

**PREVALENCE AND DETERMINANTS OF UNDIAGNOSED DIABETES  
MELLITUS AMONG PATIENTS PRESENTING FOR ELECTIVE SURGERY  
AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET KENYA**

**BY**

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## DECLARATION

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## **DEDICATION**

I dedicate this work to the memory of my late sister, Georgina Cheptoo, whose passion, dedication, and commitment to diabetes education left an enduring legacy.

## ABSTRACT

**Background:** Diabetes mellitus (DM) is a group of metabolic disorders characterized by chronic hyperglycemia due to defects in insulin secretion, action, or both. The International Diabetes Federation estimates that over 10.5% of adults aged 20–79 years globally have diabetes, with half undiagnosed. In Kenya, the true prevalence is unclear, and the reported 3% likely underestimates the burden. Routine diabetes screening is uncommon, particularly among elective surgical patients. Known risk factors include age, overweight/obesity, physical inactivity, poor diet, family history, and comorbidities such as hypertension and dyslipidaemia. However, local evidence on these determinants remains limited, underscoring the need to assess undiagnosed diabetes among elective surgical patients.

**Objective:** To determine the prevalence of undiagnosed DM and describe the social, demographic, economic, lifestyle and clinical factors associated with undiagnosed DM among patients presenting for elective surgery at Moi Teaching and Referral Hospital (MTRH).

**Methods:** This was a descriptive cross-sectional study conducted in four surgical wards of MTRH (Kilimanjaro, Longonot, Rehema, and Sergoit). A total of 540 adult patients ( $\geq 18$  years) admitted for elective surgery with unknown diabetes status were recruited through consecutive sampling. Data was collected using a structured questionnaire and clinical measurements, including fasting plasma glucose. Undiagnosed diabetes mellitus was defined as fasting plasma glucose  $\geq 7.0$  mmol/L with no prior history of diabetes.

Ethical approval was obtained from the Institutional Research and Ethics Committee (IREC) of Moi University/MTRH, and permission to undertake the study was granted by hospital management. Written informed consent was obtained from all participants.

Data were analyzed using SPSS version 20. Descriptive statistics were used to summarize variables as frequencies and percentages (n, %). Associations were assessed using binary logistic regression, with results presented as odds ratios (OR) and 95% confidence intervals (CI). Statistical significance was set at  $p < 0.05$ .

**Results:** The prevalence of undiagnosed DM among patients presenting for elective surgery in MTRH was 3.5%. The highest prevalence was found in the age group 36–55 years, with a rate of 6.3%. Single individuals exhibited a significantly higher likelihood of undiagnosed DM (p-value of 0.029). Additionally, business persons and those employed portrayed a higher likelihood of undiagnosed DM with statistically significant associations (p-values of 0.04, 0.01 and 0.02 respectively). Although clinical, lifestyle and dietary factors were found to be associated with the undiagnosed DM, these relationships were not statistically significant.

**Conclusion:** There is a higher proportion of persons with undiagnosed diabetes among those presenting for elective surgery at MTRH compared to the general population. Among those presenting for elective surgery, the middle-aged, and employed are at a higher risk of undiagnosed diabetes.

**Recommendations:** Routine screening is recommended in all adults undergoing elective surgery at the Moi Teaching and Referral Hospital and similar healthcare facilities to enable early detection and appropriate management of undiagnosed diabetes. The Ministry of Health Kenya should incorporate opportunistic diabetes screening into national guidelines and strengthen implementation across hospital settings

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## DEFINITION OF TERMS

**Diabetes Mellitus:** A group of metabolic disorders characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action or both.

**Determinants:** Factors which decisively affect the nature or outcome of something.

**Elective surgery:** A non-emergency surgical procedure that is scheduled in advance at a time agreed upon by the patient and the clinician

**Rural:** Outside a town or city

**Undiagnosed Diabetes Mellitus:** A clinical condition in which an individual meets established diagnostic criteria for diabetes mellitus but has not been previously identified or formally diagnosed by a healthcare professional.

**Urban:** Within a town or city

**LIST OF ABBREVIATIONS**

|      |   |                                                  |
|------|---|--------------------------------------------------|
| ADA  | – | American Diabetes Association                    |
| AHA  | – | American Heart Association                       |
| BMI  | – | Body Mass Index                                  |
| CDC  | – | Centers for Disease Control and Prevention       |
| CHD  | – | Coronary Heart Disease                           |
| CHP  | – | Community Health Program                         |
| CI   | – | Confidence Interval                              |
| CKD  | – | Chronic Kidney Disease                           |
| CVA  | – | Cerebrovascular Accident                         |
| CVD  | – | Cardiovascular Disease                           |
| DCCT | – | Diabetes Control and Complications Trial         |
| DM   | – | Diabetes Mellitus                                |
| DMI  | – | Kenya Diabetes Management and Information Centre |
| ENT  | – | Ear, Nose and Throat                             |
| ESRD | – | End-Stage Renal Disease                          |
| ESRP | – | End-Stage Renal Pathology                        |
| FPG  | – | Fasting Plasma Glucose                           |
| GDP  | – | Gross Domestic Product                           |
| GDM  | – | Gestational Diabetes Mellitus                    |
| HDL  | – | High-Density Lipoprotein                         |
| ICU  | – | Intensive Care Unit                              |
| IDF  | – | International Diabetes Federation                |

|        |   |                                                                  |
|--------|---|------------------------------------------------------------------|
| IFG    | – | Impaired Fasting Glucose                                         |
| IGT    | – | Impaired Glucose Tolerance                                       |
| IREC   | – | Institutional Research and Ethics Committee                      |
| KNH    | – | Kenyatta National Hospital                                       |
| LDL    | – | Low-Density Lipoprotein                                          |
| LMIC   | – | Low- and Middle-Income Countries                                 |
| MI     | – | Myocardial Infarction                                            |
| MOH    | – | Ministry of Health                                               |
| MOPC   | – | Medical Outpatient Clinic                                        |
| MTRH   | – | Moi Teaching and Referral Hospital                               |
| NCDs   | – | Non-Communicable Diseases                                        |
| NCEP   | – | National Cholesterol Education Program                           |
| NGCP   | – | National Glycohemoglobin Certification Program                   |
| NGSP   | – | National Glycohemoglobin Standardization Program                 |
| NHANES | – | National Health and Nutrition Examination Survey                 |
| NIDDK  | – | National Institute of Diabetes and Digestive and Kidney Diseases |
| NIH    | – | National Institute of Health                                     |
| NPO    | – | Nil Per Os (nothing by mouth)                                    |
| OGTT   | – | Oral Glucose Tolerance Test                                      |
| OR     | – | Odds Ratio                                                       |
| PAD    | – | Peripheral Arterial Disease                                      |
| PCOS   | – | Polycystic Ovary Syndrome                                        |
| POD    | – | Peripheral Organ Damage                                          |

|      |   |                                             |
|------|---|---------------------------------------------|
| RA   | – | Rheumatoid Arthritis                        |
| RPG  | – | Random Plasma Glucose                       |
| SDG  | – | Sustainable Development Goal                |
| SES  | – | Socioeconomic Status                        |
| SOPC | – | Surgical Outpatient Clinic                  |
| SPSS | – | Statistical Package for the Social Sciences |
| SSA  | – | Sub-Saharan Africa                          |
| T1DM | – | Type 1 Diabetes Mellitus                    |
| T2DM | – | Type 2 Diabetes Mellitus                    |
| USD  | – | United States Dollar                        |
| WDF  | – | World Diabetes Foundation                   |
| WHO  | – | World Health Organization                   |

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## **CHAPTER ONE**

### **1.0 INTRODUCTION**

#### **1.1 Background**

Diabetes mellitus (DM) is a group of metabolic disorders characterized by persistent high blood sugar. This condition results from inadequate insulin production by the pancreas or reduced sensitivity of the body's cells to insulin. Consequently, this leads to impaired metabolism of carbohydrates, fats, and proteins (Kasper et al., 2012; Hall, 2011). The World Health Organization (WHO) defines diabetes mellitus as a chronic disease that can be inherited or acquired due to insulin deficiency or the body's inability to utilize the insulin produced (WHO, 1999). The resultant elevated blood glucose levels can damage many of the body's systems, particularly the blood vessels and nerves, contributing to severe complications such as heart disease, stroke, kidney failure, nerve damage, and blindness.

A significant challenge in managing diabetes is that many individuals remain unaware they have the condition, particularly during the early stages when symptoms are often mild or non-existent. Hyperglycemia can occur without noticeable symptoms, which means a large number of people go undiagnosed until they experience severe health issues (Baynes, 2015). This is especially true for type 2 diabetes mellitus (T2DM), where approximately 75% of cases are diagnosed incidentally. This delayed diagnosis can lead to long-term damage to vital organs before the condition is identified (Brunner & Suddarth, 2010). The management of diabetes, once diagnosed, is complex and demands continuous medical care, patient education, and self-monitoring, which can be overwhelming for many individuals.

According to the International Diabetes Federation (IDF), 537 million adults aged 20 to 79 years worldwide, equivalent to 1 in every 10 adults, were living with diabetes in 2021. This number is projected to rise to 643 million by 2030 and to 783 million by 2045 (IDF, 2021). The socioeconomic impact of this increase is substantial, affecting healthcare systems, productivity, and household economies. Developing countries bear the greatest burden due to limited healthcare resources, inadequate screening programs, and reduced access to care. Globally, diabetes predominantly affects middle-aged individuals between the ages of 40 and 59 years, with 77% of affected individuals residing in low- and middle-income countries (Standl et al., 2019; Piyasena et al., 2019).

There are four main categories of diabetes mellitus: Type 1 diabetes mellitus (T1DM), Type 2 diabetes mellitus (T2DM), Gestational diabetes mellitus (GDM) and other specific types secondary to identifiable causes such as pancreatic disease, endocrine disorders, or drug-induced conditions. Among these, T1DM and T2DM are the most common. Type 1 Diabetes Mellitus is characterized by absolute insulin deficiency due to autoimmune destruction of pancreatic beta cells, while T2DM is characterized by insulin resistance and relative insulin deficiency. The GDM occurs during pregnancy and increases the risk of adverse maternal and neonatal outcomes. It is also a risk to development of T2DM in the future. Other forms are less common and are associated with specific genetic or secondary causes.

In Western countries, socioeconomic and racial disparities influence the progression of diabetes and related conditions such as obesity and hypertension (Williams et al., 2016). Rapid socioeconomic transitions, urbanization, dietary changes, and increased life expectancy, have contributed to a global rise in diabetes prevalence. Without regular

screening, many cases remain undiagnosed, increasing the risk of complications and long-term morbidity (Mattei et al., 2015).

The burden of diabetes is particularly pronounced in countries such as India, where both diagnosed and undiagnosed cases are high. The prevalence is expected to increase significantly, especially in urban areas, contributing to widening disparities between urban and rural populations. Diabetes is a major contributor to cardiovascular diseases and mortality, with undiagnosed cases playing a significant role in disease burden. Surgical patients with undiagnosed diabetes are at increased risk of adverse outcomes, including higher mortality rates (Pradeepa & Mohan, 2021; Morrish et al., 2001; Zimmet & Alberti, 2016).

Similarly, in Singapore, the prevalence of undiagnosed diabetes increased from 8.8% in 2017 to 9.8% in 2020, largely due to limited awareness of risk factors and preventive measures. Among surgical patients, approximately 11.3% were found to have undiagnosed diabetes, highlighting the importance of routine screening in perioperative care (Subramaniam et al., 2022; Teo et al., 2020).

In Africa, the prevalence of diabetes is estimated at approximately 4.5%, with a considerable proportion of cases remaining undiagnosed (IDF, 2021). Regional variations exist, with studies reporting undiagnosed diabetes prevalence ranging from 1.46% to 4.72% across different regions. In Ethiopia, undiagnosed diabetes prevalence has been reported to be as high as 11.5%, with factors such as body mass index, educational level, family history, and comorbid conditions playing a significant role (Asmelash & Asmelash, 2019; Yatbarek et al., 2021; Worede, 2017).

In Kenya, emerging evidence from clinical settings indicates a substantial burden of undiagnosed diabetes, particularly among patients seeking care for other chronic conditions. A cross-sectional study conducted among hypertensive patients attending Kiambu District Hospital reported a prevalence of undiagnosed diabetes of approximately 14% and prediabetes of 18%, with advancing age, increased body mass index, and family history identified as key determinants (Meme et al., 2015). Similarly, a study conducted in Tharaka Nithi County reported an undiagnosed diabetes prevalence of approximately 5%, with age, body mass index, and marital status identified as significant predictors (Kithuri & Thurania, 2025).

Evidence from surgical settings in Kenya remains limited. However, findings from Kenyatta National Hospital have demonstrated the presence of undiagnosed diabetes and impaired fasting blood glucose among patients undergoing surgical procedures, indicating missed opportunities for early detection within perioperative care (Mwangi, 2014).

Despite this, national estimates suggest that diabetes prevalence in Kenya is approximately 3%, with projections indicating an increase to 4.5% in the coming years (IDF, 2021; WHO, 2019). More than half of individuals with diabetes in Kenya remain unaware of their condition, highlighting a substantial hidden burden. This discrepancy between national estimates and higher prevalence observed in facility-based studies suggests that many cases remain undiagnosed until individuals present with other health conditions.

Undiagnosed diabetes has serious implications, particularly in surgical settings. Hyperglycemia is associated with increased risk of postoperative complications, including surgical site infections, delayed wound healing, prolonged hospital stay, and increased mortality (Gwaro, 2006; Zambouri, 2007). Despite this, routine preoperative screening for

diabetes is not consistently implemented in many healthcare settings in Kenya, representing a critical gap in perioperative care. Patients with undiagnosed diabetes may therefore undergo surgery without appropriate glycemic optimization, increasing the risk of adverse outcomes.

Furthermore, the physiological stress associated with surgery may unmask previously undiagnosed diabetes, further increasing perioperative risk. Elective surgery provides a unique opportunity for early detection, as patients undergo structured clinical evaluation prior to intervention. Incorporating routine diabetes screening into preoperative assessment protocols could significantly improve surgical outcomes while also facilitating early diagnosis and long-term disease management.

Moi Teaching and Referral Hospital (MTRH), located in Eldoret, is one of the largest referral hospitals in Kenya, serving a population across Western Kenya and neighboring countries. As a major surgical center, it provides an ideal setting to assess the prevalence and determinants of undiagnosed diabetes among patients presenting for elective surgery. This study therefore seeks to determine the prevalence and determinants of undiagnosed diabetes mellitus among patients presenting for elective surgery at MTRH. The findings are expected to contribute to strengthening screening strategies, improving perioperative care, and informing public health interventions aimed at reducing the burden of undiagnosed diabetes in Kenya

## 1.2 Problem Statement

Diabetes mellitus is a major public health challenge globally, with an estimated 10.5% of adults aged 20–79 years affected, and nearly half of all cases remaining undiagnosed, placing individuals at risk of developing complications before diagnosis (International

Diabetes Federation, 2021). Undiagnosed diabetes is particularly concerning in clinical settings where physiological stress, such as surgery, can precipitate acute metabolic complications. Beyond individual clinical outcomes, undiagnosed diabetes contributes significantly to increased healthcare costs, loss of productivity, and a growing burden on already strained health systems, particularly in low- and middle-income countries.

In surgical populations, undiagnosed diabetes is frequently detected during perioperative assessment, indicating missed opportunities for early diagnosis and management. In many healthcare settings, patients scheduled for elective surgery undergo preoperative evaluation including clinical assessment and basic laboratory investigations. However, routine screening for diabetes is not consistently implemented in many low- and middle-income countries, contributing to continued late diagnosis (World Health Organization [WHO], 2023).

In Kenya, undiagnosed diabetes continue to pose a significant public health concern, with national survey findings indicating that nearly half of individuals living with diabetes are unaware of their condition. This suggests that many patients seeking healthcare services, including those presenting for elective surgery, may have previously unrecognized diabetes mellitus (Mohamed et al., 2018).

Undiagnosed diabetes increases the risk of complications, hospital admissions, and long-term disability, thereby placing a growing demand on already constrained healthcare services.

At Moi Teaching and Referral Hospital (MTRH), patients scheduled for elective surgery typically undergo preoperative clinical review. Routine screening specifically for diabetes is not consistently performed. Consequently, the prevalence of undiagnosed diabetes in this

population remains unknown. This represents a critical gap in perioperative care and a missed opportunity for early detection of a major non-communicable disease.

Given the increasing burden of diabetes in Kenya and the absence of routine screening in surgical settings, there is a need to determine the prevalence and describe factors associated with undiagnosed diabetes mellitus among patients presenting for elective surgery at MTRH.

### **1.3 Justification**

At Moi Teaching and Referral Hospital (MTRH), there is no documented evidence to guide routine preoperative screening for diabetes among patients scheduled for elective surgery, creating uncertainty in clinical decision-making and limiting the implementation of targeted perioperative interventions.

This study aimed to generate local evidence on the prevalence and determinants of undiagnosed diabetes among elective surgical patients, addressing the existing evidence gap at MTRH. The findings may help identify high-risk patient groups and provide evidence to support routine or risk-based preoperative diabetes screening and standardized preoperative assessment protocols at MTRH and similar healthcare settings, with the potential to improve perioperative outcomes.

At a national level, the evidence generated may contribute to the development and/or refinement of clinical guidelines on perioperative care and non-communicable disease screening, supporting the integration of opportunistic diabetes screening into routine healthcare services in Kenya.

By providing context-specific evidence to support early detection of diabetes within surgical care pathways, this study contributes to strengthening health system responsiveness, improving patient safety, and reducing avoidable morbidity and mortality associated with undiagnosed diabetes.

#### **1.4 Research Question**

What is the prevalence and determinants of undiagnosed diabetes mellitus among patients presenting for elective surgery at Moi Teaching and Referral Hospital?

#### **1.5 Objectives**

##### **1.5.1 Broad Objective**

The main objective was to describe the prevalence and determinants of undiagnosed DM among patients presenting for elective surgery at MTRH.

##### **1.5.2 Specific Objectives**

1. To determine the prevalence of undiagnosed DM among patients presenting for elective surgery at MTRH.
2. To describe the socio-demographic factors associated with undiagnosed DM among patients presenting for elective surgery at MTRH.
3. To describe the economic factors associated with undiagnosed DM among patients presenting for elective surgery at MTRH.
4. To determine the clinical factors associated with undiagnosed DM among patients presenting for elective surgery at MTRH.
5. To determine the lifestyle factors associated with undiagnosed DM among patients presenting for elective surgery at MTRH.

## **1.6 Significance**

The findings of this study are expected to be of public health relevance across different levels of the health system. For patients, early identification of undiagnosed diabetes mellitus may facilitate timely diagnosis and management, potentially reducing the risk of perioperative complications such as infections, poor wound healing, and prolonged hospital stay among patients undergoing elective surgery.

For Moi Teaching and Referral Hospital (MTRH), the results may provide evidence to inform the development or strengthening of preoperative screening practices for diabetes mellitus, contributing to improved perioperative risk assessment and patient safety.

At the community level, the findings may contribute to increased awareness of diabetes mellitus, its risk factors, and the importance of early screening, which could encourage preventive health-seeking behavior.

For policy makers at the county and national levels, including the Ministry of Health, the study may provide locally generated evidence to support consideration of integrating diabetes screening into preoperative care protocols and broader non-communicable disease control strategies in line with national health priorities.

## **CHAPTER TWO**

### **2.0 LITERATURE REVIEW**

#### **2.1 Literature Search Strategy**

This literature review was conducted to identify existing evidence on the prevalence and determinants of undiagnosed diabetes mellitus, with a focus on adult populations and surgical patients, where this was available.

A structured search was performed using electronic databases including PubMed and Google Scholar. Additional sources included reports from the World Health Organization (WHO) and the International Diabetes Federation (IDF).

The search used combinations of the following key terms:

1. Undiagnosed diabetes mellitus
2. Prevalence of undiagnosed diabetes
3. Determinants of diabetes mellitus
4. Risk factors for undiagnosed diabetes
5. Elective surgery patients and diabetes
6. Sub-Saharan Africa diabetes prevalence
7. Kenya diabetes prevalence

The Boolean operators ‘and’ and ‘or’ were used to refine the search.

Studies dating from 1968 onwards were included, with a focus on more recent publications, to provide historical context and foundational evidence on the prevalence, determinants, and risk factors of diabetes mellitus. These studies illuminate the evolution of research methods and highlight long-term trends and persistent gaps that inform contemporary peer-reviewed articles.

Studies were excluded if they focused on individuals with a known or prior diagnosis of diabetes mellitus, as the review aimed to examine risk factors and prevalence among those with undiagnosed disease. Research limited to populations under 18 years was also excluded to maintain relevance to adult populations

## **2.2 Global burden of diabetes mellitus and undiagnosed diabetes**

The global prevalence of diabetes continues to rise, largely driven by poor lifestyle habits, dietary changes, urbanization, aging populations, and the increasing prevalence of obesity. According to the IDF, approximately 783 million adults worldwide, are projected to be living with diabetes by 2045, marking a 46% increase from 2021 levels (IDF Atlas, 2022). This rapid escalation highlights the urgent need for effective public health interventions and underscores the importance of early diagnosis.

Studies have shown that rising incidence of diabetes is closely linked to socioeconomic disparities which influence access to healthcare and educational resources on preventive practices (Zhou et al., 2022). In rural areas, where health facilities are often scarce, the lack of access to routine diabetes screening largely contributes to late diagnosis and consequently leads to a higher burden of disease complications (Gonzalez et al., 2022).

Globally, diabetes prevalence varies considerably across different geographic regions and income groups. High-income nations report a higher prevalence (11.1%) compared to low-income countries (5.5%); with this discrepancy often attributed to differences in diagnostic capacity, healthcare infrastructure, and lifestyle factors. Urban areas generally report higher rates of diabetes (12.1%) compared to rural regions (8.3%), largely due to urbanization, which encourages sedentary lifestyles, coupled with access to calorie-dense, processed foods. However, it is important to note that low-and middle-income countries

are expected to experience the fastest increase in diabetes prevalence due to urban migration and the associated rapid lifestyle changes associated with economic growth (Choi et al., 2021). This trend is particularly evident in parts of sub-Saharan Africa, where diabetes rates are climbing at unprecedented rates, due to changing diets and reduced physical activity levels, presenting significant challenges for public health management (Mensah et al., 2023)

Middle-income countries are expected to experience the greatest increase in diabetes prevalence between 2021 and 2045, with an estimated rise of (21.1%), compared to more modest increases in high- and low-income countries with growth rates of 11.9% (IDF, 2021). These trends reflect both demographic shifts and the changing nature of risk factors, including economic development and its associated lifestyle changes. In these regions, the double burden of malnutrition and non-communicable diseases like diabetes complicates the response strategies to address the growth (Lee & Prabhakaran, 2023). Additionally, lack of healthcare workforce trained in diabetes care poses additional challenges, leading to delays in diagnosis and provision of effective treatments (Anand et al., 2023)

The economic burden of diabetes is equally concerning, with global healthcare expenditure attributed to diabetes projected to rise from an estimated 966 billion USD in 2021 to 1.054 billion USD by 2045 (Sun et al., 2022). This surge in costs is driven not only by the growing number of diabetes cases but also by the complexity of care required to manage diabetes-related complications such as cardiovascular diseases, renal failure, neuropathies, and diabetic foot. The indirect costs of diabetes, such as lost productivity, disability, and premature mortality, add substantially to the economic impact (McKinsey Global Institute, 2021). Some regions like Southeast Asia, experience an

economic strain from diabetes that affects the entire families, as out-of-pocket healthcare expenditures, can exceed 25% of annual household income, placing immense economic strain on families (Sharma et al., 2023).

