nil Leucocytes-nil Proteins-nil Blood-nil Bilirubin-nil		
38.	Urea	2.5-7.1mmol/L or 8-20mg/dl or 6-23mg/dl if above 60 years		
39.	Electrolyte	Sodium 136-146 mEq/L (136-146 mmol/L) Chloride 96-106 mmol/L Potassium 3.5-4.5 mEq/L (3.5-4.5 mmol/L)		
40.	Creatinine	0.9 to 1.3 mg/dL in men and 0.6 to 1.1 mg/dL in women		
41.	Lipid profle	Total lipid 400-800mg/dl Total cholesterol 150-250mg/dl Triglycerides 10-150mg/dl Free fatty acids 9-15mg/dl Low LDL less than 100-130mg/dl HDL 60mg/dl or higher		

SECTION C: MANAGEMENT OF DIABETES

42.What treatment are you using currently?

Treatment	Tick(√)	Code
Oral anti-diabetics		1
Insulin		2
Both		3

43.Tick the current treatment the patient is on?

	Tick against the drug	Tick (√)	Code
	Metformin 500mg OD		1
	Metformin 500mg BD		2
	Metformin 500mg + Glibenclamide 5mg OD		3
	Metformin 500mg Bd+ Glibenclamide 5mg BD		4
	Metformin 850mg bd		5
	Metformin 1000mg bd		6
	Metformin 500mg bd + Glibenclamide 10mg and5mg od		7
	Metformin+glibenclamide+insulin		8
	Metformin+insulin		9
	Insulin only		10
	Enalapril in addition to antidiabetics		11
Others (specify)			12

SECTION D: RISK FACTORS FOR MICROVASCULAR COMPLICATIONS

44.<u>What your BMI</u>

BMI range	Tick(√)	Code
Below 18.5 (underweight)		1
18.5-24.9 (normal)		2
25-29.9 (overweight)		3
30 and above (obese)		4

45.Do you smoke?

Smoking	Tick(√)	Code
Yes		1
No		2

46.If yes to 23, for how many years?

Smoking years	Tick(√)	Code
1-3 years		1
4-6 years		2
7-9 years		3
10-12 years		4
13-15 years		5
16-18 years		6
19-21 years		7
22-24 years		8
25 and above years		9

47.Yes. If yes, how many cigarettes do you smoke on an average per day? Number of cigarettes:

Number of cigarette sticks smoked per day	Tick(√)	Code
Less than 5		1
6-10		2
11-15		3
16 and above		4

48.Have you ever taken alcohol?

Alcohol taking	Tick(√)	Code
Yes		1
No		2

49.If yes to no 26, how often do you take alcohol?

Frequency of Alcohol Intake	Tick(√)	Code
Daily		1
Weekly		2
Monthly		3
Only during special occasions		4
Yearly		5
No longer take at all		6

50.If yes to 26, for how many years?

Years of alcohol consumption	Tick(√)	Code
1-3 years		1

4-6 years		2
7-9 years		3
10-12 years		4
13-15 years		5
16-18 years		6
19-21 years		7
22-24 years		8
25 and above years		9

51. In the last 1 week have you had a physical exercise lasting for atleast 30 minutes?

Physical Excercise	**Tick(√)**	**Code**
Yes		1
No		2

52.If yes in 29 how often do you perform the excercises?

Frequency of exercise	**Tick(√)**	**Code**
Daily		1
Once weekly		2
2-3 times a week		3
Once every 2 weeks		4
Monthy		5
Only when recommended by health care professional		6
Never		7

