RELATIONSHIP BETWEEN ABO, RHESUS D BLOOD GROUPS AND DIABETES MELLITUS IN PATIENTS ATTENDING KANDARA LEVEL 4 HOSPITAL IN MURANGA COUNTY, KENYA.

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCES IN MEDICAL LABORATORY DEGREE IN HAEMATOLOGY AND BLOOD TRANSFUSION OF MOUNT KENYA UNIVERSITY.

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DECLARATION

The research thesis I am submitting is entirely my own work and has not been previously submitted for a degree at any other university or for any other recognition.

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DEDICATION

This thesis is dedicated to anyone interested in learning about connection between ABO and rhesus D blood types and diabetes mellitus at Kandara level 4 Hospital.

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ABSTRACT

Blood is categorised into types depending on the presence or absence of antigens on the red blood cell surface. Currently, there are four blood groups: A, B, AB, and O. In addition to blood grouping, blood can be classed as rhesus negative or positive based on the lack or presence of a protein on the surface of red blood cells known as the rhesus D antigen. Diabetes is one of the four most common non-communicable diseases, accounting for around 4 million deaths globally. Diabetes is classified into three types: T1DM, T2DM, and GDM. DM is a group of disorders that impact how the body processes blood glucose. Gestational diabetes is described as varying degrees of glucose intolerance that develops during pregnancy.To yet, there is insufficient evidence linking the ABO and rhesus D blood groups to diabetes mellitus. The link between ABO blood type distribution and diabetes mellitus is always ambiguous because no diseases have been linked to a lack of ABO blood group antigen expression. The link between ABO, rhesus D bloodtypes, and diabetes mellitus was investigated at Kandara Sub-County Hospital in Murang'a County. Participants in the study were recruited at random from individuals with high blood sugar levels. The subjects' blood groups and sugar levels were determined using Anti A, Anti B, and Anti D sera and a Ceracheck glucometer, respectively. The data from this study was documented on an Excel Spread Sheet and analysed with SPSS version 20. The frequency, mean, median, and standard deviation of blood groups as well as blood sugar levels were calculated. A correlation analysis was performed to investigate the association between blood types, the rhesus factor, and diabetes. The majority of diabetic patients were female (69.4%), with 30.6% being male. The age range was 2 to 85 years, with a mean of 30.97. Blood group O+ had the highest occurrence in both male and female diabetic patients, at 47% and 51% respectively. However, the prevalence of blood groups did not differ substantially between male and female diabetes patients ($F(1, 14) = 1.20$, $p=0.29$). The study individuals' glucose concentrations ranged from 7 mmol/L to 17 mmol/L. The mean glucose levels ranged from 7.5 to 12.95 mmol/l among diabetes individuals of diverse ages. Females aged 61-65 years had the highest mean glucose levels (14.9mmol/l).Males aged 26-30 had the highest mean glucose levels (13.3 mmol/l). However, there was no significant difference in glucose concentrations between male and female diabetes patients throughout the age groups ($t15=1.10$, $p=0.287$). Diabetic patients with blood group AB+ had the highest blood sugar level of 11.21 mmol/L. However, blood sugar concentrations in male and female diabetic patients did not change substantially among age groups ($t6=0.27$, $p=0.79$). The Pearson correlation coefficient was $R=0.24$, $SE=0.45$, 95% CI, $p>0.05$. This implies that there is no link between blood groups and blood sugar levels, with the blood group effect accounting for 5% of the variation in blood sugar level.It is established that there is no link between diabetes and ABO blood groups, and persons with Group- AB+ are more likely to develop the condition.

Key words: Blood group; Rhesus D; Diabetes.

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LIST OF ABBREVIATIONS

AHG- Anti-human globulin

ADA- American diabetes association

CDC- Centers for Disease Control

CHS-Centre for health solutions

DKA- Diabetic Ketoacidosis

FBS- Fasting blood sugar

GDM- Gestational Diabetes Mellitus

MFMER- Mayo Foundation for Medical Examination and Research

IDF- International diabetes federation

NIHCE- National Institute for Health and Clinical Excellence

MDG- Milleniun 21 Development Goals

NICE- National Institute for Clinical Excellence

NACOSTI- National Commission For Science, Technology and

InnovationNIDDK- National Institute of Diabetes and Digestive and

Kidney Diseases

(-) Negative

OPD- Out-patient department

(+) Positive

RBS- Random blood sugar

RBC- Red blood cells

RBS- Random blood sugar

RhD positive- Rhesus D positive

RhD negative- Rhesus D negative

T1DM- Type 1 Diabetes Mellitus

T2DM- Type 2 Diabetes Mellitus

WHO- World Health Organization

Mg/dl- Milligrammes per deciliter

MMOL- Minimoles per litre

CHAPTER ONE

INTRODUCTION

1.1Background Information

The ABO blood group classification usually identifies blood types according to the diverse kinds of antigens in the RBC's and antibodies in the plasma (Li, 2020). (A, B, AB, O) are the four types of blood groups which are classified according to availability or lack of antibodies and antigens on red blood cells surfaces (Nazario, 2020). In addition, rhesus D antigen which is a protein can be present on surface of RBC (WHO, 2012). Individuals with this protein are referred to as Rhesus D positive. This makes an individual to have either of the following blood groups: A rhesus D positive (A+), A rhesus D negative (A-), B rhesus D positive (B+), B rhesus D negative (B-), O rhesus D positive (O+), O rhesus D negative (O-), AB rhesus D positive (AB+) and AB rhesus D negative (AB-) (Davis, 2008).

Rhesus D antigen system together with ABO blood group system are used to investigate which blood type will be suitable for a safe red blood cell transfusion (Khan, 2010). O negative blood type (universal blood donor type) has the lowest risk of producing serious reactions for most people who obtain it in any immune deficient infants and emergency transfusions (Rajiv, 2020). O negative red blood cells may be given to anybody, if the condition is dangerous or the identical blood type is in insufficient amount during emergency cases. Blood donors with type AB positive blood group are termed as universal recipients because they accept red blood cells from any blood type and only give blood to a person with the same blood type. Blood donors with type AB negative blood type are universal plasma donors and can donate plasma to any other blood types (Berkley, 2021).

In terms of prevalence a Study by Jun, (2020) stated that the worldwide prevalence of

blood groups A, B, AB and O were 31.90%, 24.14%, 8.42% and 35.54% respectively. About 85% of the United Kingdom populace is Rhesus D positive (36% of the populace has O+, the most prevalent group). Around the continent the distribution in Belgium was A, B, AB and 0 blood groups was 37%,9%,3.0% and 6.0% respectively (Croix, 2010), Australia as 32.0%,12.0%,4.0% and 38.0% (Roteskreuz, 2011), Brazil as 34.0%,8%,25% and 36% (Sanguineos, 2013) and Russia as 25.2%,21.28%,4.2% and 45.6% respectively (Krasnoyarsk regional blood center, 2021).

In Africa, the prevalence of blood groups stands as: blood group A (24.6%); blood group B (20.7%); blood group AB (4.5%) and blood group O (50.3%) (Edgar, 2016). In Kenya the prevalence of blood groups stands as A-26.2, B-22.0, AB-4.4 and O-47.4 with Rhesus D positive blood group accounting up to 96.1% (Githiomi, 2017). In Murang'a County the prevalence of blood groups stands at D (positive)-0.75% and D (negative)-3.9% (Kaviti, 2018).

Blood sugar is an important component and it determines the healthy condition of the blood. Diabetes is one of the blood sugar related illnesses and is a condition that arises when your blood sugar, is too high. Insulin is a hormone that ensures proper functioning of sugar in the blood. Categories of diabetes mellitus include: i) type 1 diabetes mellitus (T1DM) which occurs when your pancrease doesn't make insulin or makes very little, ii) type 2 diabetes mellitus (T2DM) which results when the body doesn't use insulin properly and iii) GDM occurs during pregnancy in women without diabetes, (CDC, 2017).

A study in African region, reported the average prevalence of diabetes to be at 4.9% in 2013 (Orchard, 2015). Higher Prevalence rates of diabetes were reported in Reunion (15.4%), Seychelles (12.1%) and Gabon (10.7%) (WHO, 2014). In Ethiopia the prevalence of diabetes mellitus stands at 6.5% (Makinen,2016). Previous studies by Kimanzi, (2014) in both rural and urban Kenya found diabetes frequency was at 3.5–5%,

with higher magnitudes amongst those in the urban areas. In Murang'a Countythe prevalence of diabetes stands at 8% (Kamau, 2018).

Diabetes is one of the four main non-communicable illnesses causing about 4 million deaths worldwide (June, 2017). Low-income countries are likely to experience 92% rise in death rate due to diabetes by 2040 (WHO, 2014). Undiagnosed diabetes usually poses a public health concern with expensive community wellbeing consequences specifically in Africa (Gagliardino, 2017). Thus, it is very important to scrutinize the burden and danger implications of diabetes at national level to develop policies and national programs (MOH, 2015). Despite achievements to regulate communicable diseases, health status has deteriorated partly due to the rise of non-communicable diseases (NCDs) leading to 28% of deaths in 2010 with 2% of this in Africa (WHO, 2018).

Diabetes prevalence in Kenya stands at 3.3% and expects to rise to 4.5% by 2025 as estimated by the World Health Organization (WHO, 2020). The WHO Report 2002 estimates globally deaths of 7.1 million people due to blood pressure, 4.4 million deaths due to high cholesterol and 2.6 million deaths due to extreme body mass (IDF, 2007). Diabetes was the 9th principal reason of demise internationally with an estimate of 1.5 million cessation of life and before 70 years of age 48% of losses occurred in 2019(WHO, 2020). There was a 5% rise in premature death rates (i.e. before 70 years of age) in diabetes between 2000 to 2016. A drop in premature mortality rates was observed due to diabetes in high-income countries from 2000 to 2010 but then increased in 2010-2016 (NIDDK, 2017).

Blood group antigens are genetical alleles and they usually play a vital role to comprehend heredity and pre-disposition to illness (Atum, 2017). There has been necessity to find out any probable relation between ABO and rhesus blood groups and different diseases, since

the encounter of blood groups; For example, diabetes has been highly linked with blood group A and B (Waseem, 2012). In addition, association between T1DM, T2DM and GDM with blood groups, especially with A, AB and Rhesus positive blood groups have been reported (Sidhu, 2015).

ABO antigens usually appear on the surface of numerous human cells and tissues, including the epithelium, sensory nerves, platelets, and vascular endothelium together with their appearance on RBCs (WHO, 2014). During the development of different diseases there has been a vital involvement of the ABO and Rh blood group antigens as shown by the ABO and Rh blood group system (Rodgers, 2022). Thus, this study, will figure out the association between ABO and rhesus D blood groups with diabetes mellitus in Murang'a County, Kenya.

1.2. Statement of the Problem.

The frequency and distribution of these blood groups differed distinctly in various ecological zones, races, ethnic and socioeconomic groups. Earlier studies reported conflicting results on the relation between ABO and rhesus D blood groups with diabetes mellitus. Scientists suggested that people suffering from diabetes mellitus were increasing due to socio-demographic factors or genetic changes, socio-demographic factors which contributed to diabetes mellitus included population growth, aging, urbanization, low physical activity and the high prevalence of obesity. Additional to socio-demographic factors, over the past years in the 19th century, researchers found out the relationship between particular blood groups and increased susceptibility to inherited traits and many hereditary diseases included diabetes mellitus (Berhanie, 2020). The ABO and rhesus D blood group system was one of such genetic make-up of an individual that provided much valuable information for each person. However, the association between the distribution of the ABO blood types and diabetes mellitus was always conflicting because no diseases was known to result from the lack of expression of ABO blood group antigens (Mihretie, 2020). For that reason, recommendations were made for larger studies in various ethnic groups. However, to date, the evidence for the association between ABO and rhesus D blood group with diabetes mellitus was still insufficient. Hence, this study was to find out if there's any relation between ABO and rhesus D blood groups with diabetes mellitus in

Muranga County.

1.3. Justification of the study.

This study provides knowledge on relations between ABO, rhesus D blood groups and diabetes mellitus. This knowledge will be very crucial for stakeholders in the management of diabetes: the ministry of health and non-governmental organizations working on diabetes for example Centre for Health Solutions (CHS). This is because, information generated from this study forms a basis for early prevention measures of diabetes. Such measures include counselling on dieting, blood sugar screening, diabetes detection and management thus alleviating on mortalities due to diabetes in Murang'a County.