While the global burden of diabetes is well documented, one crucial issue that often goes unaddressed is the prevalence of undiagnosed diabetes. In many countries, especially the low-resource settings, a large proportion of individuals with diabetes are unaware of their condition. This poses a high risk of complications as the global burden of diabetes continues to grow, leading to an increased need for comprehensive strategies to address this menace. These strategies should focus on enhancing preventive measures, promoting early diagnosis, and implementing cost-effective management approaches to curb the economic impact of diabetes. For healthcare systems, this challenge demands innovative solutions in both policy and practice to improve detection, care and outcome.

### **2.3 Sub-Saharan Africa's burden of diabetes mellitus and undiagnosed diabetes**

Sub-Saharan Africa (SSA) is increasingly affected by the global diabetes epidemic. Once primarily burdened by infectious diseases, the region now faces a dual burden of both communicable and non-communicable diseases (NCDs), with diabetes emerging as a leading contributor to this growing challenge. The rise in diabetes across SSA is particularly troubling because it comes at a time when many countries in the region are still grappling with limited healthcare infrastructure, including understaffed healthcare facilities, and inadequate diagnostic resources. This situation exacerbates the risk of undiagnosed diabetes, leaving the population vulnerable to complications.

The IDF estimates that more than 12 million people in SSA are currently living with diabetes, with an alarmingly high portion of these cases remaining undiagnosed. Estimates

indicate that up to 81% of individuals with diabetes in this region are unaware of their condition, which means that they are not receiving treatment to manage their health; as a result they are at higher risk of severe complications, such as heart disease, stroke, and kidney failure (WHO 2021; Harvard, 2023). Many of these undiagnosed individuals only receive a diagnosis once complications have already set in, hence sometimes complicating the treatment and reducing its effectiveness (IDF, 2021).

Several factors contribute to the high rate of undiagnosed diabetes in SSA. One of the significant contributors is the lack of awareness about the disease, which prevents many individuals from seeking medical care despite having the symptoms. Limited access to health facilities especially in the rural areas further exacerbates the problem. Socioeconomic barriers, such as poverty, and lack of health insurance, makes it difficult for people to seek timely diagnosis and treatment (Mutiyambizi et al., 2019).

Historically, diabetes was considered a disease of affluence, affecting mainly high-income countries. However, SSA's rapid urbanization, changing dietary habits, and increasing rates of obesity have fuelled a sharp rise in diabetes cases. The shift in lifestyle has led to increased consumption of processed, high calorie foods, while physical activity levels decline as more people move into urban areas. Studies show that over 75% of diabetes-related deaths in SSA occur in individuals under the age of 60, a stark contrast to high-income countries where diabetes predominantly affects older adults. These early deaths have profound social and economic impacts, as diabetes disproportionately affects working-age adults, impacting their families and overall productivity (Atun et al. 2017). Furthermore, the region has experienced a dramatic shift in its disease profile, with non-communicable diseases such as diabetes now accounting for a significant proportion of the

disease burden (IDF, 2021). In this context, the high rates of undiagnosed diabetes in SSA represent a major public health crisis.

Urbanization has been a key driver of this epidemic. Cities across SSA are expanding rapidly, leading to shifts in dietary patterns and physical activity levels. Urban dwellers are more likely to consume processed, calorie-dense foods while engaging in less physical activity compared to their rural counterparts. As a result, urban populations in SSA are disproportionately affected by diabetes. A study conducted in Nairobi, Kenya, found that diabetes prevalence in urban areas was 10.7%, compared to just 2.7% in rural areas (Kenya Diabetes Management and Information Centre, 2015). This urban-rural disparity highlights the role of environmental and lifestyle factors in the rise of diabetes in SSA. Additionally, as economies in the region grow, there is a worrying trend where diabetes prevalence among people aged 55-65 has reached as high as 30% in some areas (Harvard T. H. Chan, 2023).

The economic impact of diabetes in SSA is also significant. Diabetes-related healthcare costs place a heavy burden on individuals, families, and health systems. In many cases, out-of-pocket expenses for diabetes management can be prohibitively high, forcing individuals to forgo treatment. Estimates suggest that the cost of diabetes in SSA could nearly triple by 2030, accounting for a substantial share of the region's GDP. This lack of access to affordable care leads to poorer health outcomes and higher mortality rates. Governments and international organizations need to address the rising tide of diabetes in SSA through increased investment in healthcare infrastructure, education, and awareness campaigns.

In response to this growing crisis, experts are calling for community-driven initiatives, expanded funding, and training of healthcare workers to improve prevention, early detection and management of diabetes. Novel approaches such as mobile health technologies are being tested to enhance early diagnosis and remote monitoring, offering hope for mitigating diabetes-related health issues across the African Region (Atun et al. 2017)

#### **2.4 Diabetes mellitus and undiagnosed diabetes in elective surgery patients in Kenya**

Kenya is experiencing a growing burden of diabetes mellitus, reflecting broader global and regional trends driven by urbanization, demographic transitions, and lifestyle changes. According to the International Diabetes Federation, approximately 3.0% of the adult population in Kenya was living with diabetes in 2021, although this figure is likely an underestimate due to the high proportion of undiagnosed cases (IDF, 2021). This suggests that a significant number of individuals remain unaware of their condition, increasing the risk of late presentation with complications.

Population-based studies in Kenya demonstrate notable variations in diabetes prevalence across different settings. A study conducted in Nairobi and Nakuru reported a diabetes prevalence of 10.7% in urban population compared to 2.7% in the rural, with a considerable proportion of individuals also identified as having prediabetes or impaired glucose tolerance (Kenya Diabetes Management and Information Centre, 2015). These findings highlight the role of urbanization and lifestyle transitions, including reduced physical activity and increased consumption of processed foods, in driving the diabetes epidemic in Kenya. Similar findings have been reported by Ayah et al. (2013), who observed increasing

prevalence of diabetes in urban populations, alongside a substantial burden of undiagnosed cases.

Despite this growing burden, access to diabetes screening remains limited in Kenya. Evidence indicates that a large proportion of the population has never undergone blood glucose testing, reflecting gaps in awareness, accessibility, and utilization of preventive health services (Scutti, 2023; The Star, 2023). This lack of routine screening contributes significantly to the high proportion of undiagnosed diabetes and delays in diagnosis.

Facility-based studies further highlight the magnitude of undiagnosed diabetes within clinical populations. As noted in Chapter 1, a study among hypertensive patients in Kiambu County found an undiagnosed diabetes prevalence of approximately 14% (Meme et al., 2015), confirming that patients already in the healthcare system represent a high-risk group in whom routine screening could yield meaningful diagnoses.

In surgical settings, the perioperative consequences of undiagnosed diabetes are well established, as detailed in Section 2.10. Evidence from Kenyan hospital settings, including studies conducted at Kenyatta National Hospital, confirms that a proportion of patients presenting for surgery have previously unrecognized diabetes or impaired glucose regulation, highlighting missed opportunities for early diagnosis (Mwangi, 2014).

Despite the established perioperative risk, routine preoperative diabetes screening is not consistently implemented in many healthcare facilities in Kenya, particularly in resource-limited settings, representing a missed opportunity for early detection.

At MTRH, given the high proportions of undiagnosed diabetes documented in community and facility-based studies across Kenya, a significant number of surgical patients likely present with unrecognized disease.

Understanding the prevalence and determinants of undiagnosed diabetes in this population is therefore essential for informing targeted screening strategies and improving perioperative management, the primary objectives of the current study.

## **2.5 Socio-demographic and economic characteristics associated with undiagnosed diabetes mellitus**

Socio-demographic and economic characteristics play an important role in the occurrence, distribution, detection, and management of diabetes mellitus. Several studies conducted globally and within sub-Saharan Africa have demonstrated that factors such as age, sex, occupation, education level, income, and place of residence influence diabetes risk either directly through biological mechanisms or indirectly through their effects on lifestyle behaviors, healthcare access, and health-seeking practices (IDF, 2024; Asmelash & Asmelash, 2019).

The prevalence of undiagnosed diabetes mellitus may vary substantially across different socio-demographic groups because opportunities for screening, awareness regarding diabetes symptoms, and utilization of preventive healthcare services are often unequally distributed within populations. In many low- and middle-income countries, rapid urbanization, socioeconomic transition, and changing occupational structures have further contributed to the increasing burden of diabetes mellitus and other non-communicable diseases (Mbanya et al., 2010).

Understanding the relationship between socio-demographic and economic factors and undiagnosed diabetes mellitus is important for identification of high-risk population and development of targeted screening strategies.

### **2.5.1 Age and Undiagnosed Diabetes Mellitus**

Age is one of the strongest established predictors of type 2 diabetes mellitus globally. The prevalence of diabetes generally increases progressively with advancing age because of cumulative exposure to metabolic risk factors, increasing insulin resistance, declining pancreatic beta-cell function, reduced physical activity, and increasing adiposity over time (Cho et al., 2018). Aging is also associated with changes in body composition, hormonal regulation, and glucose metabolism that contribute to impaired glycemic control and increased risk of metabolic diseases. Several epidemiological studies conducted globally have demonstrated strong associations between increasing age and the prevalence of diabetes. The International Diabetes Federation reports that adults aged above 45 years account for a substantial proportion of individuals living with diabetes mellitus worldwide (IDF, 2024). Similarly, systematic reviews conducted within sub-Saharan Africa have consistently demonstrated increasing diabetes prevalence with advancing age (Asmelash & Asmelash, 2019; Yeboah et al., 2019). The relationship between age and undiagnosed diabetes mellitus may, however, differ slightly from the relationship observed with overall diabetes prevalence. Although older adults generally have higher biological risk of diabetes mellitus, several studies have reported a substantial burden of undiagnosed diabetes among middle-aged adults, particularly individuals aged between 35 and 55 years (Yatbarek et al., 2021). Middle-aged adults may represent a particularly important high-risk group for undiagnosed diabetes mellitus because they often remain economically active, asymptomatic, and less likely to seek routine preventive healthcare services. This age group frequently experiences progressive weight gain, occupational stress, reduced physical activity, nutritional transition, and cumulative exposure to metabolic risk factors,

particularly within rapidly urbanizing low- and middle-income countries. These factors collectively contribute to increased metabolic risk while simultaneously reducing opportunities for early diabetes detection (Mbanya et al., 2010). In contrast, older adults may demonstrate lower prevalence of undiagnosed diabetes despite higher overall diabetes prevalence because they generally interact more frequently with healthcare systems due to other chronic conditions such as cardiovascular disease that include hypertension, arthritis, and respiratory illnesses. These repeated healthcare encounters increase opportunities for incidental glucose testing and earlier diabetes diagnosis. Several studies conducted in African outpatient settings have similarly observed that management of one chronic illness may inadvertently facilitate diagnosis of additional metabolic conditions including diabetes mellitus. The aging population has important implications for future diabetes burden globally. Improvements in life expectancy and demographic transition have contributed to increasing proportions of older adults within many populations, particularly in low- and middle-income countries. Because diabetes prevalence increases with age, demographic aging is expected to contribute substantially to increasing burden of diabetes mellitus over the coming decades (IDF, 2024). The relationship between age and diabetes mellitus is further complicated by coexistence of other age-related chronic diseases. Older adults frequently experience hypertension, obesity, cardiovascular diseases, chronic kidney disease, and reduced mobility, all of which may contribute to increased metabolic dysfunction and diabetes risk. Polypharmacy, frailty, and reduced physiological reserve may further complicate diabetes management among elderly population. Despite the traditionally higher burden of diabetes among older adults, younger and middle-aged population are increasingly being affected by type 2 diabetes mellitus because of changing

lifestyle and environmental exposures. Earlier onset of obesity, sedentary behavior, unhealthy dietary practices, urbanization, and increasing psychosocial stress have contributed to rising diabetes prevalence among economically productive populations, particularly in low- and middle-income countries including Kenya. Early-onset diabetes is particularly concerning because it exposes affected individuals to prolonged duration of hyperglycemia and increased lifetime risk of complications. Overall, existing evidence demonstrates that increasing age is strongly associated with diabetes mellitus, while middle-aged adults may represent a particularly important high-risk group for undiagnosed disease because of cumulative metabolic exposure combined with relatively low utilization of preventive healthcare services. These findings highlight the importance of routine opportunistic screening among middle-aged and older adults, particularly within low-resource healthcare settings where diabetes diagnosis frequently occurs late in disease progression.

In addition to age, sex-related biological, behavioral, and sociocultural differences may also influence diabetes risk and opportunities for disease detection.

### **2.5.2 Sex and Undiagnosed Diabetes Mellitus**

Sex differences in diabetes mellitus prevalence, risk exposure, healthcare utilization, and disease detection have been widely reported in the global literature, although findings remain inconsistent across populations and settings. Some studies have demonstrated higher prevalence of diabetes mellitus among men, while others have reported greater burden among women, particularly within low- and middle-income countries and African populations (Hall et al., 2011). These variations suggest that biological, hormonal, behavioral, sociocultural, and environmental factors all contribute to observed sex

differences in diabetes burden. Biological differences between men and women influence fat distribution, insulin sensitivity, hormonal regulation, and metabolic function. Men are generally more likely to accumulate visceral adipose tissue, which is strongly associated with insulin resistance and metabolic syndrome. Women, on the other hand, tend to accumulate more subcutaneous fat during early adulthood, but experience increased central and visceral fat accumulation during menopause, contributing to a higher cardiometabolic risk (Chang & Christakos, 2018; Lizcano & Guzmán, 2014) (

Hormonal influences also contribute to sex-related differences in diabetes risk. Estrogen has been shown to exert protective metabolic effects through regulation of body fat distribution, insulin sensitivity, and glucose metabolism. Declining estrogen levels during menopause may therefore contribute to increasing diabetes prevalence among older women. Pregnancy-related metabolic changes and gestational diabetes mellitus may further increase future risk of type 2 diabetes mellitus among women.

Several studies conducted in sub-Saharan Africa have reported higher obesity prevalence among women compared with men, particularly in urban settings (Mbanya et al., 2010). Sociocultural perceptions regarding body weight may partly contribute to these differences. In some African communities, overweight body habitus among women has traditionally been associated with social status, attractiveness, fertility, and economic well-being, potentially influencing obesity prevalence and metabolic risk.

Behavioral risk factors associated with diabetes mellitus may also differ between men and women. Men generally demonstrate higher prevalence of smoking, harmful alcohol consumption, occupational stress exposure, and delayed healthcare-seeking behavior

compared with women. These factors contribute to insulin resistance, chronic inflammation, endothelial dysfunction, and increased cardiovascular risk.

Differences in healthcare utilization patterns between men and women may significantly influence prevalence of undiagnosed diabetes mellitus. Women frequently interact with healthcare systems through antenatal care, reproductive health services, family planning programs, and child health clinics, increasing opportunities for incidental glucose testing and early diagnosis. Men, in contrast, are often less likely to seek preventive healthcare services and may delay medical evaluation until symptoms become severe, potentially contributing to prolonged periods of undiagnosed disease.

Studies examining the relationship between sex and undiagnosed diabetes mellitus have produced inconsistent findings. Some studies have reported higher prevalence of undiagnosed diabetes among men, partly attributed to lower healthcare utilization and greater exposure to behavioral risk factors. Other studies, however, have found higher prevalence among women, particularly in populations with high obesity prevalence and limited access to preventive healthcare services.

The International Diabetes Federation reports relatively comparable global diabetes prevalence between men and women, although important regional differences exist (IDF, 2024). In many African countries, women demonstrate higher obesity prevalence than men, while men may demonstrate higher exposure to smoking- and alcohol-related risk factors. The interaction between these exposures contributes to variability in sex-specific diabetes patterns across populations.

Urbanization and socioeconomic transition may further influence sex-related diabetes risk. Increasing participation of women in formal employment may reduce occupational

physical activity and increase exposure to sedentary work environments. At the same time, economic pressures, caregiving responsibilities, and psychosocial stress may contribute indirectly to unhealthy dietary behavior, reduced exercise, and obesity.

Overall, existing evidence demonstrates that sex influences diabetes risk, metabolic exposure, healthcare utilization, and opportunities for disease detection. However, findings regarding the relationship between sex and undiagnosed diabetes mellitus remain inconsistent across populations and settings. These variations likely reflect complex interactions between biological, behavioral, sociocultural, and healthcare access factors.

Occupational patterns and work-related lifestyle behaviors have also emerged as important determinants of diabetes risk and opportunities for disease detection.

### **2.5.3 Occupation and Undiagnosed Diabetes Mellitus**

Occupation has increasingly been recognized as an important factor associated with diabetes mellitus and other non-communicable diseases. Occupational status influences lifestyle behavior, income, physical activity, stress exposure, dietary practices, and healthcare utilization, all of which may affect diabetes risk and opportunities for disease detection.

Globally, transition toward sedentary employment has contributed substantially to the rising burden of diabetes mellitus. Office-based work, prolonged sitting, irregular meal schedules, occupational stress, reduced physical activity, and dependence on motorized transport have become increasingly common, particularly within urban populations (Hu et al., 2003). These occupational and lifestyle changes contribute to obesity, insulin resistance, and metabolic dysfunction, thereby increasing diabetes risk among economically active adults.

Several studies have reported higher prevalence of diabetes mellitus among formally employed individuals and those engaged in sedentary occupations compared with persons involved in physically demanding work. Wang et al. (2022) reported that prolonged occupational sitting was significantly associated with increased diabetes risk, particularly among working-age adults in urban settings.

Occupation may influence diabetes risk through multiple pathways. Long working hours and occupational stress may contribute to unhealthy dietary behavior, reduced physical activity, poor sleep quality, and increased psychosocial stress. Persistent stress exposure may further contribute to insulin resistance, abdominal obesity, hypertension, and impaired glucose metabolism (Nyberg et al., 2014).

Businesspersons and self-employed individuals may represent particularly vulnerable occupational groups because commercial activity is frequently associated with irregular schedules, prolonged sedentary behavior, inconsistent meal timing, and limited opportunities for structured physical activity. Urban business environments may also encourage increased reliance on convenience foods and prolonged working hours, both of which may contribute to increased diabetes risk.

Studies conducted within African populations similarly suggest that urbanization and changing occupational structures contribute substantially to the increasing burden of non-communicable diseases. Urban employment patterns characterized by reduced physical activity and changing dietary practices have been associated with increasing obesity and diabetes prevalence across sub-Saharan Africa (Mbanya et al., 2010). In Kenya, economic transition and urbanization have similarly contributed to changing occupational structures and increasing sedentary lifestyles.

However, findings regarding occupation and undiagnosed diabetes mellitus remain inconsistent. Some studies have reported higher diabetes prevalence among unemployed individuals and low-income populations because of limited healthcare access, poor diet quality, and reduced preventive healthcare utilization. Emilioh et al. (2024), in a study conducted among hypertensive patients in Tharaka Nithi County, reported that unemployment was associated with increased odds of undiagnosed diabetes mellitus. The authors suggested that financial constraints and reduced access to preventive healthcare services may partly explain this relationship.

Other studies have reported no statistically significant association between occupation and undiagnosed diabetes mellitus after adjustment for confounding factors such as obesity, income, education, and physical activity. The Kenya STEPwise survey similarly did not identify occupation as an independent predictor of undiagnosed diabetes following multivariable analysis (Mohamed et al., 2018).

Occupation may also influence opportunities for diabetes diagnosis and healthcare utilization. Economically active adults frequently prioritize occupational and financial responsibilities over preventive healthcare visits, resulting in delayed medical evaluation and reduced opportunities for routine screening. Conversely, some occupational groups may experience greater access to employer-sponsored healthcare services or occupational health programs, thereby increasing opportunities for early diagnosis.

Overall, existing evidence suggests that occupation influences diabetes risk through its effects on physical activity, dietary behavior, psychosocial stress, healthcare utilization, and broader lifestyle patterns. However, the association between occupation and undiagnosed diabetes mellitus remains inconsistent across studies and populations. These

differences likely reflect variation in socioeconomic context, urbanization, occupational structure, and healthcare access.

## **2.6 Clinical and lifestyle factors associated with undiagnosed DM.**

### **2.6.1 Body mass index (BMI)**

Body mass index (BMI) is a critical indicator for assessing an individual's risk of developing type 2 diabetes. It categorizes individuals' weight into groups; underweight, normal weight, overweight and obese based on their height and weight. This simple and widely available measure helps assess obesity, which is a major modifiable risk factor for type 2 diabetes. Obesity has been associated with increased insulin resistance, which impairs the body's ability to regulate blood glucose effectively and increases the risk of developing type 2 diabetes mellitus. Individuals with elevated body mass index (BMI) have also been reported to be at higher risk of undiagnosed diabetes, partly because the disease may remain asymptomatic during its early stages.

Elevated body mass index (BMI) has consistently been associated with increased risk of type 2 diabetes mellitus. Obesity contributes to insulin resistance and impaired glucose metabolism, particularly through excess abdominal fat accumulation, which interferes with normal insulin function (NIDDK, 2023). Individuals with overweight and obesity are also more likely to have undiagnosed diabetes because type 2 diabetes mellitus may remain asymptomatic during its early stages. Consequently, delayed diagnosis may increase the risk of complications such as cardiovascular disease, kidney disease, and other diabetes-related conditions. Studies have shown that weight loss can prevent or even reverse diabetes in its early stages by improving insulin sensitivity and reducing blood glucose levels (Chia et al., 2018; WHO, 2022). However, without screening for BMI and glucose

levels, individuals may not realize the need for lifestyle changes or the importance of seeking timely intervention in SSA and other LMIC regions. The relationship between BMI and undiagnosed diabetes is becoming more pronounced due to increased adoption of sedentary lifestyles and shifts towards intake of highly processed foods. The growing prevalence of obesity in urban areas is a major factor contributing to rising rates of undiagnosed diabetes. In Kenya, for instance, urban populations are more likely to experience a dual burden of obesity and diabetes due to their exposure to processed and junk food, which is a quick fix, and less physically active lifestyles (Ayah et al. 2013). The increase in these trends highlights the need for targeted public health strategies to address both obesity and diabetes including routine screening for high-risk individuals based on BMI. Furthermore, the global trend towards higher BMI as a result of increasing dietary shifts put greater emphasis on preventive measures. Public health policies focusing on reducing obesity through improved access to nutritious food, physical activity and encouraging regular health checkups are crucial in mitigating the growing diabetes burden. Education about the risks associated with high BMI and the importance of regular screening for diabetes should be prioritized, especially in populations at high risk of undiagnosed diabetes.

