SCREENING STRATEGIES TO DETECT GESTATIONAL DIABETES MELLITUS IN AIC KIJABE HOSPITAL, KENYA

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A Research Thesis Presented to the Institute of Postgraduate Studies of Kabarak University in Partial Fulfilment of the Requirements for the Award of the Master of Medicine Degree in Family Medicine.

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DECLARATION

1. I do declare that:

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ii. That the work has not in-cooperated material from other works or a paraphrase of such material without due and appropriate acknowledgement.

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RECOMMENDATION

To: The Institute of Postgraduate Studies

The research thesis entitled "Screening Strategies to Detect Prevalence of Gestational Diabetes Mellitus in AIC Kijabe Hospital, Kenya" authored by Sarah Wanjiku Kiptinness is presented to the Institute of Postgraduate Studies of Kabarak University. We have reviewed the thesis document and recommend it be accepted in partial fulfilment of the requirement for the award of the Master of Medicine, Family Medicine.

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DEDICATION

I dedicate this thesis to the Healthcare workers of AIC Kijabe Hospital in recognition of their unconditional support during the pursuit of this academic task.

ABSTRACT

Background Gestational DM has been associated with increased risk of perinatal mortality and morbidity however, screening recommendations are not clearly described in Kenyan guidelines. Kenyan studies have shown wide-ranging prevalence rates for GDM between 1.1%-16.7% which reflects inconsistences in GDM screening strategies. The purpose of this study was to assess the utility of the selective and universal screening strategies in detecting GDM in AIC Kijabe Hospital. Methods This was a cross-sectional retrospective and prospective study. Study participants between 24- and 32-weeks' gestation had a risk factor screening questionnaire administered, followed by a 75g oral glucose tolerance test (OGTT) if appropriate. Results A total of 343 were selectively screened for GDM from the retrospective data, while 38 women were universally screened for GDM in the prospective arm of the study. The detection of GDM was 13.2% and 2.6% in the universal and selective screening strategies, respectively (p=0.016). A first degree relative with DM, stillbirth and macrosomia were the most frequently observed risk factors at 21.8%, 17.2% and 9.2%, respectively. Forty-three percent (42.9%) of GDM cases were diagnosed in the absence of risk factors for GDM. Conclusion Universal screening detected a significantly higher rate of GDM than the selective screening strategy. Recommendations Kenyan health facilities should adopt the universal screening strategy for GDM, for early diagnosis and prevention of maternal and neonatal complications amongst pregnant women in Kenya. The true prevalence of GDM in Kenya will be clearly defined once universal screening is widely adopted.

Keywords: *Gestational Diabetes Mellitus, Selective Screening, Universal Screening*

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ABBREVIATIONS AND ACRONYMS

ADA American Diabetes Association

AIC Africa Inland Church

AICKH Africa Inland Church Kijabe Hospital

DIPSI Diabetes in Pregnancy Study Group Of India

EMR Emergency Medical Records

GCT Glucose Challenge Test

GDM Gestational Diabetes Mellitus

IADPSG International Association of Diabetes in Pregnancy Study Groups

IDF International Diabetes Federation

IUFD Intrauterine Foetal Death

LMIC Low- and Middle-Income Countries

MUAC Mid Upper Arm Circumference

NICE National Institute of Health and Clinical Excellence

NIH National Institute of Health

OGTT Oral Glucose Tolerance Test

WHO World Health Organisation

OPERATIONAL DEFINITION OF TERMS

Gestational Diabetes Mellitus: This is diabetes that is first diagnosed after the first trimester of pregnancy.

Oral Glucose Tolerance Test: Blood test done to diagnose GDM in pregnant women

Screening Strategies: In this document refers to universal and selective screening as defined below.

Universal Screening: All pregnant women between 24-32 weeks get screened with an oral glucose tolerance test for GDM.

Selective Screening: Only screen pregnant women who have pre-defined risk factors associated with GDM.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter discusses the background, problem statement, purpose, objectives, research questions, justification, scope, limitations, and assumptions of the study.

1.2 Background of the Study

Pregnancy causes an increase in insulin levels and resistance which predisposes pregnant women to develop diabetes in pregnancy. Gestational diabetes mellitus (GDM) is a hyperglycaemic condition in pregnancy that develops during the 2nd or 3rd trimester (Riddle et al., 2018). Women with hyperglycaemia before 12 weeks of their pregnancy are categorized as those with overt type 2 diabetes that was present prior to pregnancy. GDM usually resolves after pregnancy, however, pregnant women may develop adverse events during pregnancy as and/or long term sequelae affecting the mother and infant (Mwanri, Kinabo, Ramaiya, & Feskens, 2015). Perinatally, pregnant women with GDM are at risk of hypertension in pregnancy, preterm delivery, and c-section delivery. The foetal complications include macrosomia, shoulder dystocia, hypoglycaemia and hyperbilirubinemia of the new-born (Kim, 2010).

The IDF reported a worldwide prevalence of hyperglycaemia in pregnancy as 16.2% by the year 2015, of which 85.1% was due to GDM(Ogurtsova et al., 2017).Low and middle-income countries have reported a higher prevalence of GDM than high-income countries.GDM is diagnosed in 7.6% of women in the USA(Casagrande, Linder, & Cowie, 2018). The overall prevalence of GDM in Europe is 5.4% (Eades, Cameron, & Evans, 2017). A systematic review by Macaulay et al., (2014) that had a representation of only 6 African countries described a prevalence as high as 13.9% (Macaulay, Dunger,

& Norris, 2014).In Kenya, studies have been published regarding prevalence and risk factors observed in GDM. Adelaide et al., (2011) in a cross-sectional study, randomly screened 102 pregnant women between 24- and 36-weeks' gestation at Kenyatta National Hospital antenatal clinic described a GDM prevalence of 16.7% using the universal screening strategy (Adelaide, Ogutu, & Munguti, 2011). In Western Kenya, a larger, multicentre study was conducted and a lower prevalence of 2.6% was reported. This study used a 2-step screening technique where all pregnant women had a glucose challenge test (GCT), and only those with impaired glucose tolerance proceeded to have the 75g OGTT(Pastakia et al., 2017). These variations in Kenyan data are mainly due to the paucity of good data in the country and the different screening strategies used in these studies. Ninety percent of hyperglycaemia in pregnancy cases are inLMICs(Guariguata, Linnenkamp, Beagley, Whiting, & Cho, 2014). Therefore, screening for early detection and management of GDM is required in these low- and middle-income countries with high prevalence. Unfortunately, most screening for GDM is carried out in the high-income countries where prevalence is lower.

The International Association of Diabetes and Pregnancy Study Groups (IADPSG) is an organisation that was created to facilitate the collaboration of multiple authoritative international bodies concerned with obstetrics and diabetes, that was created to develop guidelines focusing on management of diabetes in pregnancy. This body was created to develop a unified international approach to GDM screening and diagnosis because different screening strategies were being used in different countries. The IADPSG recommended high-risk women should be screened for pre-existing DM using random or fasting glucose levels or haemoglobin A1C (HbA1C) in the first obstetric visit. Subsequently, all women are universally screened for GDM at 24 to 28 weeks of pregnancy using a 2-hour OGTT(International Association of Diabetes and Pregnancy

Study Groups [IADPSG], 2010). Nevertheless, these recommendations for universal screening are yet to be adopted internationally and countries continue to screen according to their preferences or not screen at all.

Most GDM screening and diagnostic guidelines have been developed in high-income countries. There was no involvement of the African states in the IADPSG recommendation for GDM screening partly because most African states have not established national guidelines of their own for screening and management of GDM. Understandably, conditions such as pre-eclampsia and HIV infection in pregnant women which contribute to higher perinatal morbidity and mortality rates make screening for GDM seem like less of a priority in the African context (Coetzee, 2009). Concerns about cost-effectiveness and subsequent management and follow-up of mothers with GDM pose significant challenges that need to be overcome (Utz, Kolsteren, & De Brouwere, 2016). Nonetheless, screening for GDM allows an early opportunity for effective treatment and improvement of maternal and foetal outcomes perinatally and in the future.

Some of the challenges of the IADPSG screening recommendations is its application in the African, low-resource setting. Universal screening may be difficult to achieve, and screening of women based on a risk factor profile may be more acceptable. Some well-resourced countries in Europe and the United Kingdom recommend risk factor-based screening in their national guidelines (National Institute for Health and Clinical Excellence [NICE], 2015; Benhalima et al., 2015). The USA decided to adopt the universal screening strategy due to the high burden of risk factors in their general population (90%), noting that selective screening strategy further complicated the screening process and only reduced the number of screens by 10% (Danilenko-Dixon, Van Winter, Nelson, & Ogburn, 1999). African nations should similarly assess the risk

factor burden in their population in order to inform policy makers on the appropriate screening recommendations based on African data.

Several risk factors have been identified and associated with GDM. These include age above 30 years; pre-pregnancy BMI greater than 25kg/$m^{2;}$ MUAC > 30cm; GDM in a prior pregnancy; history of a LGA baby > 4.5kg; unexplained stillbirth; hypertension; relative with DM and race (Hispanic, African or Asian) (American Diabetes Association [ADA], 2017; Mwanri et al., 2015; NICE, 2015). Notably, one of the described risk factors in the American and United Kingdom guidelines is ethnicity. All the international guidelines that advocate for risk factor-based screening include non-Caucasian ethnicities as a significant predisposing factor for GDM. This means that all Africans would qualify for GDM screening based on the current guidelines and consequently lead to universal screening in all people of African, Asian and South American descent.

A meta-analysis in Asia found that GDM in a prior pregnancy, family history of DM and BMI had the highest odds ratio associated with developing GDM compared to other risk factors (Kai Wei Lee, 2018). In Kenya, a multicentre study in the urban Nairobi city described pre-pregnancy weight, 1st degree relative with DM and age as predisposing factors for GDM (Adoyo, Mbakaya, Nyambati, & Kombe, 2016). A study in Turkey, a primarily Caucasian population, similarly found that age, BMI and pregnancy weight gain had the highest predisposition for developing GDM. Therefore, ethnicity alone may not be a substantial risk factor in necessitating GDM screening.

Kenya's National Guidelines for Quality Obstetric and Perinatal Care acknowledges the need to selectively screen for GDM, however, detailed criteria on screening and diagnosis of GDM have not been clearly described. The guideline describes risk factors, screening approach and diagnostic criteria for pregnant women with overtDM and not

women who develop GDM during their current pregnancy(Ministry of Medical Services & Ministry of Public Health and Sanitation, 2010). In practice, most screening is initiated by the clinician and is dependent on their own knowledge and practices on GDM. AIC Kijabe Hospital, a level 5 peri-urban referral Hospital in Kiambu County, Kenya currently uses the risk factor-based approach to screen pregnant women for GDM. The hospitals' guidelines for GDM screening were developed from international guidelines and modified to suit the low-resource setting. The main modification made from the international guidelines was excluding ethnicity as a risk factor for GDM. The hospital's screening guideline is yet to be validated. However, until the risk factor profile in the population and the GDM detection rate of the two screening strategies is understood, an informed decision on the appropriate screening method for our specific population cannot be made. This study aims to assess the utility of the selectiveand universal screening strategies in detecting GDM in pregnant women from the peri-urban community that AIC Kijabe Hospital serves.

1.3 Statement of the Problem

GDM has been a rising concern among pregnant women in recent years. Globally, 14% of women develop hyperglycaemia in pregnancy with the greatest burden being in the LMICs(Ogurtsova et al., 2017). This is projected to increase due to the rise in obesity and sedentary lifestyles that increase the risks of developing GDM (Kampmann et al., 2015).

GDM cannot be taken lightly as it results in several complications such as an increased risk of gestational hypertension and caesarean deliveries for pregnant women and birth trauma and macrosomia for the foetus perinatally (Buchanan, Xiang, & Page, 2012). Additionally, GDM predisposes a significant number of women (up to a 60% chance) totype II DM in the next decade of their lives(Centers for Disease Control and

Prevention [CDC], 2011). Children ofwomen with GDM have are more likely to haveDM and cardiovascular disease due to subsequent obesity (Krishnaveni, 2010). Therefore, preventing and managing GDM in pregnancy will aid in halting the rise of obesity and metabolic syndrome in the overall population. This is one of the global targets of the World Health Organisation (WHO) for prevention and control of NCDs(World Health Organization [WHO], 2013b).