1.3 Objectives

Broad objective

To determine the relationship between ABO, rhesus D blood groups and diabetes mellitus in MurangaCounty, Kenya.

Specific Objectives

i. To determine prevalence of ABO and rhesus D blood groups in male and female diabetic patients attending Kandara level 4 hospital, Murang'a County.
ii. To determine blood sugars levels of diabetic patients in different age groups attending Kandara level 4 hospital diabetic clinic in Murang'a County.
iii. To determine the relationship between glucose concentrations and blood groups of the study subjects attending Kandara level 4 Hospital, Murang'a County.

1.4 Research Questions

i. What is the prevalence of ABO and rhesus D blood groups in male and female diabetic patients attending Kandara level 4 hospital in Murang'a County?
ii. What is the blood sugars levels of diabetic patients in different age groups attending diabetic clinic at Kandara level 4 Hospital, Murang'a County?
iii. What is the relationship between glucose concentrations and blood groups of the study subjects?

1.5Research limitations

The study has the following limitations:

i. Inadequate research fund limit on the geographical coverage and number of ethnic groups to be sampled.

ii. Selection bias- not everyone was selected for the study only those with high blood sugar levels.

iii. Patients not agreeing to participate in the study (especially under aged children when parents don't consent for them to participate in the study and also some adults not liking the idea of being in a study).

iv. Prevalence of blood groups were affected by geographical distribution, race and ethnicity as well.

1.6 Delimitation

This study included individuals with high blood sugar levels attending diabetic clinic in Kandara level 4 Hospital in Muranga County.

1.7 Null Hypothesis

v. The prevalence of ABO and rhesus D blood groups in male and female is not different in people attending diabetic clinic at Kandara level 4 hospital in Muranga County.

vi. The concentration of blood sugars in different age groups in individuals attending diabetic clinic in Kandara level 4 Hospital, Muranga County?

vii. There is no correlation between ABO, rhesus D blood groups and diabetes mellitus.

1.8 Conceptual Framework

My study's dependent variable was diabetes mellitus (DM) and the independent variable was ABO blood group. The studys'dependent variable were classified into two main groups: socio-demographic parameters that influence diabetes mellitus (e.g.,ageing, urbanization, overweight and low levels of exercise) and medical problems (blood sugar level, diabetes kinds and body mass index).

Dependent variables

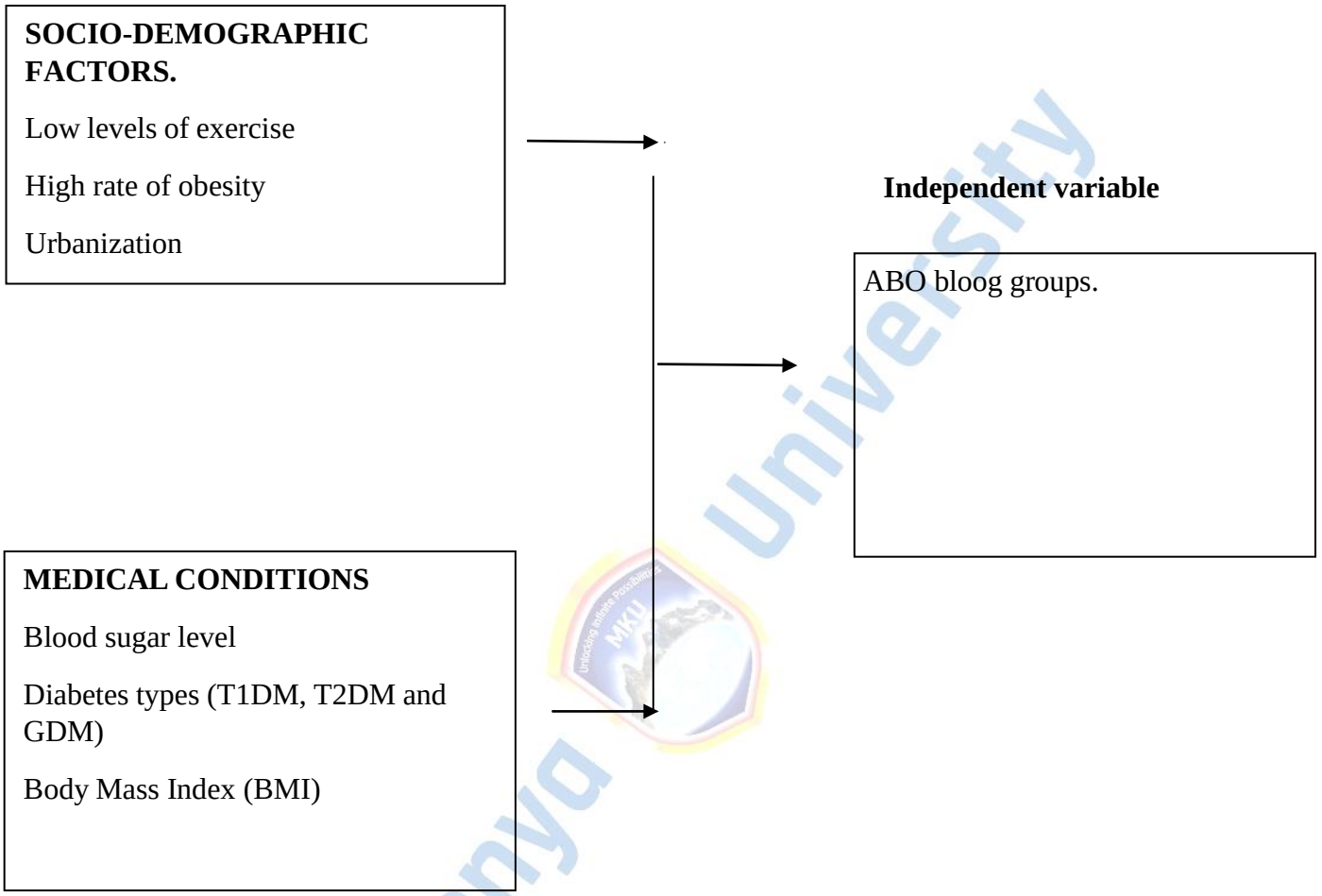

Figure 1.1 Conceptual framework demonstrating the link between study variables.(Berhanie, (2020)).

CHAPTER TWO

LITERATURE REVIEW

2.1. Blood Group ABO

Blood group antigens are amongst the genetical determinants that play an important role to understand inheritances and illness vulnerability (Atum, 2017). RBC's antigens is the base of blood grouping as it comprises of carbohydrates attached to proteins. The most reviewed group is the ABO in the human population out of a hundred blood group systems involved over five hundred antigens (WHO, 2015). But was more than a century ago in 1900 that Karl Landsteiner of the University of Vienna recognized that blood plasma comprises of antibodies targeted to certain antigens and that RBCs comprise of antigens on their surfaces. Studies have shown that the existence of blood groups vary evidently in diverse races, ethnic and socioeconomic groups (MFMER, 2022).

Studies on prevalence of blood groups in the United States stated blood group A as the most predominant blood group at 41% (Roteskreuz, 2006). Similar patterns were reported in Australia (Australian red cross, 2020), Cameroon (Ndoula, 2021), Egypt (Aristocousle, 2017) and in Somalia (Ali, 2020). However, a study in India by Wang, (2012), reported a different prevalence rate with blood group O being the most prevalent at 37.12%. In addition, Wang, (2012) reported a rhesus prevalence of 94.61%.

2.1.1 Why is RH factor Important?

Although it doesn't have an impact on your general health, knowing your Rh status is crucial if you're expecting. Every pregnant person undergoes the Rh factor test in the first trimester of their pregnancy. Thisblood test identifies your Rh factor.

2.1.2 Causes of RH incompatibility.

When a Rh-negative person becomes pregnant with a foetus whose blood type is Rh-positive, this is known as Rh incompatibility. Your immune system produces antibodies in response to this discrepancy, which is referred to as Rh incompatibility. The fetus's red blood cells are attacked by your immune system because these antibodies cause your body to mistake them for alien objects (Rh sensitization). Your healthcare provider for pregnancy can give you an injection of immune globulin to stop this from happening.

Additionally, it may occur during:

a) Amniocentesis and chronic villus sampling (CVS) tests.

b) vaginal bleeding when pregnant

c) Abdominal trauma or injury.

d) Complications from an early pregnancy, such as an ectopic pregnancy or miscarriage.

d) An attempt to turn a breech baby after external cephalic verson (ECV).

e) During labour and delivery, a tiny quantity of the fetus's blood may mix with your own.

2.1.3 Diagnosis of RH incompatibility.

Rh incompatibility is diagnosed via blood test. You will be tested to find out if you're Rh-negative when you become pregnant.

If you are Rh-negative your healthcare practitioner will give you Rh immune globulin to stop the production of antibodies. This usually appears around week 28 of pregnancy,and if the foetus is Rh-positive, it may reappear within 72 hours of delivery. In the early stages of pregnancy, if your doctor thinks your blood has mixed with the fetus's, you might receive a dose.

Rh illness is a serious condition that might endanger the foetus' survival.

The pregnant person is unaffected by Rh incompatibility. In a foetus, it can result in hemolytic anaemia which usually destroys the foetus RBC's faster than it can replace

them. Effects of RH incopatibility include:

a) Jaundice and liver failure.

b) Heart failure.

c) Stillbirth.

In moderate side effects, the foetus may not require treatment, and in most cases, the foetus recover completely. In severe circumstances, the foetus may need a blood transfusion to restore its red blood cells.To avoid significant complications from anaemia, you may need to deliver birth early.

Rh illness has become increasingly rare with the introduction of Rh immunoglobulin injections.

2.2 Types of Diabetes Mellitus

According to WHO, 422 million people worldwide have diabetes mellitus and the figures are on the increasing trend from an anticipated 30 million cases in 1985 to 382 million in 2013. If such trend continues, more than half a billion population of the world will be diabetic by 2035 (WHO, 2018). DiabetesMellitus is seen both in the developed and the developing countries but the incidence is significantly higher in developing world (MFMER, 2022). It is reported that one in every 11 individuals aged between 20 to 79 years old had DM (particularly T2DM). Blood group ‒B‖ has a high association with T2DM and ‒O‖ blood group has a minimum association with T2DM. Blood group ‒A‖ and ‒AB‖ are nearly similarly dispersed in both diabetic and non-diabetic populace (Suraya, 2016).

CDC, (2022) report warns that DM is likely to become a global epidemic by the year 2025. A similar report by WHO, (2018) predicted that there would be 170 % increase in cases of diabetes mellitus in the developing countries from 84 million in 1995 to 224 million by the year 2025. In South East Asia, 72 million people were known to be living with diabetes in 2013 and it has been projected that this number

would reach 123 million by 2035 (National Diabetes Statistics (NDS), 2010). In Nepal, the frequency of diabetes was projected to be 2% in 2000 and has been predicted to affect 10% population by 2030 (Herman, 2020). Some of the factors reported to contribute to the increase in prevalence of diabetes include family history/ hereditary, age, being overweight and unhealthy lifestyle.

According to the American Diabetes Association, 1.25 million U.S. kids and adults have T1DM (Roteskreuz, 2017). T1DM is the commonest endocrine and metabolic disease of childhood (less than 19 years of age in USA) and most commonly associated with chronic autoimmune condition. The disease causes destruction of cells in the pancrease that make insulin, called beta cells and usually affects 90% of childhood and adolescent population. Diagnosis of T1DM is done by finding the evidence of autoimmunity
{presence of anti-islets cell antibodies (ICA) and (IA2) (MFMER, 2022).

Type 2 diabetes mellitus is commonly associated with individuals over 45 years of age, but more and more kids, teenagers, and young adults are also developing it (CDC, 2021). Type 2 diabetes had an impact on around 462 million people equivalent to 6.28% of the world's populace (4.4% of those aged 15–49 years, 15% of those aged 50–69, and 22% of those aged 70+), or an incidence rate of 6,059 cases per 100,000 in 2017 (KHAN, 2017). There will be an upsurge in the worldwide frequency of T2DM to 7,079 people per 100,000 by 2030 as projected, reflecting to a continuous growth across all areas of the world (Abdul, 2020).