The BMI also serves as an important tool for healthcare professionals when managing diabetes. By monitoring BMI changes in patients, healthcare providers can identify at-risk individuals who might benefit from interventions such as weight management programs, dietary counselling and increased physical activity. And identification of individuals with high BMI allows for interventions that can prevent or delay the onset of type 2 diabetes, potentially improving overall health outcomes and reducing the burden on healthcare

systems (Mitchell, 2020; NIDDK, 2023). While existing literature highlights the importance of BMI as a screening tool for diabetes, the current study aims to leverage BMI to assess the prevalence of undiagnosed diabetes in patients presenting for elective surgery at MTRH, with a particular focus on its role in identifying individuals at risk. It can provide insights into how BMI correlates with undiagnosed type 2 diabetes specifically among surgical candidates, which may be a high-risk group for undiagnosed diabetes.

### **2.6.2 Hypertension**

Hypertension (sustained elevated blood pressure  $\geq 140/90$ mmHg) is a significant clinical factor in the development of type 2 diabetes and the progression of its complications. The association between hypertension and insulin resistance plays a significant role in the development of T2DM, especially in individuals with existing risk factors like obesity, physical inactivity and poor dietary habits (ADA,2024; CDC, 2024). When hypertension and diabetes coexist, they create harmful synergy that greatly increases the risk of cardiovascular diseases such as heart attacks, strokes and heart failure (AHA, 2023). High blood pressure damages blood vessels, promoting atherosclerosis, a condition in which plaque accumulates in the arteries, narrowing them and impairing blood flow. This further raises the risk of serious cardiovascular complications in individuals with diabetes. People with diabetes, particularly those with poorly controlled blood sugar, are more likely to develop hypertension. Hypertension affects approximately 70 to 80% of people who have diabetes (AHA, 2023).

The coexistence of both high blood pressure and diabetes often leads to a vicious circle where hypertension worsens the effects of diabetes on organs such as the heart, kidneys and eyes. Additionally, the damage caused by high blood pressure to the kidneys can

accelerate the progression of diabetic kidney disease, potentially leading to end-stage renal failure if not properly managed (WHO, 2022). The combined risk of hypertension and diabetes highlights the importance of monitoring and managing both conditions simultaneously. Individuals with these conditions are at heightened risk of developing complications like diabetic retinopathy, peripheral arterial disease and neuropathy, which can lead to blindness, limb amputation and other debilitating health issues if not identified and treated early (CDC, 2024).

One of the reasons why hypertension and diabetes often go undiagnosed is that high blood pressure is often asymptomatic, and early-stage diabetes may present few obvious symptoms. As such, individuals may not seek medical help until more serious health problems emerge, hence delaying diagnosis and treatment increasing likelihood of irreversible damage (AHA, 2023). Given these risks, routine screening for high blood pressure and individuals with or at risk for diabetes is essential for early diagnosis and intervention. Regular monitoring of hypertension along with appropriate management through medication, lifestyle modifications (such as weight loss, physical activity and diet changes), and proper glucose monitoring can help reduce the risk of developing severe complications. Health care systems must prioritize integrated care that addresses both hypertension and diabetes together, particularly for populations at high risk, to prevent the progression of these conditions and improve long term health outcomes (ADA, 2024; CDC, 2023).

### **2.6.3 Dyslipidemia**

Dyslipidemia refers to an imbalance or irregularity in the lipid levels within the bloodstream and is a significant risk factor for type 2 diabetes and its complications.

Dyslipidemia in individuals with diabetes is often marked by elevated low-density lipoprotein (LDL) cholesterol, reduced high density lipoprotein (HDL) cholesterol, and increased triglycerides which are common features in individuals with diabetes. These lipid abnormalities are commonly seen in diabetic patients and are closely associated with insulin resistance, a characteristic of type 2 diabetes. Elevated fatty acids and lipoproteins can impair the body's ability to respond to insulin, increasing the risk of both the onset and progression of diabetes (ADA, 2024). According to the National Cholesterol Education Program Expert Panel (Cholesterol in Adults NCEP Adult Treatment Panel III, 2002), dyslipidemia is defined as presence of any of the following: Total cholesterol  $>5.2\text{mmol/l}$  ( $200\text{mg/dl}$ ), and/or increased LDL cholesterol  $>2.6\text{mmol/l}$  ( $130\text{mg/dl}$ ), and/or decreased HDL cholesterol  $<1.03\text{mmol/l}$  for males or  $<1.3\text{mmol/l}$  for females and/or Triglycerides  $>1.7\text{mmol/L}$  ( $150\text{mg/dl}$ ).

People with dyslipidemia are at an increased risk of developing type 2 diabetes, particularly when combined with other risk factors such as obesity and physical inactivity. Elevated triglyceride levels and low HDL cholesterol are frequently found in individuals with metabolic syndrome, which includes hypertension, obesity and insulin resistance, all of which increase the likelihood of developing diabetes (AHA, 2023). Moreover, dyslipidemia also contributes to the development of atherosclerosis, a condition where plaque builds up in the blood vessels leading to cardiovascular complications such as coronary artery disease, stroke and peripheral artery disease, which are more common in individuals with diabetes (AHA, 2023). In older adults, dyslipidemia (high total cholesterol, low HDL-C and elevated triglycerides) has been associated with impaired fasting glycaemia (IFG), a precursor to diabetes (Passos et al., 2005).

Despite the strong connection between dyslipidemia and diabetes, many individuals with dyslipidemia are unaware of their condition, as abnormal lipid profiles are often asymptomatic. This lack of awareness is concerning because individuals may not seek medical attention until they experience more severe complications such as cardiovascular events or progression to diabetes (WHO, 2023). Early detection and management of dyslipidemia through regular screenings, lifestyle changes (including improved diets and physical activity) and medication can help prevent the development of T2DM and reduce the risk of complications. Healthcare systems must prioritize integrated care for managing both dyslipidemia and diabetes, particularly in high risk populations. Managing dyslipidemia alongside blood sugar control is crucial for preventing the adverse events such as cardiovascular disease, kidney damage and nerve complications (ADA, 2024). Early screening and treatment strategies are important in reducing the burden of undiagnosed diabetes, ensuring that individuals receive the appropriate intervention before complications arise.

#### **2.6.4 Alcohol and tobacco use**

Both alcohol and tobacco use have been shown to contribute to insulin resistance, impaired glucose metabolism and development of other comorbidities, increasing the risk of diabetes-related complications. However, the relationship between alcohol consumption and diabetes is complex with studies reporting both positive and negative associations. Moderate to heavy alcohol consumption has been found to be associated with an increased risk of developing T2DM, especially among people with additional risk factors such as old age, physical inactivity and obesity. Passos et al. (2005) found that alcohol use among

elderly individuals was associated with impaired fasting glucose, a condition that progresses to diabetes if not addressed.

Heavy drinking has been consistently identified as a risk factor for the development of T2DM with several studies showing a higher risk for those with heavy drinking patterns (Wei et al., 2000; Holbrook et al., 1990). A prospective study by Carlsson et al. (2003) and Pomerleau, J (1999) found that high alcohol consumption in men was associated with an increased burden of diabetes highlighting the harmful effects of excessive alcohol intake on glucose metabolism. Although moderate drinking may offer some cardiovascular benefits, heavy alcohol consumption can lead to insulin resistance and liver dysfunction complicating diabetes management and increasing the likelihood of undiagnosed diabetes. In addition, alcohol can interfere with blood sugar control, causing fluctuations that may go unnoticed in individuals who do not undergo regular screenings for diabetes (Morris et al., 2022).

Tobacco use, particularly smoking, has been found to be a significant risk factor for T2DM. Cigarette smoking contributes to insulin resistance and increases inflammation and oxidative stress, which can further damage blood vessels and/organs leading to the onset of diabetes (ADA, 2024; AHA, 2023). Several studies examining the link between smoking and diabetes have shown a positive association between cigarette smoking and the incidence of diabetes (Feskens, 1989; Rimm et al., 1993). It has been reported that the strongest association occurs in individuals who smoke more than one pack of cigarettes per day (Feskens, 1989; Rimm et al., 1995; Kawakami et al., 1997). Apart from increasing the risk of diabetes, smoking has also been reported to contribute to complications such as heart disease, kidney failure and neuropathy in those already diagnosed with diabetes

(WHO, 2023). This underscores the importance of addressing smoking as part of diabetes prevention, diagnosis and management.

Given the role of alcohol and tobacco use in the development of T2DM, it is important to incorporate these lifestyle factors into diabetes risk assessment along with routine screening for diabetes. Programs focusing on smoking cessation and reduction of alcohol consumption can play a significant role in the prevention and management of diabetes. Healthy lifestyles such as reduction in alcohol consumption and smoking cessation can help lower the overall burden of diabetes by preventing diabetes and improving health outcomes for individuals for people living with diabetes (CDC, 2023; NIH, 2023). In conclusion, routine screening for alcohol and tobacco use is an integral part in diabetes risk assessment, particularly for individuals in high-risk groups (ADA, 2024).

### **2.6.5 Diet**

Diet plays a critical role in the prevention, development and management of T2DM. Certain dietary patterns have been linked to a higher risk of developing diabetes, while others have been associated with reduced risk for diabetes. Diet related behaviors influence metabolic health by affecting glucose metabolism, body composition and insulin sensitivity. For people at risk of diabetes, dietary habits can either offer protection or exacerbate their condition.

A study done in Finland identified two major dietary patterns; a prudent diet, characterized by high consumption of vegetables, fruits and whole grains and a conservative diet characterized by butter, potatoes, whole milk and red meat. The study found that adherence to the prudent diet pattern was associated with a reduced risk of diabetes whereas the conservative diet was linked to a significantly higher risk of developing diabetes (Jukka et

al., 2005). This highlights the importance of nutrient-dense diets in mitigating the risk of diabetes and the detrimental effects of high saturated fats and refined carbohydrates.

Globally, dietary transitions in LMICs have contributed to rising diabetes prevalence. Increased consumption of processed, calorie dense foods, particularly in urban areas, has displaced traditional diets rich in fresh produce, whole grains and legumes. These dietary shifts compounded by sedentary lifestyles, are fueling the global diabetes epidemic (Popkin, 2017). In high income countries, excessive intake of sugar sweetened beverages and fast foods have been reported as a major contributor to poor glycemic control and weight gain, both of which increase the risk of diabetes (Malik et al., 2010).

For individuals already at risk or living with diagnosed diabetes, diets high in simple carbohydrates and low in fiber have been associated with poor glucose control. Conversely, diets rich in whole grains, lean protein, nuts, seeds and unsaturated fat have been shown to improve insulin sensitivity and reduce the risk of diabetes (Ley et al., 2014). For example, the Mediterranean diet, which emphasizes olive oil, vegetables, fruits, whole grains and nuts, has been associated with lower incidences of diabetes and improved metabolic outcomes (Esposito et al., 2010).

Addressing dietary behaviors is an essential component of diabetes prevention and early detection. For individuals in high-risk groups, such as those with elevated BMI or a family history of diabetes, dietary intervention may significantly reduce the progression to diabetes and its associated complications.

#### **2.6.6 Physical inactivity**

Physical activity, defined as any bodily movement produced by skeletal muscles that require energy expenditure, plays an important role in preventing and managing non-

communicable diseases, including diabetes. It encompasses all types of movements, whether during leisure time, transport to get to and from places, or as part of a person's work or domestic activities (WHO, 2024). Physical activity is classified as light, moderate or vigorous based on energy expenditure and physiological response (CDC, 2022). Light intensity activities involve minimal effort, such as slow walking. Moderate intensity activities result in a noticeable increase in heart rate and breathing, like brisk walking. Vigorous intensity activities lead to a substantial increase in heart rate and breathing. Incorporating any of these activities into one's daily life has been shown to significantly improve metabolic health and reduce the risk of diabetes. Sedentary lifestyle, on the other hand, is a major contributor to diabetes as it negatively impact glucose metabolism and reduce insulin sensitivity. Several studies have shown that physical inactivity is associated with insulin resistance in non-diabetic individuals and is positively correlated with impaired fasting glucose, a precursor of T2DM (Mayer-Davis *et al.*, 1998). Lack of physical activity diminishes the efficiency of glucose uptake by muscle cells exacerbating metabolic dysfunction. In contrast, regular exercise improves insulin sensitivity by increasing muscle fiber and capillary density, which enhances glucose utilization, mediated by insulin (Helmrich *et al.*, 1991, Utriainen *et al.*, 1996).

A large-scale study done in the United States of America found that individuals engaging in regular moderate to vigorous physical activity had a 50% lower risk of developing T2DM (Helmrich *et al.*, 1991). Globally, physical inactivity is on the rise, particularly in urban settings, where sedentary work environments, increased screen time and motorized transportation currently dominate. According to WHO, (2024), 31% percent of adults and 80% of adolescents (aged 11-17 years) globally do not meet the recommended moderate

intensity physical activity of 150 minutes per week. This contributes to the growing burden of NCDs including diabetes.

Activities like cycling and walking have been shown to be effective in improving insulin sensitivity and lowering glucose levels. Public health interventions promoting physical activity should hence focus on integrating contextualized exercise into daily routines. Additionally, community-based programs and policies that create supportive environments for physical activity, such as pedestrian friendly infrastructure and accessible exercise facilities have been recommended to promote physical activity. For healthcare providers, educating patients about the benefits of regular exercise, tailoring physical activity plans to individual needs, and incorporating physical activity assessments into routine diabetes screenings are effective strategies to reduce the risk of diabetes and its complications.

#### **2.6.7 First degree relatives with DM**

Among the non-modifiable risk factors for diabetes and impaired fasting glucose, having a first degree relative with DM is one of the strongest factors. Family history reflects a combination of genetic predisposition and shared lifestyle or environmental factors that contribute to the risk of developing diabetes. In a study done by Tariku et al., (2013), individuals with first degree relatives with diabetes were found to be significantly more likely to have impaired fasting glucose and diabetes, highlighting the role of familial patterns in the prevalence of this condition. A comprehensive systematic review and meta-analysis by Spurr et al., (2020) which included 51 observational studies and over 500,000 participants, further strengthen the evidence linking family history and diabetes. The review revealed that individuals with a positive family history of diabetes were significantly at higher risk of developing prediabetes. Notably, the risk was high among

those with first degree relatives; parents, siblings or children affected by diabetes, compared to those with no family history.

Research from diverse populations indicates that offsprings of diabetic parents often exhibit insulin resistance and beta cell dysfunction early, even before the onset of clinical symptoms (Meigs et al., 2000; Kahn et al., 2009). These findings emphasize the importance of early screening and preventive interventions in high risk individuals with a family history of diabetes. As such, health providers should prioritize risk assessment for individuals with known family history of diabetes and include genetic counseling and lifestyle modification programs tailored to this high-risk group. This has potential to significantly reduce the progression from prediabetes to diabetes.

## **2.7 Presentation of diabetes mellitus**

Diabetes mellitus (DM) is a chronic condition that often presents with a combination of signs and symptoms due to persistent elevated blood glucose levels. There are three classical presentations of diabetes mellitus; polyphagia, polydipsia and Polyuria (Kumar et al, 2010). Other common symptoms of diabetes mellitus are weight loss, dehydration and blurred vision. These symptoms result from the body's response to high blood sugar and the resulting metabolic disruptions.

1. Polyuria - Polyuria occurs when the kidneys, overwhelmed by the excess glucose in the blood, excrete more glucose through urine, leading to more frequent urination. This results in the loss of electrolytes and fluids contributing to dehydration.

2. Polydipsia - Polydipsia is a direct result of polyuria. The body attempts to compensate for fluid loss leading to an insatiable need to drink water.

3. Polyphagia - Despite elevated blood glucose levels in patients with diabetes, cells are unable to properly take up glucose leading to a compensatory increase in hunger. This symptom is prominent in type one diabetes where there is absolute lack of insulin production.

4. Dehydration - This is a result of increased urination associated with polyuria. The significant loss of fluid increases the feeling of thirst and can result in dry skin, dizziness and weakness.

5. Blurred vision - Persistent hyperglycemia can cause damage to the blood vessels around the eyes, leading to fluid leakage resulting in blurred vision. If left untreated, this can contribute to the development of diabetic retinopathy.

6. Weight loss - Despite eating excessively, individuals with diabetes, particularly type 1, may experience unexplained weight loss. This is a result of the body breaking down fat and muscle tissue for energy because of absence of sufficient insulin that would otherwise facilitate uptake of glucose by cells.

These symptoms are indicative of an underlying metabolic dysfunction and are a key factor in the diagnosis of diabetes. For T2DM, which primarily is due to insulin resistance and eventual beta cell dysfunction, many individuals may not experience symptoms until the disease progresses significantly and causes complications. In contrast, for type 1 diabetes, which is an immune disorder that leads to the destruction of insulin producing beta cells, the onset of these symptoms is often sudden and severe.

The presence of these symptoms often prompts individuals to seek medical attention, but they can go unnoticed in early stages of type 2 diabetes. Many individuals with type 2 diabetes remain asymptomatic or have mild symptoms for years. There is thus a need for

regular screening, especially for high-risk populations (Kumar et al.,2010). Furthermore, these classical signs and symptoms may be complicated by the presence of other comorbid conditions such as obesity, dyslipidemia and hypertension, making early detection and management of diabetes crucial in preventing long term complications.

## **2.8 Screening and diagnosis of diabetes mellitus**

Early identification of diabetes is a cornerstone in preventing long-term complications and improving patient outcomes. Screening aims to detect individuals at high risk before clinical symptoms appear, particularly given the silent progression of Type 2 diabetes mellitus. For a condition to be suitable for screening, it must have significant public health importance, available effective treatment, accessible diagnostic tests with adequate sensitivity and specificity, acceptability to the community, and cost-effectiveness (Wilson et al., 1968). Diabetes fulfills these criteria due to its global prevalence and potential for serious complications.

Screening strategies target individuals with established risk factors, including elevated Body Mass Index ( $\text{BMI} \geq 25$ ), family history of diabetes, hypertension, dyslipidemia, and belonging to high-risk ethnic populations (ADA, 2024). Age is also an important consideration, with recommendations suggesting screening from 35 years onwards even in the absence of other risk factors. Diagnostic tests commonly employed include Fasting Plasma Glucose (FPG), Glycosylated Hemoglobin (HbA1c), and the Oral Glucose Tolerance Test (OGTT). According to the American Diabetes Association (ADA), diabetes is diagnosed by an FPG level  $\geq 126$  mg/dL (7.0 mmol/L), an HbA1c  $\geq 6.5\%$  (48 mmol/mol), a 2-hour plasma glucose  $\geq 200$  mg/dL (11.1 mmol/L) during a 75-g Oral Glucose Tolerance Test (OGTT), or a random plasma glucose  $\geq 200$  mg/dL (11.1 mmol/L) in individuals

presenting with classic symptoms of hyperglycemia or hyperglycemic crisis. In asymptomatic individuals, an abnormal result should generally be confirmed by repeat testing on a subsequent day unless unequivocal hyperglycemia is present (ADA, 2024). While HbA1c offers a stable assessment of long-term glycemia and correlates well with chronic complications, its cost and potential inaccuracies in individuals with hemoglobinopathies limit universal applicability (Nathan et al., 2005; ADA, 2014). The FPG is simpler, widely available, and cost-effective, making it the preferred initial screening tool in many low-resource settings (Bonora & Tuomilehto, 2011).

Screening can occur in healthcare facilities or through community-based initiatives. Healthcare-based screening allows structured follow-up, confirmatory testing, and timely management of individuals diagnosed with diabetes. In contrast, community-based approaches, including mobile clinics and public health outreach programs, expand coverage in underserved populations but may face challenges in confirmatory testing and follow-up (Kengne et al., 2005). Regardless of approach, effective screening remains central to reducing the burden of undiagnosed diabetes, particularly in regions like sub-Saharan Africa, where prevalence is rising.

## **2.9 Complications of diabetes mellitus**

Diabetes mellitus is associated with a spectrum of long-term complications that significantly impact morbidity, mortality, and quality of life. Complications are commonly divided into microvascular and macrovascular categories. Microvascular complications, resulting from chronic hyperglycemia, include diabetic retinopathy, nephropathy, and neuropathy. Retinopathy, a major cause of vision loss, develops from progressive damage to retinal blood vessels, often remaining asymptomatic until advanced stages (Mbanya &

Sobngwi, 2010; Nkumbe et al., 2010). Nephropathy is a leading cause of chronic kidney disease and dialysis, with prevalence ranging widely depending on disease duration and population studied (Gross et al., 2005; Mbanya & Sobngwi, 2010). Diabetic neuropathy affects both peripheral and autonomic nerves, contributing to foot ulcers, infections, and non-traumatic amputations, which are particularly common in African populations (Abbott et al., 2011; Abbas et al., 2005).

Macrovascular complications primarily affect large blood vessels and are responsible for elevated risks of cardiovascular disease, stroke, and peripheral arterial disease. Diabetes amplifies risk factors such as hypertension, dyslipidemia, and abdominal obesity, leading to a two- to four-fold increase in cardiovascular events compared to non-diabetic individuals (Almdal et al., 2004; Kengne et al., 2005). Coronary heart disease, stroke, and diabetic cardiomyopathy are major contributors to mortality among people with diabetes, with pre-diabetes also associated with increased cardiovascular risk (Fisman et al., 2008). Peripheral arterial disease, often undiagnosed until severe, further underscores the importance of early detection and management (Fowkes et al., 2013).

While the clinical and public health significance of screening, diagnosis, and complications is well documented, this study focuses on determinants of diabetes, including demographic, lifestyle, and clinical risk factors, as the primary focus of the literature review.