Screening enables early detection and management of GDM and therefore prevents the associated adverse events from occurring in both the mother and child. A number of studies on prevalence of GDM in Kenya have been done describing a prevalence as high as 16.7% (Adelaide et al., 2011). However, less research has been done to assess which screening strategy best detects GDM in our population; the risk factors observed in women of child-bearing age and those who eventually develop GDM. Screening and diagnostic criteria have also remained controversial despite the IAPDSG recommendations. There has been debate on which screening approach (universal versus selective) best diagnoses GDM. Studies looking at the prevalence of risk factors in the general population and women who develop GDM have helped inform several countries on the appropriate screening strategies. The Endocrine Society of United States of America adopted the IADPSG recommendations, however, the United Kingdom NICE guidelines recommend selective screening(Blumer et al., 2013; NICE, 2015). As mentioned earlier, the USA decided on universal screening based on a 90% prevalence of RF in women of child-bearing age described by Danilenko-Dixon et al.(1999). In South Africa, selective screening demonstrated a low specificity (58.6%) and sensitivity (58.7%), which lead to the decision to universally screen all pregnant women for GDM (Adam et al., 2017). A clear understanding of the risk-factor profile in the total

population and those who develop GDM will better inform policy makers which screening strategy best detects GDM.

Failure to screen and manage GDM in Kenya can result in higher rates of maternal and foetal morbidity and directly increase the rates of diabetes and other non-communicable diseases in the future. Screening for GDM has not been a routine requirement in most Kenyan health facilities possibly attributed to the fact that the Kenya national guidelines provide minimal data on whom and how to screen and diagnose GDM. This study has provided more information on which screening strategy will best detect GDM in the Kenyan population.

1.4 Purpose of the Study

The purpose of this study was to assess which screening strategy, the selective or universal screening strategy, bests detects GDMin AIC Kijabe Hospital, Kenya.

1.5 Research Objectives

Amongst pregnant women between 24-32 weeks' gestation attending antenatal clinic in AIC Kijabe Hospital over a 4-month screening period, the following constitute the research objectives for this study:

i. Assess the utility of the selective screening strategy in detecting GDM using the IADPSG diagnostic criteria.
ii. Assess the utility of the universal screening strategy in detecting GDM using the IADPSG diagnostic criteria.
iii. Compare universal and selective screening strategies in detecting GDM.

1.6 Research Questions

Using pregnant women between 24-32 weeks' gestation attending antenatal clinic in AIC Kijabe Hospital as the study population, the following constitute the research questions for this research study:

i. What is the utility of the selective screening strategy in detecting GDM using the IADPSG diagnostic criteria.
ii. What is the utility of the universal screening strategy in detecting GDM using the IADPSG diagnostic criteria?
iii. How does the selective screening strategy compare to the universal screening strategy in detecting GDM?

1.7 Significance of the Study

The results from this study will be of benefit to the participants of this study, as they will be screened for GDM in accordance to most international guidelines on comprehensive antenatal care and therefore improve the quality of care the participants receive. The participant will be educated on gestational diabetes in general and will be informed about her test outcomes. If she is found to have GDM, appropriate care and treatment will be provided to her at the AIC Kijabe Hospital high-risk clinic.

AIC Kijabe Hospital will also benefit from this study as they will be informed on the on which screening strategy, universal or selective screening, has a better detection rate for GDM. This data will provide local evidence and support the decision by policy makers at the hospital on which GDM screening strategy should be used in AICKH.

On a national scale, this study will provide further information on which screening strategy will best detect the prevalence of GDM in Kenya. The variation of prevalence rate of GDM from Kenyan studies could be a factor of the different screening strategies used in each of the studies. Thus, once this study assesses which screening strategy best

detects GDM, a national prevalence study using the recommended screening approach can be used to determine GDM burden in Kenya. Following assessment of the risk factors used in the selective screening strategy, this study will inform health providers on the distribution and burden of risk factors amongst pregnant women attending AIC Kijabe Hospital antenatal clinic. In addition, once the universal screening strategy is implemented, the study will be able to evaluate the proportion of women without risk factors that develop GDM. Consequently, this study will assess if the current selective screening recommendation is an acceptable screening method in our population. Therefore, this study will inform national policy makers on which screening strategy can best detect prevalence of GDM in Kenya. Subsequently, the Ministry of Health can develop well informed national obstetric guidelines on GDM screening methods appropriate to our population, which will be adopted by all healthcare facilities on a national scale.

Globally, minimal research has been done on GDM screening and diagnosis techniques in LMICs, yet the burden is highest in these countries. The WHO has not been able to develop recommendations for screening and diagnosis of GDM in LMIC and has emphasised that GDM screening strategies are an area of priority in research to facilitate the development of these guidelines (World Health Organization, 2016). This study will provide necessary information for policy makers who develop guidelines and therefore help achieve this mandate by the WHO.

1.8 Scope of the Study

The study will be conducted at AIC Kijabe hospital antenatal clinic. AIC Kijabe hospital is in Lari division of Kiambu County, Kenya, approximately 60 kilometres from Nairobi by road. The County covers an area of 1.323.9 square kilometres.

1.9 Limitations of the Study

Possible foreseen limitations to the study include failure to fast appropriately for the OGTT; symptomatic hypoglycaemia; adverse reactions to glucose solution and an undesirably long ANC visit.

Failure to fast appropriately for the OGTT. Patients who wish to take part in the study shall be consented and enrolled one visit prior to the OGTT testing date. They will be registered and scheduled in the research study diary with their phone numbers collected. This is to ensure that participants fast for a minimum of 8 hours prior to the OGTT. The participant shall be advised to arrive at 8 am on the advised date for testing. The testing date will be informed by the medical practitioner managing the patient so that the test may be done on the same date as their routine ANC visit. In addition, participants will be called by the principal investigator one week before their return date and a text message will be sent the day before to encourage them to fast from midnight and remind them to present at the clinic by 8 am.

Long ANC visit. The OGTT is a 2-hour long test that will lengthen the ANC visit. To ensure that the time is used efficiently, a research assistant will retrieve the files of the study participants and deliver them to the ANC triage area by 8 am. This will save the participant the time it takes to line up and wait for file retrieval from the records area. Therefore, once the participant arrives at the hospital, they will directly present themselves at the family clinic and they will be attended to immediately. Medical practitioners attending to enrolled patients shall be advised to schedule their return dates to be on two specific days of the week (Tuesdays and Thursdays) for ease in planning and organisation. A research assistant will be made available on these two days of the week to carry out the OGTT in the family clinic. This will eliminate the time it takes for

participants to be attended to, as well as the waiting time for results from the main hospital laboratory.

1.10 Assumptions of the Study

There is an increasing health burden of GDM amongst pregnant women globally, with the highest prevalence rates in low- and middle-income countries. Most research and screening guidelines for GDM have been developed and used in the high-income countries where prevalence rates are lower. Less data and screening guidelines have been studied and made available to the African population. Little is known about the prevalence of GDM in Kenya, as few and small studies have been done and demonstrate a wide range in prevalence rates (2%-16%) within the country. There has been no standard screening and diagnostic criteria developed or endorsed by the Ministry of Health in Kenya which has resulted in little or no screening and diagnostic protocols in most government health facilities. Screening and diagnosis of GDM will increase costs to the already financially strained healthcare system in Kenya. However, the short-term costs to the mother and child and long-term costs of development non-communicable disease may be even harder to bear. It is, therefore, necessary to determine which screening strategy can best detect GDM, and subsequently used to determine the prevalence of GDM in Kenya using internationally recognised diagnostic criteria in a peri-urban and rural community in Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter shall include a general overview of literature related to the main concepts as well as a review of literature based on each of the three objectives. The chapter ends with a conceptual framework.

2.2 General overview of Literature Related to the Main Concepts

GDMis a hyperglycaemic state identified after 12-weeks of pregnancy (Riddle et al., 2018). The burden of GDM varies in different countries based on ethnicity, socioeconomic,demographic and other independent risk factors. Screening approaches to GDM also vary globally with some nations not even screening at all. Diagnostic criteria have also evolved through the decades and have had a direct impact on prevalence rates described. In the last decade, there have been efforts to internationally standardise GDM screening and diagnostic criteria and encourage adoption of these criteria universally especially in low- and middle-income countries where screening and diagnosis have been low yet the prevalence of GDM is highest.

2.3 Prevalence of Gestational Diabetes Mellitus

GDM prevalence has been studied for several years now, however, in the last 2 decades, the prevalence has increased by up to 10 to100 per cent and therefore become a global health concern (Ferrara, 2007). The United States of America (U.S.A) demonstrated this rise in prevalence from of 0.3% in 1979-1980; 5.8% in 2008-2010 and 7-10% in 2016-2018 (Casagrande et al., 2018; Facts & Diabetes, 2011; Lavery et al., 2017). This is a 30% prevalence increase in 40 years. European studies have reported a similar yet gradual rise in prevalence rates from 0.9% in the 1980s to 11.1 in 2010-2016 (Eades et al., 2017). Increase in prevalence has been demonstrated amongst the Asian, Hispanic

and African American populations, with a lower prevalence in Caucasian populations (Ferrara, 2007). This highlights the association between race and ethnicity and GDM prevalence.

The trend in prevalence in the low- and middle-income countries, where these ethnicities are prevalent, has not been clearly reported as fewer studies have been done over the years in these regions. However, the International Diabetes Federation (IDF) described a global rise in GDM, with 91.6% of GDM cases being in the LMIC(Ogurtsova et al., 2017). To further emphasise this, a systematic review found thatthe highest prevalence of GDM is in the Middle East and North Africa at 12.9 %, Southeast Asia and Western Pacific follow closely at 11.7%, Central and South America (11.2%), Africa (8.9%), and North America and the Caribbean with a median prevalence of 7%. The lowest prevalence at 5.8% is in Europe. Only two articles from Africa, done in Nigeria and Tanzania, qualified to be in this review (Zhu & Zhang, 2016).

The scarcity of good, quality data from Africa reveals that little is understood about the prevalence and burden of GDM in the continent. Two systematic reviews on GDM prevalence in Africa have been published in the last 5 years. One review had a representation of 6 of the 54 African nations, and only 14 articles qualified to be included in the review. The authors, using this minimal data, described a prevalence ranging from 0% (Tanzania) to 13.6% (Nigeria) and emphasised the need for further African studies to describe the GDM burden in Africa(Macaulay et al., 2014).

Another review described a similar median prevalence of 14% from 6 African countries. Half of the articles included were from West Africa (Mwanri et al., 2015). Following the publication of these reviews further studies have been done to provide more information on the prevalence of GDM in Africa. One such study was a small, single-centre

prospective study done in Uganda that described a GDM prevalence as high as 30% using the WHO diagnostic criteria. This value is almost 3 times the expected prevalence, however, 61% of the studied women had a BMI>25 and the mean gestation of OGTT screening was between 30 to 34 weeks rather than the recommended 24-28 weeks gestation. These two factors could partially explain the high prevalence rates in this study (Nakabuye at al., 2017). In Rwanda, another small, multi-centre study done in 3 urban centres described a prevalence of 8.3% which was comparable to global data (Mapira et al., 2017).

A small prospective study was done in Kenyatta National Hospital, the largest referral hospital in Kenya, demonstrated a GDM prevalence of 16.7%, however, it was not clear what diagnostic criteria were used in the study and capillary blood glucose, which is not recommended for GDM diagnosis, was used for testing (Adelaide et al., 2011). Bosire (2012) in his Master of Medicine thesis found the prevalence of GDM at KNH to be 11.6% using the O'Sullivan 50g glucose challenge test and 75g OGTT. In Aga Khan University Hospital, a hospital that serves the urban, wealthier Kenyan population in Nairobi, Muriithiet al.(2014) described a much lower GDM prevalence of 1.08% using plasma glucose readings and the IADPSG diagnostic criteria (Muriithi et al., 2014). In Western Kenya, a multicentre study including the second largest referral hospital in Kenya revealed a lower prevalence of 2.9% using the IADPSG diagnostic criteria and HbA1C (Pastakia et al., 2017). These disparities in the Kenyan data make it difficult to define the GDM prevalence in Kenya. Significant differences in methodology, mainly screening and diagnostic criteria and blood sampling sites (venous versus capillary), between these four Kenyan studies, may explain the wide range in the prevalence described.