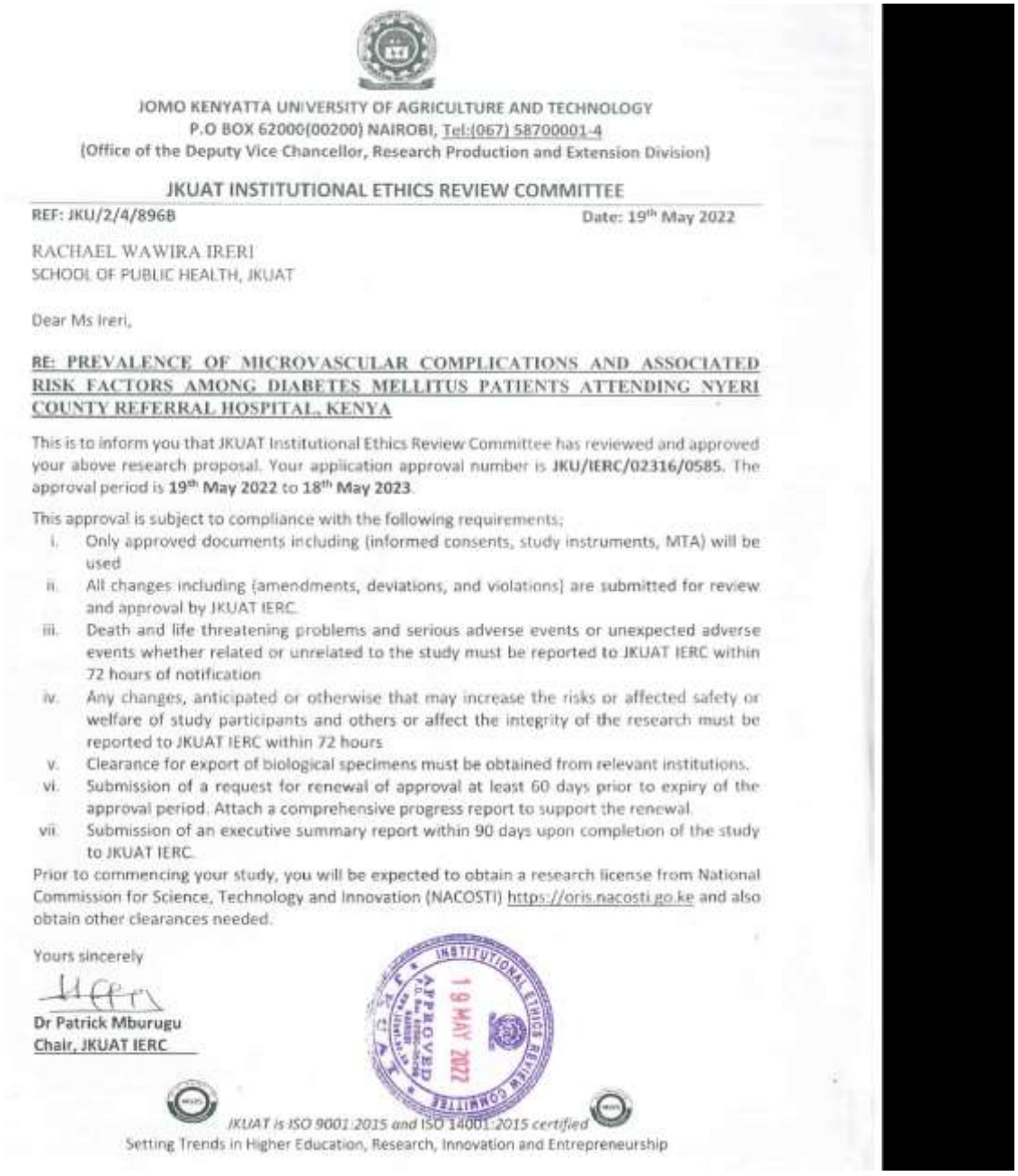
SECTION E: DIABETES SELF-MANAGEMENT PRACTICES

S/no.	**Summary of Diabetes self-care activities**	**Scores**								**Remarks**
	Items	0	1	2	3	4	5	6	7	
	Diet									
53.	How many of the last SEVEN DAYS have you followed a healthful eating plan									
54.	On average, over the past month, how many DAYS PER WEEK have you followed your eating plan?									