## **2.10 Admission of patients with diabetes mellitus for surgery**

The increasing global burden of diabetes mellitus has major implications for surgical care and perioperative management. Diabetes mellitus is currently among the most common chronic medical conditions encountered in surgical practice worldwide, with growing numbers of diabetic patients undergoing both elective and emergency surgical procedures

each year (International Diabetes Federation [IDF], 2024). Improvements in surgical techniques, anesthesia, and chronic disease management have contributed to increased surgical access and improved survival among patients with chronic illnesses, including diabetes mellitus. Consequently, perioperative management of patients with diabetes has become an increasingly important aspect of modern surgical and anesthetic care.

Patients with diabetes mellitus undergoing surgery face substantially higher perioperative risk compared with non-diabetic patients (Duggan et al., 2017). Several studies have demonstrated that diabetes mellitus is associated with increased postoperative morbidity and mortality, including surgical site infections, impaired wound healing, prolonged hospitalization, cardiovascular complications, renal dysfunction, intensive care unit admission, and increased postoperative mortality (Frisch et al., 2010; Teo et al., 2020). These adverse outcomes are largely related to perioperative hyperglycemia, impaired immune function, chronic inflammation, endothelial dysfunction, and underlying microvascular and macrovascular complications associated with diabetes mellitus.

The perioperative period is characterized by a complex neuroendocrine stress response that significantly alters glucose metabolism. Surgical stress stimulates increased secretion of cortisol, catecholamines, glucagon, and growth hormone, all of which function as counter-regulatory hormones opposing insulin action (Chilelli & Raghavan, 2024). These hormones increase hepatic glucose production while simultaneously impairing peripheral insulin sensitivity, resulting in stress-induced hyperglycemia. In patients with pre-existing diabetes mellitus, the physiological stress response to surgery may exacerbate underlying metabolic dysfunction and precipitate severe perioperative hyperglycemia or acute metabolic decompensation.

Even among individuals without previously diagnosed diabetes mellitus, surgery may unmask underlying abnormalities in glucose metabolism. Some patients presenting for surgery may already have undiagnosed diabetes mellitus or impaired glucose tolerance that has remained asymptomatic for prolonged periods. During surgical stress, the resulting hyperglycemia may become clinically apparent for the first time. Consequently, the perioperative period may serve as an important opportunity for incidental identification of previously undiagnosed diabetes mellitus.

Perioperative hyperglycemia has consistently been associated with poor surgical outcomes among both diabetic and non-diabetic patients (Umpierrez et al., 2002). Elevated blood glucose levels impair neutrophil chemotaxis and phagocytic activity, reduce collagen synthesis, impair wound healing, and increase susceptibility to infection (Marhoffer et al., 1992). Hyperglycemia also contributes to endothelial dysfunction, oxidative stress, platelet activation, and systemic inflammatory responses, thereby increasing risk of cardiovascular complications and thrombotic events following surgery (Dhatariya et al., 2020).

Several studies have demonstrated that perioperative hyperglycemia independently predicts postoperative morbidity and mortality. Frisch et al. (2010), in a study involving non-cardiac surgical patients, reported that perioperative hyperglycemia was significantly associated with increased postoperative complications and mortality even among patients without known diabetes mellitus. Similarly, Kwon et al. (2013) observed that postoperative hyperglycemia was associated with increased risk of surgical site infections and prolonged hospital stay.

Importantly, evidence suggests that patients with newly detected hyperglycemia or previously undiagnosed diabetes may experience poorer surgical outcomes than patients

with established diabetes mellitus (Umpierrez et al., 2002). This may partly be because patients with known diabetes are more likely to receive structured perioperative glucose monitoring and glycemic management, while hyperglycemia in previously undiagnosed patients may remain unrecognized or inadequately treated. Undiagnosed diabetes mellitus therefore represents a significant but often overlooked contributor to perioperative risk.

The burden of diabetes mellitus among surgical patients continues to increase globally due to population aging, increasing obesity prevalence, urbanization, sedentary lifestyles, and changing dietary patterns (IDF, 2024). The International Diabetes Federation estimates that approximately 589 million adults worldwide were living with diabetes mellitus in 2024, with projections indicating substantial increases over coming decades (IDF, 2024). Importantly, a significant proportion of these individuals remain undiagnosed, particularly within low- and middle-income countries where preventive healthcare systems and screening programs remain inadequately developed.

As discussed in Section 2.3, sub-Saharan Africa is projected to experience one of the fastest increases in diabetes prevalence globally, with diabetes screening remaining inconsistent across many healthcare systems and resulting in high proportions of undiagnosed disease (IDF, 2024; Mbanya et al., 2010).

The International Diabetes Federation estimates that approximately 73% of adults living with diabetes mellitus in Africa remain undiagnosed, representing the highest proportion globally (IDF, 2024). This reflects major gaps in routine screening, preventive healthcare access, laboratory infrastructure, public awareness, and integration of non-communicable disease services within primary healthcare systems. Consequently, many individuals remain asymptomatic and undiagnosed until complications develop or incidental

hyperglycemia is detected during hospital admission for unrelated illnesses, including surgery.

In Kenya, the burden of diabetes mellitus has similarly increased over recent decades. Urbanization, changing dietary patterns, reduced occupational physical activity, increasing motorized transport, and rising obesity prevalence have contributed significantly to increasing prevalence of metabolic disease (Mohamed et al., 2018). However, routine diabetes screening remains limited in many healthcare settings, particularly among asymptomatic adults. As a result, many patients may present for surgery with previously undiagnosed diabetes mellitus.

The perioperative period therefore provides an important opportunity for opportunistic diabetes screening. Patients presenting for elective surgery routinely undergo preoperative evaluation involving clinical assessment, laboratory investigations, anesthesia review, and perioperative risk assessment. Integration of glucose testing into routine preoperative investigations may therefore facilitate identification of previously undiagnosed diabetes mellitus before surgery. Such opportunistic screening may be particularly valuable in low-resource settings where routine community-based diabetes screening programs remain underdeveloped.

Several professional organizations and perioperative guidelines emphasize the importance of perioperative glucose assessment and glycemic control among surgical patients. The American Diabetes Association recommends perioperative glucose monitoring and optimization of glycemic status before surgery because poor glycemic control is associated with adverse surgical outcomes (American Diabetes Association, 2024). Similarly,

perioperative guidelines from anesthetic and surgical societies advocate routine assessment of diabetes status among high-risk surgical patients.

Screening approaches for diabetes mellitus among surgical patients may include fasting plasma glucose testing, random blood glucose testing, oral glucose tolerance testing, or glycated hemoglobin (HbA1c) measurement depending on available resources and institutional protocols. Fasting plasma glucose testing remains one of the most widely utilized screening methods because it is relatively inexpensive, simple to perform, and widely available in many healthcare settings. HbA1c assessment provides additional information regarding long-term glycemic status and may assist in distinguishing chronic diabetes mellitus from transient stress hyperglycemia. However, HbA1c testing may be less accessible in many low-resource settings because of higher cost and limited laboratory availability.

Identification of previously undiagnosed diabetes mellitus before surgery may provide several important clinical benefits. First, diagnosis permits initiation of perioperative glucose monitoring and glycemic optimization, potentially reducing risk of postoperative complications. Second, newly diagnosed patients may be referred for long-term chronic disease management, lifestyle counseling, and cardiovascular risk reduction. Third, early diagnosis creates opportunities for prevention of future diabetes-related complications including nephropathy, neuropathy, retinopathy, stroke, and cardiovascular disease.

Preoperative identification of diabetes mellitus may also influence anesthetic and surgical management. Poor glycemic control may necessitate postponement of elective surgery until metabolic stabilization is achieved. In addition, perioperative insulin administration strategies, fluid management, antibiotic prophylaxis, and postoperative monitoring may

require modification among diabetic patients. Early diagnosis therefore has important implications for perioperative safety and postoperative outcomes.

Despite the recognized importance of perioperative glycemic control, routine preoperative diabetes screening remains inconsistently implemented in many low- and middle-income countries. Screening practices frequently vary between healthcare institutions depending on laboratory capacity, institutional protocols, clinician awareness, resource availability, and financial constraints. In some healthcare settings, glucose testing may only be performed among patients with overt symptoms or obvious risk factors, potentially resulting in missed opportunities for diagnosis among asymptomatic individuals.

Resource limitations represent an important challenge in perioperative diabetes management within many African healthcare systems. Limited laboratory infrastructure, shortages of trained healthcare personnel, inconsistent availability of glucose monitoring equipment, and competing healthcare priorities may constrain implementation of comprehensive screening programs (Pastakia et al., 2017). Furthermore, healthcare systems within many low-resource settings continue to allocate substantial resources toward communicable diseases, often resulting in comparatively limited investment in prevention and management of non-communicable diseases.

Patient-related factors may also contribute to delayed diagnosis of diabetes mellitus among surgical populations. Low health literacy, limited awareness regarding diabetes symptoms, fear of diagnosis, financial barriers to healthcare access, and inconsistent healthcare utilization may all reduce opportunities for early metabolic screening. Because type 2 diabetes mellitus frequently progresses gradually and remains asymptomatic for prolonged

periods, many individuals remain unaware of their condition until complications develop or incidental testing is performed.

The increasing burden of undiagnosed diabetes mellitus among surgical patients has important implications for healthcare systems. Undiagnosed hyperglycemia contributes not only to increased postoperative morbidity and mortality but also to prolonged hospitalization, increased healthcare expenditure, and greater demand for critical care services. Within resource-limited healthcare systems already experiencing substantial infrastructural and financial constraints, prevention of avoidable perioperative complications is particularly important.

Hospital-based opportunistic screening may therefore represent a practical and cost-effective strategy for improving diabetes detection in low-resource settings. Unlike community-based screening programs that require extensive outreach infrastructure and long-term follow-up systems, hospital-based screening utilizes existing healthcare interactions and institutional systems. Surgical patients are already engaged within structured clinical pathways, making preoperative glucose assessment operationally feasible within many healthcare settings.

Several studies conducted in surgical populations have demonstrated that routine preoperative glucose screening can identify substantial numbers of previously undiagnosed diabetes cases (Teo et al., 2020; Kwon et al., 2015). These findings support recommendations advocating integration of metabolic screening into standard perioperative care pathways. Opportunistic diagnosis during surgical admission may further facilitate linkage to chronic disease management programs and improve long-term continuity of care.

In addition to identifying overt diabetes mellitus, preoperative glucose assessment may also identify patients with impaired fasting glucose or prediabetes. Recognition of prediabetes is clinically important because individuals with impaired glucose regulation remain at elevated risk of progression to overt diabetes mellitus and cardiovascular disease. Early lifestyle modification and risk-factor management may therefore reduce future disease burden among these patients.

The increasing overlap between surgical care and chronic disease management highlights the importance of integrated healthcare approaches within modern health systems. Surgical admission should not focus exclusively on the immediate operative condition but should also provide opportunities for broader health assessment, preventive care, and identification of chronic illnesses. Integration of non-communicable disease screening into perioperative pathways may therefore contribute significantly to strengthening preventive healthcare delivery within hospital systems.

For Kenya specifically, where many adults interact with healthcare systems only intermittently, surgical admission may represent one of the few realistic opportunities for metabolic assessment among asymptomatic individuals, making incorporation of fasting plasma glucose testing into standard preoperative protocols a pragmatic and high-yield intervention.

Overall, the increasing burden of diabetes mellitus among surgical patients underscores the importance of perioperative metabolic assessment and opportunistic screening within hospital settings. Early identification of previously undiagnosed diabetes mellitus may improve perioperative safety, facilitate timely initiation of chronic disease management, reduce postoperative complications, and contribute to long-term reduction in diabetes-

related morbidity and mortality. Consequently, strengthening routine preoperative glucose assessment should be considered an important component of improving perioperative care and non-communicable disease management within low-resource healthcare systems.

## **2. Guiding theories**

Risk factor epidemiology provides the primary lens for this study by focusing on determinants associated with disease occurrence. Diabetes mellitus develops through a combination of modifiable factors (e.g., obesity, hypertension, physical inactivity, diet) and non-modifiable factors (e.g., age, sex, genetic predisposition) (Beaglehole et al., 2008; Obura et al., 2021).

The socioecological model (SEM) conceptualizes health outcomes as the result of interactions across multiple levels, including individual, interpersonal, institutional, community, and policy factors (McLeroy et al., 1988). This perspective situates undiagnosed diabetes within broader contextual influences such as healthcare access, hospital screening practices, and socioeconomic conditions.

The HBM explains health-related behavior based on perceptions of susceptibility, severity, benefits, and barriers (Rosenstock, 1974; Janz & Becker, 1984). It provides a behavioral dimension for understanding how health-seeking practices and prior healthcare utilization may influence the likelihood of detection.

### 3. Linking theories to study variables

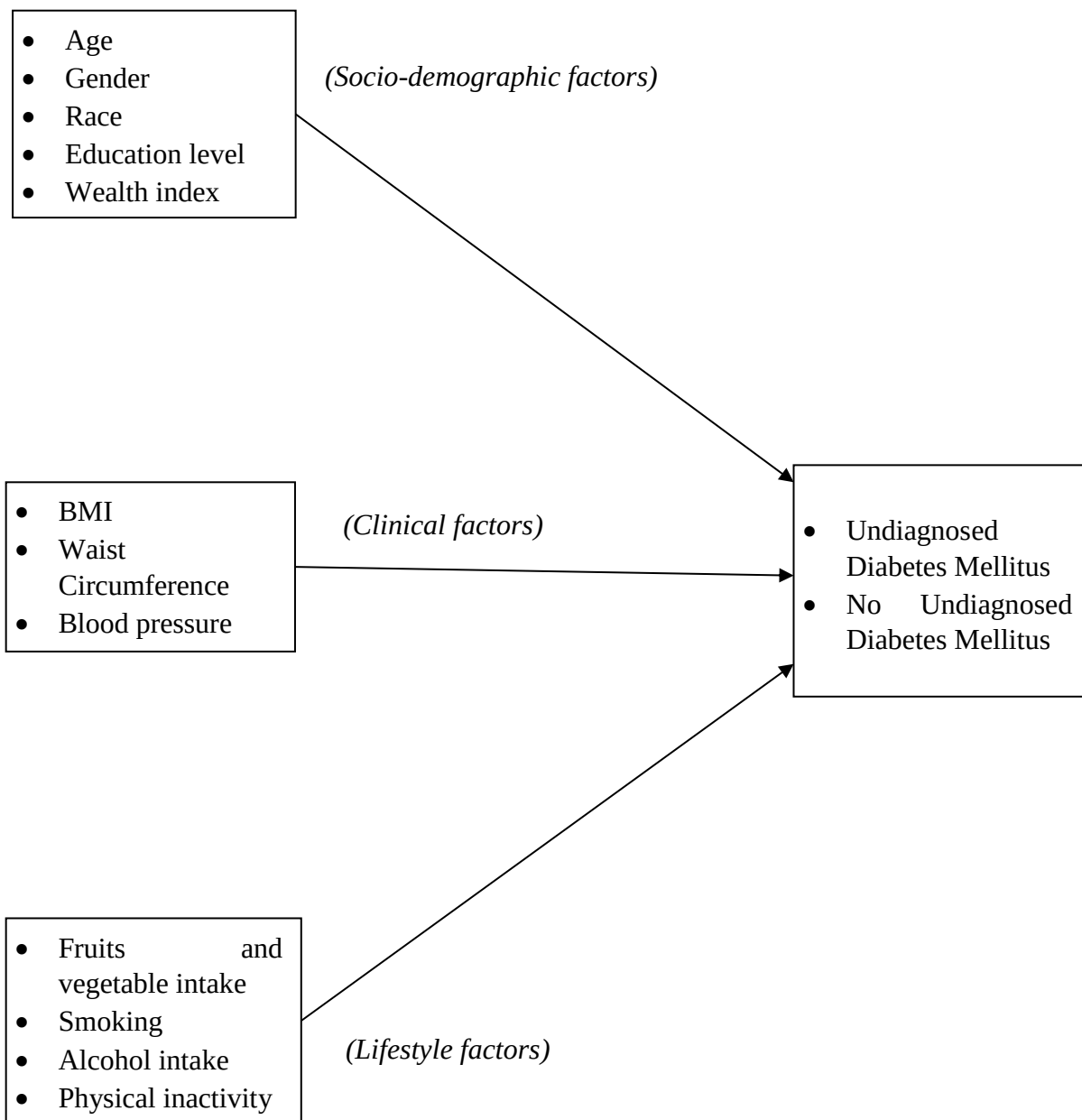
| Theoretical domain          | Study variables                                                                | Conceptual focus                       |
|-----------------------------|--------------------------------------------------------------------------------|----------------------------------------|
| Risk factor epidemiology    | Age, BMI, hypertension, diet, physical activity, family history, comorbidities | Biological and lifestyle determinants  |
| Socioecological model (SEM) | Education, socioeconomic status, access to care, hospital screening practices  | Contextual and system-level influences |
| Health belief model (HBM)   | Health-seeking behavior, prior healthcare utilization                          | Behavioral influences on diagnosis     |

This study is grounded in risk factor epidemiology, SEM, and HBM. Together, these frameworks explain the persistence of undiagnosed diabetes through the interaction of biological risk factors, contextual influences, and health-seeking behavior.

## 2.11 Conceptual framework of variables for diabetes

### Independent variables

### Dependent variables



## **CHAPTER THREE**

### **3.0 METHODOLOGY**

This chapter outlines the study area and population, study design, sample size determination, sampling procedure, data collection method, laboratory procedure, data management and analysis, and ethical considerations. It provides a detailed description of how the study was conducted to ensure validity, reliability, and reproducibility of the findings.

#### **3.1 Study area**

The study was conducted at Moi Teaching and Referral Hospital (MTRH) in Eldoret, Kenya, a national teaching and referral hospital affiliated with Moi University College of Health Sciences. The hospital serves a catchment population of over 25 million people from across Kenya, parts of Eastern Uganda, South Sudan, Northern Tanzania, and Democratic Republic of Congo. Moi Teaching and Referral Hospital provides specialized medical and surgical services across multiple disciplines and serves as a major teaching and research institution. Owing to its high surgical workload and diverse patient population, it provided an appropriate setting for assessing the prevalence and determinants of undiagnosed diabetes mellitus among patients presenting for elective surgery.

#### **3.2 Study Population**

The target population comprised adult patients aged 18 years and above presenting for elective surgical procedures in the selected wards during the study period.

### 3.3 Study design

This was a descriptive cross-sectional study aimed at determining the prevalence and determinants for undiagnosed diabetes mellitus.

### 3.4 Sample Size Determination

The sample size was calculated using the Sample Size Formula for Proportions (Israel, 1992).

$$n = (Z^2 \times p \times (1-p)) / E^2$$

Where:

E is the margin error.

Z is the Z-score corresponding to the desired confidence interval

p is the estimated proportion of the population.

The sample size was calculated at 0.04217 margin error, 95% confidence interval (corresponding Z-score,  $Z \approx 1.96$ ).

$$n = (1.96^2 \times 0.5 \times (1-0.5)) / 0.04217^2$$

$$n = (3.8416 \times 0.25) / 0.00178016$$

$$n = 0.9604 / 0.00178016$$

$$n = 539.99$$

The sample size was 540 participants. Data was collected in 22 months, amidst seasonality changes.

### 3.5 Sampling Procedure

All patients booked for elective surgery at Moi Teaching and Referral Hospital who met the inclusion criteria were considered for participation in the study. Eligible participants were identified from the theatre list prepared by each ward on the eve of surgery.

Consecutive sampling was used, whereby all eligible and consenting patients were enrolled until the required sample size was achieved.

### **3.6 Inclusion/Exclusion criteria**

#### **3.6.1 Inclusion criteria**

- Patients admitted in Longonot, Rehema, Kilimanjaro and Sergoit wards of MTRH presenting for elective surgery with unknown DM status.
- Patients aged 18 years and above

#### **3.6.2 Exclusion criteria**

Patients who were critically ill or unable to give informed consent.

### **3.7 Study variables**

#### **3.7.1 Dependent variable**

‘New DM’ or undiagnosed DM was defined as: a fasting plasma glucose (FPG) level  $\geq 7\text{mmol/l}$  with no prior history of DM. ‘No DM’ was FPG levels less than  $7\text{mmol/l}$  with no prior history of DM.

#### **3.7.2 Independent variables**

##### **Socio-demographic factors**

- i. Age – Categorized into 5-year intervals starting from 18 years and above.
- ii. Sex – Categorized as male or female.
- iii. Marital status – Categorized as single, married, widowed, or divorced.
- iv. Education level – Categorized as no formal education, primary, secondary, college, or university level.
- v. Residence – Categorized as urban or rural.

### **Economic factors**

- i. Occupation – Categorized as unemployed or engaged in various occupations.
- ii. Income level – Categorized as < KSh 5,000; KSh 5,001–20,000; and > KSh 20,000.

### **Clinical factors**

- i. Body Mass Index (BMI) – Categorized as underweight (<18.5 kg/m<sup>2</sup>), normal weight (18.5–24.9 kg/m<sup>2</sup>), overweight (25.0–29.9 kg/m<sup>2</sup>), or obese (≥30.0 kg/m<sup>2</sup>).
- ii. Blood pressure – Categorized as elevated (≥140/90 mmHg) or normal (<140/90 mmHg).
- iii. Family history of diabetes mellitus – Defined as presence of diabetes in first-degree relatives (yes or no).
- iv. Dyslipidemia – Based on documented diagnosis or patient history (yes or no).

### **Lifestyle (behavioral) factors**

- i. Smoking status – Categorized as current tobacco use (yes or no).
- ii. Alcohol use – Categorized as current alcohol use (yes or no).
- iii. Diet (fruits and vegetables intake) – Categorized based on daily consumption (yes or no).
- iv. Physical activity – Categorized based on participation in routine physical activity, defined as any bodily movement during work, transport, or leisure (yes or no).

## **3.8 Procedure/Assessments**

All study procedures were conducted by the principal investigator and a trained research assistant with a background in laboratory technology. The principal investigator developed the data collection tools, obtained ethical approval from the Institutional Research and Ethics Committee (IREC), and trained the research assistant to ensure adherence to the study protocol and standardized procedures.

The study questionnaires were pre-tested among patients admitted for elective surgery at Moi Teaching and Referral Hospital in the Kilimanjaro, Longonot, Rehema, and Sergoit surgical wards. A total of eight participants were selected, with two participants from each ward, who were not included in the main study. The pre-test was conducted to assess the clarity, relevance, and feasibility of the questionnaires, and necessary modifications were made accordingly.

Eligible participants were identified after admission to the surgical wards for elective surgery through review of the theatre list prepared by the operating surgeon. Patients who met the inclusion criteria were approached in the ward and the study was explained in detail. Those who agreed to participate provided written informed consent. For participants unable to read, the consent form was read clearly in Kiswahili or English, as per the participants preference , and any questions addressed before consent was obtained.

Following consent, data collection was conducted in three stages.