GDM is frequently described as glucose intolerance of flexible notch with first recognition during gestationwith frequency increasing at epidemic proportions (Dabelea, 2016). However, reported frequency globally varies between 1 and 45% of pregnancies (Buckley, 2012). The total frequency of gestational diabetes mellitus was 13.2% in America. Frequency rose with age, from 8% to 26% in women aged 45 years or more

(American Diabetes Association (ADA), 2016). The pre-test was most commonly received by younger women; the rate of getting both tests rose with age (Zhang, 2016).

There has been curiosity to learn any likely relations between ABO and rhesus blood groups and variety of illnesses since the detection of blood groups in 1900, for example, type 1 diabetes has been reported to highly linked with blood group A and B (Waseem, 2012; Tanu, (2017).

DM is a chronic disease that affects people all over the world, however it is more prevalent (particularly type 2) in developed countries. Diabetes was predicted to affect 246 million people worldwide in 2007, and without appropriate interventions, the prevalence is expected to climb to 592 million by 2035 (IDF, 2014). Diabetes's increasing occurrence serves as a substantial catalyst for morbidity, premature mortality, and rising health-care expenses (Mayosi et al., 2009).

According to the IDF, global diabetes rates will increase by 54% between 2010 and 2030 (from 284.6 to 438.4 million). This rise is expected to reach 98% in Sub-Saharan Africa (12.1 to 23.9 million) (International Diabetes Federation, 2009). Notably, glucose intolerance is expected to increase by 75.8% in Sub-Saharan countries during the same time period (from 26.9 to 47.3 million). This is double the predicted global growth of 37% (IDF, 2009).

According to the Kenya National Diabetes Strategy (KNDS), the vast majority of diabetics in poor nations are between the ages of 45 and 64. These are the same people who are expected to propel their countries' economies forward in order to meet the agreed-upon worldwide development goals. Diabetes, in addition to reducing productivity, imposes a significant economic burden in terms of healthcare costs, lost output while type 2 diabetes is generally preventable, the prevalence is increasing due to a lack of extensive public health prevention programmes and educational resources (Mayosi et al., 2009). To reduce the burden of diabetes, public health interventions must

be implemented to delay the onset of difficulties (KNDS, 2010). This necessitates significant lifestyle changes for people at risk of diabetes, as well as aggressive treatment for those who already have it. A high-risk approach addressing individuals at risk of diabetes is required, as is a public health approach aiming at reducing diabetes risk factors at the community level (KNDS, 2010).

2.3Impact of Diabetes Mellitus.

According to the Kenya National Diabetes Strategy (KNDS), the great majority of diabetics in developing countries are aged 45 to 64. These are the same people who are expected to drive their countries' economies forward in order to reach the internationally agreed-upon development goals. Diabetes not only reduces productivity but also imposes a significant economic burden in terms of healthcare costs and lost output. According to the World Health Organisation, 8.5% of people aged 18 and up had diabetes in 2014, and diabetes was the direct cause of 1.5 million deaths in 2019, with 48% occurring before the age of 70.

From 2000 to 2019, age-standardized diabetes mortality rates rose by 3%. Diabetes-related mortality has increased by 13% in low- and middle-income countries globally (Global Burden of Diabetes, 2019). Diabetes is responsible for a considerable amount of worldwide health expenses. The growing global diabetes epidemic and associated diabetic complications have devastating financial consequences, particularly in Africa, where patients and families face the majority of the costs (Milovanovic, 2015). Diabetes-related health expenditures were expected to reach $3.3 billion globally in 2017, according to the IDF.

According to projections, Africa will experience the greatest growth in both the burden of diabetes and related diabetic complications, while contributing the least to global diabetes care costs (Rose, 2013). The International Diabetes Federation (IDF) predicted that diabetes-related health-care costs will total $3.3 billion in 2017. In Nigeria, the

national annual direct costs of diabetes are estimated to be between $1.071 billion and $1.639 billion per year, while Cameroon's estimated monthly direct medical costs per individualare $148, and Sudan's direct cost is $175 per year, which only includes the cost of medications and ambulatory care. However, many African countries' diabetes estimating costs may be underestimated dueto a lack of data on the relative contribution of diabetes complications.

According to study in Kenya, the frequency is 4.2% in the general population, 2.2% in rural areas, and 12.2% in urban areas (Dirk, 2009). The diabetes prevalence survey discovered an alarming increase in impaired glucose tolerance, with rates ranging from 8.6% in rural areas to 13.2% in cities. Gender also had an impact on diabetes prevalence in Kenya, where 60.3% of women and 19.5% of males live in metropolitan areas. In rural areas, diabetes affected 22.6% of women and 10% of men (Christensen, 2009).

Diabetes mellitus is prevalent in some rural areas of the country, such as Nyeri in central Kenya and Kilifiin the coast region, with more than 20% among the wealthier households in the major urban centres.

2.4 Classification and Pathophysiology of Diabetes Mellitus.

Diabetes mellitus was marked by its complicated pathophysiology and varied appearance. The new classification was based on both disease etiology and pathophysiology, and it was useful for clinicalassessment and treatment selection. Diabetes is classified into three types: type 1 diabetes mellitus (T1DM), type 2 diabetes, and gestational diabetes.

Type 1 diabetes mellitus is an autoimmune disorder in which T-cells destroy pancreatic β-cells, resulting in insulin deficiency and hyperglycemia (Skylar, 2017). The pathogenesis of this autoimmune disorder wasrevealed to be influenced by both inherited and environmental factors. Michels (2015) discovered that pancreatic β-cell-specific

autoimmunity may develop swiftly in infants and children (juvenile onset) or gradually in adults (late onset).

The immune system's rate of pancreatic β-cell death is a key factor in disease progression. Children and adolescents may have sudden β-cell loss and failure, resulting in diabetic ketoacidosis (DKA), which is generally the first indication of the condition. Even in adults, β-cells can release enough insulin to preventketoacidosis for years (Grossman, 2015). However, due to progressive insulin deficiency, these people become insulin-dependent, culminating in severe hyperglycemia and ketosis.

Type 2 diabetes mellitus, also known as non-insulin-dependent diabetic mellitus (NIDDM) or adult-onset diabetes, accounts for roughly 90-95% of all diabetes cases. This type of diabetes is defined by two insulin-related issues: insulin resistance and β-cell dysfunction (Newguarg, 2008). Insulin resistance is induced by the breakdown of many cellular pathways, which results in a reduced response or sensitivity of cells in peripheral tissues, notably muscle, liver, and adipose tissue, to insulin. In the early stages of the disease, low insulin sensitivity caused hyperfunction of β-cells, resulting in increased insulin production to maintainnormoglycemia.

Higher levels of circulating insulin (hyperinsulinemia) aid to prevent hyperglycemia. However, increased insulin release from β-cells did not fully compensate for the loss of insulin sensitivity. Furthermore, β-cell activity decreases, leading to insulin insufficiency. As a result, normoglycemia cannot be maintained, andhyperglycemia develops.

Despite reduced insulin levels, insulin production is usually enough to avoid DKA (Muoio, 2008). Certainmedications, including sodium-glucose co-transporter-2 (SGLT2) inhibitors, corticosteroids, and atypical antipsychotics (second-generation antipsychotics), can also cause DKA (Fadini, 2017). The pathophysiology of this kind of diabetes is complex, involving multiple known and unknown factors, and may be definitively described as a combination of genetic (polygenic) predispositions and

significant environmental influences.

T2DM is more commonly associated with advanced age, obesity, a family history of diabetes, physical inactivity, and the adoption of modern lifestyles. The high prevalence of T2DM in the aforementioned racial or ethnic groups, as well as its strong relationship with first-degree blood relatives, suggest that genetic variables play a role in the disease's aetiology, but these factors are complex and largely unexplored(Scott, 2008). Unlike T1DM, Zeggini (2008) found no relationship between this illness and immune response genes, including autoimmunity, resulting in no immune-mediated pancreatic β-cell death. Because of its strong link to increased body fat content or obesity, patients with T2DM frequently had other cardiovascular risk factors such as hypertension and lipoprotein metabolic abnormalities characterised by elevated triglycerides and low levels of high-density lipoproteins. In the absence of any substantial physiological stressors, patients with T2DM typically did not require insulin therapy at the timeof illness onset or later in life (Defronzo, 2004).

Gestational diabetes Mellitus is established at the start or during pregnancy, usually in the second or thirdtrimester. During early pregnancy, both fasting and postprandial blood glucose levels are normally lower than normal; nevertheless, blood glucose levels rise during the third trimester of pregnancy, and when theselevels reach diabetic levels, the disease is recognised as GDM (ADA, 2014). GDM accounts for about 90% of all pregnancy-related diabetes and complications. GDM represented for 1% to 14% of all births, and its frequency varied greatly amongst populations evaluated (Wong, 2014).

GDM occurred more frequently in certain racial or ethnic groups than in others, and the effect of ethnicityon GDM risk is large and well-established. Asian Indians had the highest rate of GDM, followed by aboriginal Australians, Middle Easterners (Lebanese, Syrian, Iranian, Iraqi, or Afghan), Filipinos, Pacific Islanders, and Chinese, Japanese, Korean, and Mexican women. Blacks and non-Hispanic white women had lower rates (Yuen 2014).

The risk of GDM rises with age, obesity, previous pregnancy with large kids, and a history of poor glucosetolerance or GDM (Osson 2010). Furthermore, GDM was linked with a greater lifetime risk of developing T2DM. Regular and lifetime monitoring for any sort of glucose impairment was thus strongly advocated toachieve early detection of T2DM in such individuals (Edelstein, 2015).

2.5 Risk factors for Diabetes Mellitus (DM) include

i. **Weight**.

Being overweight and a person's fatty tissue makes their cells more insulin-resistant, increasing their risk of diabetes (Tuei et al., 2010).

ii. **Physical inactivity.**

The more inactive a person is, the higher the risk of getting T2DM. to in

iii. **Family history.**

If a parent or sibling has DM, the chances of developing it increases.

iv. **Race.**

Anyone who identify's as African American, Asian American, Latino-Hispanic American, NativeAmerican, or Pacific Islander are more likely to get diabetes than others.

v. **Age.**

Diabetes is more prone to develop with age. This is due in part to the fact that as people age, while tend tomove less, lose muscle mass, and acquire weight, but diabetes is also becoming more prevalent among children, adolescents, and young adults (KNDS, 2010).

vi. **Gestational Diabetes.**

If a woman develops gestational diabetes when pregnant, she is more likely to develop pre-diabetes and type 2 diabetes in later life. Concieving a baby weighing more than 4 kilogrammes increasesthe risk of type 2 diabetes in women (KNDS 2010).

vii.Polycystic Ovary Syndrome.

Women with polycystic ovarian syndrome, a ailment marked by unequal menstrual periods and beingoverweight, are more prone to acquire T2DM.

viii.High blood pressure.

Is usually associated to an enlarged danger of diabetes.

Viiii.High cholesterol and triglyceride levels.

Low levels of high-density lipoprotein (HDL), or "best cholesterol," increase the danger of type 2 diabetes. High triglyceride levels are also linked with an amplified risk of developing T2DM (Tuei et al., 2010, Rheeder, 2006.

2.6 Signs and Symptoms of diabetes

DM has three distinct symptoms: polyuria, polydypsia, and polyphagia. Other symptoms include hyperglycemia, glycosuria, genital itching, emaciation, dry mouth, unexplained weight loss, fatigue, blurred vision,headaches, and loss of consciousness (Mollentze, 2012). When severe DM is not treated, coma develops, accompanied by weakness, sweet (acetone) breath odour, nausea, headache, vomiting, dyspnea, a sense of intoxication, delirium, and profound coma, which leads to demise (Dropkin, 2010)

2.7 Health Impact of Diabetes Mellitus

DM usually harms the heart, blood vessels, eyes, kidneys, and nerves.

a) Adults with diabetes have a two- to three-fold increased risk of heart attack and stroke.

b) When paired with decreased blood flow, neuropathy in the feet with raised risk of foot ulcers, infection,and the need for limb amputation.

c) Diabetic retinopathy was a leading source of blindness, arising from long-term destruction to the retina's small blood vessels. It has rendered nearly one million individuals blind.

d) leading source of kidney failure.

e) Usually get more negative outcomes from a variety of viral diseases, including Covid-19.