Several GDM prevalence studies have been done to help define the global burden of GDM amongst pregnant women. Unfortunately, most studies have been done in the high-income countries which have the lowest prevalence globally. African studies on GDM prevalence are sparse with small study populations. Screening models and diagnostic criteria used in these studies have been inconsistent or not clearly defined therefore affecting the prevalence rates described by these studies.

2.4 Screening and Diagnostic Criteria for Gestational Diabetes Mellitus

Screening and diagnosis for GDM are done after 24 weeks' gestation because insulin resistance develops during the second trimester of pregnancy. Women who have features suggestive of pre-gestational DM or high-risk factors can be screened before 24 weeks for early diagnosis of overt DM. Most guidelines recommend GDM screening to occur between 24 to 28 weeks gestation, however, it is not clear why the specific cut-off of 28 weeks gestation. Many studies were done in the African population extend the screening period to 32 weeks due to late presentation of women to ANC clinic compounded with difficulties of access to healthcare (Muriithi et al., 2014; Olagbuji et al., 2015).

There are 2 main pathways that have been used to screen and test pregnant women for GDM. One is to have all women undergo an OGTT which is a diagnostic test for GDM. The alternative pathway is a 2-step technique where a 1-hour GCT is administered, followed by the diagnostic OGTT if GCT results are abnormal. The GCT is a test done in pregnant women to screen for GDM that does not require a fasting state. A 50g glucose solution is administered and then a 1-hour plasma glucose level is collected. A blood sugar >/= to 7.8mmol/L is indicative of impaired glucose tolerance and women will need to have a follow-up OGTT diagnostic test. The GCT is not diagnostic for GDM. A systematic review by Leeuwen *et al.* (2012) described a sensitivity and specificity of 74% and 85%, respectively, when the GCT was administered to all women and not just

those with risk factors. Even though higher sensitivities would be desirable for the GCT, this test may be used to screen women at low risk for GDM (Van Leeuwen et al., 2012). ACOG (unlike ADA) and Germany recommend the GCT in the screening diagnostic pathway for GDM (Benhalima et al., 2015; Riddle et al., 2018).

The OGTT was first evaluated for the screening of GDM by O'Sullivan et al in the late 1950s. Since these early years, the 100g -OGTT for GDM screening has been modified to the Carpenter Couston criteria in the 1980s and now the International Association of Diabetes and Pregnancy Study Groups (IADPSG) screening and diagnostic criteria. The O'Sullivan and Mahan criteria were established following the screening of 752 pregnant women with 100g glucose 3-hour OGTT. The normal upper limit was at 2 standard deviations above the mean. Any 2 abnormal values from the 3-hour test were diagnostic for GDM (Gunn et al., 1980).

The hyperglycaemia and adverse pregnancy outcome (HAPO) study revealed a directly proportional increase in predefined adverse pregnancy outcomes to eachplasma glucose valuefasting, 1 hour and 2-hour) in the OGTT. The adverse pregnancy outcomes included were macrosomic babies, neonatal hypoglycaemia, neonatal hyperinsulinemia, primary caesarean section, birth trauma/shoulder dystocia, foetal adiposity and preeclampsia. All these outcomes had a proportional relationship to maternal plasma glucose below diagnostic values for pre-gestational diabetes and persisted following adjustment of confounding factors such as age, BMI, parity and mean arterial pressure (The HAPO Study Cooperative Research Group, 2008).

These findings from the HAPO study resulted in a shift in screening and diagnostic criteria internationally. The International Association of Diabetes and Pregnancy Study Groups (IADPSG)is an organization that seeks to collaborate and facilitate decision

making by all national and regional stakeholders involved in diabetes and pregnancy with an aim to standardizing and improving the quality of care for diabetes in pregnancy. In 2008, the IADPSG developed new diagnostic criteria using glucose cut-off levels that resulted in 75% increased risk of macrosomia, foetal hyperinsulinemia and foetal adiposity. The IADPSG panel recommended a glucose level above or equal to of 5.1 mmol/L (fasting), 10.0 mmol/L (at 1 hour), 8.5 mmol/L (at 2 hours) as diagnostic for GDM. Most international bodies such as the WHO (2013), Endocrine Society of the USA and FIGO have implemented the IADPSG criteria to diagnose GDM(Blumer et al., 2013; Simeoni & Sobngwi, 2015).

However, ACOG and the NIH in England both published a consensus following the IADPSG recommendations opting not to adopt the IADPSG recommendations for GDM diagnosis due to insufficient evidence and maintained the Carpenter and Couston 2 step-approach to screening and diagnosis(American Association of Family Physicians, 2013 (Vandorsten et al., 2013). The IADPSG diagnostic criteria doubled the GDM prevalence. Agarwal *et al.* 2015 compared the IADPSG diagnostic criteria to 8 international expert panel diagnostic criteria and described a 1.5 to 4.9 fold increase in GDM prevalence using the IADPSG diagnostic criteria (Agarwal, Dhatt, & Othman, 2015). Controversies on whether this increase in prevalence results in detection of previously ignored risks or unnecessary interventions in healthy pregnant women continue to ensue (McIntyre et al., 2015; Reddi et al., 2016).The Atlantic Diabetes in Pregnancy (ADIP) programme screened 5500 European women for GDM using the IADPSG and “old” 1999 WHO criteria. As shown in other studies IADPSG diagnostic criteria resulted in a higher GDM prevalence; 12.4% had GDM using IADPSG compared to 9.4% WHO criteria. In the IADPSG-defined GDM group, there were significantly more negative maternal outcomes such as gestational, hypertension, caesarean sections and polyhydramnios.

An Australian retrospective study involving over 3000 pregnant women compared the 1998 Australia Diabetes in Pregnancy Society (ADIPS) criteria with the IADPSG criteria for GDM screening and diagnosis and confirmed this increase in prevalence associated with IADPSG criteria from 13% (ADIPS) to 16% (IADPSG). The authors concluded that this increase in prevalence was accompanied by better pregnancy outcomes and potential long-standing benefits to women and children affected by GDM that may be worth the increase in healthcare burden (Laafira et al., 2016).

In view of these findings, several international bodies have adopted their guidelines in compliance with the IADPSG criteria. The WHO amended 1999 WHO diagnostic criteria to comply with the IADPSG criteria resulting in the development of the 2013 WHO diagnostic criteria for GDM (WHO, 2013a). The ADA and the Endocrine Society also both accepted the IADPSG criteria to theirGDM screening and diagnosis guidelines (American Diabetes Association, 2017; Blumer et al., 2013). The European Board and College of Obstetrics and Gynaecology (EBCOG) has proposed the using 2013 WHO criteria, adoption of the IADPSG criteria, for dtecting GDM in all European countries in order to achieve uniformity in the region (Benhalima et al., 2015).

In Africa, most countries do not have national guidelines for the management of GDM and therefore no diagnostic criteria unique to the African population exists (Utz et al., 2016). Kenya's National Guidelines for Quality Obstetric and Perinatal Care only describe the screening and diagnostic criteria for overt/pre-gestational diabetes mellitus. Most GDM studies done in Africa use screening and diagnostic criteria from other guidelines developed in high resource settings. There is an increased burden of healthcare cost and health resource associated with the IADPSG recommended criteria due to the increased prevalence associated with the criterion. Concerns have been raised

on whether low- and middle-income countries could sustain the IADPSG recommendations.

As a result, low- and middle-income countries such as Peru, Nicaragua,Guyana Colombia and Guatemala have implemented the IADPSG criteria with the modification of a 2-step process involving the first step of a 1-hour 50g glucose tolerance test (GCT) prior to the IADPSG diagnostic test, even though this 2-step method is yet to be validated (Bhavadharini et al., 2016). The National Guidelines for Quality Obstetrics and Perinatal Care in Kenya, recommend the use of diabetes mellitus blood glucose cut-off values (FBS > 7.8mmol/L and RBS of 11.1mmol/L), which has been proven to be inaccurate for the diagnosis of GDM (Ministry of Medical Services & Ministry of Public Health and Sanitation, 2010).

In low resource countries, cost-effectiveness, as well as barriers to health accessibility, pose a challenge to effective GDM screening and diagnosis. The Women in India with GDM Strategy (WINGS) project created by the IDFaimed to improve pregnancy outcomes of women and children affected by GDM and enhance access to healthcare in a low resource setting. The project sought to develop a cost-effective screening method and compared several screening criteria that were thought to reduce cost including the Diabetes in Pregnancy Study Group of India (DIPSI) criteria. The DIPSI criteria recommended a simplified, one-step non-fasting screening and diagnostic OGTT of 75g-glucose load with a 2-hour glucose level greater than 7.8mmol/L being positive for GDM. Unfortunately, the DIPSI criteria demonstrated a low sensitivity of 22% to 40% (Herath et al., 2015; Mohan et al., 2014).

Another aspect of screening that the WINGS project evaluated to reduce costs and workload in low resource settings was the use of capillary blood glucose (CBG) for

glucose testing instead of the venous plasma glucose (VPG) recommended by guidelines. No obstetric guideline recommends CBG in their diagnostic criteria for GDM. The WINGS project found the CBG has a low sensitivity and could not replace the use of the VPG. Having evaluated these options for cost-effective detection of GDM in the low resource setting, the WINGS project still recommended the single step, fasting 75g OGTT using the IADPSG criteria using VPG as the gold standard for GDM screening and diagnosis even in the low resource setting (Bhavadharini et al., 2016; International Diabetes Foundation, 2015).

In Germany, the 50g glucose challenge test is done to screen women at risk of GDM. Women who have an abnormal 1-hour glucose level (>7.8mmol/L) following a 50g glucose load, proceed to have the diagnostic 75g OGTT using the IADPSG criteria. This screening and diagnostic approach are yet to be validated. Ireland and France, in Europe, have accepted the IADPSG diagnostic criteria but only screen high-risk pregnant women with recognisable risk factors (Benhalima et al., 2015). The Council of EBCOG proposed uniform new WHO criteria for GDM screening and diagnosis but was unable to recommend a specific strategy for screening whether universal or risk-factor-based for different European populations. A selective screening approach using the IADPSG criteria in the low resource setting may be an acceptable alternative to screening and diagnosis of GDM.

2.5 Risk Factors in Selective Screening of Gestational Diabetes Mellitus

Predisposing factors related to the development of GDM have been extensively described by several studies and been incorporated into most national guidelines. The United Kingdom NICE guidelines recommend risk assessment and screening for GDM in any pregnant woman with any of the following characteristics: history of baby weighing 4.5 kg or above; BMI > 30 kg/m^2; prior pregnancy complicated by GDM;

relative with DM or minority ethnicity. The minority ethnicities described are the African, African American, Asian, Native American and Hispanic ethnicities. The NICE guidelines have a selective screening approach to the screening of GDM and have not adopted the IADPSG diagnostic criteria (National Institute for Health and Clinical Excellence, 2015).

The America Diabetes Association (ADA) have described an even more extensive list of risk factors compared to the NICE guidelines. ADA uses these risk factors for early identification of women with undiagnosed type II DM and not as a screening strategy to detect GDM as in the NICE guidelines. ADA recommends a universal approach to the screening of pregnant women at 24 to 28 weeks of their pregnancy and has endorsed the use of the IADPSG diagnostic criteria.

Both these guidelines (ADA and NICE)mention ethnicity as a risk for developing GDM, this would make a risk factor based strategy in African, Asian and Hispanic countries impractical as all women would have to be screened based on their ethnicity being a risk factor.

In Peru, 1300 pregnant women were screened for GDM using the IADPSG diagnostic criteria and evaluated for GDM risk factors. The study described DM family history as a risk for GDM (OR: 1.53, 95%CI: 1.13–2.07); BMI > 25 kg/m^2 (OR: 1.83, 95%CI: 1.19–2.81) and depression (OR: 1.52, 95%CI: 1.09–2.12). This study was one of the few studies that identified depression as a risk factor for GDM as most studies looking at risk factors have not evaluated depression for risk of developing GDM. In this study, the increased risk of GDM in depression was comparable to that of family history of DM (OR: 1.53 and OR: 1.52 respectively) (Larrabure-Torrealva et al., 2018).