1. A structured interviewer-administered questionnaire was used to collect socio-demographic, economic, lifestyle, and clinical information.
2. Physical and clinical measurements were obtained as described below:  
  
Height was measured using a SECA height meter and recorded in centimeters, while weight was measured using a SECA bathroom scale and recorded in kilograms. These measurements were used to compute body mass index (BMI). Blood pressure was measured using an Omron M2 IntelliSense automatic blood pressure monitor after the participant had rested.
3. Participants were instructed to fast for at least 8 hours prior to surgery. On the morning of surgery, fasting status was confirmed verbally before blood sample collection. Fasting

plasma glucose was measured at the bedside using a Freestyle Optium glucose meter with capillary (finger-prick) blood. For participants with fasting plasma glucose levels greater than 7.0 mmol/L, additional capillary blood samples were obtained by finger stick for glycated hemoglobin (HbA1c) analysis. Sample collection was performed using Siemens DCA Vantage analyzer cartridges, which were appropriately labeled with unique participant identifiers, safely transported, and analyzed within 5 minutes of collection in accordance with manufacturer guidelines.

All results were recorded immediately on the data collection forms using participant identification codes and subsequently entered into the study database for analysis (see Appendix III and Appendix IV).

### **3.9 Data Management**

Filled questionnaires were kept in the custody of the researcher to reduce chances of interference. A Microsoft Office-Excel database was created in password protected computer to record the information collected through the questionnaire. This information was entered into the database by the research assistant.

#### **3.9.1 Analysis and Presentation**

Data were analyzed using SPSS version 20. Descriptive statistics, including frequencies, percentages, and means where appropriate, were used to summarize the distribution of the study variables. Prior to inferential analysis, selected independent variables were categorized by combining related categories where appropriate to improve analytical stability and ease of interpretation. The dependent variable, initially measured as a continuous variable, was categorized using a predefined diagnostic cut-off point.

Bivariate analyses were conducted to examine associations between each independent variable and undiagnosed diabetes mellitus. Variables for inclusion in the multivariable binary logistic regression model were selected a priori based on biological plausibility and evidence from previous literature. In addition, variables with a p-value  $<0.20$  in the bivariate analysis were considered for inclusion in the multivariable model. All selected variables were entered simultaneously into the multivariable binary logistic regression model to identify factors independently associated with undiagnosed diabetes mellitus while controlling for potential confounding. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported, and statistical significance was set at  $p < 0.05$  (Garth, 2008). The findings were presented in tables.

The study findings will be disseminated to Moi Teaching and Referral Hospital (MTRH) and shared with relevant stakeholders. In addition, the results will be submitted for publication in peer-reviewed journals.

### **3.10 Ethical Consideration**

#### **3.10.1 Ethical Approval**

Ethical approval for this study was obtained from the Institutional Research and Ethics Committee (IREC) of Moi University and Moi Teaching and Referral Hospital. Permission to conduct the study was also obtained from Moi Teaching and Referral Hospital management.

No major protocol amendments were made during the study period. Ethical approval was renewed upon expiry of the initial approval in accordance with Institutional Research and Ethics Committee requirements.

### **3.10.2 Informed consent process**

Written informed consent was obtained from all participants prior to enrollment into the study. The purpose of the study, procedures involved, potential risks and benefits, and measures to ensure confidentiality were explained to participants in a language they understood.

Participants were informed that participation was voluntary and that they had the right to decline or withdraw from the study at any time without affecting the care they receive.

The researcher/RA administered the consent process, provided participants with an opportunity to ask questions, and obtained written consent before proceeding with data collection.

### **3.10.3 Privacy and Confidentiality**

Confidentiality and privacy of participants were maintained throughout the study. Each participant was assigned a unique identification number, and no personal identifiers were included in the dataset.

All data collection tools and records were securely stored in locked cabinets accessible only to the research team. Electronic data were stored in password-protected databases. Documents containing identifying information, such as consent forms, were stored separately from study data.

The RA was trained on confidentiality procedures and adhered to strict ethical standards. Participant information was not shared with unauthorized individuals and was used solely for the purposes of this study.

#### **3.10.4 Risks and risk mitigation**

The study posed minimal risk to participants. The main risk involved slight discomfort during finger-prick blood sample collection for fasting plasma glucose testing and HbA1c. Appropriate precautions were taken to ensure participant safety during sample collection.

#### **3.10.5 Benefits**

There was no monetary compensation for participation in the study. However, participants benefited from screening for diabetes mellitus, which could facilitate early detection of undiagnosed diabetes.

Participants found to have elevated blood glucose levels were informed of their results and referred to a clinician for further evaluation and management in line with hospital protocols.

#### **3.10.6 Referral and clinical support for new DM**

Participants identified with abnormal findings, including elevated blood glucose levels, were referred to the attending clinician for appropriate follow-up care within Moi Teaching and Referral Hospital. This ensured continuity of care and appropriate clinical management.

#### **3.10.7 Data Dissemination**

The findings of this study will be disseminated to Moi Teaching and Referral Hospital management, Moi University, and other relevant stakeholders through presentations and sharing of the final thesis. The results will also be submitted for publication in peer-reviewed journals. No identifying information will be included in any reports or publications.

## **CHAPTER FOUR**

### **4.0 RESULTS**

This chapter presents the findings of the study according to the study objectives. The findings include the prevalence of undiagnosed diabetes mellitus, the socio-demographic, clinical, lifestyle, and dietary characteristics of the study participants, and the associations between socio-demographic, economic, clinical, lifestyle, and dietary factors and undiagnosed diabetes mellitus.

#### **4.1 Prevalence of undiagnosed diabetes mellitus**

Out of the 540 participants in this study, 19 of them were found to have undiagnosed diabetes mellitus. This translates to 3.5% prevalence across all the sexes, ages and all other variables. However, the number (and percentages) of those with undiagnosed DM varies from one variable to the other as discussed in subsequent sections.

##### **4.1.1 Socio-demographic distribution of the respondents**

The study population was predominantly male (60.2%), the majority were aged 55 years or younger, reflecting a largely working-age population. Most participants were married (70.7%), suggesting the presence of social support that may influence healthcare utilization and perioperative decision-making. Educational attainment was generally low to moderate, with over three-quarters (38.3%) having primary or secondary level of education, a factor that may affect health literacy and awareness of chronic conditions such as diabetes mellitus. Farming and unemployment were the most common occupational categories with 30.4% and 28.0% respectively. Nearly two thirds (60.7%) of participants earned less than Ksh 5,000 per month, indicating predominantly low-income population. Most respondents resided in urban areas, consistent with the hospital's role as a tertiary referral centre.

Collectively, these socio-demographic characteristics described an economically vulnerable adult population in which undiagnosed diabetes mellitus may remain unrecognized without routine preoperative screening.

**Table 1** Socio-demographic characteristics of study participants

| Variable and coding category | Percentage % | Total, n = 540 |
|------------------------------|--------------|----------------|
| <b>Sex</b>                   |              |                |
| Female                       | 39.8         | 215            |
| Male                         | 60.2         | 325            |
| <b>Age (in years)</b>        |              |                |
| 18-35                        | 36.8         | 198            |
| 36-55                        | 34.6         | 187            |
| >55                          | 28.7         | 155            |
| <b>Marital status</b>        |              |                |
| Single                       | 19.3         | 104            |
| Married                      | 70.7         | 382            |
| Widowed                      | 8            | 43             |
| Divorced                     | 2            | 11             |
| <b>Level of education</b>    |              |                |
| None                         | 6.7          | 36             |
| Primary                      | 38.3         | 207            |
| Secondary                    | 38.3         | 207            |
| College                      | 12.2         | 66             |
| University                   | 4.4          | 24             |
| <b>Occupation</b>            |              |                |
| Unemployed                   | 28           | 151            |
| Business                     | 24.1         | 130            |
| Farmer                       | 30.4         | 164            |
| Employed                     | 15.2         | 82             |
| Retired                      | 2.41         | 13             |
| <b>Income (in Ksh)</b>       |              |                |
| <5000                        | 60.7         | 328            |
| 5001-20000                   | 30.6         | 165            |
| >20000                       | 8.7          | 47             |
| <b>Residence</b>             |              |                |
| Rural                        | 28           | 151            |
| Urban                        | 72.1         | 389            |
| <b>Religion</b>              |              |                |
| Muslims                      | 5            | 27             |
| Christians                   | 95           | 513            |

**Table 2:** Distribution of undiagnosed DM by socio-demographic characteristics (N=540)

| Variable                  | Undiagnosed DM,<br>n=19 | Undiagnosed<br>DM (%) | Non-DM,<br>n=521 |
|---------------------------|-------------------------|-----------------------|------------------|
| <b>Sex</b>                |                         |                       |                  |
| Female                    | 8                       | 3.7                   | 207              |
| Male                      | 11                      | 3.4                   | 314              |
| <b>Age (in years)</b>     |                         |                       |                  |
| 18-35                     | 3                       | 1.54                  | 195              |
| 36-55                     | 11                      | 6.3                   | 176              |
| >55                       | 5                       | 3.33                  | 150              |
| <b>Marital status</b>     |                         |                       |                  |
| Single                    | 2                       | 1.92                  | 102              |
| Married                   | 13                      | 3.4                   | 369              |
| Widowed                   | 2                       | 4.7                   | 41               |
| Divorced                  | 2                       | 18.2                  | 9                |
| <b>Level of education</b> |                         |                       |                  |
| None                      | 2                       | 5.6                   | 34               |
| Primary                   | 7                       | 3.4                   | 200              |
| Secondary                 | 8                       | 4                     | 199              |
| College                   | 2                       | 3                     | 64               |
| University                | 0                       | .                     | 24               |
| <b>Occupation</b>         |                         |                       |                  |
| Unemployed                | 4                       | 2.7                   | 147              |
| Business                  | 5                       | 3.9                   | 125              |
| Farmer                    | 6                       | 3.7                   | 158              |
| Employed                  | 4                       | 4.9                   | 78               |
| Retired                   | 0                       | .                     | 13               |
| <b>Income (in Ksh)</b>    |                         |                       |                  |
| <5000                     | 11                      | 3.5                   | 317              |
| 5001-20000                | 7                       | 4.4                   | 158              |
| >20000                    | 1                       | 2.1                   | 46               |
| <b>Residence</b>          |                         |                       |                  |
| Rural                     | 7                       | 4.9                   | 144              |
| Urban                     | 12                      | 3.1                   | 377              |
| <b>Religion</b>           |                         |                       |                  |
| Muslims                   | 0                       | .                     | 27               |
| Christians                | 19                      | 3.8                   | 494              |

**Note.** Percentages represent the proportion of undiagnosed diabetes mellitus cases within each socio-demographic category.

Table 2 shows the distribution of undiagnosed diabetes mellitus across selected socio-demographic characteristics of participants.

Undiagnosed DM was more frequently observed among participants aged 36-55 years (6.3%) compared to other age groups suggesting a higher burden within this middle-aged population. Slight difference was observed by sex, with females recording a higher proportion of undiagnosed cases (3.7%) than males.

Variations were observed across several socio-demographic categories; however, some groups had small numbers of cases, which limits meaningful comparison and warrants cautious interpretation. Education level also showed disparities, with those having no formal education at 5.6%. In terms of occupation, the employed had a prevalence of 4.9%, and rural residents showed a higher prevalence at 4.9%. Finally, all identified undiagnosed cases (3.9%) occurred among Christians participants, reflecting the religious composition of the study population rather than a true difference by religion.

#### 4.1.2 Distribution of undiagnosed DM across clinical, lifestyle and dietary factors

**Table 3:** Clinical characteristics of respondents by undiagnosed DM Status

| Variable                          | Undiagnosed DM, (n=19) | Undiagnosed DM 3.5% | No DM, (n=521) |
|-----------------------------------|------------------------|---------------------|----------------|
| <b>High blood pressure</b>        |                        |                     |                |
| Yes                               | 7                      | 4                   | 169            |
| No                                | 12                     | 3.3                 | 352            |
| <b>Body mass index</b>            |                        |                     |                |
| Underweight                       | 1                      | 1.7                 | 58             |
| Normal weight                     | 12                     | 4.2                 | 273            |
| Overweight                        | 5                      | 3.8                 | 127            |
| Obese                             | 1                      | 1.7                 | 58             |
| <b>DM history for participant</b> |                        |                     |                |
| Yes                               | 0                      | 0.0                 | 11             |
| No                                | 19                     | 3.6                 | 510            |
| <b>DM family history</b>          |                        |                     |                |
| Yes                               | 4                      | 4.1                 | 93             |
| No                                | 16                     | 3.7                 | 428            |
| <b>BP history for participant</b> |                        |                     |                |
| Yes                               | 2                      | 2.3                 | 85             |
| No                                | 17                     | 3.8                 | 436            |

**Note.** Percentages represent the proportion of participants with undiagnosed diabetes mellitus within each clinical category.

Table 3 above summarizes the distribution of undiagnosed DM across selected clinical characteristics. Slightly higher proportions of undiagnosed DM were observed among participants with elevated blood pressure 7/169 (4%), and those with normal BMI 12/273(4.2%), those with no history of DM 19/510 (3.6%), those who had DM history in the family 16/428, (3.7%), and those with no history of high blood pressure 17/436 (3.8%). The number of undiagnosed diabetes cases within each clinical category was however, small, and the reported percentages represent within group proportions rather than population-level prevalence.

**Table 4:** Distribution of undiagnosed DM by lifestyle factors

| Variable and coding category       | Undiagnosed DM, (n-19) | Undiagnosed DM % | No DM, (n=521) |
|------------------------------------|------------------------|------------------|----------------|
| <b>Cigarette smoking</b>           |                        |                  |                |
| Yes                                | 0                      | 0.0              | 19             |
| No                                 | 3                      | 0.7              | 448            |
| Yes but stopped ( <i>smoking</i> ) | 16                     | 22.9             | 54             |
| <b>Alcohol consumption</b>         |                        |                  |                |
| Yes                                | 3                      | 3.1              | 94             |
| No                                 | 12                     | 3.3              | 356            |
| Yes but stopped ( <i>alcohol</i> ) | 4                      | 5.3              | 71             |
| <b>Physical exercise</b>           |                        |                  |                |
| Yes                                | 10                     | 4.6              | 208            |
| No                                 | 9                      | 2.8              | 313            |

**Note.** Percentages represent the proportion of participants with undiagnosed diabetes mellitus within each lifestyle category.

Table 4 presents the distribution of undiagnosed DM across selected lifestyle factors. A higher within-category proportion of undiagnosed diabetes was observed among those who smoked cigarettes but stopped (22.9%), and those who used to consume alcohol but stopped (5.3%), compared to current users and never users (0% and 5.3%) respectively. The number of undiagnosed diabetes cases was small across all lifestyle categories, however, and these findings should therefore be interpreted cautiously. The relationship

between lifestyle factors and undiagnosed diabetes mellitus was further explored using logistic regression analysis.

**Table 5:** Undiagnosed DM distribution by dietary factors

| Variable and coding category | New DM, (n=19) | New DM % | No DM, (n=521) |
|------------------------------|----------------|----------|----------------|
| <b>Fruit intake</b>          |                |          |                |
| Yes                          | 6              | 3.8      | 151            |
| No                           | 13             | 3.4      | 370            |
| <b>Vegetable intake</b>      |                |          |                |
| Yes                          | 17             | 3.7      | 446            |
| No                           | 2              | 2.6      | 75             |

Table 5 presents the distribution of undiagnosed diabetes mellitus by dietary factors. The proportions of undiagnosed diabetes were similar among participants who reported consuming fruits and vegetables and those who did not. The potential association between dietary factors and undiagnosed diabetes mellitus is further explored using logistic regression analysis.

#### **4.2 Relationship between socio-demographic and economic characteristics and undiagnosed DM**

Before a logistic regression test was run, data preparations steps were undertaken to ensure variables were suitable for analysis. This included recoding and categorization of variable, where applicable and changing the dependent variable from continuous to categorical. The dependent variable, diabetes status, was categorized into a binary outcome representing the presence or absence of undiagnosed diabetes mellitus to meet the assumptions of logistic regression. Selected independent variables that were originally continuous or had multiple sparse categories were grouped into clinically and contextually meaningful categories to ensure sufficient observations per group and to improve model stability.

Grouping the continuous variables helps increase the statistical power of the test, hence increasing the likelihood of detecting significant associations between variables (Baguley, 2004). Age classification was guided by the age periods of human life from youth to elderly (Dyussenbayev, 2017) and was grouped as 18 – 35 years (youths), 36-55 years (Middle-aged adults), above 55 (older adults) to make the variable categorical. For the dependent variables, all the participants whose FPG was  $\geq 7$ mmol/litre were considered to have undiagnosed DM and coded as yes, otherwise was a no.

**Table 6** Socio-demographic & economic characteristics associated with Undiagnosed DM

| <i>Variable Relationship</i> | <i>Categories</i>     | <i>Adjusted odds ratio[95%CI]</i> | <i>p-value (Sig)</i> |
|------------------------------|-----------------------|-----------------------------------|----------------------|
| <i>Age</i>                   | 18 – 35 years         | 2.33 [0.07 – 1.10]                | 0.892                |
|                              | 36 - 55               | 4.23 [1.65-18.02]                 | 0.042*               |
|                              | Above 55              | ref                               | -                    |
| <i>Gender</i>                | Male                  | 0.90 [0.37 – 2.25]                | 0.901                |
|                              | Female                | ref                               | -                    |
| <i>Marital status</i>        | Single                | 1.12 [0.43 – 2.88]                | 0.029                |
|                              | Married               | 0.15 [0.23-0.96]                  | 0.036                |
|                              | Widowed               | 0.46 [0.45-4.63]                  | 0.506                |
|                              | Divorced              | ref                               | -                    |
| <i>Religion</i>              | Muslim                | 1.04                              | 0.866                |
|                              | Christian             | ref                               | -                    |
| <i>Residence</i>             | Urban                 | 1.50                              | 0.871                |
|                              | Rural                 | ref                               | -                    |
| <i>Level of education</i>    | No formal education   | 1.10 [0.45-2.66]                  | 0.871                |
|                              | Primary education     | 1.74 [0.23-2.06]                  | 0.897                |
|                              | Secondary education   | 1.43 [0.23- 3.18]                 | 0.887                |
|                              | College               | 0.23 [0.63 - 2.11]                | 0.90                 |
|                              | Tertiary/university   | ref                               | -                    |
| <i>Occupation</i>            | Unemployed            | 1.85 [3.01 – 11.03]               | 0.17                 |
|                              | Business Person       | 8.68 [4.50 – 16.00]               | 0.010*               |
|                              | Farmer                | 2.74 [3.52 – 12.76]               | 0.280                |
|                              | Employed              | 11.0 [ 5.50 -22.01]               | 0.020*               |
|                              | Retired               | ref                               | -                    |
| <i>Income</i>                | Below Kshs. 5,000     | 0.889 [0.363 – 2.173]             | .262                 |
|                              | Ksh 5,000 – Ksh 20000 | 0.799 [.260-.327]                 | .243                 |
|                              | $\geq$ Ksh. 20,000    | ref                               | -                    |

**Note.** Ref: Reference category. OR: odds ratio; CI: confidence interval. Statistical significance assessed at  $\alpha : 0.05$ .

Table 6 presents the results of a multivariable binary logistic regression analysis examining the association between socio-demographic and economic characteristics of undiagnosed DM. The results reveal that age group and occupation were the only factors independently associated with undiagnosed diabetes mellitus.

Participants aged 36-55 years had significantly higher odds of undiagnosed DM compared with those aged 55 years (adjusted OR =4.23; 95% CI: 1.65 – 18.02; p=0.042). In contrast, there was no statistically significant association between undiagnosed diabetes mellitus and age 18–35 years, as the corresponding confidence interval included unity.

With respect to occupation, the business persons (adjusted OR = 8.68; 95% CI: 4.50–16.00; p=0.010) and employed individuals (adjusted OR = 11.00; 95% CI: 5.50–22.01; p=0.020) had a significantly higher odds of undiagnosed diabetes mellitus compared with retired participants.

Other socio-demographic variables, including sex, marital status, religion, place of residence, level of education, and monthly income, were not independently associated with undiagnosed diabetes mellitus after adjustment, as their 95% confidence intervals crossed 1 and p-values exceeded 0.05.

Overall, the findings indicated that being aged 36–55 years and occupation status were key determinants of undiagnosed diabetes mellitus in this study population. However, the wide confidence intervals observed for several estimates suggested limited precision, likely due to the small number of undiagnosed diabetes cases, and the results should therefore be interpreted with caution.

### 4.3 Relationship between clinical, lifestyle and dietary factors associated with undiagnosed DM

Before regression analysis, some variables with a continuous scale were transformed to be categorical; BMI was grouped into: underweight (BMI<18.5), normal weight (BMI 18.5 – 24.9), overweight (BMI 25 – 29.9) and obese (BMI>30) and blood pressure (high for SBP  $\geq 140$ mmHg and/or DBP  $\geq 90$ mmHg, coded as yes; otherwise, a no, while the rest of the independent variables remained unchanged. For the dependent variable, FPG of  $\geq 7$ mmol/litre was considered to have undiagnosed DM and coded as yes; otherwise, was a no.

**Table 7:** Clinical, lifestyle and dietary factors associated with Undiagnosed DM

| <b>Variable relationship</b>      | <b>Category</b> | <b>Odds Ratio</b>  | <b>p – value</b> |
|-----------------------------------|-----------------|--------------------|------------------|
| <i>High blood pressure</i>        | Yes             | 1.07 [0.39 - 2.92] | 0.893            |
|                                   | No              | 1                  |                  |
| <i>Body mass Index</i>            | Normal          | 0.23 [0.48 – 3.20] | 0.663            |
|                                   | Overweight      | 1.54 [0.87 – 4.17] | 0.194            |
|                                   | Obese           | 1                  |                  |
| <i>DM history for participant</i> | Yes             | 1.04 [1.02 – 1.05] | 0.522            |
|                                   | No              | 1                  |                  |
| <i>DM family history</i>          | Yes             | 1.22 [0.41 – 3.59] | 0.721            |
|                                   | No              | 1                  |                  |
| <i>BP history for participant</i> | Yes             | 0.60 [0.14 – 2.66] | 0.500            |
|                                   | No              | 1                  |                  |
| <i>Cigarette smoking</i>          | Yes             | 1.15 [0.34 – 3.84] | 0.827            |
|                                   | No              | 1                  |                  |
| <i>Alcohol consumption</i>        | Yes             | 1.25 [0.50 – 3.11] | 0.635            |
|                                   | No              | 1                  |                  |
| <i>Physical exercise</i>          | Yes             | 1.72 [0.71 – 4.16] | 0.224            |
|                                   | No              | 1                  |                  |
| <i>Fruit intake</i>               | Daily           | 1.13 [0.44 – 2.91] | 0.807            |
|                                   | Not daily       | 1                  |                  |
| <i>Vegetable intake</i>           | Daily           | 1.41 [0.33 – 5.20] | 0.636            |
|                                   | Not daily       | 1                  |                  |

The results shown in table 7 present a relationship between clinical, lifestyle and dietary factors and undiagnosed DM. After adjustment for other variables included in the model,

none of the clinical, lifestyle, or dietary factors examined were independently associated with undiagnosed diabetes mellitus. Although some categories had odds ratios greater or less than one, all corresponding 95% confidence intervals included 1 and all p-values exceeded 0.05, indicating that these associations were not statistically significant.