2.8 Complications of Diabetes

Diabetes patients face a high risk of complications, such as

i) Eye disease.

Diabetic retinopathy develops in direct proportion to the extent of diabetes and the level of blood sugar stabilisation attained. Frequent eye exams and therapy can help stop serious vision complications and blindness led by diabetic retinopathy. Which causes eye destruction and impairs visibility (Tuei et al., 2010).

ii. Kidney disease.

Diabetic nephropathy is a disorder that can damage the kidneys over time. Incase of kidneys failure, toxic leftover products remain in the body, fluids build up, and chemical equilibrium is upset. Controlling your blood glucose levels, receiving regular kidney and blood pressure checks, and living a healthy lifestyle all help to reduce your risk of developing renal problems. Urine testing can detect early symptoms of renal problems, and therapy can prevent further damage (Ogbera, 2006).

iii. Nerve injuries and lower-limb issues.

Diabetes causes progressive neurological deterioration, which can lead to reduced sensation in the hands and feet. Inadequate circulation caused by high blood glucose

impairs regular wound curing in the extremities, allowing minor destruction to remain and progress to irreparable damage. Regular foot inspections and full yearly foot inspections by a clinician can help reduce the frequency of lower limb problems (Ogbera, 2006).

iv. Heart disease and stroke.

Diabetes patients are more likely to develop heart disease and stroke as a result of excessive blood glucose levels (BGLs), which are linked to high blood pressure and cholesterol. According to Mollentze (2012), one-third of diabetics have hypertension or obesity.

v.Sexual Health.

Sexual dysfunction is more common in diabetics because untreated diabetes destroys blood vessels and the nervous system, resulting in decreased blood flow and lack of sensation in sexual organs. Which induces vaginal dryness in women and erectile dysfunction in men (Tui et al., 2010). Other risk factors for diabetes difficulties can be decreased by early detection and management of hypertension, as well as the use of lipid-lowering medicines. Diabetes side effects such as cardiovascular disease, foot problems, eye problems, kidney problems, and neuropathy can be avoided via regular monitoring and early intervention (National Institute for Clinical Excellence, 2008).

2.9 Management of diabetes mellitus

DM therapy aims to decrease symptoms while preventing or reducing the progression of difficulties. Monitoring glycemia and blood pressure decreases risk of microvascular (eye and kidney disease) danger;controlling lipids and hypertension reduces macrovascular (coronary, cerebrovascular, and peripheral vascular) risk; and quitting smoking lowers metabolic and neurologic risk. Diabetes therapy is greatly delivered by a multidisciplinary group of diabetes experts that collaborate closely with patients and their families

(Mollentze, 2012).

Diet management necessitates control and understanding of the variety of nutrients joining the digestive tract, allowing for indirect, considerable control over blood glucose levels (Walker, 2007). Diabetes patients see huge changes in their blood glucose levels as a result of diet control, and some can completely regulate the condition with dietary 17 adjustment. Diabetes can lead to a variety of issues, thusits critical to keep blood sugar levels as close to normal as possible, and food is the most significant aspect in achieving this degree of control (Ono, 2008). As a result, diabetics must limit their caloric intake to whatis required to maintain an ideal weight.

2.9.1 Physical activity or exercise

Usually lowers blood sugar levels by delivering glucose into cells, where it is converted into energy, allowing diabetics to better control their blood glucose levels. During exercise, muscles utilise glucose without insulin, which lowers blood glucose levels. It also enhances insulin sensitivity, which reduces insulin resistance during exercising and allows body cells to use glucose more efficiently. Workouts supports people with type 2 diabetes preventing long-term complications including arteriosclerosis, whichresult to heart attack. Purpose of these activity is to complete at least thirty (30) minutes of cardiovascularworkouts most days of the week. The workouts include walking, running, swimming, and cycling (Knowler et al., 2002).

2.9.2 Blood glucose management.

Refers to diabetics' capacity to maintain normal blood sugar levels (euglycemia) (Adams, 2008). Many of diabetes's long-term complications, notably microvascular difficulties, are the result of years of hyperglycemia (Adams, 2008). A glucose metre is used to measure blood sugar levels, which are expressedin mg/dL. Glucose levels typically vary between 4.5 and 7.0 mmol/L (80 to 125 mg/dL).

Diabetes is best treated by having individuals measure and record their own blood glucose levels. Patients can improve their diabetes treatment by keeping a blood sugar diary while documenting the impact on diet and exercise (Huang et al., 2007). In order to obtain proper dosing and timing, insulin patients must actively participate. Blood glucose levels deteroriate during the day, and glucose records are imprecise pointers of the fluctuations, the proportion of glycosylated haemoglobin is used as a proxy measurement oflong-term glycemic controls in the clinical management of diabetic patients.

Adequate glycemic management would imply that sugar levels were usually normal (70-130 mg/dL, or 3.9-7.2 mmol/L) and comparable from those without diabetes (Huang et al., 2007). Poor glycemic managementis defined as chronically raised blood sugar and glycosylated haemoglobin levels, that ranges from 200-500 mg/dl (11-28 mmol/L) and 9-15% or higher for months or years before severe consequences emerge(Walker, 2007).

2.9.3 Personal glucose monitoring

Patients who use home glucose monitors to monitor their glucose levels on a regular basis may have bettermanagement and results with T2DM. Sugar tracking is quite costly (mainly due to the price of the test strips) and needs a significant dedication from the client. Patients may find the energy with the cost beneficial if they use the values to make reasonable changes to their diet, workouts, and oral drugs. Peopleoften make these changes after getting diabetes management training from a clinician or health care professional. This reduces diabetes patients' hospital hospitalisations (Kibriya et al., 1999).

Clients who take oral drugs and do not automatically adapt to their medication dosage will loose out on all the advantages of self-monitoring. Continuous Glucose Monitoring (CGM) technology is increasingly emerging to supply diabetics with information regarding the rate and direction of their sugar fluctuations (International Diabetes Federation, 2012).

2.10 Management Strategies for Type 2 Diabetes

T2DM administration techniques include attaining and upholding a healthy weight, effective weight loss initiatives, physical activity, cultural appropriateness, incorporating national noncommunicable disease strategies, conducting a local joint tactical needs assessment, establishing regional tactics, communicating messages to the entire population, encouraging a healthy diet, and educating those involved in advocating healthy habits (Dropkin, 2010).

Adjustments in hazadous variables are most likely to happen when a planned set of activities is effectively implemented to inspire people to stick to a proper weight, engage in regular physical activity, and eat nutricious meals (Dropkin, 2010). Knowledge is critical for effecting these adjustments, and it is most helpful when offered through a range of channels and locations, such as community organisations, learning centres, place of work, the press, spiritual organisations, and health institutions (KNDS, 2010).

Knowledgable lessons are more successful when accompanied by action (NIHCE, 2011). Chronic illnesses, such as diabetes, can be exceedingly costly in terms of both health and money if ignored.Treatment costs and productivity losses undercut and restrict economic progress, having a substantial influence on SDGs, Vision 2030, and other national development targets (WDF, 2007).

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progress, having a substantial influence on SDGs, Vision 2030, and other national development targets (WDF, 2007).

2.11 Type 2 diabetes mellitus can be diagnosed clinically

Physicians should conduct a thorough physical and medical assessment, including

i. Height and weight measurements.
ii. Blood pressure readings.
iii. Thyroid Examination
iv. Inspect hands, fingers, feet, and toes for circulation problems.
v. A family history of diabetes, cardiovascular disease, and stroke.
vi. Past infections and medical issues.
vii. Current medications, including both prescription and over-the-counter options.
viii. Taking vitamins, minerals, and herbal supplements, as well as eating and exercising habits.
ix. Smoking history and support for stopping.
x. Signs of pregnancy or fertility concerns for female patients.
xi. Vision abnormalities to diagnose eye health problems
xii. Urinary abnormalities that could indicate kidney disease (Dropkin, 2010; Walker, 2007).

2.12 Ways to Prevent Diabetes Mellitus

Lifestyle adjustments were shown to help prevent growth of diabetes mellitus. To prevent diabetic complications,

a) A healthy weight should be maintained.
b) More daily exercises are encouraged for weight management.
c) A healthy diet with low sugars and low calories.
d) Tobacco usage should be avoided because it increases risk of developing diabetes and cardiovascularillnesses.

2.13 Diagnoses and Treatments

Blood glucose testing is a reasonably inexpensive method of making an early diagnosis. Diabetes treatment entailed nutrition, daily exercises and other known risk factors for blood vessel injury. Quitting smoking was also critical to avoiding complications.

Low- and middle-income nations can benefit from cost-effective interventions such as

a)Management of glucose levels, especially TIDM individuals that require insulin; while T2DMindividuals are treated with oral medication and may need insulin.

a) Controlling blood pressure;

b) Encouraging self-care treatments such as proper feet care, cleanliness and seek expert assistance.

CHAPTER THREE

STUDY METHODOLOGY

3.1 Study area

Research was done at Kandara Level 4 Hospital Diabetic Clinic located in Muranga County. The hospital provides good medical services which had a gap that l needed to solve. The amaizing team that made my data collection journey easy and accorded me the necessary assistance whenever l felt challenged/stuck.

3.2 Study Subjects

All diabetic patients who attended Kandara level 4 hospital diabetic clinic.

3.3Study design

A descriptive cross-sectional study was used. This design was appropriate for this study because of the active screening and monitoring of blood sugar levels and determination of blood groups of the study participants.

3.4 Inclusion criteria

a) All consenting diabetic patients who visited the diabetic clinic at Kandara level 4 hospital above 18years of age.

b) Consenting parents that allowed their children who were diabetic to participate in the study (childrenbelow 18 years).

c) Long-term diabetes patients who have been following up with diabetic clinics for at least six (6) months.

d)All diabetic patients under study irrespective of glucose control and treatment (oral drugs /insulininjections).

3.5 Exclusion criteria

a) Non-consenting patients above 18 years of age.

b) Any patient visiting the hospital for other purposes.

c) Non-consenting adults and parents not willing to let their children participate in the study (below 18years of age)

d) People without excessive blood sugar levels were not permitted to participate in the trial.

e) Patients on steroids.

f) Immuno-compromised states like blood malignancy, bone marrow transplantation.

g) Any diabetic patients attending diabetic clinics outside Kandara level 4 hospital.

3.6 Sample size determination

The Kothari formula was used.

$n = z^2 P q e^2$

z = 1.96 at 95% Confidence Interval (C.I)

p = 0.5 (no prevalence rate available)q = 0.5

e = error margin usually 0.05n = 1.962x 0.5x0.5x0.05^2

= 384.16

Therefore, a sample size of 385 was used.

3.7 Sampling and sampling techniques

The study was carried out at Kandara level 4 Hospital in Muranga County. Purposive random sampling was utilised to pick study participants in Kandara level 4 hospital in order to obtain more thorough information about my study participants as the number of

diabetes mellitus problems grew.

A simple random selection approach with an interval of five (5) clients was used to pick consenting participants who satisfied the inclusion criteria until the needed sample size was achieved.

The probability proportionate to size (PPS) technique was also employed to determine the number of responses from the hospital. Participants were separated into fifteen (15) groups, each of which was scheduled to visit the hospital for a weekly review.

3.8 Research instruments

A standardised questionnaire with closed-ended questions was used to collect data on participants' bloodgroups, blood sugar levels, and methods for controlling and managing their sugar levels. The interviewer introduced himself/herself to the subject, and after obtaining informed consent, he/she read the questions from the questionnaire to the participant and enabled the individual to respond adequately without influence. The questions were clear and straightforward, making it easy for participants to respond.

3.9 Procedures

a) Blood grouping procedure.

The Blood Grouping test was done by a slide method.

i) Slide Method.

The patient hand was dangled downwards to increase blood flow in the fingers, 70% alcohol was used to clean the fingertip to be pierced, then pierced with a sterile lancet and a drop of blood was placed in three cavities followed by a drop of anti-sera's (anti-A, anti-B and anti-D) were added to every cavity. They were mixed together with a clean stick and waited for agglutination to occur in the form of fine red granules within 30 seconds.

The DU test procedure was done only to those rhesus factor that are not satisfactory under the slide method.

ii) DU Test.

Helped to differentiate between true rhesus D negative from rhesus D positive.