A Sub-Saharan Africa systematic review described GDM prevalence and risk factors after reviewing 22 studies from this region. Only 6 studies from Nigeria, Cameroon and Tanzania reported associations of risk factors for GDM. The risk factors highlighted were previous foetal macrosomia; previous unexplained stillbirth; first-degree relative with type II diabetes; high MUAC and age > 30 years. HIV-status and pre-pregnancy BMI were also described as independent risk factors, however, odds ratios were not provided and therefore could not be confirmed as independent risk factors (Mwanri et al., 2015).

In Kenya, a retrospective cohort study involving 238 respondents described similar GDM risk factors. The study described risk of acquiring GDM in pregnant women with hypertension; pre-pregnancy weight above 70kg;family history of DM and maternal age above 31 years (Adoyo et al., 2016). Weight alone is not an objective evaluation of obesity and a BMI calculation would have been a better parameter to evaluate this risk factor. Now that several factors have been associated with developing GDM, a few studies have evaluated the efficacy of a risk factor-based approach to the screening of GDM rather than screening all women between 24-28 weeks gestation (universal screening). The selective screening approach would be a more cost-effective, resource-saving strategy towards GDM screening that could be more practical to adopt than the universal approach in middle- and low- income countries with inadequate health resource.

A single centre, cross-sectional study in Sri Lanka assessed the detection rates of GDM using selective screening and universal screening strategies. They also compared the IADPSG and WHO diagnostic criteria. In spite of the diagnostic criteria used, universal screening detected higher rates of GDM in comparison to the selective screening strategy (23.2% versus 20.1% in the IADPSG criteria group and 18.2% versus 15.7% in the

WHO criteria group). The authors of the study summarized that selective screening had a lower detection rate than universal screening. Furthermore, the p-values of 0.7 and 0.4 in the WHO and IADPSG criteria groups respectively made this difference in detection rates insignificant(Meththananda Herath et al., 2016).

A similar study comparing universal and selective screening strategies in South Africa screened 554 pregnant with 75g - OGTT and GDM were diagnosed by the IADPSG criteria. The study showed that if selective screening alone was conducted, 10.6% of women with GDM would have been left undiagnosed (Adam at al., 2017). The authors did not provide the p-values, however, using the numbers indicated in the study the reduced detection rate in risk factor-based screening approach compared to the universal screening approach was significant (P-value < 0.0002).

A systematic review by Farrar et al. (2017) found that as the sensitivity of the selective screening approach increased so did the number of women needed to have a diagnostic test also increase. To have a sensitivity of 90% (90 detections) with the selective screening strategy, almost all women had to be screened with an OGTT. Additionally, combining risk factors in order to achieve higher sensitivities resulted in lower specificities and more false-positive results. There was no evidence that applying several risk factors was better than using 1 or two risk factors in the selective screening strategy. Furthermore, maternal age (25 years and older) and BMI (greater than or equal to 25kg/m^2) were the only 2 risk factors that would detect majority of GDM cases.

However, based on the systematic review findings already mentioned above almost all the women will have to be screened to have a sensitivity of 90% (Farrar et al., 2017). This study revealed that in order to get high sensitivities and specificities in the selective screening strategy, almost all women need to be tested for GDM. In the USA, 90% of

women have a risk factor for GDM, which would result in this proportion of women requiring screening during pregnancy (Williams et al., 1999). In Nigeria, 20% of women would have remained undiagnosed for GDM when selective screening is done(Olagbuji et al., 2015). Similarly, at the Aga Khan University Hospital, Muriithi e*t al.* 2012 illustrated that 48.1% of GDM diagnoses were identified in women without any risk factors (Muriithi et al., 2014). Therefore, the universal approach recommended by most screening guidelines including the IADPSG criteria may be the appropriate screening approach for GDM after all.

2.6 Conceptual Framework

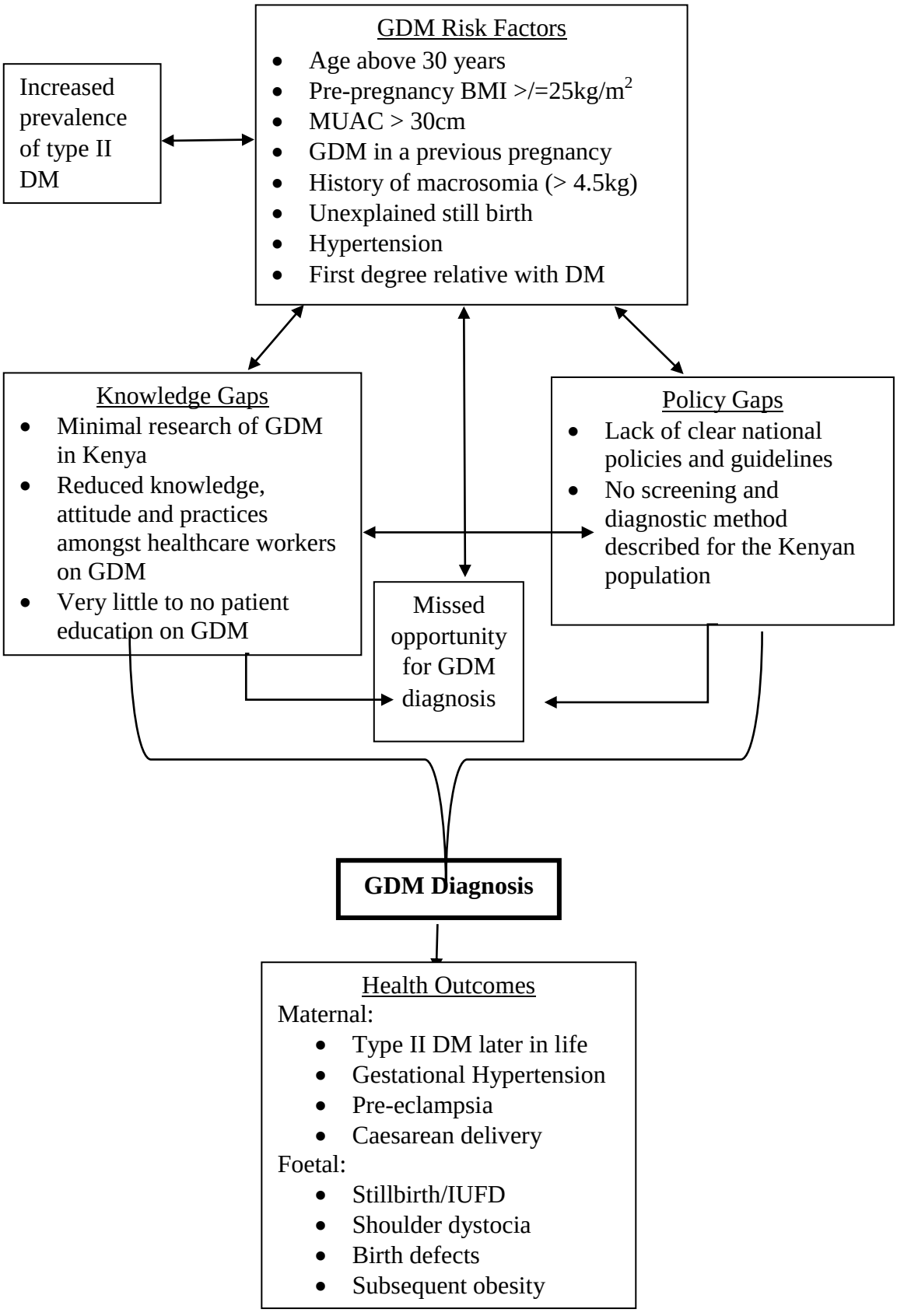

Figure 1: Conceptual Framework for the Study

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter discusses the research design, study location, study population, selection criteria, sampling method and sampling size, data collection procedure, ethical consideration and the data analysis procedures.

3.2 Research Design

The study was a cross-sectional study design from October 2019 to April 2020. The study included a retrospective arm (October 2019 to January 2020) and a prospective arm (February 2020 to April 2020). This cross-sectional study sought to establish the overall prevalence and risk factors associated with GDM in the antenatal clinic at AIC Kijabe Hospital. A cross-sectional study was the best-suited design for this research question as it allowed the researcher to measure the exposure and the disease status at the same time. This design did not require extensive follow-up and was, therefore, less costly and quicker than other designs.

3.3 Location of Study

The study was conducted at AIC Kijabe hospital antenatal clinic. AIC Kijabe hospital is in Lari division of Kiambu County, Kenya, approximately 60 kilometres from Nairobi by road. The County covers an area of 1.323.9 square kilometres. As a result of urbanisation in this area, AIC Kijabe Hospital as a study location provided information on prevalence amongst rural and urban dwellers. This study location also assisted in describing the pattern of risk factors affecting these population groups.

Pregnant women attending the antenatal clinic came from peri-urban and rural communities because the hospital is in a rural setup and is accessible to clients from

towns within Kiambu and Nairobi county. There were 3 antenatal clinics that the hospital run. The general antenatal clinic run daily from Monday to Friday managing approximately 20 “walk-in” patients per day. This clinic was staffed by clinical officers, medical officer interns and family medicine residents. The high-risk clinic was a scheduled clinic that handled pregnant women with high-risk pregnancies such as multiple gestations and pregnancies complicated by medical conditions. Women diagnosed with gestational diabetes were referred to this clinic for specialised care by a medical officer and/or family medicine resident. The high-risk clinic handled approximately 10 patients a day. The general antenatal clinic and high-risk clinic had an obstetrician available for any consultations on patients. The private clinic was running once a week by an obstetrician & gynaecologist who saw both obstetric and gynaecological private patients. This clinic was not included in the study.

All antenatal clinics routinely screened for GDM from 24 weeks gestation using the selective screening strategy and the IADPSG diagnostic criteria. Universal screening for GDM was not the screening approach used at AIC Kijabe Hospital.

3.4 Study Population

The population of this study included adult (>18 years) pregnant women between 24 to 32 weeks gestation attending AIC Kijabe Hospital antenatal clinics.

Inclusion criteria:

i. Pregnant women between 24- and 32-weeks’ gestation. Gestational age was calculated from the patients last normal menstrual period or obstetric scan estimation.

Exclusion criteria:

i. Women with type 2DM
ii. Women with HIV infection

iii. Patients on *current* medications that alter glucose metabolisms such as sulfonylureas, protease inhibitors, stavudine, beta-agonists, thiazide diuretics and steroids
iv. Women of Caucasian, Asian and Hispanic ethnicities
v. Ill patients requiring admission

3.5 Sampling Procedure

In the retrospective arm, all medical records of women attending ANC at Kijabe Hospital were reviewed for risk factors and GDM screening results as per the laid down protocol.

On the prospective arm, study participants were consecutively sampled according to the laid down protocol. However, the desired sample size of 108 for the prospective arm of the study was not achieved due to the following factors which resulted in delays in achieving the desired sample size within the laid down timelines.

i) During data collection, majority (55%) of women had their first ANC visit at AICKH after 32 weeks. Thus, most women attended clinic after the gestational age required to meet the inclusion criteria of this study. Women seen between 28 and 32 weeks would need to be given a return date of less than 4 weeks to be enrolled in the study. Most women found this short return date unfavourable due to distance and travel costs and therefore declined to be enrolled in the study.
ii) During the prospective arm of the study (February 2020 to April 2020), the Coronavirus pandemic greatly affected the numbers of women attending the Kijabe ANC clinic. Therefore, the number of women who could be enrolled to the prospective arm of the study reduced, and a few of those already recruited did not show up on the scheduled day for OGTT testing.

It took approximately 4 months to complete recruitment for this study.

3.6 Sample Size

This being a cross-sectional study looking at proportions, the Cochran (1963) formula which was developed to yield a representative sample for proportions, was the most suited sample calculation formula for this study. However, since the overall population of women attending AIC Kijabe Hospital was small (approximately 800 pregnant women annually), the Cochran formula modification for small sample size was used to calculate the final sample size. Based on the GDM prevalence in Africa, the prevalence in the study population was assumed to be 9%.