Specifically, there was no statistically significant association between undiagnosed diabetes mellitus and high blood pressure status, body mass index category, personal or family history of diabetes mellitus, history of hypertension, cigarette smoking, alcohol consumption, physical activity, fruit intake, or vegetable intake.

Overall, these findings suggest that clinical, lifestyle, and dietary factors examined in this study did not show evidence of an independent association with undiagnosed diabetes mellitus. The wide confidence intervals observed for several estimates indicate limited precision, likely due to the small number of undiagnosed diabetes cases.

## **CHAPTER FIVE**

### **5.0 Introduction**

This chapter presents the discussion, arising from the study findings. The results are interpreted in relation to the study objectives and situated within existing literature from Kenya, sub-Saharan Africa, and comparable international settings.

The chapter further examines the clinical and public health implications of undiagnosed diabetes mellitus within surgical populations, particularly in low- and middle-income healthcare settings where routine metabolic screening remains inconsistent. The discussion also contextualizes the findings within the broader epidemiological transition characterized by increasing burden of non-communicable diseases, urbanization, changing dietary patterns, and rising prevalence of obesity and sedentary lifestyles across sub-Saharan Africa.

Methodological considerations and study limitations are also addressed to facilitate appropriate interpretation.

### **5.1 Discussion**

#### **5.1.1 Overview of prevalence of undiagnosed diabetes**

In this study, the prevalence of undiagnosed DM among patients scheduled for elective surgery at Moi Teaching and Referral Hospital (MTRH) was observed at 3.5%, (95% CI: 2.3 - 5.4). This prevalence is higher than that reported among preoperative patients at Kenyatta National Hospital in Kenya (1.2%) (Njihia, 2014), and slightly higher than that observed among surgical patients in a tertiary hospital in South Korea (3.2%) (Kwon et al., 2015). However, the confidence intervals of these estimates overlap with the confidence interval observed in the present study, suggesting that the difference in prevalence may not

be statistically meaningful. Conversely, the prevalence observed at MTRH was lower than that reported among non-cardiac surgical patients aged 45 years and above in Asia (7.4%) (Teo et al., 2020) and among patients undergoing coronary artery bypass graft surgery in Germany (5.2%) (Lauruschkat et al., 2005), populations characterized by older age, greater clinical complexity, and higher baseline cardiovascular risk

The observed variation in prevalence across the studies may be attributed to differences in age distribution, case-mix, and screening thresholds, and healthcare system practices across different settings. Unlike higher-resource settings where routine preoperative glycemic screening is standard practice, screening for diabetes in many Kenyan referral hospitals is often opportunistic and symptom-driven diabetes screening programs, which may influence detection rates and reduce the proportion of undiagnosed cases. As a national referral hospital MTRH, serves patients from both urban and rural settings, many of whom have had limited prior access to preventive healthcare services. Consequently, a proportion of diabetes cases may remain undetected until preoperative evaluation, contributing to the observed burden of undiagnosed diabetes in this setting.

### **5.1.2 Sociodemographic factors and Undiagnosed Diabetes**

In the analysis, age category and occupation were the only social-demographic factors independently associated with undiagnosed DM. Participants aged 36–55 years had significantly higher odds of undiagnosed diabetes compared with those aged 55 years (adjusted OR = 4.23; 95% CI: 1.65–18.02;  $p = 0.042$ ). This finding is consistent with prior studies reporting higher burden of undiagnosed diabetes among middle-aged adults, a group that may accumulate metabolic risk over time while remaining asymptomatic and less likely to seek routine screening (Meme et al., 2015; Yitbarek et al., 2021).

The absence of a statistically significant association between undiagnosed diabetes and age 18–35 years likely reflects the comparatively lower cumulative metabolic risk in younger adults, while the lower odds observed among those aged above 55 years may reflect higher healthcare utilization and increased likelihood of prior diagnosis in older age groups.

Occupation was also independently associated with undiagnosed diabetes, with employed individuals and businesspersons demonstrating higher odds (adjusted OR=8.68; 95% CI: [4.50 – 16.00]; P= 0.01 and OR =11.0; 95% CI: [5.50 -22.01]; P= 0.02) compared with retired participants. This finding may reflect occupational and lifestyle factors common among working adults, including sedentary behavior, irregular eating patterns, work-related stress, and limited opportunities for preventive health screening. In the Kenyan context, retired individuals are often older and may have increased interaction with healthcare services due to comorbid conditions, increasing the likelihood of prior diabetes diagnosis.

These findings contrast with results from other studies conducted in Kenya. For instance, Emilioh et al. (2024), in a study among hypertensive patients attending outpatient clinics in Tharaka Nithi County, reported that unemployed individuals had higher odds of undiagnosed diabetes (adjusted OR =2.85; 95% CI: 1.21–6.68;  $p < 0.05$ ), while employment status was not associated with increased risk. Similarly, national and community-based studies in Kenya, such as the STEPS survey by Mohamed et al. (2018), did not identify occupation as an independent predictor of undiagnosed diabetes after adjustment, with confidence intervals for occupational categories generally including unity, indicating non-significant associations. The observed differences may be explained by variation in study population and healthcare contexts.

Other socio-demographic variables, including sex, marital status, religion, place of residence, level of education, and income, were not independently associated with undiagnosed diabetes mellitus after adjustment. Although crude differences were observed, confidence intervals for these estimates included unity and p-values exceeded 0.05, indicating that the observed variations may be due to chance or residual confounding rather than true underlying associations (Altman & Bland, 2005).

Overall, the findings indicated that middle-aged and economically active adults were more likely to have undiagnosed diabetes within the elective surgical population, while other socio-demographic factors do not independently influence risk after adjustment.

### **5.1.3 Clinical, lifestyle and dietary factors and undiagnosed diabetes**

In this study, none of the clinical, lifestyle, or dietary factors examined demonstrated an independent association with undiagnosed diabetes mellitus in the multivariable analysis. Although point estimates suggested higher odds among participants with elevated blood pressure, overweight status, positive family history of diabetes, smoking, alcohol consumption, physical inactivity and daily intake of fruits or vegetables, all corresponding confidence intervals included unity and the p-values exceeded 0.05, indicating a lack of statistical significance.

The absence of statistically significant associations may be partly attributable to the limited number of undiagnosed diabetes cases, which reduces statistical power and results in wide confidence intervals. Wide confidence intervals reflect imprecision and limit the ability to detect modest but potentially important effects (Rothman et al., 2008). Nevertheless, the direction of several point estimates aligns with established biological mechanisms and

findings from larger population-based studies linking hypertension, excess adiposity, family history, and lifestyle risk factors to diabetes (Seifu et al., 2020; Dereje et al., 2020). The absence of significant associations between dietary factors and undiagnosed diabetes is also consistent with findings from studies emphasizing that overall dietary patterns, rather than individual food groups, are more strongly associated with diabetes risk (Bantie et al., 2019; Connor et al., 2013). Similarly, the unexpected pattern observed for physical activity, where higher crude prevalence was seen among individuals reporting regular exercise, has been reported in other cross-sectional studies and is frequently attributed to reverse causality or self-report bias (Hakim et al., 2017).

Overall, when this is compared with existing literature, the finding of this study aligns with broader evidence indicating that undiagnosed diabetes remains a significant but heterogeneous problem among surgical patients, with prevalence and associated factors strongly influenced by population characteristics, healthcare access, and screening practices. The use of confidence intervals in this study allows for more cautious interpretation of differences across studies and highlights the need to avoid over-interpretation of non-significant findings. Differences between this study and others may therefore reflect methodological and contextual factors rather than true epidemiological divergence.

#### **5.1.4 Perioperative implications of undiagnosed diabetes mellitus**

The clinical significance of undiagnosed diabetes mellitus in surgical patients extends well beyond the simple question of prevalence. Patients with unrecognized hyperglycemia entering the perioperative pathway represent a particularly vulnerable groups, as they lack the benefit of preoperative glycemic optimization that is routinely implemented for patients

with established diagnoses. The physiological stress of surgery, anaesthesia and postoperative recovery triggers a neuroendocrine response characterized by the release of counter-regulatory hormones, including cortisol, glucagon, catecholamines, and growth hormone. These hormones promote hepatic glucose production and simultaneously impair peripheral insulin sensitivity, resulting in significant perioperative hyperglycemia even in patients who may have had borderline fasting glucose levels prior to admission (NIDDK,2023). In patients with previously undiagnosed diabetes, this stress response may precipitate acute metabolic decompensation, potentially manifesting as new-onset hyperglycemic crisis.

A growing body of evidence confirms that perioperative hyperglycemia is an independent predictor of adverse surgical outcomes across diverse patient populations and surgical specialties. A systematic review and meta-analysis published by Huang et al. (2022) examined the association of diabetes mellitus with postoperative complications following non-cardiac surgery and identified diabetes as an independent risk factor for wound infections, wound healing disruption, haematoma formation and renal insufficiency. The proposed biological mechanisms include neutrophilic dysfunction, impaired macrophage activity, reduced angiogenesis, and tissue hypoxia resulting from chronic hyperglycemia-induced vascular injury. These physiological impairments collectively compromise the inflammatory and proliferative phases of wound healing, creating conditions that favour surgical site infection and delayed tissue repair. Furthermore, a 2023 review of perioperative glycemic management in elective cardiac and non-cardiac surgery (Perioperative Medicine, 2023) confirmed that hyperglycemia is associated with increased rates of postoperative infection, prolonged length of hospital stay, and higher mortality in

both known diabetic and non-diabetic patients, underscoring the importance of glucose monitoring as a universal perioperative safety measure rather than one reserved exclusively for patients with a prior diabetes diagnosis.

The concern regarding patients with undiagnosed diabetes is especially acute because, unlike patients with established diagnoses who may receive pre-admission glycemic optimization and structured perioperative insulin protocols, undiagnosed patients enter surgery without any metabolic preparation. Evidence from retrospective cohort studies suggests that new-onset hyperglycemia in surgical patients, that is, hyperglycemia identified for the first time in the hospital setting, is associated with higher in-hospital mortality than hyperglycemia in patients with a prior diabetes diagnosis (Levetan et al., 1998). This counterintuitive finding more likely reflected the absence of adaptive metabolic responses and preoperative optimization in patients with newly discovered disease, compounded by the fact that clinical teams may not recognize or prioritize glucose management when a formal diabetes diagnosis has not been established. The present study finding of a 3.5% prevalence of undiagnosed diabetes among elective surgical patients at MTRH is therefore clinically significant not merely as an epidemiological observation but as a marker of preventable perioperative risk.

In resource-limited settings such as Kenyan referral hospitals, the operational implications of this finding are particularly pressing. The preoperative period, while constituting a brief clinical window, offers an unparalleled opportunity for systematic screening that is unavailable in many outpatient community settings. Patients presenting for elective surgery are, by definition, in structured contact with the health system; they have been assessed,

admitted, and scheduled for a planned procedure. This structured contact provides the infrastructure necessary for systematic blood glucose measurement, result interpretation, and, where required, short-term glycemic stabilization prior to the operative procedure. A 2023 review of preoperative considerations for patients with diabetes (Dhatariya et al., 2023) reinforced that stability of perioperative glucose levels is a key determinant of surgical safety and that the preoperative window is the optimal time for metabolic assessment and preparation. In the MTRH context, where fasting plasma glucose measurement was demonstrated to be both feasible and informative within the standard preoperative workflow, the practical barrier to routine screening appears to be one of policy and protocol adoption rather than clinical or logistical impossibility.

The implications extend beyond immediate perioperative safety. For patients found to have undiagnosed diabetes during preoperative screening, the diagnosis itself represents a life-changing clinical event that opens a pathway to long-term management, patient education, lifestyle intervention, and complication prevention. In the context of Kenya's National Clinical Guidelines on Management of Diabetes Mellitus (2023 edition), which explicitly identifies the need to strengthen opportunistic screening in health facility settings, the preoperative period at facilities such as MTRH represents a strategically important touchpoint. Integrating blood glucose screening into routine preoperative assessment aligns not only with institutional safety objectives but also with Kenya's national non-communicable disease control strategy and the broader Sustainable Development Goal 3 framework of reducing premature mortality from non-communicable diseases by one-third by 2030.

### **5.1.5 Contextualizing the prevalence within the regional and global epidemiological landscape**

The 3.5% prevalence of undiagnosed diabetes reported in this study must be interpreted against the evolving regional and global epidemiological context. The IDF Diabetes Atlas, 11th edition (2024) estimated that globally, 589 million adults aged 20 to 79 years were living with diagnosed or undiagnosed diabetes in 2024, with a global prevalence of 11.1%. Projections indicated that this number will rise to 853 million by 2050, representing a 44.8% increase (IDF Atlas, 2024). The African region, despite having the lowest absolute prevalence estimate of 5.0% among IDF regions, faces the most severe relative trajectory: The number of people with diabetes in Africa is expected to increase by 142% by 2050, reaching approximately 60 million. Critically, the IDF 2024 Atlas estimates that approximately 73% of adults with diabetes in the African region remain undiagnosed, the highest proportion of any IDF region globally (IDF Atlas, 2024). This structural epidemiological feature reflects the combination of weak community screening programmes, low health literacy, limited access to diagnostic facilities, and inadequate integration of NCD screening into routine primary and secondary healthcare delivery.

A systematic analysis and meta-analysis examining the sub-regional distribution of undiagnosed diabetes mellitus across African countries (Dessie et al., 2020) reported a pooled prevalence of 3.85% among adults, with Eastern Africa specifically recording a pooled prevalence of 4.43%. Individual country estimates included in the same meta-analysis varied considerably, with reports of 9% in Tanzania, 6.3% in Cameroon, 4.77% in Mauritania, and 18.1% in South Africa, reflecting the substantial heterogeneity in study populations, diagnostic thresholds, and healthcare access across the continent. The

prevalence of 3.5% reported in the present study falls within the lower range of this continental distribution, consistent with the fact that the study population was drawn from a referral hospital setting where patients may have had more prior exposure to healthcare services compared with community samples, potentially resulting in a higher proportion of previously identified cases.

When situated within the broader surgical epidemiology literature, the present findings are also broadly consistent with data from other African and low-income country surgical settings. A systematic review of undiagnosed diabetes mellitus in adult African populations (Worede, 2017; Asmelash and Asmelash, 2019) identified that undiagnosed diabetes burdens within hospital-based studies tend to cluster between 3% and 12%, with the higher estimates typically arising from populations with older age profiles, higher rates of obesity, or specific comorbidity burdens such as hypertension. The relatively lower prevalence at MTRH compared with some higher-income surgical centres likely reflects the younger age distribution of the study population (the majority aged 55 years or below), the predominance of low-income rural participants, and the inclusion of all elective surgical specialties rather than higher-risk cardiovascular or orthopaedic subgroups. These methodological and contextual distinctions explain much of the cross-study variability and should be taken into account when designing future multi-site screening studies.

#### **5.1.6 Occupational risk, lifestyle, and the working-age diabetes burden**

The independent association of occupation with undiagnosed diabetes mellitus in this study, with employed individuals and business persons demonstrating significantly higher odds than retired individuals, warrants deeper exploration within the broader framework of

occupational health and metabolic risk. The finding aligns with an emerging body of literature linking work-related exposures and the characteristics of formal employment to increased diabetes risk. Wang et al. (2022), in a long-term cohort study examining occupational and domestic physical activity in relation to diabetes risk, demonstrated that sedentary occupational activity was associated with significantly higher diabetes incidence compared with heavier occupational physical activity, after adjustment for leisure-time physical activity. This is particularly relevant in the Kenyan urban context, where formal employment increasingly involves desk-based, sedentary roles in the services and public sectors, and where commuting patterns typically involve motorized transport rather than walking or cycling.

Beyond physical inactivity, work-related psychosocial stress has been identified as an independent contributor to type 2 diabetes mellitus risk. A meta-analysis examining job strain as a risk factor for diabetes among middle-aged and older workers found that high-strain and passive occupational environments, characterized by high psychological demands combined with low control over work processes, were associated with a materially increased risk of incident diabetes (ScienceDaily, 2024). The proposed biological pathways include chronic activation of the hypothalamic-pituitary-adrenal axis leading to elevated cortisol, dysregulation of glucose homeostasis, promotion of abdominal adiposity, and disruption of sleep architecture, all of which independently contribute to insulin resistance and impaired beta-cell function. In the Kenyan employment context, where many working adults in the formal and informal business sectors experience economic uncertainty, long and irregular working hours, and limited occupational health

support, these psychobiological pathways are plausibly operative and warrant systematic investigation.

A cross-sectional analysis specifically examining socio-behavioral determinants of undiagnosed type 2 diabetes in middle-aged adults (Alrossies et al., 2026), confirmed that physical inactivity, high body mass index, and smoking history were consistently associated with undiagnosed diabetes in this demographic, and noted that the convergence of multiple behavioral risk factors created a compounding effect on undiagnosed disease burden. In the present study, while individual clinical and lifestyle risk factors did not reach statistical significance in the multivariable model, likely due to the limited sample of only 19 undiagnosed cases, the observed trends in point estimates were directionally consistent with this broader evidence base. The association with occupation may therefore serve as a proxy for a cluster of lifestyles, metabolic, and psychosocial exposures concentrated in the working-age population that collectively heighten undiagnosed diabetes risk while simultaneously reducing the likelihood of routine preventive health screening.

Businesspersons represent a distinct subgroup within this occupational risk framework. In the Kenyan urban and peri-urban economy, business activity often involves irregular hours, frequent eating of convenience foods, reduced time for structured physical activity, and high levels of financial stress. The dietary transition associated with urban commercial activity—away from traditional plant-based staples towards calorie-dense, processed, and fast foods—is a documented driver of rising diabetes prevalence in Kenyan cities (Ayah et al., 2013). Businesspersons in this study context are likely to represent a heterogeneous group that includes both formal small-to-medium enterprise operators and informal sector

traders, who share many of the metabolic risk exposures associated with urban economic activity. The higher odds of undiagnosed diabetes in this group observed in the present study is therefore plausible and adds to a growing narrative that occupational classification in LMICs may serve as an important proxy risk indicator for both primary prevention and targeted screening programmes.

#### **5.1.7 Middle age as a high-risk window for undiagnosed diabetes in sub-Saharan Africa**

The finding that participants aged 36–55 years had significantly higher odds of undiagnosed diabetes (adjusted OR = 4.23; 95% CI: 1.65–18.02;  $p = 0.042$ ) adds important local evidence to a globally recognized epidemiological pattern in which middle age represents a high-risk window for undiagnosed metabolic disease. This age group combines the dual burden of accumulating metabolic risk factors—including progressive insulin resistance, increasing adiposity, and rising comorbidity burden—with a paradoxically lower rate of preventive health-seeking compared to older adults who are more frequently engaged with the health system for management of established chronic conditions. Evidence from a cross-sectional analysis of undiagnosed type 2 diabetes in middle-aged adults (Alrossies et al., 2026) confirmed that individuals aged 35–45 years represent a high-prevalence but underscreened group, in whom the convergence of lifestyle risk factors, low awareness, and infrequent health check-ups creates a fertile epidemiological environment for disease to progress undetected.

The lower prevalence of undiagnosed diabetes in the oldest age category (above 55 years) in the present study, while perhaps counterintuitive, is consistent with a well-documented

phenomenon observed in multiple settings in sub-Saharan Africa. Older adults who regularly access healthcare for the management of comorbid conditions such as hypertension, arthritis, or respiratory illness are more likely to have undergone incidental glucose testing, leading to a higher proportion of diagnosed compared to undiagnosed cases in this age group. This selection effect has been documented in the Kenyan literature, where hypertensive patients attending outpatient clinics had a high rate of newly detected diabetes (Meme et al., 2015), suggesting that concurrent management of one condition serves as an inadvertent screening opportunity for others. In contrast, middle-aged adults in Kenya, particularly those who are economically productive and do not yet experience the health system burden associated with multi-morbidity, are less likely to attend routine outpatient services and therefore more likely to remain undiagnosed.

This epidemiological profile has important implications for the design of screening strategies. If the highest undiagnosed burden is concentrated in middle-aged, economically active individuals, then screening programmes that rely on older adults or symptomatic individuals presenting with complications will systematically miss the most prevalent undiagnosed group. Facility-based opportunistic screening—including preoperative screening of the type proposed by this study—offers a mechanism to reach this otherwise elusive demographic by capturing individuals at a health system contact point that is not predicated on symptom burden or advanced disease. The IDF Atlas (2024) specifically highlights the need for innovative approaches to screening and diagnosis in the African region, where the combination of high undiagnosed prevalence (73%), limited primary care infrastructure, and a predominantly working-age disease burden creates a specific challenge that targeted facility-based screening is well positioned to partially address.

### **5.1.8 Methodological considerations and directions for future research**

Beyond the limitations already discussed, this study highlights several methodological gaps in the broader literature on undiagnosed diabetes in surgical settings that future research should address. The cross-sectional design of this study, while appropriate for prevalence estimation, precludes any inference about causal directionality between the identified determinants and undiagnosed diabetes. Specifically, it is not possible to determine from this study whether occupation, age, and the observed (though non-significant) clinical trends represent antecedent risk factors that contributed to the development of undiagnosed diabetes, or whether they simply co-occur with undiagnosed disease due to shared upstream determinants such as socioeconomic disadvantage, poor healthcare access, or dietary exposure. Prospective cohort designs that follow working-age Kenyan adults over time, with repeat glucose assessments, would be better suited to establishing temporal relationships and identifying the most modifiable intervention targets.

The use of a single fasting plasma glucose measurement as the diagnostic criterion, while appropriate for a resource-limited screening context and consistent with WHO and ADA guidelines for initial identification of hyperglycemia, has acknowledged limitations. Current international guidelines recommend that a diagnosis of diabetes mellitus be confirmed by repeat testing on a separate day in the absence of unequivocal symptoms, or by supplementary HbA1c measurement (ADA Standards of Care, 2024). In this study, HbA1c was measured in participants with fasting plasma glucose above 7.0 mmol/L, providing a valuable secondary confirmation for the majority of undiagnosed cases. However, the use of a single measurement for initial classification may have resulted in

some degree of misclassification, particularly for participants whose glucose was transiently elevated due to pre-admission physiological stress or incomplete fasting. Future studies should incorporate confirmatory two-point diagnostic protocols, and where feasible, HbA1c measurement as a primary or co-primary screening modality, particularly given its operational advantages of not requiring fasting and its lower susceptibility to acute stress-related elevation.