5% cell suspension of red blood cells was prepared by-mixing 5 drops of sedimented RBCs with 2 ml of normal saline, then centrifuged at 1500 RPM for 1 minute and the supernatant was discarded. 4 ml of normal saline was added into the sedimented RBCs and mixed well. Tubes were labelled as T (where the anti-D will be added), C (where a drop of 22% bovine albumin will be added), a drop of the 5% cell suspension was added to each tube by a Pasteur pipette and mixed well, then both incubated at 37°C for 15 minutes. After incubation was complete cells in each tube were washed three times with fresh normal saline, after the last wash all normal saline was removed completely and two drops of Coombs reagent was added. The contents of the tube were gently mixed before centrifugation at 1500 RPM for 1 minute. Gentle agitation was used to resuspend the cells, which were then inspected macroscopically for agglutination. If any confusion arose, the results were validated microscopically.

iii) Blood glucose analysis.

A test strip was inserted into the glucometer, a side of the fingertip of the patient pricked with the needle and a droplet of blood added to the test strip edge. The blood sugar level was displayed on the screen of the meter after a few seconds.

iv) The association of ABO, rhesus D, and diabetes.

A chi-square test was used to examine whether the two categorised variables were connected. The chi-squared test is calculated using the following formula:

$$x_c^2 = \frac{\Sigma\,(O_i - E_i)^2}{E_i}$$

Where

c = Degrees of freedom

O = Observed Value

E = Expected Value

d)Applying the Quality Control Solution

A glucose metre was placed on a level place. The QC solution to be tested was selected. A metre was used to measure the quantity of the QC solution and l verified it was not expired. The solution was carefully mixed by inverting the bottle five times, the cap of the vial was removed and the tip was wiped off with a tissue to remove any dried deposit. When the vial was opened for the first time the date is usually indicated. The first drop of the solution is usually discarded. A second drop of QC solution is usually applied to the front border of the yellow window at the end of the test strip. When enough solution is applied to the test strip, an hourglass icon usually appears on the screen, indicating that the metre is assessing the QC solution. The result appeared on the screen in 5 seconds, followed by the control bottle symbol and a blinking "L." Please do not remove the test strip at this time. The forward arrow button was used to show the level of the QC solution used; if you used QC solution vial 1, press the arrow button once.If you used QC Solution Vial 2, press the arrow button twice. To save the current level in the metre, press the on/off/set button.

e) Quality control (QC) tests.

These are tests that show the dependability of CERA-CHEK® glucometer metre readings throughout a wide range (using Quality Control solution vials 1 and 2). The strip is tested and the solution's integrity is ensured. Precision of the operator's method. All operators must be competent and precise when undertaking quality control procedures. It’s a great way to keep your metering skills sharp. When to Conduct Quality Control Tests:

a) Daily.

b) Before any test is performed.

c) When a new container of test strips or a vial of quality control solution is opened.

d) If a metre has fallen.

e) If any query arises regarding the glucose results of an individual to confirm the functionality of the metre.

3.10 Data collection, analysis and presentations/ Social demographic data collection

a) Data acquisition.

Diabetes mellitus was diagnosed by analysing the patient's chart during data collection. Skilled medical laboratory officers collected sociodemographic and clinical data, as well as semi-structured questionnaires. A computerised weighing scale was used to determine height and weight.

The research subjects' ABO blood groups were determined using known anti-A and anti-B seras. Members'rhesus blood groups were determined using the slide method, and those who tested negative for rhesus were validated again using the test tube method with anti-D and AHG. The Cera-check glucometer was used to asses diabetic patients' random levels of blood sugar. Every test was conducted in accordance with the manufacturer's specifications.

b) Data analysis.

All data from this study was documented on the Excel Spread Sheet. The data was processed using the Statistical Package for Social Science (SPSS) version 20. The frequency, mean, median, and standard deviation of blood groups as well as blood sugar levels were calculated. A correlation analysis was used to determine the relationship between blood types, rhesus factor, and diabetes. The chi-square test was performed to compare the mean values of the different blood types.

All variables' frequency distributions were calculated and displayed using frequency tables and charts. The Z score test was used to evaluate qualitative variables, with p-values <0.05 indicating statistical significance. A bivariate study was conducted to determine the connection between ABO, rhesus D, and diabetes mellitus. The chi-square test was used to determine the association between ABO and rhesus D blood groups and diabetes.

4.0 Quality control and assurance

The questionnaire was pretested on members representing 5-6% of study's sample size at Kandara level 4 hospital to ensure correctness and consistency, to calculate the time required to fill out the questionnaires before data collection. Data collectors conducted a one-day training session on the study'sobjectives, interview methodologies, laboratory test protocols, and quality control. My superiors and the hospital laboratory in-charge kept track of data gathering during the entire process. A professional medical laboratory officer served as the lead investigator, collecting sociodemographic and clinical data and regularly checked the quality of measuring devices. Standard operating procedures were followed throughout the preanalytical, analytical, and postanalytical processes to assure quality of laboratory findings. Quality control samples (blood group anti-seras and Cerra check glucometer) were done on a daily basis to ensure the results' accuracy. Anti-A and anti-B sera were tested for purity using known A and B cell suspensions. The quality control sample results for the Cerra check glucometer were recorded on a daily blood glucose chart given by the hospital laboratory.

4.1 ETHICAL CONSIDERATION FOR THE PARTICIPANT

Voluntary participation: The study subjects were informed that they might opt in or out of the study at any moment. They were informed about their right to accept or reject participation.

Informed consent: Purpose, benefits, risks, and funding prior to agreeing or rejecting to participate was well known by every individual in the study.

Anonymity: The participant's identities won't be displayed and the research tools will be given random numbers. Personally identifiable data will not be collected.

Potential for harm: Physical, social, psychological, and other sorts of harm were avoided to guarantee that the research had no detrimental impact on the participants. No risks are linked with any involvement in the study, and information you will submit will not endanger the services received from the university. Completing the questionnaire will however take approximately 10 minutes, and incase you are uncomfortable answering any questions, you can skip them.

Benefits: There are no cash incentives for involvement in the study, it will be helpful in discovering more on management of DM. The data gained will assist in raising awareness on recommended management guidelines to improve services received to help you manage the condition better. This will lessen diabetes mellitus-related problems among diabetes patients in the community.

Ethical approval: The research proposal was submitted to Mount Kenya University Ethics and Research Committee for approval. Permission by NACOSTI, medical superintendent, Laboratory manager, Laboratory officer in charge of Hematology and Blood transfusion laboratory and Diabetic Clinic in Kandara sub-county hospital was sought in advance. Participants in the study

were educated about the study and its benefits prior to doing the interviews. Only people who accepted to be part of the study participated in interviews.

4.2 Validity

To ensure data validity, the data collecting tool was tailored to the study objectives and included enough questions to address all variables. The questionnaires were numbered sequentially before sending and validating after every data collection. The research was restricted to the field of study.

4.3 Reliability

Was guaranted by employing an established, questionnaire and carefully choosing an exercise supervising research supporters for the interview techniques who took part in pre-testing to Guarantee that the questions were given correctly during data collection. The finalized questionnaires were examined daily at the end of every data collection.

CHAPTER FOUR

RESULTS

DEMOGRAPHICS

A total of three hundred and eight five study subjects participated in the study. The gender distribution of the study subjects were two hundred and sixty seven females (69.4%) and one hundred and eighteen males (30.6%). The age distribution was 2 years to 85 years with a mean age of 30.97 years as show in table 1A and 1B below.

GENDER DISTRIBUTION OF THE STUDY SUBJECTS

	Frequency	Percent
f	267	69.4
m	118	30.6
Total	385	100.0

Table 1A: The gender distribution of the study subjects.

Nb/f=female, m=male

AGE DISTRIBUTION OF THE STUDY SUBJECTS

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	385	2	85	30.97	17.23

Table 1B: The age distribution of the study subjects.

INTERNAL QUALITY CONTROL OF THE STUDY

The internal quality control of the current study involved an aspect of clinical laboratory medicine. The blood transfusion aspect of the study dealt with the determination of the blood groups for the studied population and the clinical chemistry aspect dealt with the determination of the blood glucose concentration of the study subjects.

The blood transfusion science internal quality control was performed qualitatively i.e. determination of positive and negative reactions. Positive reaction internal quality control aimed at determining the reaction between all the grouping sera i.e. Anti-A, Ant-B and Anti-D with panels of cells of known blood group A (antigen A), blood group B (antigen B) and rhesus D (antigen D) respectively. The analysis was performed before the blood grouping of the study subjects. In all the 13 sessions of the study, A cells produced a positive reaction with Anti-A, B cells produced a positive reaction with Anti-B, while antigen D cells produced a positive reaction with Anti-D. as shown in Table 2A below. Negative reaction internal quality control aimed at determining the reaction between the known cells and normal saline. All the cells did not show any reaction with the normal saline as shown in table 2A below.

Table 2 A: Blood grouping internal quality control report.

	Control Cells			Normal Saline
Anti-sera	A	B	D	
A	+VE	O	O	-VE
B	O	+VE	O	-VE
D	O	O	+VE	-VE

NB/ O= NO TEST DONE, +VE =POSITIVE REACTION, -VE= NEGATIVE REACTION

The internal quality control for blood glucose was carried out using the control solution provided by the manufacturer of the glucose electrodes reagent kit. The assigned glucose internal quality control range was (3.6-13.4) mmol/l with a mean glucose concentration of 8.5 mmol/l. The value of one standard deviation of the assigned internal quality control solution was 2.45 mmol/l. The study internal quality control for the 13sessions of the study gave a range of (4.1-11.9) mmol/l with a mean of 8 mmol/l and one standard deviationof 1.95 mmol/l. The internal quality control results for glucose were within the assigned internal quality control range. The internal quality control of glucose analysis is

shown in Table 2 B below.

Table 2B: Glucose internal quality control report.

Parameter (unit)	Assigned internal quality control results				Current study internal quality control results		
	session	(IQC range) mmol/l	Mean (mmol/l)	IQC 1SD (mmol/l)	(IQC Range (mmol/l)	Mean (mmol/l)	IQC 1SD (mmol/l)
Glucose (mmol/ l)	13	3.6-13.4	8.5	2.45	4.1-11.9	8	1.95

OBJECTIVE 1: To determine prevalence of ABO and rhesus D blood groups in male and female diabetic patients attending Kandara level 4 hospital, Murang'a County.

Whole blood was drawn from three hundred and eight five study subjects and the blood group for each study subjected was determined qualitatively. The distribution of the blood groups for the study subjects were as follows: Seventy-seven (77(20%) study subjects were blood group A RHESUS D positive while twenty seven (27(7.01%) study subjects were blood group A RHESUS D negative. Twenty six (26(6.75%) study subjects were blood group B RHESUS D positive while thirteen (13(3.4%) study subjects were blood group B RHESUS D negative. Fourteen (14(3.6%) study subjects were of blood group AB rhesus D positive while six (6(1.6%) study subjects were blood group AB rhesus D negative. It was noted from the study that there were no male subject whose blood group was AB rhesus D positive. On the other hand blood AB rhesus D negative was found to be the blood group with least number (6 (1.6%) of the study subjects. Study subjects who had blood group O rhesus D positive were one hundred and ninety

one (191(49.6%). Blood group O rhesus D positive was found to be the blood group with the highest number of the study subjects. Study subjects whose blood group was O rhesus D negative were thirty one (31(8%). The prevalence of ABO and rhesus D blood groups in male and female diabetic patients are as shown in table 3 below.

PREVALENCE OF ABO AND RHESUS D BLOOD GROUPS IN MALE AND FEMALE DIABETIC PATIENTS

Blood group	BGA +VE	BGA -VE	BGB +VE	BGB -VE	BGAB +VE	BGAB -VE	BGO+VE	BGO-VE
Number of study subjects	77(20%)	27(7.01%)	26(6.75%)	13(3.4%)	14(3.6%)	6(1.6%)	191(49.6%)	31(8%)

Table 3: The prevalence of ABO and rhesus D blood groups in male and female diabetic patients

NB- BG=BLOOD GROUP, +VE=POSITIVE, -VE=NEGATIVE

Figure 4.1a: Shows prevalence of ABO blood groups in male and female

The total number of male and female diabetic patients were 267 and 118 respectively. Blood group O+ had the highest prevalence in both male and female diabetic patients at 47% and 51% respectively (Figure4.1a). There was no male diabetic patient with blood group AB+. However, the prevalence of the blood groups were not significantly different among male and female diabetic patients (F (1, 14) =1.20, p=0.29).