Cochran Formula:

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where:

n_o = Cochran sample size recommendation

Z= critical value for alpha (At p-value of 0.05, Z=1.96)

p = estimated prevalence of GDM in the study population that is 9%

q = 1 - p

e = the degree of precision (5%), is the maximum error we would expect to make at 95% confidence interval.

Therefore:

$n = 1.96^2 \times 0.09 (1-0.09)/0.05^2$

n= 3.84 x 0.09 x 0.91 / 0.0025

n= 0.315/0.0025= 126.

Cochran Formula modified for small populations

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where:

n_o = Cochran sample size recommendation (126)

N = population size (800)

n = new adjusted sample size

Therefore:

n = 126 / [1 + (125/800)]

n = 126 / 1.15625

n = 108

Using this formula, the minimum required sample size was 108.

A sample of 108pregnant women between 24 and 32 weeks gestationwas targeted for the prospective arm of this study, however only 38 women were enrolled to the prospective arm of the study. The retrospective arm of the study also required a minimum of 108 EMR chart reviews, however a total of 343 EMR charts were reviewed within the laid down timeline.

3.7 Instrumentation

Data Collection Tool: This was used to collect demographic data and evaluate risk factors and symptoms for GDM. Risk factors considered were: age above 30 years; pre-pregnancy BMI greater than or equal to 25kg/m^2; MUAC> 30cm; GDM in a previous pregnancy; history of macrosomia> 4.5kg; unexplained stillbirth; hypertension (chronic or gestational); and a first degree relative with DM. At the end of the questionnaire, the 75g OGTT results using the IADPSG cut-off points were documented (Appendix 2).

Equipment: There was a mid-upper arm circumference (MUAC) tape measure to calculate body mass index (BMI). A blood glucose testing kit was used which included a high-quality glucometer calibrated to read both venous and capillary blood sugar levels and undergo frequent quality control checks. A 75g glucose load solution was provided by the AIC Kijabe laboratory.

3.8 Data Collection Procedures

Prospective data

The principal investigator trained all healthcare workers (3 nurses, 2 clinical officers, 4 medical officers and 6 family medicine residents) working in the antenatal clinic on GDM, new implementation of GDM universal screening, and procedure of enrolment to the study. The lead clinical officer working at the ANC was trained further and employed as the research assistant for the study. All healthcare workers in the antenatal clinic began to sensitize all pregnant women about the study through patient education at the time of consultation. Participants who fit the inclusion criteria were consecutively recruited to take part in the study. Participants were consented and enrolled one visit prior to the OGTT testing date and given an OGTT slip with the date booked for OGTT. They were registered and scheduled in the research study diary with their phone numbers collected. This was to ensure that participants could be contacted and reminded to fast for a minimum of 8 hours prior to testing.

The healthcare worker who consented the patient placed the consent form in a research file stored in a secure room in the antenatal clinic. He/she also documented the participant's name and date of the return for OGTT testing in the research study diary. Healthcare workers attending to enrolled participants were advised to schedule no more than 3 participants per day (Monday to Friday) for ease in planning and organisation. Participants were called by the principal investigator one week before their return date

and a text message was sent the day before to encourage them to fast from midnight and arrive at the clinic by 8 am.

On return, the participant was received by the nursing officer and/or principal investigator, vitals were taken, and the nurse confirmed if the patient had fasted for at least 8 hours and was stable enough to proceed to the laboratory for testing. If a client arrived later than 8 am for the OGTT but has met the requirements of 8-hour fasting and was clinically stable, they were allowed to proceed to the lab for testing. The participant had her MUAC, weight and routine vital signs taken by then nurse and documented on the data collection form (Appendix 2). The participants would then go to the AIC Kijabe laboratory for the OGTT. Venous plasma glucose sample of the study participants was collected, and the reading recorded using a glucometer.

First, a fasting blood sugar reading was taken and then the participant was given a 75g glucose load solution to ingest within 10 mins. A random blood sugar reading from venous plasma was collected at 1 and 2 hours following the 75g glucose load. Timing and results were documented in the data collection form by the laboratory research assistant. The results were also be recorded in the patient's file on the electronic medical records system. Once the 2-hour test was done, the participant was given a snack and then fast-tracked to see the medical practitioner for their antenatal review and interpretation of results. Participants without GDM continued with their antenatal visits as usual, while participants diagnosed with GDM were referred to the high-risk antenatal clinic as per Kijabe Hospital protocol. The diagnosis of GDM or overt DM in pregnancy was made using the IADPSG diagnostic criteria described in the table below.

Retrospective Data

The principal investigator audited the electronic medical records (EMR) of all women who attended Kijabe ANC for a 4-month period between October 2019 to January 2020.

Data on their risk factors of all pregnant women attending ANC were collected and the OGTT results of those who met the criteria for testing were collected and analysed. The retrospective OGTTs were done based on the selective screening strategy and GDM diagnosis of both the retrospective and prospective data was based on the IADPSG diagnostic criteria.

Table 1: IADPSG Diagnostic Criteria for Gestational Diabetes Mellitus (GDM) and Overt Diabetes Mellitus (DM)

Time	GDM (mmol/L)	Overt DM (mmol/L)
0 hrs (Fasting)	>/= 5.1	>/= 7.0
1 hr	>/= 10	n/a
2 hrs	>/= 8.5	>/= 11.1

Note. One or more of these values from a 75-g OGTT must be equalled or exceeded for the diagnosis of GDM or Overt DM. Adapted from "International Association of Diabetes and Pregnancy Study Groups Recommendations on the Diagnosis and Classification of Hyperglycaemia in Pregnancy." by the International Association of Diabetes and Pregnancy Study Groups Consensus Panel, 2010, *Diabetes care*, *33*(3), 676-682.

All data collected on the data collection forms was kept in a research file together with the consent forms and stored in a secure room under lock and key in the antenatal clinic. The data collected was also put in an electronic database by the principal investigator. The database was secured by password and only the principal investigator could access the data.

3.9 Data Analysis

Patient names and identifiers were removed from all collected data prior to data analysis. Data was analysed using the Statistical Package for the Social Sciences (SPSS) version

23.Descriptive statistics were used to describe the population and presented in forms of tables, charts and graphs. Chi-square tests and odds ratios were calculated to analyse the categorical data collected. The statistical level of significance will be $p<0.05$ with a 95% confidence interval.

3.10 Ethical Considerations

Study approval was sought from Kabarak University and AIC Kijabe Hospital ethics review boards. Enrolment of participants and data collection began once approval from both boards is obtained. Written informed consent by study participants was obtained in Kiswahili and English (Appendix 1). Literate participants read the consent forms in their preferred language and signed the document. Illiterate participants had the consent form read to them in English or Kiswahili by a research assistant and placed a thumbprint as a signature. Research assistants were available to answer any questions or clarifications from the consent form. All participants were allowed to leave the study at any point once it began until 4 months after data collection. This is because it will be difficult to retrieve the specific data of the participant once it is on the database.

Participant confidentiality was observed throughout the course of the study. All research assistants were instructed on the importance of patient confidentiality by the principal investigator. In addition, all research assistants were medical practitioners who had already been trained on the concepts of patient confidentiality in their practice. All data collection forms were kept in a secure cabinet in the antenatal clinic. Electronic data had all patient names and identifiers removed and filed in a pass code-protected database. The database was accessible to the principal investigator and one research assistant.

There was minimal risk to participants enrolled in this study. Participants were required to fast for at least 8 hours from midnight as per IADPSG recommendations and testing

was done immediately they arrived in the clinic. Participants were not subjected to more than 12 hours of fasting unless they arrived at the clinic late, were found to be clinically stable on triage and are willing to proceed with the OGTT. The 75g glucose load was given in room temperature water and the patient was allowed to ingest it slowly over 10 mins to reduce the risk of nausea and vomiting associated with the glucose solution. If a patient had an episode of vomiting or could not tolerate the glucose solution, they were discontinued from the study and proceeded to the clinic for consultation with the doctor. They received their snack and allowed to eat once able to do so.

Participants had approximately 3ml, not exceeding 5ml, of blood sampled during the venous blood sampling for the blood glucose levels. Infection prevention and safety were observed by the use of clean, sterile methods for blood sample collection and waste disposal. The research assistants were trained phlebotomists who were familiar with these sterile techniques. Any adverse outcome (e.g. profuse bleeding, profuse vomiting, fainting) resulted in immediate transfer of the patient to the emergency department for treatment and the obstetric team and principal investigator were alerted immediately. This study did not involve offering any treatment to participants.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter presents the findings, interpretations and discussion according to the objectives and research questions of this study. The chapter will define the prevalence of gestational diabetes mellitus (GDM) utilising universal screening approach with an oral glucose tolerance test using the IADPSG diagnostic criteria. In addition, the prevalence of risk factors and their correlation with GDM will be described.

4.2 General and Demographic Information

4.2.1 General Information

This cross-sectional study consisted of a retrospective and prospective arm. The retrospective arm represented the selective screening strategy, which is the AICKH GDM screening protocol, while the prospective arm represented the universal screening strategy that was adopted as a new intervention during this study. A sample size of 108 was targeted on each arm of the study. Three hundred and forty-three (343) were screened in the retrospective arm (surpassing the minimum required sample size) and 38 women in the prospective arm of the study (falling short of the desired sample size for reasons described below). Forty-nine out of the 343 selectively screened women had an OGTT done to diagnose GDM in the retrospective arm. While all 38 women were tested for GDM based on the newly implemented universal screening strategy in the prospective arm of the study (figure 2).

Some of the problems encountered during the study that played a role in the reduced response rate on the prospective arm of the study included:

During data collection, 35% of women presented for their first obstetric visit before 28 weeks. Majority (55%) of women had their first ANC visit at AICKH after 32 weeks. Thus, most women attended clinic after the gestational age required to meet the inclusion criteria of this study. Women seen between 28 and 32 weeks would need to be given a return date of less than 4 weeks to be enrolled in the study. Most women found this short return date unfavourable due to distance and travel costs.

During the prospective arm of the study (February 2020 to April 2020), the Coronavirus pandemic greatly affected the numbers of women attending the Kijabe ANC clinic. Therefore, the number of women who could be enrolled to the prospective arm of the study reduced, and a few of those already recruited did not show up on the scheduled day for OGTT testing.