The low absolute number of undiagnosed diabetes cases ( $n = 19$ ) represents a significant constraint on the analytical power of this study and, as discussed, resulted in wide confidence intervals that limit the precision of all odds ratio estimates. While this is an inherent consequence of the true prevalence in the study population and the available sample size, future studies aimed at characterizing the determinants of undiagnosed diabetes in surgical populations in Kenya should be designed with larger sample sizes or conducted as multi-site studies pooling data across several referral hospitals. Collaborative multi-site designs would not only increase statistical power but would also allow examination of between-facility variation in undiagnosed diabetes prevalence, and assess whether systematic differences in preoperative practice, patient demographics, or catchment populations explain observed differences. The AMPATH network's established presence across western Kenya and its experience in chronic disease management provide an institutional platform that could facilitate such a collaborative research agenda.

Future research in this field should also examine the downstream outcomes of preoperative diabetes detection. Questions of immediate policy relevance include: what proportion of patients identified with undiagnosed diabetes through preoperative screening subsequently

receive formal post-discharge diabetes management; what is the impact of preoperative identification and glycemic optimization on specific perioperative outcomes such as surgical site infection rates, wound healing, length of hospital stay, and 30-day readmission; and what cost-effectiveness profile does routine preoperative fasting glucose screening present relative to the costs of managing the perioperative complications attributable to undiagnosed hyperglycemia? These questions are answerable through clinical outcomes studies in the Kenyan hospital setting and would provide the evidentiary basis for evidence-based policy reform at both institutional and national levels. Finally, qualitative research exploring the perspectives of surgical patients and clinical teams on preoperative diabetes screening—including perceived barriers, enablers, and acceptable screening formats—would complement the quantitative evidence generated by this and similar studies, and strengthen the foundation for sustainable implementation.

## **5.2 Study Limitations**

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional design limits the ability to establish causal relationships, and reverse causality between the selected factors and undiagnosed diabetes mellitus cannot be ruled out. Second, the relatively small number of undiagnosed diabetes cases reduced the statistical power of the study and resulted in wide confidence intervals, thereby limiting the precision of the estimates and increasing the possibility that some true associations were not detected. Third, some variables, particularly lifestyle and dietary factors, were self-reported and therefore subject to recall and social desirability bias. In addition, the single-center nature of the study may limit the generalizability of the findings to other surgical populations in Kenya or similar settings. Finally, the use of a single fasting plasma

glucose measurement for diagnosis may have resulted in misclassification in some cases, as confirmatory testing is generally recommended in clinical practice.

### **5.3 Delimitations of the study**

This study was limited to adult patients aged 18 years and above presenting for elective surgery at Moi Teaching and Referral Hospital. Emergency surgical patients were excluded because the urgency of care and perioperative instability would have limited the feasibility of standardized fasting glucose assessment and comprehensive participant evaluation. The study further focused on undiagnosed diabetes mellitus among patients without a known prior diagnosis of diabetes, as the primary objective was to determine the burden of previously unrecognized disease within the elective surgical population.

The study utilized fasting plasma glucose measurement as the primary diagnostic method because it is widely recommended, relatively affordable, readily available, and feasible within routine hospital practice in low-resource settings. Although additional diagnostic approaches such as glycated hemoglobin (HbA1c) testing or oral glucose tolerance testing may provide broader assessment of glycemic status, these methods were beyond the logistical and financial scope of the study.

The study was also restricted to selected socio-demographic, clinical, lifestyle, and dietary factors considered most relevant to the study objectives based on existing literature. Other potential determinants of undiagnosed diabetes mellitus, including genetic factors, detailed dietary composition, psychosocial variables, and long-term physical activity patterns, were not extensively assessed.

Despite these delimitations, the study provides important insight into the prevalence of undiagnosed diabetes mellitus among elective surgical patients and identifies important

high-risk subgroups within the study population. The findings therefore contribute useful evidence for strengthening opportunistic diabetes screening and perioperative metabolic assessment within similar healthcare settings.

## **CHAPTER SIX**

### **6.0 CONCLUSION AND RECOMMENDATIONS**

#### **6.1 Conclusion**

- The prevalence of undiagnosed diabetes mellitus among patients presenting for elective surgery at Moi Teaching and Referral Hospital was higher compared to the estimated prevalence of diabetes in the general Kenyan adult population.
- Middle-aged adults (36–55 years) were at higher risk of having undiagnosed diabetes mellitus than the other age groups.
- Those who were employed and those engaged in business were more likely to have undiagnosed diabetes mellitus than the unemployed, farmers and the retired.

#### **6.2 Recommendations**

Based on the findings of this study, the following recommendations are suggested:

- Hospitals should incorporate routine diabetes screening prior to surgical interventions among middle aged adults (36-55 years), employed and business persons.
- The Ministry of Health should develop and implement guidelines requiring health facilities to conduct routine diabetes screening before any surgical procedure is performed.
- Further research should explore the underlying factors contributing to the observed demographic and lifestyle associations with undiagnosed diabetes mellitus to inform more effective screening and prevention strategies.

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## APPENDICES

### APPENDIX I: CONSENT (ENGLISH)

**Study title:** Prevalence of undiagnosed diabetes mellitus and its determinants among patients presenting for elective surgery.

**Principal Investigator:** Joan Kimetto

**Organization:** Moi University

**Sponsor:** Self-sponsored - Joan Kimetto

**Informed consent for:** Patients presenting for elective surgical intervention.

**This informed consent has two parts.**

- Information sheet (to share information about the study with you)
- Certificate of consent (for signatures if you choose to participate)

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

#### **PART I: Information sheet**

##### **Introduction**

You are being asked to take part in a study. This information is provided make you understand what the study is about. Please read this form carefully. You will be given a chance to ask questions. If you decide to be in the study, you will show consent by signing the consent form that will be provided. A copy of this consent form will be given to you for your records.

Taking part in this research study is voluntary. You may choose not to take part in the study. You could still receive other treatments. Saying no will not affect your rights to healthcare or services. You are also free to withdraw from this study at any time. If after data collection you choose to quit, you can request that the information provided by you

be destroyed under supervision- and thus not used in the research study. You will be notified if new information becomes available about the risks or benefits of this research. Then you can decide if you want to stay in the study

**Purpose**

The purpose of this research is to find out the prevalence of undiagnosed diabetes mellitus in patients going in for elective surgery in MTRH and to know the risk factors associated with diabetes in these patients. Diabetes mellitus is a condition that occurs when the body is unable to regulate the amount of glucose (sugar) in the blood causing the blood glucose level to rise. This is often caused by lack or insufficient amount of Insulin, a hormone produced by the pancreas to regulate the blood glucose level between certain limits. Undiagnosed diabetes mellitus therefore means one has this condition, but it has not been known yet.

The purpose of this study is also to fulfill the requirement of Master of Science in Public Health Program at Moi University.

**Type of Research**

The project involves questionnaires, interviews, clinical assessments and a drawing of blood from a fingertip and in some participants, from the arm for some laboratory tests.

**Why have I been identified for the study?**

I chose you to take part in this study because you are among the patients scheduled for elective surgery in MTRH. The study is specific to patients admitted for elective surgery. The results of this study will aid in improving care provided for elective surgery at MTRH.

**How long will the study take?**

The research will be done in two days taking 30 minutes today and 10 minutes tomorrow before surgery.

**What will happen to me in the study?**

This study involves collecting information through a questionnaire, measuring your height, weight and blood pressure, and assessing your blood sugar levels using a finger-prick test and, if needed, an HbA1c test to evaluate your average blood sugar over time.

After providing consent, you will fill a questionnaire that will collect data on your socio-demographic, socio-economic and other related characteristics. The questions are not sensitive, and you may choose not to answer any question you are not comfortable with.

Your height will be measured using a wall-mounted measuring tape, and you will be asked to remove your shoes and stand upright against the wall with your feet together and looking straight ahead. Your weight will be measured using a weighing scale, and you will be asked to stand still on the scale while the measurement is recorded.

Your blood pressure will also be measured while you are seated and relaxed. You will be asked to rest before the measurement. A cuff will be placed on your upper arm and the machine will inflate to take the reading.

Tomorrow morning, before you go to the theatre, a small blood sample will be taken from one of your fingertips for blood sugar testing using a sterile lancet. You will be asked not to eat or drink anything except water overnight before the test. Your finger will be cleaned before the prick is made, and a small amount of blood will be collected. You may feel slight discomfort during this procedure. If your blood sugar is found to be elevated, another finger-prick blood sample will be taken for the HbA1c test.

All the procedures of this study have been approved by the appropriate authority and Institutional Research and d Ethics Committee of Moi University (IREC).

**Risk**

The study involves no foreseeable risk or harm. You are likely to feel a slight pain during blood sample collection from your fingertip and vein on your arm. Injuries are less likely to occur.

**Benefits**

The benefit of participating in this study to you is that you will get to know your health status as regards to diabetes mellitus. If any test done will be found to be abnormal, it shall be communicated to your primary physician to facilitate further management.

The findings of this research will inform policies that concern patients going in for surgery in this hospital. There are no costs to you for participating in this study.

**Reimbursements**

No reimbursements will be made. The study itself will benefit the patient because of the free checkup and screening.

**Questions on the study**

If you have any questions related to the questionnaires now or any time during the study, please feel free to ask or discuss with me. Please contact me on the following address

**Joan Kimetto**

**P.O box 4606,**

**Eldoret, Kenya**

**Tel: +254720411137, Email: [joankimeto4561@gmail.com](mailto:joankimeto4561@gmail.com)**

You can also contact my School supervisors; Dr. Samson Ndege at +254722842927 and Prof. Fatma Some at +254722726199 and the IREC via email - [irecoffice@gmail.com](mailto:irecoffice@gmail.com)

### **Confidentiality**

Ethical clearance was attained from IREC which is a recognized body. A unique code number on each questionnaire will be used so that your personal identity will not be disclosed. All the information in connection with this study will remain confidential and the questionnaire will be destroyed after completion of the study.

All reasonable efforts will be made to keep your protected information (private and confidential). Protected Information is information that is, or has been, collected or maintained and can be linked back to you. Using or sharing (“disclosure”) of such information must follow National privacy guidelines. By signing the consent document for this study, you are giving permission (“authorization”) for the uses and disclosures of your personal information. A decision to take part in this research means that you agree to let the research team use and share your Protected Information as described below.

As part of the study, Joan Kimetto and her study team may share the results of your laboratory tests. These may be study or non-study related. They may also share portions of your medical record, with the groups named below:

-The National Bioethics committee    - The Institutional Review and Ethics Committee

### **SECTION B: Consent**

I have read or have had read to me the description of the research study. The investigator or his/her representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks, discomforts and side effects as

well as the possible benefits (if any) of the study. I freely volunteer to take part in this study.

---

|                     |                                 |             |
|---------------------|---------------------------------|-------------|
| Name of Participant | Signature of subject/thumbprint | Date & Time |
|---------------------|---------------------------------|-------------|

(Witness to print if the subject is unable to write

---

|                                |                         |
|--------------------------------|-------------------------|
| Name of Representative/Witness | Relationship to Subject |
|--------------------------------|-------------------------|

---

|                                  |                                          |      |
|----------------------------------|------------------------------------------|------|
| Name of person Obtaining Consent | Signature of person<br>Obtaining Consent | Date |
|----------------------------------|------------------------------------------|------|

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|                              |                           |      |
|------------------------------|---------------------------|------|
| Printed name of Investigator | Signature of Investigator | Date |
|------------------------------|---------------------------|------|

## **APPENDIX II: INFORMED CONSENT (RIDHAA)-KISWAHILI**

**Mada:** Kisukari kisichojulikana na sababu zake miongoni mwa wagonjwa wanaofanyiwa upasuaji wa hiari katika hospitali ya rufaa ya moi, eldoret

**Mdadisi:** Joan Kimetto

**Chuo:** Moi University

**Mdhamini:** Binafsi

**Ridhaa ya:** Wagonjwa wanaohitaji upasuaji wa hiari

### **Sehemu mbili**

- Marelezo kuhusu lenfo letu (Kukujulisha kuhusu utafiti/udadisi huu)
- Cheti cha ridhaa (kwa ajili ya sahihi za kuonyesha kukubali kushiriki)

Utapewa fomu moja iliyotiwa sahihi

### **SEHEMU I: Ridhaa**

#### **Utangulizi**

Unaalikwa kushiriki katika utafiti huu na marelezo haya yanakueleza kuhusu utafiti wenyewe. Tafadhali soma kwa uangalifu na tapewa muda wa kuuliza maswali. Ukikubali kushiriki katika utafiti huu utapewa fomu kwa minaajili ya rekodi yako mwenyewe.

Kushiriki sio kwa lazima bali ni kwa hiari yako na utapokea matibabu kama kawaida.

Unareweza kuchagua kutoshiriki katika utafiti huu na hakutakua na mabadiliko katika uhuru wako wa kupokea matibabu. Unaweza pia kujiondoa katika utafiti huu wakati wowote na ukihitaji kujiondoa katikati ya utafiti basi taarifa yoyote kukuhusu itafutiliwa mbali na haitatumika katika utafiti huu. Pia utajulishwa kuhusu mambo yatakayotokea kuhusu hatari ama manufaa ya utafiti huu. Utakua na uhuru wa kubaki katika utafiti pia

#### **Sababu**

Utafiti huu ni wa kudadisi na kujua idadi ya ugonjwa wa kisukari kisichojulikana kwa wagonjwa wanaofanyiwa upasuaji hapa hospitali ya rufaa na mafunzo ya Moi (MTRH) Pia ni kuhitimisha shahada katika chuo kikuu cha Moi. Ugonjwa wa kisukari ni hali ambapo mwili inakosa kutengeneza kemikali ya insulin ya kutosha hivyo basi kusababisha kiwango cha sukari kwa mwili kuwa juu.

### **Aina ya Utafiti**

Utafiti huu unahitaji kuyajibu maswali kadhaa na pia kutoa damu ya kutumia kwa uchunguzi.

### **Mbona nimekuchagua katika utafiti huu?**

Nimekuchagua kwa sababu wewe ni mmoja wa wagonjwa ambao tungependa kujua hali yao ya kisukari. Pia, matokeo ya utafiti huu yatasaidia kukuelewa wewe mwenyewe na jinsi ya kuboresha afya yako zaidi.

### **Muda wa Utafiti**

Utahitajika kwa muda wa dakika takriban thelathini leo na dakika kama kumi kesho kabla ya kuenda upasuaji.

### **Nini nitafanyiwa wakati wa utafiti?**

Utafiti huu unahusisha kukusanya taarifa kupitia dodoso, na vipimo tofauti - kupima urefu wako, uzito na shinikizo la damu, na kutathmini viwango vya sukari yako ya damu kwa kutumia kipimo cha kidole na, ikihitajika, kipimo cha HbA1c ili kutathmini wastani wa sukari yako ya damu katika miezi tatu.

Baada ya kutoa idhini, utajaza dodoso ambalo litakusanya data kuhusu habari zako zinazohusika na ugonjwa kisukari. Maswali si nyeti, na unaweza kuchagua kutojibu swali lolote ambalo huna raha nalo.

Kisha urefu wako utapimwa kwa kutumia mkanda wa kupimia uliowekwa ukutani. Utaulizwa kuvua viatu vyako na kusimama wima dhidi ya ukuta huku miguu yako ikiwa pamoja na kutazama mbele. Uzito wako utapimwa kwa kutumia mizani ya kupimia, na utaulizwa kusimama tuli kwenye mizani wakati kipimo kinarekodiwa.

Shinikizo lako la damu pia litapimwa ukiwa umeketi na umepumzika

Kesho asubuhi, kabla ya kwenda kwa chumba cha upasuaji, sampuli ndogo ya damu itachukuliwa kutoka kwenye ncha ya kidole chako kwa ajili ya kupima sukari ya damu kwa kutumia. Utaulizwa usile au kunywa chochote usiku kucha kabla ya mapimo hayo. Kidole chako kitasafishwa kabla ya kudungwa, na kiasi kidogo cha damu kitakusanywa. Unaweza kuhisi maumivu kidogo wakati wa utaratibu huu. Ikiwa sukari yako ya damu itapatikana kuwa juu, sampuli nyingine ya damu ya kidole itachukuliwa kwa kipimo cha HbA1c.

Taratibu zote za utafiti huu zimeidhinishwa na mamlaka inayofaa na Kamati ya Utafiti ya Kitaasisi na d Maadili ya Chuo Kikuu cha Moi (IREC).

### **Hatari**

Utafiti huu haina hatari kwako bali utahisi uchungu kidogo utakapo tolewa damu kiasi mkononi mwako. Mauivu ya aina yoyote hayatatokea kwako.

### **Manufaa**

Manufaa utakayopata kutokana na kushiriki katika utafiti huu ni kwamba utajua hali yako ya kisukari, kiwango cha mafuta kwenye mwili wako na jinsi mwili wako unadhibiti sukari. Kama yoyote katika hizi itapatikana kuwa na shida, utarelekezwa kwa madaktari ambao watakuongoza katika tiba.

Matokeo ya utafiti huu utachangia kuboresha huduma wanaopewa wagonjwa wanaofanyiwa upasuaji hospitalini humu haswa kuhusu ugonjwa wa kisukari. Utafiti huu

hautakugarimu malipo yoyote

### **Malipo**

Kushiriki kwako hautakugarimu hela zozote

### **Maswali kuhusu utafiti huu**

Ukiwa na maswali kuhusu utafiti huu tafadhali kua na uhuru wa kunifikia

**Joan Kimetto S.L.P 4606. Eldoret, Kenya, Simu: +254720411137**

**Email: [joankimeto4561@gmail.com](mailto:joankimeto4561@gmail.com)**

Unaweza pia kuwafikia walimu wangu wa chuo kikuu Dkt. Samson Ndege kupitia +254722842927 na Prof. Fatma Some at +254722726199. Pia waweza kuwasiliana na IREC kwa barua pepe-- irecoffice@gmail.com

### **Siri**

Kila dodoso itakua na namabri tofauti ili majina yako yasitumike na iwe siri. Taarifa utakayotupa pia itakua ya siri na hakuna atakayeyatumia baada ya udadisi huu kwa sababu nitayachoma baada ya utafiti.

Katika utafiti huu, Joan Kimetto na watu wake wanawezakutumia taarifa yako lakini itakua ni kwa ajili ya utafiti tu. Tunaweza kutumia taarifa hiyo pamoja na:

- The National Bioethics. Committee,
- The Institutional Review and Ethics Committee

### **SEHEMU II B: Kibali**

Nimesoma na kuelewa marelezo kuhusu utafiti huu. Mdadisi ameeleza vyema na kujibu maswali ninazo kwa sasa. Nimeelezwa kuhusu hatari, na manufaa ya akushiriki katika utafiti huu. Nakubali kushiriki kwa hiari yangu mwenyewe

|                  |        |              |
|------------------|--------|--------------|
| _____            | _____  | _____        |
| Jina la mshiriki | Sahihi | Tarehe & saa |

|                 |                      |
|-----------------|----------------------|
| _____           | _____                |
| Jina la shahidi | Uhusiano na mshiriki |

|                               |        |        |
|-------------------------------|--------|--------|
| _____                         | _____  | _____  |
| Jina la mwenye kupokea ridhaa | Sahihi | Tarehe |

|                 |                   |        |
|-----------------|-------------------|--------|
| _____           | _____             | _____  |
| Jina la mdadisi | Sahihi ya mdadisi | Tarehe |

**APPENDIX III: QUESTIONNAIRE****Date**.....**Code**.....**Time**.....

Please answer the following questions by putting a tick on the appropriate answer.

| <b>SECTION A: SOCIO-DEMOGRAPHIC AND ECONOMIC DATA</b>         |                                                                                                                                                           |                  |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
|                                                               | <b>Response</b>                                                                                                                                           | <b>Code</b>      |
| 1.Age (years)                                                 |                                                                                                                                                           |                  |
| 2. Place of residence                                         |                                                                                                                                                           |                  |
| 3.Gender                                                      | <input type="checkbox"/> Male<br><input type="checkbox"/> Female                                                                                          | 1<br>2           |
| 4. Marital status                                             | <input type="checkbox"/> Single<br><input type="checkbox"/> Married<br><input type="checkbox"/> Widowed<br><input type="checkbox"/> Divorced/Separated    | 1<br>2<br>3<br>4 |
| 5. Religion                                                   | <input type="checkbox"/> Muslim<br><input type="checkbox"/> Christian<br><input type="checkbox"/> Others Specify.....                                     | 1<br>2<br>3      |
| 6. Residence (Urban or Rural)                                 | <input type="checkbox"/> Urban<br><input type="checkbox"/> Rural                                                                                          | 1<br>2           |
| 7. Level of Education<br><br>(choose one from the categories) | <input type="checkbox"/> None<br><input type="checkbox"/> Primary school<br><input type="checkbox"/> Secondary school<br><input type="checkbox"/> College | 1<br>2<br>3<br>4 |

|                                                             |                                                                                                                                                                                                      |                       |
|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
|                                                             | <input type="checkbox"/> Tertiary/University                                                                                                                                                         | 5                     |
| 8. Occupation (choose one from the categories)              | <input type="checkbox"/> Unemployed<br><input type="checkbox"/> Business person<br><input type="checkbox"/> Farmer<br><input type="checkbox"/> Employed as _____<br><input type="checkbox"/> Retired | 1<br>2<br>3<br>4<br>5 |
| 9. Monthly Income in Kshs (choose one from the categories). | <input type="checkbox"/> Below 5,000<br><input type="checkbox"/> 5,001 – 20,000<br><input type="checkbox"/> Above 20,001                                                                             | 1<br>2<br>3           |
| 10. What type of house do you live in?                      | <input type="checkbox"/> Permanent<br><input type="checkbox"/> Semi Permanent<br><input type="checkbox"/> Temporary                                                                                  | 1<br>2<br>3           |
| <b>Section B. Health related data</b>                       |                                                                                                                                                                                                      |                       |
| 11. Blood pressure                                          | Systolic_____/Diastolic_____.(mmHg)                                                                                                                                                                  |                       |
| 12. FPG and HbA1c                                           | _____(mmol/l) _____%                                                                                                                                                                                 |                       |
| 13. Body weight                                             | _____(Kg)                                                                                                                                                                                            |                       |
| 14. Height                                                  | _____(M)                                                                                                                                                                                             |                       |
| 15. Body mass Index                                         | _____                                                                                                                                                                                                |                       |

|                                                                                                                     |                                                                                                                                                                                                        |                              |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| 16. Have you ever been found to have high blood glucose? a health examination, during an illness, during pregnancy) | <input type="checkbox"/> Yes<br><br><input type="checkbox"/> No                                                                                                                                        | 1<br><br>2                   |
| 17. Have you been diagnosed with high blood pressure?                                                               | <input type="checkbox"/> Yes<br><br><input type="checkbox"/> No                                                                                                                                        | 1<br><br>2                   |
| 18. Do you have family member with diabetes?                                                                        | <input type="checkbox"/> Yes<br><br><input type="checkbox"/> No                                                                                                                                        | 1<br><br>2                   |
| 19. Do you smoke cigarettes?                                                                                        | <input type="checkbox"/> Yes<br><br><input type="checkbox"/> No<br><br><input type="checkbox"/> Yes but stopped                                                                                        | 1<br><br>2<br><br>3          |
| 20. Do you take alcohol?                                                                                            | <input type="checkbox"/> Yes<br><br><input type="checkbox"/> No<br><br><input type="checkbox"/> Yes but stopped                                                                                        | 1<br><br>2<br><br>3          |
| 21. Do you take part in any physical exercise for 30 minutes daily?                                                 | <input type="checkbox"/> Yes<br><br><input type="checkbox"/> No (If No go to (b))                                                                                                                      | 1<br><br>2                   |
| b) Why?                                                                                                             | <input type="checkbox"/> I don't have time<br><br><input type="checkbox"/> I don't like exercises<br><br><input type="checkbox"/> Health reasons<br><br><input type="checkbox"/> Others (specify)..... | 1<br><br>2<br><br>3<br><br>4 |
| 22. How often do you take fruits?                                                                                   | <input type="checkbox"/> Daily<br><br><input type="checkbox"/> Not daily                                                                                                                               | 1<br><br>2                   |

|                                                                          |                                                                                                                                                                                               |                  |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 23. How often do you take vegetables?                                    | <input type="checkbox"/> Daily<br><input type="checkbox"/> Not daily                                                                                                                          | 1<br>2           |
| 24. Which treatment drugs are you currently using? (Tick all that apply) | <input type="checkbox"/> Lipid lowering drugs (Statins etc)<br><input type="checkbox"/> Anti-hypertensives<br><input type="checkbox"/> ARVs<br><input type="checkbox"/> Others (specify)..... | 1<br>2<br>3<br>4 |