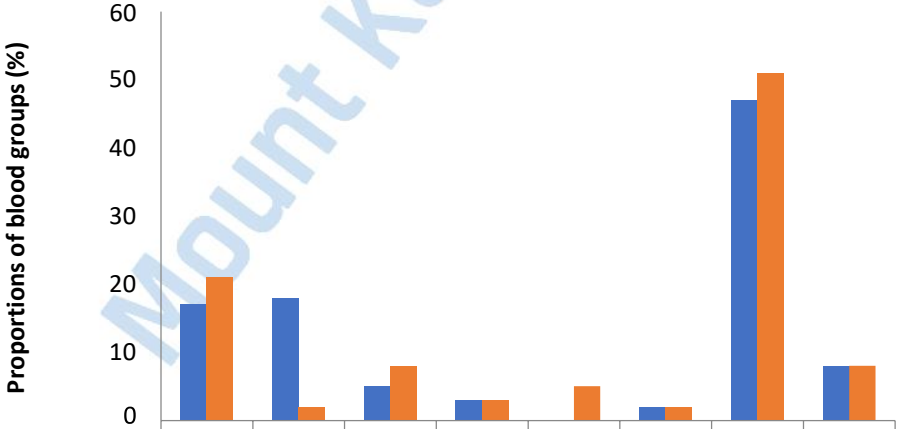


Figure 4.1a: Shows prevalence of ABO blood groups in male and female.

OBJECTIVE 2: To determine blood sugars levels of diabetic patients in different age groups attending Kandara level 4 hospital diabetic clinic in Murang'a County.

The blood glucose concentration of each study subject was analyzed quantitatively. The minimum glucose concentration of the study subjects was 7 mmol/L while the maximum glucose concentration of the study subjects was 17 mmol/L as shown in table 4 A below. The mean glucose concentration for the whole study population irrespective of gender was 10.52 mmol/L. The mean glucose concentration for the males and females study subjects was 10.54 mmol/l and 10.19 mmol/l respectively. The glucose concentration difference between male and female study population was not statistically significant with t=1.738 and p value 0.085 as shown in table 4 B below.

Table 4A: The glucose concentration of the study subjects.

Descriptive Statistics

	Number	Minimum	Maximum	Mean	Std. Deviation
ALL GLU	385	7.0	17.0	10.519	1.9355

NB/ GLU=GLUCOSE,

Table 4B: Comparison between male and female glucose concentration among the studied population

gender	number	Mean	Mean difference	Std. Deviation	Std error mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed
Male	119	10.554	.362		.2084	Lower	Upper	1.738	118	.085
female	119	10.192		2.2730		-.0504	.7748			

Age group glucose concentration across the study population

The study subjects were arranged in groups of 10 years giving the following age groups: 0-10years,11-21 years,22-32 years,33-43 years, 44-54 years, 55-65 years, 66-76 years, 77-87 years and finally 88-98 years. Age group 0-10 years had 30 study subjects with the lowest glucose concentration of 7.5 mmol/l and the

subject with the highest glucose concentration of 14 mmol/l. The mean glucose concentration of the study

subjects in this age group was 10.36 mmol/l. Age group 11-21 years had 121 study subjects with the study subject with lowest glucose concentration of 7.8 mmol/l and the subject with the highest glucose concentration of 17 mmol/l. The mean glucose concentration of the study subjects in this age group was 10.39 mmol/l. Age group 22-32 years had 101 study subjects with the study subject with lowest glucose concentration of 7.6 mmol/l and the subject with the highest glucose concentration of 14 mmol/l. The mean glucose concentration of the study subjects in this age group was 10.37 mmol/l. Age group 33-43 years had 8 study subjects with the study subject with lowest glucose concentration of 7.8 mmol/l and the subject with the highest glucose concentration of 14 mmol/l. The mean glucose concentration of the study subjects in this age group was 9.84 mmol/l. Age group 44-54 years had 77 study subjects with the study subject with lowest glucose concentration of 7.5 mmol/l and the subject with the highest glucose concentration of 14.5 mmol/l. The mean glucose concentration of the study subjects in this age group was 10.22 mmol/l. Age group 55-65 years had 34 study subjects with the study subject with lowest glucose concentration of 7.8 mmol/l and the subject with the highest glucose concentration of 15.9 mmol/l. The mean glucose concentration of the study subjects in this age group was 11.6 mmol/l. Age group 66-76 years had 28 study subjects with the study subject with lowest glucose concentration of 7.8 mmol/l and the subject with the highest glucose concentration of 14 mmol/l. The mean glucose concentration of the study subjects in this age group was 10.89 mmol/l. Age group 77-87 years had 13 study subjects with the study subject with lowest glucose concentration of 7 mmol/l and the subject with the highest glucose concentration of 14 mmol/l. The mean glucose concentration of the study subjects in this age group was11.35 mmol/l. Age group 88-98 years had 3 study subjects with the study subject with lowest glucose concentration of 11.7 mmol/l and the subject with the highest glucose concentration of 13 mmol/l. The mean glucose concentration of the study subjects in this age group was12.17 mmol/l.

Table 5A: Glucose concentrations among the various study group population

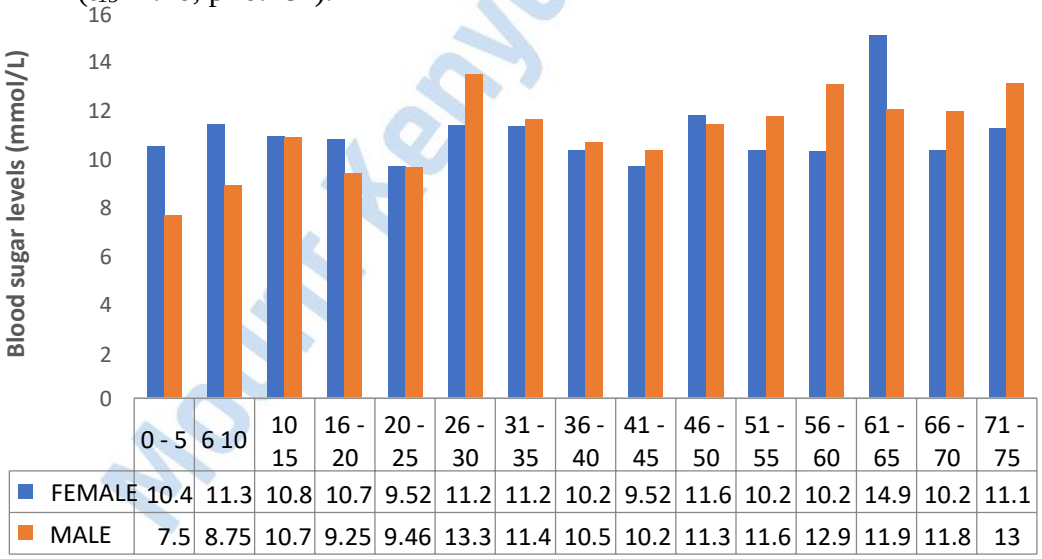
AGE GROUP	Number	Minimum [Glu]	Maximum [Glu]	Group mean [Glu]

A0-10YRS	30	7.5	14.0	10.357
A11-21YRS	112	7.8	17.0	10.388
A22-32YRS	101	7.6	14.0	10.374
A33-43YR	8	7.8	14.0	9.837
A44-54YR	77	7.5	14.5	10.223
A55-65YR	34	7.8	15.9	11.600
A66-76YR	28	7.8	14.0	10.889
A77-87YR	13	7.0	14.0	11.354
A88-98YR	3	11.7	13.0	12.167

NB/ A=AGE GROUP, YRS= YEARS, [Glu] = glucose concentration in mmol/l

Figure 4.2a: Shows blood sugar levels in different age groups.

The mean glucose concentration ranged from 7.5 to 12.95 mmol/l for different diabetic patients in various age groups. The mean glucose concentration in different age groups were shown in Figure 4.2a. Age group 61-65 years had females with the highest mean glucose concentration of 14.9mmol/l. Age group of 26-30 years had males with highest mean glucose concentration of 13.3 mmol/l. However, the glucose concentrations did not vary significantly between male and female diabetic patients in different age groups (t_{15}=1.10, p=0.287).



	0 - 5	6 10	10 15	16 - 20	20 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75
FEMALE	10.4	11.3	10.8	10.7	9.52	11.2	11.2	10.2	9.52	11.6	10.2	10.2	14.9	10.2	11.1
MALE	7.5	8.75	10.7	9.25	9.46	13.3	11.4	10.5	10.2	11.3	11.6	12.9	11.9	11.8	13

Figure 4.2a: Shows blood sugar levels in different age groups.

Figure 4.2b: shows a line fit plot for relationship between age groups and blood sugar levels.

The blood sugar levels are off the predicted levels thus non-linear relationship. The Pearson correlation coefficient between the age and blood sugar level was, R=0.67, SE=17.25, CI=95%, $p<0.05$. This therefore

means a positive relationship between age and blood sugar levels, with 45% change in blood sugar level accounted for by an increase in age group.

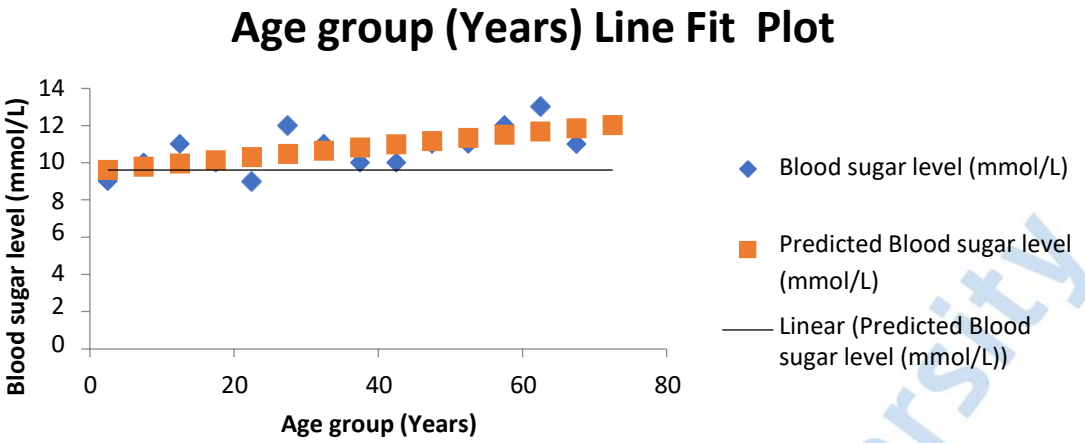


Figure 4.2b: Shows relationship between age groups and blood sugar levels.

OBJECTIVE 3: To determine the relationship between glucose concentration and blood groups of the study subjects.

Since there was no gender differences between the blood glucose concentrations, the blood groups were therefore considered without any gender reference. In blood group A +VE the study subject with the lowest glucose concentration had 7 mmol/l while the study subject with the highest had blood glucose concentration of 17 mmol/l. The mean glucose concentration of study subjects with blood group A+VE was 10.16 mmol/L. In blood group A -VE the study subject with the lowest glucose concentration had 7.8 mmol/l while the study subject with the highest had blood glucose concentration of 13 mmol/l. The mean glucose concentration of study subjects with blood group A-VE was 10.13 mmol/L. In blood group B+VE the study subject with the lowest glucose concentration had 7.5 mmol/l while the study subject with the highest had blood glucose concentration of 14 mmol/l. The mean glucose concentration of study subjects with blood group B+VE was 10.54 mmol/L. In blood group B -VE the study subject with the lowest glucose concentration had 7.9 mmol/l while the study subject with the highest had blood glucose concentration of 13.8 mmol/l. The mean glucose concentration of study subjects with blood group B-VE was 10.59 mmol/L. In blood group AB+VE the study subject with the lowest glucose concentration had 8.5mmol/l while the study subject with the highest had blood glucose concentration of 13.9 mmol/l. The mean glucose concentration of study subjects with blood group AB+VE was 11.43 mmol/L. In blood group AB -VE the study subject with the lowest glucose concentration had 8.5 mmol/l while the study subject with the highest had blood glucose concentration of 13 mmol/l. The mean glucose concentration ofstudy subjects with blood group AB-VE was 10.57 mmol/L. Similarly, in blood group O +VE the study subject with the lowest glucose concentration had 7.6 mmol/l while the study subject with the highest having blood glucose

concentration of 15.9 mmol/l. The mean glucose concentration of study subjects with blood group O+VE was 10.6 mmol/L. Likewise, the study subject in blood group O –VE had a low glucoseconcentration of 8 mmol/L while the subject with the highest glucose concentration had 14.5 mmol/L, with an overall mean glucose concentration of blood group O-VE had 10.8 mmol/L. The status of blood glucose concentration in all the blood groups is as shown in table 6A below.