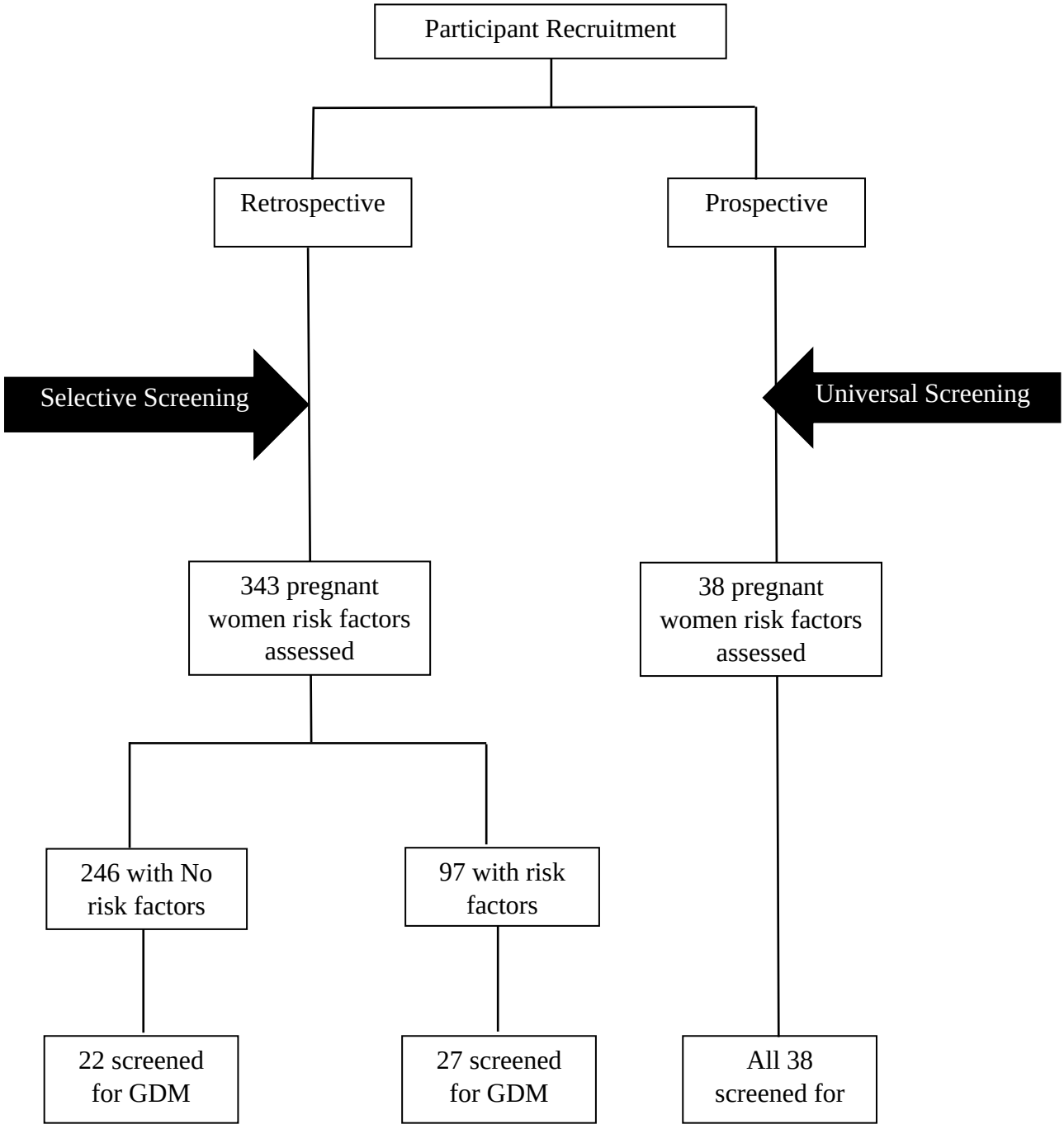

Figure 2: Participant Recruitment Flowchart for the Study

4.2.2. Demographic Data

The mean age of the study participants attending ANC at AICKH was 27 years, with ages ranging from 19 to 44 years. Majority were below 30 years of age, with highest frequency between 20 to 29 years. The average weight of pregnant women at the time of screening was 77.2 kgs, the lowest weight was 56kg and the highest was 117kg. Eighty nine percent (88.9%) of women weighed less than 89 kgs in the third trimester of their pregnancy. Sixty-six percent (66.4%) of pregnant women had their first ANC at AICKH after 28 weeks gestation.

Table 2: Demographic Characteristics of Study Participants at Baseline

	Variable	Frequency (n)	Percentage (%)
Age (years)	<20	13	3.4
	20-29	183	48.0
	30-39	137	36.0
	40-49	48	12.6
Weight during 3rd trimester (kg)	50-69	100	26.4
	70-89	238	62.5
	90-119	43	11.3
Gestational age at first visit (weeks)	<27+6	128	33.6
	>28	253	66.4

4.3 Results

4.3.1 Frequency of Gestation Diabetes Mellitus Based on Different Screening Strategies

The prospective arm of the study used the universal screening strategy, while the retrospective arm used the selective strategy based on AIC Kijabe hospital screening

protocol. Thirty-eight women were universally screened on the prospective arm of the study, of which 5 screened positive for GDM and 1 for overt DM resulting in a frequency of 13.2%for GDM cases and 2.6% for overt DM cases detected according to the universal screening approach.

Three hundred and forty-three women in the retrospective arm of the study were screened for GDM using the selective screening criteria. Nine women screened positive for GDM, and 3 women had overt DM out of the total population of 343. The selective screening strategy detected a frequency of 2.6 % cases of GDM and 0.9% cases of overt DM. Ninety-seven women had at least one risk factor but only 27 women (27.8%) had an OGTT done. Two hundred and forty-six women had no risk factors, yet 22 women from this group had an OGTT in the absence any risk factors, contrary to the selective screening approach recommended in the hospital screening protocol. Nevertheless, the GDM cases detected in the retrospective arm was calculated based on the intention-to-treat analysis.

Using the Pearson chi-square test for categorical data, the universal screening strategy detected a significantly higher proportion of GDM at 13.2%in comparison to the selective screening strategy at 2.6% (p=0.016).No significant difference was found between the cases of overt DM detected by the two screening strategies. See Table 3.

Table 3: Frequency of GDM and Overt DM using Universal and Selective Screening Strategy

	Screening Strategy		**P-value**
	Universal	Selective	
GDM, n (%)	5 (13.2)	9 (2.6)	0.016
Overt DM, n (%)	1 (2.6)	3 (0.9)	0.927

4.3.2 Frequency of Risk Factors Used in Selective Screening Strategy in all Pregnant Women

The selective screening strategy is dependent on the risk factor profile of pregnant women. Only women with at least one risk factor are enrolled for GDM testing in the selective screening strategy. It was therefore important to describe the frequencies of the risk factors in the study population in order to assess the utility of selective strategy appropriately.

Seven risk factors predisposing to GDM were collected and evaluated from all study participants. These highlighted risk factors were: i) BMI greater than 30 kg/m^2; ii) history of gestational diabetes; iii) baby weighing greater than 4.5 kg in a previous pregnancy; iv) unexplained stillbirth; v) DM family history; vi) chronic hypertension; and vii) pre-eclampsia or gestational hypertension.

Combined data from the retrospective and prospective arm of the study was used to evaluate the frequency of risk factors in the study population. The retrospective arm of the study had 100% response rate on five risk factors (previous gestational diabetes, unexplained stillbirth, previous baby weighing 4.5 kg or above, chronic hypertension, and history of pre-eclampsia or gestational hypertension). Twenty-six files did not have family history of diabetes documented, which reduced the response rate to 93.4%. There was no record of BMI on any of the women attending ANC in the retrospective arm of the study. The prospective arm of the study had 100% response rate on the following six risk factors: previous macrosomia, previous gestational diabetes, unexplained stillbirth, chronic hypertension, history of pre-eclampsia or gestational hypertension and family history of 1^{st}degree relative with DM. BMI was recorded in 21.1% of the prospective data. For this reason, the BMI of pregnant women as a risk factor for GDM could not be evaluated further in this study.

A total of 381 women had their risk factor profiles reviewed and the frequency was calculated. Two hundred and sixty-nine had no risk factors (70.6%) while 112 (29.4%). A large proportion of women (24.9%)had at least one risk factor, 4.2% had two risk factors and only 0.3% of women had three risk factors (table 4, figure 3). A relative with diabetes had the highest frequency at 18.2%, followed by stillbirth at 10%; chronic hypertension at 5.1%; baby's birthweight above 4500g at 4.4%; a history of pre-eclampsia or gestational hypertension at 3.3% and a history of GDM at 0.5%.A significantly larger proportion of women with a history of macrosomia (OR 3.3, 95% CI 1.2 – 9.0, p=0.012) and history of a stillbirth (OR 2.4, 95% CI 1.2 – 4.8, p=0.011) were screened for GDM compared to those who were not screened. There was no significant difference in the risk factor frequencies of history of GDM (OR 3.5, 95% CI 0.1 – 137, p=0.346), chronic hypertension (OR 1.9, 95% CI 0.7 – 5.0, p=0.162), gestational hypertension or pre-eclampsia (OR 1.0, 95% CI 0.2 – 3.7, p=0.946) and first degree relative with DM (OR 1.3, 95% CI 0.7 – 2.4, p=0.320) between the study participants who were screened and not screened for GDM.

Table 4: Presence and Absence of Risk Factors of all women attending ANC at Kijabe Hospital

	All Pregnant Women Attending ANC N=381
No Risk Factors, n (%)	269 (70.6)
Risk Factors present, n (%)	112 (29.4)
1 risk factor	95 (24.9)
2 risk factors	16 (4.2)
3 risk factors	1 (0.3)

had a GDM frequency of 2.6%, while the universal screening approach had a13.2 % frequency.

This study was not powered for prevalence, and therefore the GDM cases diagnosed in the study can only be described as proportions/frequencies of GDM using the different screening strategies. Nevertheless, the frequencies of GDM in both arms of the study are similar to the prevalence rates of GDM described in other Kenyan studies. In the retrospective arm of the study, where selective screening strategy was used, the proportion of women with GDM falls within the range of other prevalence studies done in AKUH (1.1%) and Western Kenya (2.9%) (Pastakia et al, 2017;Muriithi et al. 2014). Unlike this study, both of these studies had all pregnant women undergo a 50g glucose challenge test, and only those with impaired glucose tolerance would proceed to have the diagnostic OGTT for GDM.

The frequency of GDM in the universal screening strategy also lies within the range of two studies done in Kenyatta National Hospital (KNH) that showed a prevalence of 11.6% and 16.7% (Bosire, 2012; Adelaide et al., 2011). Both these studies used the universal screening approach to determine GDM prevalence.

The retrospective arm of the study represented the selective screening strategy for GDM which is the recommended screening protocol at AIC Kijabe Hospital (AICKH) as well as the national obstetric guidelines in Kenya (Ministry of Medical Services, & Ministry of Public Health and Sanitation, 2010). Some inconsistencies were observed in the screening practices used in the retrospective arm of the study. Ninety-seven women had at least one risk factor and met the criteria to be tested with an OGTT according to this selective screening strategy, but only 27 women (27.8%) were tested. In addition, 22 women who did not have any risk factors and therefore not eligible for testing, had an

OGTT done and 5 additional cases of GDM were diagnosed from this group of women without risk factors. These deviations from the hospital's selective screening guideline reveal possible challenges that this screening method presents to AICKH antenatal clinic.

i. Doctors practicing in AICKH may have different screening strategy preferences. This is the case in India, based on a literature review that revealed inconsistencies in the guidelines followed by doctors for GDM screening and diagnosis (Morampudi, Balasubramanian, Gowda, Zomorodi, & Patil, 2017).

ii. Doctors may have different screening thresholds based on presumed significance of different risk factors. In this study, pregnant women with a history of stillbirth were more likely to be screened for GDM with an odds ratio of 2.4 (95% CI 1.2 - 4.8, *p*-value 0.011). Similarly, women with a history of macrosomia were more likely to have an OGTT with an odds ratio of 3.3 (95% CI 1.2 – 9.0, *p*-value 0.012). Therefore, pregnant women with a history of stillbirth or macrosomia were significantly more likely to undergo an OGTT compared to women with other recognised risk factors for GDM, reflecting a possible bias by doctors to these two risk factors.

iii. From the patient perspective, it is possible that despite being informed on the need for a GDM screen, the cost and time required for the OGTT could be prohibitive, and therefore screening is not performed. Morampudi et. al(2017) described a similar challenge in India, stating that access, cost and patient preparation for the OGTT significantly affected the rate of screening and diagnosis for GDM.

These are a few speculated reasons why selective screening has been sub-optimal in the AICKH as a GDM screening method. The USA was one of the first countries to compare the two screening strategies and found that selective screening added significant

complexity to the screening process, and therefore opted for universal screening of all pregnant women (Danilenko-Dixon et al., 1999). Similarly, Berger et al.(2009) in Canada found that selective screening implementation was more complex than universal screening as it increased the burden on the healthcare provider during assessment on whom to screen. The retrospective data collected in this study reveals that the current selective screening method at AICKH has been inconsistently implemented and therefore not reliable to detect GDM prevalence due to the complexities of accurate GDM risk factor assessment by healthcare workers working in AICKH.

As a result, a significantly lower frequency of GDM was detected using selective screening strategy at 2.6% in comparison to universal screening strategy at 13.2% ($p=0.016$).This significant difference in frequencies between the two screening strategies has been described in several studies. In Ireland, a predominantly Caucasian, low-risk country detected prevalence in universal and risk factor-based screening was 2.7% and 1.45% ($p<0.03$), respectively and concluded that universal screening was superior to selective screening (Griffin et al., 2000). In South Africa, universal screening detected a 25.8% prevalence of GDM while risk factor-based screening detected 15.2%. Ten percent of women would have been missed if the risk factor-based screening strategy was used. Based on these findings, Adam et al. (2017) concluded that risk factor-based screening is a poor strategy to diagnose GDM.