55.	On how many of the last SEVEN DAYS did you eat five or more servings of fruits and vegetables?									
56.	On how many of the last SEVEN DAYS did you eat high fat foods such as red meat or full-fat dairy products?									
57.	On how many of the last SEVEN DAYS did you space carbohydrates evenly through out the day									
	Exercise									
58.	On how many of the last SEVEN DAYS did you participate in at least 30 minutes of physical activity? (Total minutes of continuous activity, including walking).									
59.	On how many of the last SEVEN DAYS did you participate in a specific exercise session (such as swimming, walking, biking) other than what you do ar									
	Blood Sugar Testing									
60.	On how many of the last SEVEN DAYS did you test your blood sugar?									
61.	On how many of the last SEVEN DAYS did you test your blood sugar the number of times recommended by your health care provider?									
	Foot Care									
62.	On how many of the last SEVEN DAYS did you check your feet?									
63.	On how many of the last SEVEN DAYS did you inspect the inside of your shoes?									
64.	A. On how many of the last SEVEN DAYS did you wash your feet?									
65.	On how many of the last SEVEN DAYS did you soak your feet?									

66.	On how many of the last SEVEN DAYS did you dry between your toes after washing?									
	Smoking									
67.	Have you smoked a cigarette—even one puff—during the past SEVEN DAYS? 0. No 1. Yes									
68.	At your last doctor's visit, did anyone ask about your smoking status? 0. No 1. Yes									
69.	If you smoke, at your last doctor's visit, did anyone counsel you about stopping smoking or offer to refer you to a stop-smoking program? 0. No 1. Yes 2. Do not smoke									
	Medications									
70.	On how many of the last SEVEN DAYS, did you take your recommended diabetes medication?									
71.	On how many of the last SEVEN DAYS did you take your recommended insulin injections?									
72.	On how many of the last SEVEN DAYS did you take your recommended number of diabetes pills?									

Appendix III: JKUAT Institutional Ethics Review



JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
P.O BOX 62000(00200) NAIROBI, Tel:(067) 58700001-4
(Office of the Deputy Vice Chancellor, Research Production and Extension Division)

JKUAT INSTITUTIONAL ETHICS REVIEW COMMITTEE

REF: JKU/2/4/896B Date: 19th May 2022

RACHAEL WAWIRA IRERI
SCHOOL OF PUBLIC HEALTH, JKUAT

Dear Ms Ireri,

RE: PREVALENCE OF MICROVASCULAR COMPLICATIONS AND ASSOCIATED RISK FACTORS AMONG DIABETES MELLITUS PATIENTS ATTENDING NYERI COUNTY REFERRAL HOSPITAL, KENYA

This is to inform you that JKUAT Institutional Ethics Review Committee has reviewed and approved your above research proposal. Your application approval number is **JKU/IERC/02316/0585**. The approval period is **19th May 2022** to **18th May 2023**.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by JKUAT IERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to JKUAT IERC within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to JKUAT IERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. 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.
vii. Submission of an executive summary report within 90 days upon completion of the study to JKUAT IERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

Dr Patrick Mburugu
Chair, JKUAT IERC

INSTITUTIONAL ETHICS REVIEW COMMITTEE APPROVED 19 MAY 2022

JKUAT is ISO 9001:2015 and ISO 14001:2015 certified
Setting Trends in Higher Education, Research, Innovation and Entrepreneurship

Appendix IV: NACOSTI Approval

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 563350

Date of Issue: 21/July/2022

RESEARCH LICENSE

This is to Certify that Ms.. Rachael wawira Ireri of Jomo Kenyatta University of Agriculture and Technology, has been licensed to conduct research in Nyeri on the topic: Prevalence of Microvascular Complications and Associated Risk Factors Among Diabetes Mellitus Patients attending Nyeri County Referral Hospital, Kenya for the period ending : 21/July/2023.