## APPENDIX IV: DODOSO

**Kisukari kisichojulikana na sababu zake miongoni mwa wagonjwa wanaofanyiwa upasuaji wa hiari katika Hospitali Ya Rufaa Ya Moi, Eldoret**

Tafadhali jibu maswali haya kwa kuweka sahihi kwa jibu bora kwako

| <b>SEHEMU A: Demografia na uchumi</b> |                                           |             |
|---------------------------------------|-------------------------------------------|-------------|
|                                       | <b>Jibu</b>                               | <b>Kodi</b> |
| 1. Umri (miaka)                       |                                           |             |
| 2. Makaazi                            |                                           |             |
| 3. Jinsia                             | <input type="checkbox"/> Mwanaume         | 1           |
|                                       | <input type="checkbox"/> Mwanamke         | 2           |
| 4. Hali ya ndoa                       | <input type="checkbox"/> Sijaoa/sijaolewa | 1           |
|                                       | <input type="checkbox"/> Nimeoa/olewa     | 2           |
|                                       | <input type="checkbox"/> Mjane            | 3           |
|                                       | <input type="checkbox"/> Tuliachana       | 4           |
| 5. Dini                               | <input type="checkbox"/> Muislamu         | 1           |
|                                       | <input type="checkbox"/> Mkristo          | 2           |
|                                       | <input type="checkbox"/> Nyinginezo.....  | 3           |
| 6. Makaazi-Mjini au mashinani         | <input type="checkbox"/> Mjini            | 1           |
|                                       | <input type="checkbox"/> Mashambani       | 2           |
| 7. Kiwango cha elimu                  | <input type="checkbox"/> Sijaenda shule   | 1           |
|                                       | <input type="checkbox"/> Shule ya msingi  | 2           |
|                                       | <input type="checkbox"/> Sekondari        | 3           |
|                                       | <input type="checkbox"/> Koleji           | 4           |

|                                                                                                          |                                                                                                                                                                                                             |                       |
|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
|                                                                                                          | <input type="checkbox"/> Elimu ya juu                                                                                                                                                                       | 5                     |
| 8. Kazi                                                                                                  | <input type="checkbox"/> Sijaajiriwa<br><input type="checkbox"/> Mwanabiashara<br><input type="checkbox"/> Mkulima<br><input type="checkbox"/> Nimeajiriwa kama.....<br><input type="checkbox"/> Nimestaafu | 1<br>2<br>3<br>4<br>5 |
| 9. Mshahara wako kwa mwezi                                                                               | <input type="checkbox"/> Chini ya 5,000<br><input type="checkbox"/> 5,001 – 20,000<br><input type="checkbox"/> Zaidi ya 20,001                                                                              | 1<br>2<br>3           |
| 10. Aina ya nyumba unayoishi                                                                             | <input type="checkbox"/> Ya kudumu kabisa<br><input type="checkbox"/> Ya kudumu kidogo tu<br><input type="checkbox"/> Isio ya kudumu                                                                        | 1<br>2<br>3           |
| <b>Section B. Health related data</b>                                                                    |                                                                                                                                                                                                             |                       |
| 11. Blood pressure                                                                                       | Systolic____./Diastolic____.(mmHg)                                                                                                                                                                          |                       |
| 12. FPG na HbA1c                                                                                         | _____(mmol/l) _____%                                                                                                                                                                                        |                       |
| 13. Kilo                                                                                                 | _____(Kg)                                                                                                                                                                                                   |                       |
| 14. Urefu                                                                                                | _____(M)                                                                                                                                                                                                    |                       |
| 15. Body mass Index                                                                                      | _____                                                                                                                                                                                                       |                       |
| 16. Je, umepatikana kua na sukari iliyo juu kwa damu?<br>(hospitalini ukiwa mgonjwa ama ukiwa mja mzito) | <input type="checkbox"/> Ndio<br><input type="checkbox"/> La                                                                                                                                                | 1<br>2                |

|                                                                          |                                                          |   |
|--------------------------------------------------------------------------|----------------------------------------------------------|---|
| 17. Je, umewahipatika kua na shinikizo la damu?                          | <input type="checkbox"/> Ndio                            | 1 |
|                                                                          | <input type="checkbox"/> La                              | 2 |
| 18. Kuna mtu katika familia yenyu mwenye ugonjwa wa kisukari?            | <input type="checkbox"/> Ndio                            | 1 |
|                                                                          | <input type="checkbox"/> La                              | 2 |
| 19. Je, unavuta sigara?                                                  | <input type="checkbox"/> Ndio                            | 1 |
|                                                                          | <input type="checkbox"/> La                              | 2 |
|                                                                          | <input type="checkbox"/> Nilikua mvutaji lakini nilikoma | 3 |
| 20. Je, wewe hunywa pombe ?                                              | <input type="checkbox"/> Ndio                            | 1 |
|                                                                          | <input type="checkbox"/> La                              | 2 |
|                                                                          | <input type="checkbox"/> Nilikua mlevi nikaacha          | 3 |
| 21. a) Je, unashiriki mazoezi yoyote ya kimwili kwa dakika 30 kila siku? | <input type="checkbox"/> Ndio                            | 1 |
|                                                                          | <input type="checkbox"/> La (Kama La, nenda (b))         | 2 |
| b) Mbona hushiriki?                                                      | <input type="checkbox"/> Sina wakati                     | 1 |
|                                                                          | <input type="checkbox"/> Sipendi mazoezi                 | 2 |
|                                                                          | <input type="checkbox"/> Kwa sababu ya kiafya            | 3 |
|                                                                          | <input type="checkbox"/> Nyingine.....                   | 4 |
| 22. Unakula matunda vipi?                                                | <input type="checkbox"/> Kila siku                       | 1 |
|                                                                          | <input type="checkbox"/> Sio kila siku                   | 2 |
| 23. a) Unakula mboga vipi?                                               | <input type="checkbox"/> Kila siku                       | 1 |
|                                                                          | <input type="checkbox"/> Sio kila siku                   | 2 |

|                                      |                                                             |   |
|--------------------------------------|-------------------------------------------------------------|---|
| 24. Je, unatumia tiba gani kwa sasa? | <input type="checkbox"/> Lipid lowering drugs (Statins etc) | 1 |
|                                      | <input type="checkbox"/> Anti-hypertensives                 | 2 |
|                                      | <input type="checkbox"/> ARVs                               | 3 |
|                                      | <input type="checkbox"/> Nyingine.....                      | 4 |

## **APPENDIX V: STUDY PROCEDURES**

### **Procedure for measuring height.**

The height of participants will be taken to help calculate the body mass index (BMI), which is the weight relative to the height. The height will be measured with a Mechanical roll-up measuring tape (Seca 260) with wall attachment in the nursing station.

Below are the steps that will be followed in measuring height:

1. The participant will be asked to remove their footwear (shoes, slippers, sandals, etc) and head gear (hat, cap, hair bows, comb, ribbons, etc). However, those with a scarf or veil shall not be asked to remove them (measurement may be taken over light fabric).
2. Participant will be asked stand next to the measuring board/wall facing the research assistant/ investigator.
3. Participant will be asked to stand with: feet together, heels against the measuring board/wall, knees straight.
4. Participant will be asked to look straight ahead and not tilt their head up.
5. The research assistant/ investigator will make sure eyes are the same level as the ears.
6. The measure arm will be moved gently down onto the head of the participant and the participant asked to breathe in and stand tall.
7. The height will be read in centimeters at the exact point.
8. The participant will be asked to step away from the measuring board/wall.
9. The height measurement in centimeters will be recorded in the participant's pro-forma.

**Procedure for measuring weight.**

The weight of participants will be taken to help calculate the body mass index (BMI), which is the weight relative to the height. The weight will be measured with a 762 Dial Bathroom Floor Scale at the nursing station.

Below are the steps that will be followed in measuring weight:

1. The scale will be placed on a firm, flat surface.
2. Participant will be asked to remove their footwear (shoes, slippers, sandals, etc).
3. The participant will be asked to step onto scale with one foot on each side of the scale.
4. Participant will be asked to: stand still, face forward, place arms on the side and wait until they will be asked to step off.
5. The weight in kilograms will be recorded on the participant's pro-forma.
6. The participant will be asked to step off the scale.

**Procedure for measuring Blood pressure.**

Blood pressure will be taken using an Omron M2 compact upper arm blood pressure (BP) monitor (Omron Healthcare, Inc., 1200 Lakeside Drive, Bannockburn, Illinois 60015). The patients will be required to have had at least 15 minutes of rest in a quiet place and in a relaxed sitting position with no tight-fitting clothing on the upper arm, or any thick clothing such as a sweater.

**Steps that will be followed:**

1. Participant will be seated upright with the back straight and right arm placed on the table so that the cuff will be on the same level as the heart.
2. Cuff will be wrapped on the arm so that the bottom of the cuff will be at least 1cm above the elbow. The cuff will then be fastened snugly.
3. Start button will then be pressed and the cuff will automatically inflate to take the blood pressure reading.

4. Blood pressure and pulse rate results will be displayed on the on the screen of the machine.
5. Blood pressure readings will be recorded on the pro-forma.
6. Should an error occur during the process, the cuff will be deflated and the process repeated.
7. High blood pressure readings (Systolic BP >140mmHg and Diastolic BP >90mmHg) will be confirmed manually using a mercury sphygmomanometer.

**Procedure for drawing finger stick blood.**

Finger stick blood will be drawn for HbA1c measurement. The procedure will be explained to the participant and verbal consent obtained. Universal safety procedures will be observed. Finger stick blood will be drawn from the second or third finger of the less dominant hand.

Below is an overview of the steps that will be followed:

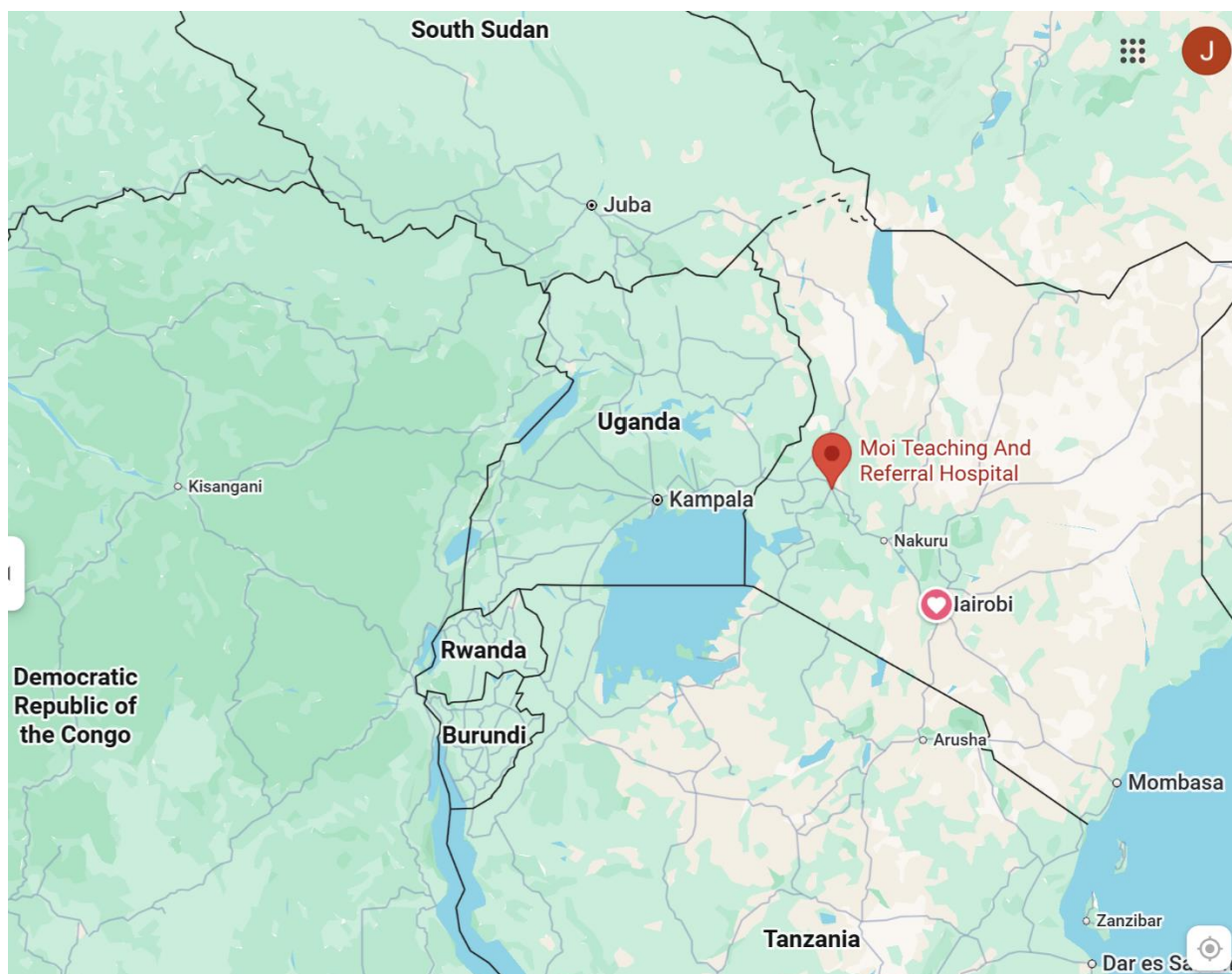
1. Finger and site selected.
2. Finger cleaned with alcohol/methylated spirit and allowed to air dry to decrease hemolysis and not alter glucose results.
3. Spring activated lancet applied to finger and a little puncture is made.
4. First drop of blood wiped away.
5. Approximately 4 drops of blood (35µL) is collected using a capillary tube.
6. An adhesive bandage is placed on the small puncture.

**Procedure for measuring HbA1c.**

Finger stick blood will be drawn according to the procedure outlined above.

1. Using the capillary tube, the whole blood is transferred to a DCA HbA1c immunoassay test cartridge for use with the DCA vantage analyzer.
2. The DCA vantage analyzer will be calibrated using a provided calibrator.

3. The Cartridge containing the sample will then loaded into the analyzer.
4. The analyzer will automatically run the test and give results within 6 minutes.
5. The results will be displayed on the screen as a percentage with ranges from 2.5% to 14%.
6. A command will then be pressed on the machine to print out the displayed results

**APPENDIX VI: LOCATION OF MOI TEACHING AND REFERRAL HOSPITAL**

Source - Google Maps. (2026). *Moi Teaching and Referral Hospital, Eldoret, Kenya*. Retrieved from Google Maps.

## APPENDIX VII: APPROVALS TO CONDUCT STUDY



MOI TEACHING AND REFERRAL HOSPITAL  
P.O. BOX 3  
ELDORET  
Tel: 334711/2/3

Reference: IREC/2017/87  
**Approval Number: 0001986**

Ms. Joan Kimeto  
Moi University,  
School of Public Health,  
P.O. Box 4606,  
**KISII- KENYA**

Dear Ms. Kimeto,

### RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

***"Prevalence of Undiagnosed Diabetes Mellitus and Its Determinants among Patients Presenting for Elective Surgery at Moi Teaching and Referral Hospital, Eldoret Kenya."***

Your proposal has been granted a Formal Approval Number: **FAN: IREC 1986** on 21<sup>st</sup> November, 2017. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 20<sup>th</sup> November, 2018. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

*For Prof. E.O. Were*

**PROF.E.O.WERE**  
**CHAIRMAN**

**INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE**

cc    CEO    -    MTRH    Principal    -    CHS    Chairman - COBES



MOI UNIVERSITY  
COLLEGE OF HEALTH SCIENCES  
P.O. BOX 4606  
ELDORET

21<sup>st</sup> November, 2017





MOI TEACHING AND REFERRAL HOSPITAL  
P.O. BOX 3  
ELDORET  
Tel: 334711/2/3

Reference: IREC/2017/87  
**Approval Number: 0001986**

Ms. Joan Kimeto,  
Moi University,  
School of Public Health,  
P.O. Box 4606-30100,  
**ELDORET-KENYA.**

Dear Ms. Kimeto,

**RE: CONTINUING APPROVAL**

The Institutional Research and Ethics Committee has reviewed your request for continuing approval to your study titled:-

***"Prevalence of Undiagnosed Diabetes Mellitus and Its Determinants among Patients Presenting for Elective Surgery at Moi Teaching and Referral Hospital".***

Your proposal has been granted a Continuing Approval with effect from 3<sup>rd</sup> December, 2019. You are therefore permitted to continue with your study.

Note that this approval is for 1 year; it will thus expire on 2<sup>nd</sup> December, 2020. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

**PROF. E. WERE**  
**CHAIRMAN**  
**INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE**

|     |           |   |      |      |   |     |
|-----|-----------|---|------|------|---|-----|
| cc: | CEO       | - | MTRH | Dean | - | SOD |
|     | Principal | - | CHS  | Dean | - | SPH |
|     | Dean      | - | SOM  | Dean | - | SON |



MOI UNIVERSITY  
COLLEGE OF HEALTH SCIENCES  
P.O. BOX 4606  
ELDORET  
Tel: 334711/2/3  
3<sup>rd</sup> December, 2019





MOI TEACHING AND REFERRAL HOSPITAL  
P.O. BOX 3  
ELDORET  
Tel: 334711/2/3

# INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)



MOI UNIVERSITY  
COLLEGE OF HEALTH SCIENCES  
P.O. BOX 4606  
ELDORET  
Tel: 334711/2/3  
3<sup>rd</sup> December, 2020

Reference: IREC/2017/87

Approval Number: 0001986

Ms. Joan Kimeto,  
Moi University,  
School of Public Health,  
P.O. Box 4606-30100,  
ELDORET-KENYA.



Dear Ms. Kimeto,

## RE: CONTINUING APPROVAL

The Institutional Research and Ethics Committee has reviewed your request for continuing approval to your study titled:-

***"Prevalence of Undiagnosed Diabetes Mellitus and Its Determinants among Patients Presenting for Elective Surgery at Moi Teaching and Referral Hospital".***

Your proposal has been granted a Continuing Approval with effect from 3<sup>rd</sup> December, 2020. You are therefore permitted to continue with your study.

Note that this approval is for 1 year; it will thus expire on 2<sup>nd</sup> December, 2021. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

**DR. S. NYABERA**  
DEPUTY-CHAIRMAN  
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

|     |           |   |      |      |   |     |
|-----|-----------|---|------|------|---|-----|
| cc: | CEO       | - | MTRH | Dean | - | SOD |
|     | Principal | - | CHS  | Dean | - | SPH |
|     | Dean      | - | SOM  | Dean | - | SON |



An ISO 9001:2015 Certified Hospital



## MOI TEACHING AND REFERRAL HOSPITAL

Telephone: (+254) 053-2033471/2/3/4  
 Mobile: 722-201277/0722-209795/0734-600461/0734-683361  
 Fax: 053-2061749  
 Email: [ceo@mtrh.go.ke](mailto:ceo@mtrh.go.ke)/directorsofficemtrh@gmail.com

Nandi Road  
 P.O. Box 3 - 30100  
 ELDORET, KENYA

Ref: ELD/MTRH/R&P/10/2/V.2/2010

16<sup>th</sup> January, 2018

Ms. Joan Kimeto,  
 Moi University,  
 School of Public Health,  
 P.O. Box 4606-30100,  
ELDORET-KENYA.

### APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:-

**"Prevalence of Undiagnosed Diabetes Mellitus and Its Determinants among Patients Presenting for Elective Surgery at Moi Teaching and Referral Hospital, Eldoret Kenya".**

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

*16/01/2018*  
**DR. WILSON K. ARUASA**  
 CHIEF EXECUTIVE OFFICER  
 P.O. Box 3 - 30100, ELDORET  
MOI TEACHING AND REFERRAL HOSPITAL

MOI TEACHING AND REFERRAL HOSPITAL  
 CEO  
 APPROVED  
 16 JAN 2018

cc - DCEO, (CS)  
 - Director of Nursing Services (DNS)  
 - HOD, HRISM

*All correspondence should be addressed to the Chief Executive Officer  
 Visit our Website: [www.mtrh.go.ke](http://www.mtrh.go.ke)*

**A WORLD CLASS TEACHING AND REFERRAL HOSPITAL**