4.4.2 Discussion on Risk Factors used in Selective Screening Strategy

This study evaluated the distribution of six risk factors in 381 women attending AIC Kijabe Hospital antenatal clinic. The risk factors evaluated included: i) previous baby weighing 4.5 kg or above; ii) previous gestational diabetes; iii) family history of first-degree relative with diabetes; iv) unexplained stillbirth v) chronic hypertension; and vi) history of pre-eclampsia or gestational hypertension. This section first describes the

distribution and number of risk factors in the total population of 381, which will inform on the burden of risk factors for GDM amongst all pregnant women. Thereafter, the risk factors observed in the 14 women who were diagnosed with GDM will be described.

The most common risk factor from the 381pregnant women evaluated was a family history of diabetes in a first degree relative at 18.6%. All four studies conducted in Kenya reported a high frequency of a family history of diabetes amongst women attending their antenatal clinics, ranging from 15.2% to 41%.The highest frequencies of 35.1% and 41.0% were seen in Aga Khan University Hospital (AKUH) and Kenyatta National Hospital (KNH) studies, respectively (Muriithi et al., 2014;Bosire, 2012). These two hospitals both serve the urban communities living in Nairobi. The study based in western province, reported a lower frequency of 15.2%, with most pregnant women in this study coming from rural communities. The AIC Kijabe Hospital (AICKH)frequency of 18.2% falls between these two groups probably due to its mixed rural and peri-urban location. Subsequently, family history of GDM was the most common risk factor among women who screened positive for GDM at AICKH with a frequency of 28.6%. A study in KNH reported a high frequency of 74.4% in all women who developed GDM (Bosire, 2012). This percentage illustrates how closely related the prevalence of type 2 diabetes in the general population is to the health and well-being of pregnant women and their children. As the prevalence of type 2 diabetes rises in the general population, so will the prevalence of GDM in pregnant women.

Stillbirth defined as fresh stillbirth or unexplained intrauterine foetal death (IUFD) had the second highest frequency in the total population of 381 women attending ANC at 10.2%.This frequency was higher than that reported in the AKUH study of 4.9%(Muriithi et al., 2014).Only one of the national hospitals (KNH) looked at stillbirth and reported it as a composite prevalence of stillbirth, preterm delivery or miscarriage at

15.6%. It was therefore difficult to make an accurate comparison of stillbirth alone as a risk factor. The frequency of macrosomia at AICKH was 4.4% which was similar to KNH and AKUH studies that reported frequencies of 5.3% and 5.4%, respectively (Bosire, 2012;Muriithi et al., 2014). In GDM, macrosomia was seen in 14.3% of women which was comparable to the 13.3% frequency seen in a KNH study (Bosire, 2012). AKUH reported a lower proportion of macrosomia at 6.3% in women with impaired glucose tolerance and not exclusively GDM. Stillbirth and macrosomia are both complications of GDM and are therefore screened as risk factors for acquiring the disease. These risk factors, stillbirth and macrosomia, were the second and third most common risk factors amongst women who screened positive for GDM in this study with frequencies of 21.4% and 14.3%, respectively. These high frequencies are most probably due to missed opportunities for diagnosing GDM in pregnant women, resulting in a high occurrence of GDM complications in the population. The AKUH frequency of these two complications and risk factors is significantly lower, 4.9% for stillbirth and 5.4% for macrosomia. This could be because AKUH is a private health facility serving pregnant women of higher economic status who have access to better healthcare services throughout the course of their pregnancy. Therefore, the population of women attending AKUH are more frequently screened and managed for GDM resulting in fewer cases of stillbirth and macrosomia.

Not surprisingly, history of GDM had the lowest frequency in this study population. Only 2 out of 381 (0.5%) women attending ANC at AICKH had a history of GDM, this was similar to the other Kenyan studies that each reported a frequency ranging from 0% to 0.9%. None of the women who screened positive for GDM had a positive history for GDM. This is similar to the Western Kenya prevalence study that reported no history of GDM in all the 616 pregnant women enrolled in the study (Pastakia et al. 2017). The

AKUH study also reported a low number of women with a history of GDM as a risk factor at 0.5% (Muriithi et al. 2014). This emphasises the low rate of screening for GDM in Kenya, especially in the public hospitals and rural communities, and the need to educate and empower public hospital health providers on GDM screening.

Interestingly, chronic hypertension was not assessed as a risk factor for GDM in any of the Kenyan studies, yet its association to development of GDM has been described in a number of studies, including the most recently published African meta-analysis study that described a statistically significant odds ratio of 2.49 (1.35-4.59)(Muche, Olayemi, & Gete,2019). The fact that all four studies did not assess chronic hypertension as a risk factor for GDM may indicate that not all the risk factors for GDM have been recognised and therefore not applied in the selective screening strategy. Of the 381 attending AICKH antenatal clinic, 112 women (29.4%) had at least one risk factor for GDM. At AKUH, 63.2% of pregnant presented with at least one risk factor. In the USA, over 90% of pregnant women were found to have at least one risk factor and this is one of the reasons why universal screening of all pregnant women is practiced(ADA, 2017).It is possible that the burden of risk factors amongst pregnant women in Kenya is higher than what has been reported. AKUH reported a risk factor burden that was double of what was seen in AICKH, probably influenced by more vigilant screening of GDM practiced at the private hospital. As national knowledge of risk factors associated with GDM increases, more screening for these risk factors and GDM will be done and a possible rise in the prevalence of these risk factors will be observed.

Fourteen women screened positive for GDM, of which 8 (57.1%) had at least one risk factor and 6 (42.9%) had no risk factors at all. This finding coincides with an AKUH study where 48.1% of women who screened positive for GDM had no risk factors. This significant finding resulted in a change in the GDM screening approach from risk factor-

based screening to universal screening of all pregnant women attending antenatal clinic at AKUH. Still, one of the recognised risk factors for GDM found in international guidelines is ethnicity(NICE, 2015). African, Hispanic and Asian women are reported to have a higher risk of developing GDM than Caucasian women, deduced from the higher prevalence rates of GDM in non-Caucasian countries. The high proportion of women developing GDM without risk factors in this study and others like it supports the presumption of African ethnicity being a possible risk factor for GDM. Furthermore, the risk factor distribution in pregnant women and those diagnosed with GDM has played a significant role for many countries in determining which screening strategy should be adopted in their National guidelines. In the USA, when Danilenko-Dixon *et al.* (1999) revealed that 90% of pregnant women had risk factors for GDM, they found that complexities associated with risk factor-based screening to spare the minimal 10% from screening was unnecessary and therefore opted for universal screening. In South Africa, Adam *et al.* (2017) noted a lower prevalence of risk factors in the overall population (45.8%) but found that risk factor-based screening had a low sensitivity (58.7%) and specificity (58.6%) and that up to 10% of women would be missed if the risk-factor based screening was implemented. As a result, universal screening is the recommended screening strategy for GDM in South Africa. In Kenya, Muriithi et al.(2014) in AKUH found that 48.1% of women with GDM did not have any risk factors and risk factor-based screening would miss a significant number of women with GDM. Consequently, following the publication of Muriithi's study results, AKUH adopted universal GDM screening as hospital policy.

Therefore, based on the high rate of GDM in women without risk factors and the suboptimal risk factor profile assessment in the selective screening strategy revealed in

this study, the universal screening approach would be the most appropriate screening method for GDM in AICKH.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the findings, and the conclusions arrived at based on the results. It also includes policy recommendations and interventions that can be done and recommendations for future research.

5.2 Summary

This cross-sectional study aimed to assess the utility of the selective and universal screening strategy to detect GDM in pregnant women attending ANC in AIC Kijabe Hospital, Kenya.

There are five main findings based on this study's research objectives.

i. GDM is diagnosed in a significantly higher proportion of pregnant women using the universal screening strategy (13.2%) compared to the risk factor-based strategy (2.6%) using the IADPSG diagnostic criteria.
ii. The selective screening strategy is inconsistently used and therefore unreliable to determine true prevalence of GDM in AICKH
iii. Family history of diabetes in a first degree relative (21.8%), history of a stillbirth (17.2%) and macrosomia (9.2%) are the most frequently observed risk factors in women screened for GDM.
iv. A large proportion (42.9%) of women diagnosed with GDM do not have risk factors.
v. The selective screening strategy will miss diagnosing a significant proportion of women with GDM

5.3 Conclusions

This study reveals that universal screening is significantly better at diagnosing GDM than the selective screening strategy and women who screen positive for GDM can present without any risk factors. Therefore, universal screening for GDM would be the most reliable screening method to diagnose GDM in AIC Kijabe Hospital.

5.4 Recommendations

5.4.1 Policy Recommendations

i. Universal screening of all pregnant women between 24 and 32-weeks gestation should be the preferred screening strategy for GDM in AIC Kijabe Hospital.

ii. The Kenya National Guidelines for Quality Obstetrics and Perinatal Care should be updated, clearly stating the risk factors for GDM and the recommended screening and diagnostic criteria for Kenya. According to this study, and other national studies, universal screening for GDM is the ideal screening strategy.

iii. Continuous medical education for healthcare workers on the increasing prevalence of GDM, its risk factors, complications and management in order to improve antenatal healthcare nationally.

5.4.2 Recommendations for Further Research

i. Larger, multicentre, trans-county studies should be done to clearly define the GDM prevalence in Kenya using the universal screening strategy.

ii. Studies evaluating additional risk factors including BMI, demographic and ethnic factors that were not evaluated in this research.

iii. Cost effectiveness analysis studies on GDM screening methods should be done to inform health policy makers.

iv. Follow-up, observational cohort studies on women who are diagnosed with GDM to assess for maternal and child outcomes in the future.

REFERENCES

Adam, S., & Rheeder, P. (2017). Screening for gestational diabetes mellitus in a South African population: Prevalence, comparison of diagnostic criteria and the role of risk factors. *South African Medical Journal*, *107*(6), 523. https:// doi.org/10.7196/SAMJ.2017.v107i6.12043

Adelaide, Ogutu, & Munguti. (2011). The prevalence of glucose intolerance among antenatal clients at Kenyatta National Hospital at, 24-36 weeks of gestation. *Ajol.Info*, *88*. Retrieved from https://www.ajol.info/ index.php/eamj /article/view/86823

Adoyo, M. A., Mbakaya, C., Nyambati, V., & Kombe, Y. (2016). Retrospective cohort study on risk factors for the development of gestational diabetes among mothers attending antenatal clinics in Nairobi County. *Pan African Medical Journal*, *24*, 1–5. https://doi.org/10.11604/pamj.2016.24.155.8093

Agarwal, M. M., Dhatt, G. S., & Othman, Y. (2015). Gestational diabetes: differences between the current international diagnostic criteria and implications of switching to IADPSG. *Journal of Diabetes and Its Complications*, *29*(4), 544–549. https://doi.org/10.1016/J.JDIACOMP.2015.03.006

American Diabetes Association. (2017). *STANDARDS OF MEDICAL CARE IN DIABETES — 2017 Standards of Medical Care in Diabetes d 2017*. *40*(January).

Benhalima, K., Mathieu, C., Damm, P., Van Assche, A., Devlieger, R., Desoye, G., … Dunne, F. (2015). A proposal for the use of uniform diagnostic criteria for gestational diabetes in Europe: an opinion paper by the European Board & College of Obstetrics and Gynaecology (EBCOG). *Diabetologia*, *58*(7), 1422–1429. https://doi.org/10.1007/s00125-015-3615-7

Bhavadharini, B., Uma, R., Saravanan, P., & Mohan, V. (2016). *Screening and diagnosis of gestational diabetes mellitus - relevance to low and middle-income countries* (Vol. 2). https://doi.org/10.1186/S40842-016-0031-Y

Blumer, I., Hadar, E., Hadden, D. R., Jovanovič, L., Mestman, J. H., Murad, M. H., & Yogev, Y. (2013). Diabetes and pregnancy: An endocrine society clinical practice guideline. *Journal of Clinical Endocrinology and Metabolism*, *98*(11), 4227–4249. https://doi.org/10.1210/jc.2013-2465

Bosire, A. N. (2012). *Screening of gestational diabetes in Kenyatta National Hospital*. Retrieved from http://erepository.uonbi.ac.ke/handle/11295/8296

Casagrande, S. S., Linder, B., & Cowie, C. C. (2018). Prevalence of gestational diabetes and subsequent Type 2 diabetes among U.S. women. *Diabetes Research and Clinical Practice*, *141*, 200–208. https://doi.org/10.1016/j.diabres.2018.05.010

Centers for Disease Control and Prevention. (2011). National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011. *Atlanta, GA: US department of health and human services, centers for disease control and prevention*, *201*(1), 2568-2569.