License No: NACOSTI/P/22/18990

563350

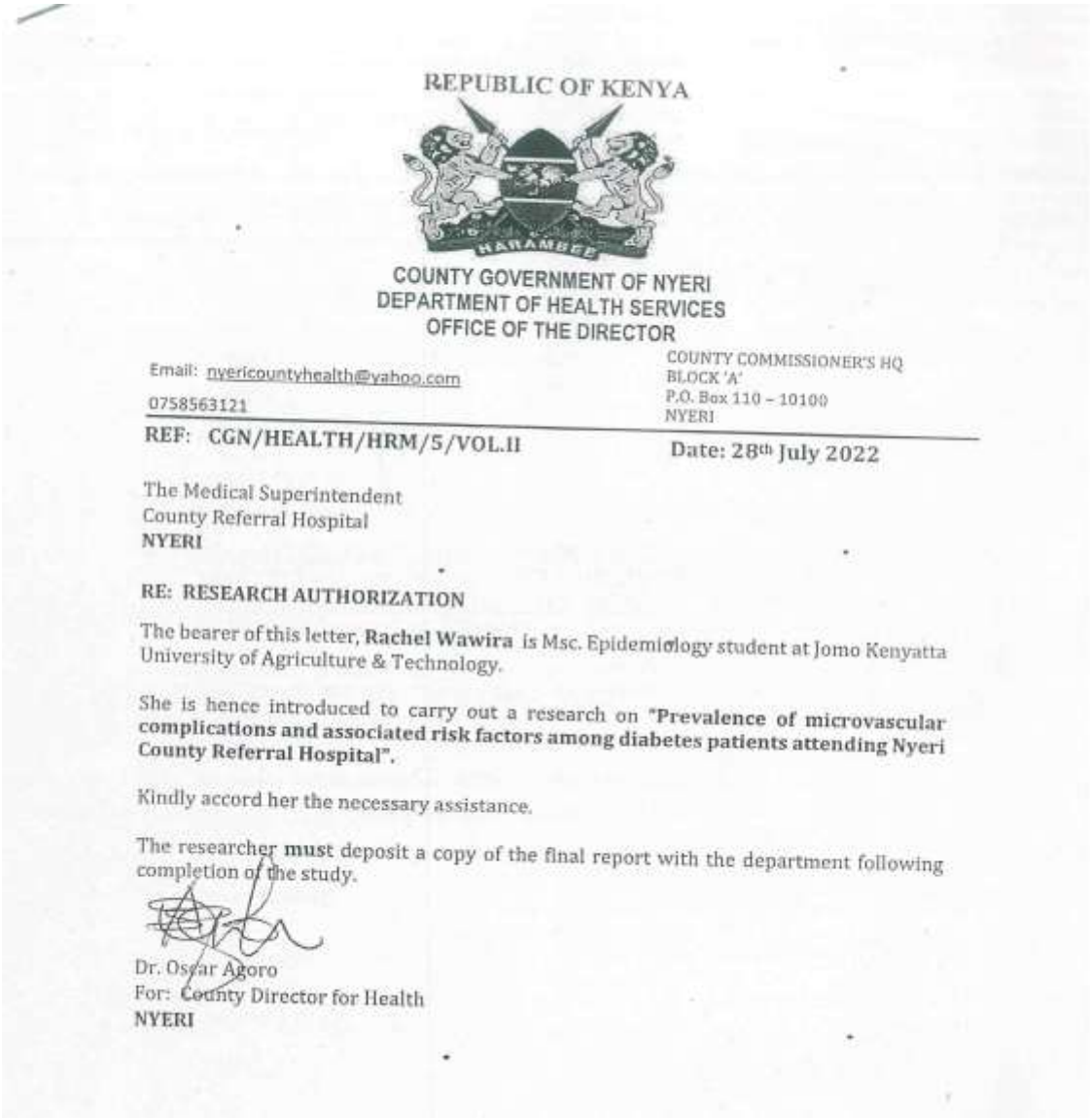
Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

Appendix V: County Government of Nyeri Research Approval



REPUBLIC OF KENYA

COUNTY GOVERNMENT OF NYERI
DEPARTMENT OF HEALTH SERVICES
OFFICE OF THE DIRECTOR

Email: nyericountyhealth@yahoo.com
0758563121

COUNTY COMMISSIONER'S HQ
BLOCK 'A'
P.O. Box 110 – 10100
NYERI

REF: CGN/HEALTH/HRM/5/VOL.II

Date: 28th July 2022

The Medical Superintendent
County Referral Hospital
NYERI

RE: RESEARCH AUTHORIZATION

The bearer of this letter, **Rachel Wawira** is Msc. Epidemiology student at Jomo Kenyatta University of Agriculture & Technology.