Table 6A: The status of blood glucose concentration in all the blood groups.

	N	Minimum	Maximum	Mean
Bld Grp A +VE	77	7.0	17.0	10.160
Bld Grp A -VE	28	7.8	13.0	10.132
Bld Grp B +VE	25	7.5	14.0	10.540
Bld Grp B -VE	13	7.9	13.8	10.585
Bld Grp AB +VE	14	8.5	13.9	11.429
Bld Grp AB -VE	6	8.5	13.0	10.567
Bld Grp O+VE	191	7.6	15.9	10.598
Bld Grp O-VE	31	8.0	14.5	10.803

NB/Bld Grp=blood group, +VE=POSITIVE, -VE=NEGATIVE, N=number of study subjects

The effect of blood group rhesus factor on the glucose concentration of the study subjects

Blood glucose concentration of the study subjects with blood group A rhesus +VE was statistically compared with those with blood group A rhesus –VE and it was established that the difference was not statistically significant i.e. t=0.000, p=1.000. Blood glucose concentration of the study subjects with blood group B rhesus +VE was statistically compared with those with blood group B rhesus –VE and it was established that the difference was not statistically significant i.e. t= -0.104, p=919. Likewise, blood glucose concentration of the study subjects with blood group AB rhesus +VE was statistically compared with those with blood group AB rhesus –VE and it was established that the difference was not statistically significant i.e. t=0.567, p=0.595. Similarly, blood glucose concentration of the study subjects with blood group O rhesus +VE was statistically compared with those with blood group O rhesus –VE and it was established that the difference was not statistically significant i.e. t= 1.629., p= 0.114. It can be concluded that the rhesus factor of any blood group of individuals has no effect of the blood glucose concentration. The above information is expressed in table 6B below.

Table 6B: Blood group rhesus factor effect on blood glucose concentration of the study subjects.

					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	BGA +VE - BGA -VE	.0000	2.7062	.5114	-1.0494	1.0494	.000	27	1.000
Pair 2	BGB +VE - BGB -VE	-.0615	2.1419	.5940	-1.3559	1.2328	-.104	12	.919
Pair 3	BGAB +VE - BGAB -VE	.6667	2.8780	1.1749	-2.3536	3.6869	.567	5	.595
Pair 4	BGO+VE - BGO-VE	.8839	3.0218	.5427	-.2245	1.9923	1.629	30	.114

Figure 4.3a: Shows blood sugar levels in different blood groups

Diabetic patients with blood group AB+ had the highest blood sugar concentration of 11.21 mmol/L. Blood sugar levels in different blood groups are shown in Figure 4.3a. However, the levels of blood sugar concentrations in male and female diabetic patients did not vary significantly among the blood groups in different age groups, (t_6=0.27, p=0.79).

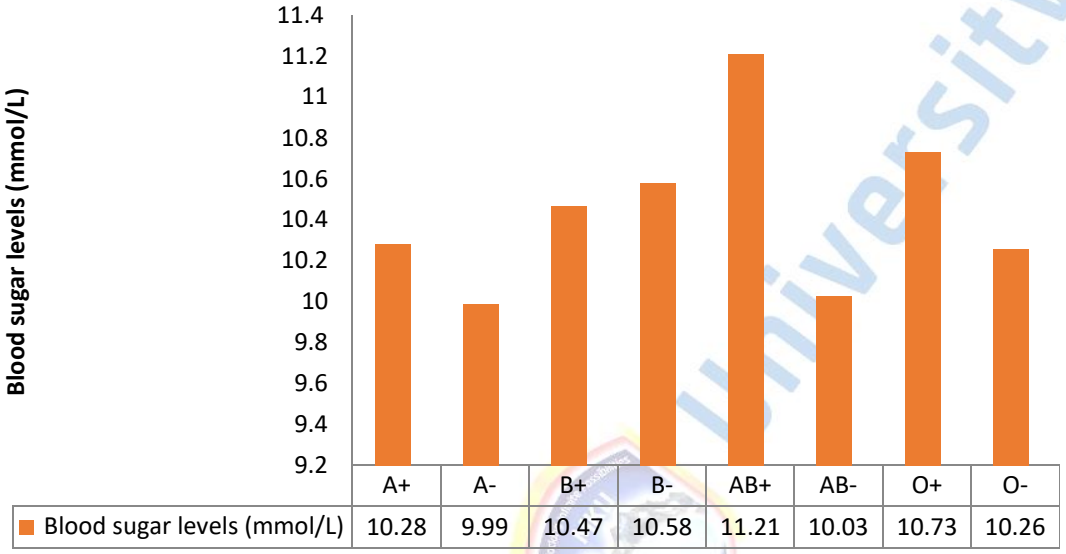


Figure 4.3a: Shows blood sugar levels in different blood groups

Figure 4.3b is a line fit plot showing relationship between blood groups and blood sugar levels.

Pearson correlation coefficient was, R=0.24, SE=0.45, CI=95%, p>0.05. This

therefore means a no relationship between blood groups and blood sugar levels, with 5% change in blood sugar level accountedfor by the effect of blood groups.

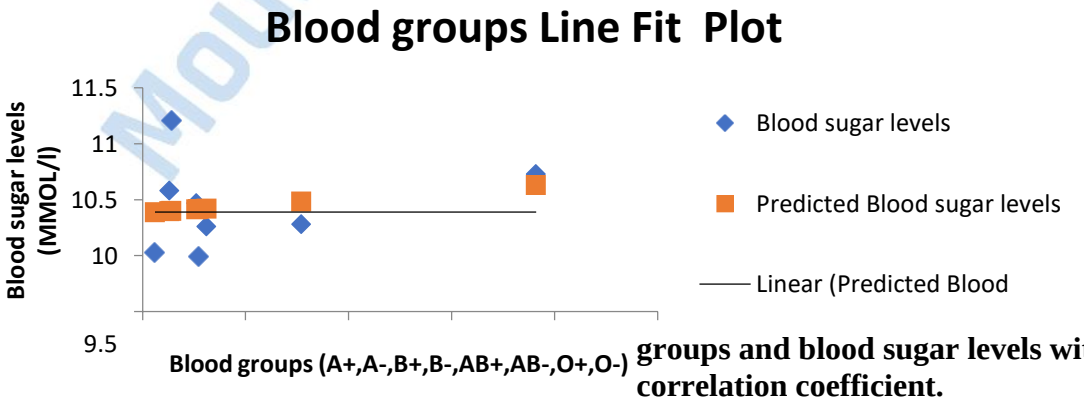


Figure 4.3b Shows a line fit plot showing relationship between blood groups and blood sugar levels with a pearson correlation coefficient.

sugar levels

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS.

DISCUSSION

5.1 Introduction

The current study's findings support the concept that hereditary factors associated with the distribution of certain blood groups may have a role in the development of diabetes mellitus. The distribution of blood types across population groupings is an essential consideration in healthcare. Several research have investigated the link between diabetes mellitus and Rh blood group; however, the populations varied, and the results were inconclusive.

5.1.1 Objective One: To determine prevalence of ABO and rhesus D blood groups in male and female diabetic patients attending Kandara level 4 hospital, Murang'a County.

This study demonstrated that, the diabetic patients, blood group O+ had the highest genotype frequency, followed in order by A+, A-, O-, B+, AB+, B-, and AB-. Blood group O+ having the highest prevalence in both male and female diabetic patients shows that it's the most common of all blood groups in both gender while AB- being the least common blood group. (Figure 4.1a). There was no male diabetic patient with blood group AB+.

A study in India by Wang, (2012), reported blood group O+ being the most prevalent at 37.12%. In addition, Wang, (2012) reported a rhesus prevalence of 94.61%. However, studies on prevalence of blood groups in the United States stated reported a different prevalence rate with blood group A+ as the most predominant blood group at 41% (Roteskreuz, 2006). Similar patterns were reported in Australia (Australian red cross, 2020), Cameroon (Ndoula, 2021), Egypt (Aristocousle, 2017) and in Somalia (Ali, 2020).

While around the continent the distribution in Belgium was A, B, AB and 0 blood groups was 37%,9%,3.0% and 6.0% respectively (Croix, 2010) and this shows prevalence varies in distinctively among different countries.

Blood group O+ had the highest genotype frequency because a protein known as non-Willebrand factor is more common in people with non-O+ blood types and has been linked to raised blood sugar levels. These blood types are also associated with numerous chemicals that have been linked to type 2 diabetes mellitus (T2DM).

5.1.2 Objective Two: To determine blood sugars levels of diabetic patients in different age groups attending Kandara level 4 hospital diabetic clinic in Murang'a County.

Age and blood sugar levels have a strong positive link, the more the age the more the rise in blood sugar levels. Thus the rise in sugar levels rises due to various risk factors and various lifestyles(Figure 4.2b).

Type 2 diabetes is most typically connected with those over the age of 45, although it is also affecting children, teenagers, and young adults (CDC, 2021). In 2017, type 2 diabetes affected approximately 462million people, accounting for 6.28% of the global population (4.4% of those aged 15-49 years, 15% of those aged 50-69, and 22% of those aged 70+), or an incidence rate of 6,059 cases per 100,000 (KHAN,2017).

GDM reported frequency globally varies between 1 and 45% of pregnancies (Buckley, 2012). The total frequency of gestational diabetes mellitus was 13.2% in America. Frequency rose with age, from 8% to 26% in women aged 45 years or more (American Diabetes Association (ADA), 2016). The pre-test was most commonly received by younger women; the rate of getting both tests rose with age (Zhang, 2016).

Some of the factors reported to contribute to the increase in prevalence of diabetes include family history/ hereditary, age, being overweight and unhealthy lifestyle. The prevalence continues to rise due to a lack of widespread public health prevention programmes and accessible educational resources.

5.1.3 Objective Three: To determine the relationship between glucose concentration and bloodgroups of the study subjects

Diabetic patients with blood group AB+ had the highest blood sugar levels of 11.21 mmol/L while blood group A- had the lowest blood sugar level of 9.99mmol/L. However, the levels of blood sugar levels in male and female diabetic patients did not vary significantly among the blood groups in different agegroups which means there is no correlation between blood groups and blood sugar levels. (Figure 4.3b).

Type 1 diabetes mellitus (T1DM) has been reported to be highly linked with blood group A+ and B+ (Waseem, 2012; Tanu, (2017). In addition, association between T1DM, T2DM and GDM with blood groups, especially with A+, AB+ and Rhesus positive blood groups have been reported (Sidhu, 2015). Blood group –B+ has a high association with T2DM and –O+ blood group has a minimum association with T2DM. Blood group –A+ and –AB+ are nearly similarly dispersed in both diabetic and non-diabetic populace (Suraya, 2016).

On the contrary, a study conducted in Pakistan found that blood group AB+ was more common in diabetes than blood groups A+ and B+ (Zenon, 2020). Studies on the link between ABO blood groups and diabetes are equivocal. While some research found no evidence of a relationship between ABO and diabetes.

Reason why there is no correlation between blood groups and blood sugar levels was because many diabetic patients are already on aggressive treatment and are aware on ways of managing diabetis mellitus. Conflicting results on the association between ABO blood types and DM could also be explained by racial and geographical variations in the genetic expression of the disease, sample size, age, and gender distribution.

5.2 CONCLUSION

The Rh blood system may play a function in glucose metabolism and alter the clinical presentation of diabetes mellitus. However, our findings indicate that there is no link between Rh blood group and diabetes mellitus. The methods by which specific genes influence blood glucose levels are poorly understood; thus, further research is required to completely understand the genetic components of diabetes mellitus. The current study had several limitations, including the prevalence of blood groups being affected by geographical distribution, race, and ethnicity, as well as underaged children whose parents did not consent for them to participate in the study, resulting in a low number of children participants:

It is established that there is no link between diabetes and ABO blood groups, and persons with blood group-AB+ are more likely to develop the condition. However, these findings are insufficient to draw astrong conclusion. Other genetic factors may be involved, necessitating more in-depth and thorough analysis.