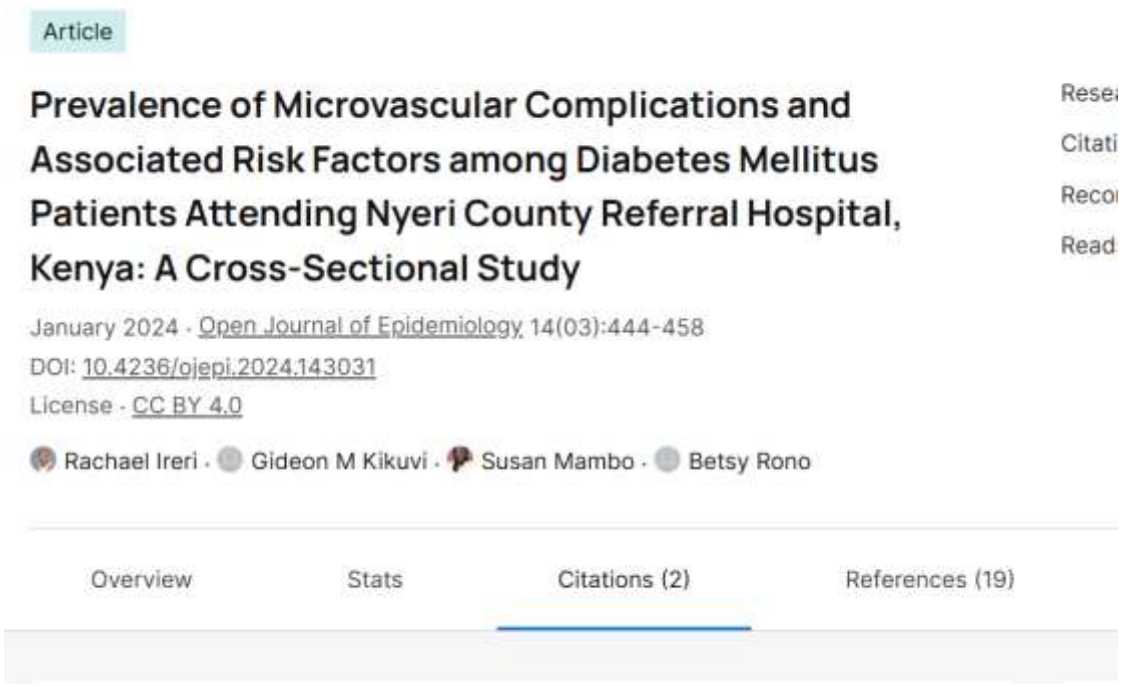
She is hence introduced to carry out a research on **"Prevalence of microvascular complications and associated risk factors among diabetes patients attending Nyeri County Referral Hospital".**

Kindly accord her the necessary assistance.

The researcher **must** deposit a copy of the final report with the department following completion of the study.

Dr. Oscar Agoro
For: County Director for Health
NYERI

Appendix VI: Research Publication



Article

Prevalence of Microvascular Complications and Associated Risk Factors among Diabetes Mellitus Patients Attending Nyeri County Referral Hospital, Kenya: A Cross-Sectional Study

Rese
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Read

January 2024 · Open Journal of Epidemiology 14(03):444-458

DOI: 10.4236/ojepi.2024.143031

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Rachael Ireri · Gideon M Kikuvi · Susan Mambo · Betsy Rono

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