Objective one: People need to be aware of their blood groups and blood sugar levels for earlier detection and prevention of diabetes mellitus.

Objective two: Public health prevention programs and educational resources need to be accessible to create more awareness of ABO blood groups and diabetes mellitus.

Objective three: Diabetic patients are now aware on ways of managing diabetes mellitus.

5.3 RECOMMENDATIONS

i. Knowledge regarding diabetes management interventions should be raised and diversify media coverage to reach a larger audience by the National and Murangá County government Department of Health. This should be standardized across health facilities in order to increase diabetic clients' knowledge of DM management interventions.

ii. Health education sessions on diabetes management techniques for the community through outreach programmes and barazas should be organized by the County Department of Health. This will enable DM customers to understand and effectively apply the practices required for good diabetes management.

iii. The County Department of Education plans academic seminars to raise awareness about the value of formal education, which has a substantial impact on DM management.

iv. Muranga County Government department of Health to plan more outreach services to people in the villages so as to reach more people who cannot acces health services easily to create more awerness on their sugar levels so as to make Muranga county a diabetes free county.

v. Blood sugar screening should be made a compulsory screening service to every patient visiting the hospital to make the awre of their sugar levels for earlier detection of diabetes mellitus.

vi. Muranga County Government to provide more laboratory supplies (blood sugar strips and blood grouping anti-seras) so as to test many people visiting the hospital.

5.4 RECOMMENDATION FOR FURTHER RESEARCH.

The study investigates several factors that influence DM clients' such as cultural characteristics, religion,and facility accessibility, to provide more information on proper planning and improving DM treatment programmes.

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Appendix 1: INFORMED CONCEPT FORM.

My name is Moreen Nyawira. A Master's student at Mount Kenyatta University. Undertaking research on the relationship between ABO, rhesus D blood groups, and diabetes mellitus in Muranga's Kandara sub-county.

The information collected from the study will be used by the Ministry of Health and the Sub-County Health Management Team to improve the community's management guidelines and practices to control diabetes mellitus and prevent diabetes-related complications among diabetic clients in Muranga County, Kandara Sub-County.

Participation. It's voluntary and questionnaires should be completely filled. The interviewer will provide guidelines on how the questions will be filled. Failure to participate is fully dependent on persons will to be present in the study without any penalties.

Benefits. No rewards will be given towards participation in the study. However, it will provide more information on management of diabetes mellitus and create awareness on guidelines to improve the services received in the hospital. Hence, lessen diabetes mellitus-related problems among diabetic patients in the community.

Risks. No risk involved in participation in the study and information provided will not be used to jeopardise services that you will receive in the institution. However, filling the questionnaire will take about 10 minutes, and if uncomfortable answering questions, you are free to skip them. A slight pain will be felt during the finger prick done to obtain blood sample for blood sugar analysis and blood group determination.

Private and discreet. Please fill out this form anonymously and in a private setting. The questionnaires will be stored in a locked safety cabinet and every information will confidential. If any questions arise, contact 0707149951.

Participant statement. Information about my participation in the study is apparent to me, and it is voluntary. I accept that all information provided will be strictly kept confidential, and that withdrawal from the study is expected at any time. If I decline to participate in this study, I will not face any penalties or discrimination, and that there are no risks to my services at the hospital.

_____ _____

Signature Date

Investigator's declaration

I, the undersigned, have described to the participant in a language that he or she understands the study's procedures, as well as the risks and advantages associated.

Name researcher……..

Researcher signature..... Date.....

Appendix 2: QUESTIONAIRES.

1.Weight…….

2.Height……...

3.Age……

4.Have you ever done a blood group test?

If yes, when and what's your blood group?

5.Have you ever received or donated blood before?

If yes, when?

6.When were you first diagnosed with diabetes?

i)less than an year

ii) 1-5 years

iii) more than 5 years and above?

7.How is your diabetes controlled?

i)Diet alone.

ii) Tablets-please give name(s) and above.

iii) Insulin injections-please give type types and doses

iv)Both insulin and tablets.

v) Insulin pump.

vi) If a pump is used, can you administer your own set and cannula change.

8.At what age when you were diagnosed with diabetes?

9.Have you ever been hospitalised for uncontrolled blood sugars?

10.Do you monitor your blood sugar at home?

If yes, how often?

11. What is the name of your meter?

12. Do you experience low blood sugar reactions?

If yes, how often?

13. Are your recent blood test showing blood sugar levels being unreasonably stable?

i)Less than 4mmol/l

ii)4-6 mmol/l

iii)7-10mmol/l

iv)11-15mmol/l

v)More than 15

14. Do you usually do daily exercises (atleast 30 minutes of physical activity) at work or during normal daily activity?

i) Yes

ii)No

15. How often do you eat vegetables or fruits?

i)Everyday

ii) Not everyday

Appendix 3: LABORATORY REQUEST FORM.

KANDARA SUB-COUNTY HOSPITAL LABORATORY

PATIENTS NUMBER ……..

AGE……

GENDER……

PHONE NUMBER……..

PATIENTS RESIDENCE……

TYPE OF SAMPLE…….

DATE OF COLLECTION…….

INVESTIGATION REQUIRED……..

DIAGNOSIS:

HISTORY:

CLINICIANS NAME…….. Signature…….. Date……

REPORT:

TEST DONE BY…… SIGN…… DATE…… TIME……..

REVIEWED BY……. SIGN…… DATE…… TIME……..

Mount Kenya University

REF: **MKU/ISERC/2528**

Date: 30 November 2022

TO: **MOREEN NYAWIRA**

REG: **MMLS/2021/75857**

Dear Sir/Madam,

RE: RELATIONSHIP BETWEEN ABO, RHESUS D BLOOD GROUPS AND DIABETES MELLITUS IN PATIENTS ATTENDING KANDARA SUB-COUNTY HOSPITAL MURANGA COUNTY, KENYA.

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1601.** The approval period is **30/11/2022 - 29/11/2023.**

This approval is subject to compliance with the following requirements;

i. Only approved documents including informed consents, study instruments, MTA will be used
ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

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

Yours sincerely,

The Chairman
Mount Kenya University
Ethics Review Committee
P.O. Box 342-01000, Thika

Dr. Peter G. Kirira
Chairman, Mount Kenya University ISERC

Mount Kenya University

DIRECTORATE OF GRADUATE STUDIES

MMLS/2021/75857

13th December, 2022

National Commission for Science Technology & Innovation (NACOSTI)
Off Waiyaki Way, Upper Kabete,
P.O Box 30623- 00100
NAIROBI, KENYA

Dear Sir/Madam,

RE: MOREEN NYAWIRA- REGISTRATION NO. MMLS/2021/75857

The purpose of this letter is to introduce the above named student who is pursuing **Master of Medical Laboratory Sciences** in the **Department of Medical Laboratory Sciences** in the **Medical School.**

The title of her research is **"Relationship Between ABO, Rhesus D Blood Groups and Diabetes Mellitus in Patients Attending Kandara Sub-County Hospital Muranga County, Kenya."**

She has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data for her research between **December, 2022 and March, 2023.**

Any assistance accorded to her will be highly appreciated.

Thank you.

Mount Kenya University
P.O.Box 342-01000, THIKA
Office of the Director
Graduate Studies

Dr. Samuel M. Karenga, Ph.D.
Director, Graduate Studies
Enc.

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **701762**

Date of Issue: **17/January/2023**

RESEARCH LICENSE

This is to Certify that Miss.. Moreen nyawira Muchoki of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Muranga on the topic: RELATIONSHIP BETWEEN ABO, RHESUS D BLOOD GROUPS AND DIABETES MELLITUS IN PATIENTS ATTENDING KANDARA SUB-COUNTY HOSPITAL MURANGA COUNTY, KENYA. for the period ending : 17/January/2024.

License No: **NACOSTI/P/23/22868**

701762

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY &
INNOVATION

Verification QR Code

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

See overleaf for conditions

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013 (Rev. 2014)

Legal Notice No. 108: The Science, Technology and Innovation (Research Licensing) Regulations, 2014

The National Commission for Science, Technology and Innovation, hereafter referred to as the Commission, was the established under the Science, Technology and Innovation Act 2013 (Revised 2014) herein after referred to as the Act. The objective of the Commission shall be to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto.

CONDITIONS OF THE RESEARCH LICENSE

1. The License is granted subject to provisions of the Constitution of Kenya, the Science, Technology and Innovation Act, and other relevant laws, policies and regulations. Accordingly, the licensee shall adhere to such procedures, standards, code of ethics and guidelines as may be prescribed by regulations made under the Act, or prescribed by provisions of International treaties of which Kenya is a signatory to
2. The research and its related activities as well as outcomes shall be beneficial to the country and shall not in any way;
    i. Endanger national security
    ii. Adversely affect the lives of Kenyans
    iii. Be in contravention of Kenya's international obligations including Biological Weapons Convention (BWC), Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Chemical, Biological, Radiological and Nuclear (CBRN).
    iv. Result in exploitation of intellectual property rights of communities in Kenya
    v. Adversely affect the environment
    vi. Adversely affect the rights of communities
    vii. Endanger public safety and national cohesion
    viii. Plagiarize someone else's work
3. The License is valid for the proposed research, location and specified period.
4. The license any rights thereunder are non-transferable
5. The Commission reserves the right to cancel the research at any time during the research period if in the opinion of the Commission the research is not implemented in conformity with the provisions of the Act or any other written law.
6. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research.
7. Excavation, filming, movement, and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
8. The License does not give authority to transfer research materials.
9. The Commission may monitor and evaluate the licensed research project for the purpose of assessing and evaluating compliance with the conditions of the License.
10. The Licensee shall submit one hard copy, and upload a soft copy of their final report (thesis) onto a platform designated by the Commission within one year of completion of the research.
11. The Commission reserves the right to modify the conditions of the License including cancellation without prior notice.
12. Research, findings and information regarding research systems shall be stored or disseminated, utilized or applied in such a manner as may be prescribed by the Commission from time to time.
13. The Licensee shall disclose to the Commission, the relevant Institutional Scientific and Ethical Review Committee, and the relevant national agencies any inventions and discoveries that are of National strategic importance.
14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

National Commission for Science, Technology and Innovation(NACOSTI),
Off Waiyaki Way, Upper Kabete,
P. O. Box 30623 - 00100 Nairobi, KENYA
Telephone: 020 4007000, 0713788787, 0735404245
E-mail: dg@nacosti.go.ke
Website: www.nacosti.go.ke

REPUBLIC OF KENYA
MINISTRY OF EDUCATION
State Department of Early Learning and Basic Education

Email: cdemuranga@gmail.com
Telephone: 060 2030227
When replying please quote

COUNTY DIRECTOR OF EDUCATION
P.O BOX 118 – 10200
MURANG'A

REF: MGA/CTY/EDU/RESEARCH/GEN/64/VOL.IV/22 **16th May, 2023**

MOREEN NYAWIRA

REG: MMLS/2021/75857

MT KENYA UNIVERSITY

RE: RESEARCH AUTHORIZATION

The County Education office is in receipt of your letter dated 16th May, 2023, and a copy of authority from NACOSTI Ref No.701762 license number NACOSTI/P/23/22868 dated 17th January, 2023 requesting for authority to carry out research on ***Relationship between ABO, Rhesus D Blood Groups and Diabetes Mellitus in Patients attending Kandara Sub County Hospital, Murang'a County, Kenya."***

Permission is hereby granted to carry out the research for a period ending **17th January, 2024** as requested.

You are kindly advised to deposit a copy of the final research report to this office.

Anne Kiilu
County Director of Education
MURANG'A

COUNTY DIRECTOR OF EDUCATION
MURANG'A
16 MAY 2023
P. O. Box 118-10200, MURANG'A

MOREEN NYAWIRA

RELATIONSHIP BETWEEN ABO, RHESUS D BLOOD GROUPS AND DIABETES MELLITUS IN PATIENTS ATTENDING KANDA...

Research Paper

Masters2024

Mount Kenya University

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