Coetzee, E. J. (2009). Pregnancy and diabetes scenario around the world: Africa. *International Journal of Gynecology & Obstetrics*, *104*(Supplement), S39–S41. https://doi.org/10.1016/j.ijgo.2008.11.027

Danilenko-Dixon, D. R., Van Winter, J. T., Nelson, R. L., & Ogburn Jr, P. L. (1999). Universal versus selective gestational diabetes screening: application of 1997 American Diabetes Association recommendations. *American journal of obstetrics and gynecology*, *181*(4), 798-802.

Eades, C. E., Cameron, D. M., & Evans, J. M. M. (2017). *Prevalence of gestational diabetes mellitus in Europe: A meta-analysis* (Vol. 129). https://doi.org /10.1016/j. diabres.2017.03.030

Farrar, Di., Simmonds, M., Bryant, M., Lawlor, D. A., Dunne, F., Tuffnell, D., & Sheldon, T. A. (2017). *Risk factor screening to identify women requiring oral glucose tolerance testing to diagnose gestational diabetes: A systematic review and meta-analysis and analysis of two pregnancy cohorts* (Vol. 12). https://doi.org/10.1371/journal.pone.0175288

Ferrara, A. (2007). Increasing prevalence of gestational diabetes mellitus: A public health perspective. *Diabetes Care*, *30*(SUPPL. 2). https://doi.org/10.2337/dc07-s206

Griffin, M. E., Coffey, M., Johnson, H., Scanlon, P., Foley, M., Stronge, J., ... & Firth, R. G. (2000). Universal vs. risk factor based screening for gestational diabetes mellitus: detection rates, gestation at diagnosis and outcome. *Diabetic Medicine*, *17*(1), 26-32.

Guariguata, L., Linnenkamp, U., Beagley, J., Whiting, D. R., & Cho, N. H. (2014). Global estimates of the prevalence of hyperglycaemia in pregnancy. *Diabetes Research and Clinical Practice*, *103*(2), 176–85. https://doi.org/10.1016 j.diabres.2013.11.003

Gunn, P. J., Of, D., Diabetes, G., Pregnancy, I. N., Of, E., & Screening, R. (1980). *screening for Gestational Diabetes*. *3*(3), 468–471.

Gupta, Y., Kalra, B., Baruah, M. P., Singla, R., & Kalra, S. (2015). Updated guidelines on screening for gestational diabetes. *International Journal of Women's Health*, *7*, 539–550. https://doi.org/10.2147/IJWH.S82046

Herath, M., Weerarathna, T. P., & Umesha, D. (2015). Is Non-Fasting Glucose Challenge test sensitive enough to diagnose Gestational Diabetes Mellitus? *International Archives of Medicine*, 1–8. https://doi.org/10.3823/1692

International Association of Diabetes and Pregnancy Study Groups Consensus Panel, I. A. of D., Consensus, P. S. G., Metzger, B. E., Gabbe, S. G., Persson, B., Buchanan, T. A., … Schmidt, M. I. (2010). The international association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. *Diabetes Care*, *33*(3), 676–82. https://doi.org/10.2337/dc09-1848

International Diabetes Foundation. (2015). *WINGS GDM Model of Care*. 20.

Kai Wei Lee1, S. M. C. (2018). Prevalence and risk factors of gestational diabetes mellitus in Asia: a systematic review and meta-analysis. *BMC Pregnancy and Childbirth*, *18*(494), 1036–44.

Kampmann, U., Madsen, L. R., Skajaa, G. O., Iversen, D. S., Moeller, N., & Ovesen, P. (2015). Gestational diabetes: A clinical update. *World Journal of Diabetes*, *6*(8), 1065–72. https://doi.org/10.4239/wjd.v6.i8.1065

Kim, C. (2010). Gestational diabetes: risks, management, and treatment options. *International Journal of Women's Health*, *2*, 339–51. https://doi.org /10.2147/IJWH.S13333

Krishnaveni, G. (2010). Intrauterine Exposure to Maternal Adiposity and Insulin Resistance and Clustering of Cardiovascular Risk Markers in Indian Children. *Diabetes Care*, *33*(2), 402–404. https://doi.org/10.2337/dc09-1393.

Laafira, A., White, S. W., Griffin, C. J., & Graham, D. (2016). Impact of the new IADPSG gestational diabetes diagnostic criteria on pregnancy outcomes in Western Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology*. https://doi.org/10.1111/ajo.12394

Larrabure-Torrealva, G. T., Martinez, S., Luque-Fernandez, M. A., Sanchez, S. E., Mascaro, P. A., Ingar, H., … Williams, M. A. (2018). Prevalence and risk factors of gestational diabetes mellitus: Findings from a universal screening feasibility program in Lima, Peru. *BMC Pregnancy and Childbirth*, *18*(1), 1–9. https://doi.org/10.1186/s12884-018-1904-0

Lavery, J. A., Friedman, A. M., Keyes, K. M., Wright, J. D., & Ananth, C. V. (2017). Gestational diabetes in the United States: temporal changes in prevalence rates between 1979 and 2010. *BJOG: An International Journal of Obstetrics and Gynaecology*, *124*(5), 804–813. https://doi.org/10.1111/1471-0528.14236

Macaulay, S., Dunger, D. B., & Norris, S. A. (2014). Gestational Diabetes Mellitus in Africa: A Systematic Review. *PLoS ONE*, *9*(6), e97871. https://doi.org/10.1371/journal.pone.0097871

Mapira, H. T., Tumusiime, D. K., Yarasheski, K., Rujeni, N., Cade, T. W., & Mutimura, E. (2017). Strategy to improve the burden of gestational diabetes in African women: Rwandan perspective. *Rwanda Journal*, *4*(1), 36. https://doi.org/ 10.4314/rj.v4i1.5F

McIntyre, H. D., Colagiuri, S., Roglic, G., & Hod, M. (2015). Diagnosis of GDM: A suggested consensus. *Best Practice and Research: Clinical Obstetrics and Gynaecology*, *29*(2). https://doi.org/10.1016/j.bpobgyn.2014.04.022

Meththananda Herath, H. M., Weerarathna, T. P., & Weerasinghe, N. P. (2016). Is Risk Factor-based Screening Good Enough to Detect Gestational Diabetes Mellitus in High-Risk Pregnant Women? A Sri Lankan Experience. *International Journal of Preventive Medicine*, *7*, 99. https://doi.org/10.4103/2008-7802.188084

Ministry of Medical Services, & Ministry of Public Health and Sanitation. (2010). *National Guidelines for Quality Obstetrics and Perinatal Care*. Ministry of Public Health and Sanitation.

Mohan, V., Mahalakshmi, M. M., Bhavadharini, B., Maheswari, K., Kalaiyarasi, G., Anjana, R. M., … Kayal, A. (2014). Comparison of screening for gestational diabetes mellitus by oral glucose tolerance tests done in the non-fasting (random) and fasting states. *Acta Diabetologica*, *51*(6), 1007–1013. https://doi.org /10.1007/s00592-014-0660-5

Morampudi, S., Balasubramanian, G., Gowda, A., Zomorodi, B., & Patil, A. S. (2017). The challenges and recommendations for gestational diabetes mellitus care in India: A Review. *Frontiers in endocrinology*, *8*, 56.

Muche, A. A., Olayemi, O. O., & Gete, Y. K. (2019). Prevalence and determinants of gestational diabetes mellitus in Africa based on the updated international diagnostic criteria: a systematic review and meta-analysis. *Archives of Public Health*, *77*(1), 36.

Muriithi, F. G., Sequeira, E., & Kunyiha, N. (2014). *Screening strategies for gestational diabetes mellitus at the Aga Khan University Hospital, Nairobi: A cross-sectional study*.

Mwanri, A. W., Kinabo, J., Ramaiya, K., & Feskens, E. J. M. (2015). Gestational diabetes mellitus in sub-Saharan Africa: systematic review and metaregression on prevalence and risk factors. *Tropical Medicine & International Health*, *20*(8), 983–1002. https://doi.org/10.1111/tmi.12521

Nakabuye, B., Bahendeka, S., & Byaruhanga, R. (2017). Prevalence of hyperglycaemia first detected during pregnancy and subsequent obstetric outcomes at St. Francis Hospital Nsambya. *BMC Research Notes*, *10*(1), 174. https://doi.org/10.1186/s13104-017-2493-0

National Institute for Health and Clinical Excellence. (2015). *Diabetes in pregnancy: management from preconception to the postnatal period*. (February). Retrieved from https://www.nice.org.uk/guidance/ng3/resources/diabetes-in-pregnancy-management-of-diabetes-and-its-complications-from-preconception-to-the-postnatal-period-51038446021%0Ahttps://www.nice.org.uk/guidance/ng3

Ogurtsova, K., da Rocha Fernandes, J. D., Huang, Y., Linnenkamp, U., Guariguata, L., Cho, N. H., … Makaroff, L. E. (2017). IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. *Diabetes Research and Clinical Practice*, *128*, 40–50. https://doi.org/10.1016/j.diabres.2017.03.024

Olagbuji, B. N., Atiba, A. S., Olofinbiyi, B. A., Akintayo, A. A., Awoleke, J. O., Ade-Ojo, I. P., … Gestational Diabetes Study Group-Nigeria. (2015). Prevalence of and risk factors for gestational diabetes using 1999, 2013 WHO and IADPSG criteria upon implementation of a universal one-step screening and diagnostic strategy in a sub-Saharan African population. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *189*, 27–32.

Pastakia, S. D., Njuguna, B., Onyango, B. A., Washington, S., Christoffersen-Deb, A., Kosgei, W. K., & Saravanan, P. (2017). Prevalence of gestational diabetes mellitus based on various screening strategies in western Kenya: a prospective comparison of point of care diagnostic methods. *BMC Pregnancy and Childbirth*, *17*(1), 226. https://doi.org/10.1186/s12884-017-1415-4

Reddi Rani, P., & Begum, J. (2016). Screening and diagnosis of gestational diabetes mellitus, where do we stand. *Journal of Clinical and Diagnostic Research*, *10*(4), QE01–QE04. https://doi.org/10.7860/JCDR/2016/17588.7689.

Riddle, M. C., Bakris, G., Blonde, L., Boulton, A. J. M., D 'Alessio, D., De Groot, M., … Cefalu, W. T. (2018). Introduction: Standards of Medical Care in Diabetes—2018. *Diabetes Care*, *41*(Supplement 1), S1–S2. https://doi.org/10.2337/dc18-Sint01

Simeoni, U., & Sobngwi, E. (2015). *I international Journal of Gynecology and Obstetrics The International Feder a tion of Gynecology and Obstetrics (F I GO) Initiative on gestational diabetes mellitus : A pr a gm a tic guide for diagnosis, management , and c. 3*.

The HAPO Study Cooperative Research Group. (2008). Hyperglycemia and Adverse Pregnancy Outcomes. *New England Journal of Medicine*, *358*(19), 1991–2002. https://doi.org/10.1056/NEJMoa0707943

Utz, B., Kolsteren, P., & De Brouwere, V. (2016). A snapshot of current gestational diabetes management practices from 26 low-income and lower-middle-income countries. *International Journal of Gynecology and Obstetrics*, *134*(2), 145–150. https://doi.org/10.1016/j.ijgo.2016.01.020

Van Leeuwen, M., Louwerse, M. D., Opmeer, B. C., Limpens, J., Serlie, M. J., Reitsma, J. B., & Mol, B. W. J. (2012). Glucose challenge test for detecting gestational diabetes mellitus: A systematic review. *BJOG: An International Journal of Obstetrics and Gynaecology*, *119*(4), 393–401. https://doi.org/10.1111/j.1471-0528.2011.03254.x

Vandorsten, J. P., Dodson, W. C., Espeland, M. A., Grobman, W. A., Guise, J. M., Mercer, B. M., … Tita, A. T. N. (2013). NIH consensus development conference: diagnosing gestational diabetes mellitus. *NIH Consensus and State-of-the-Science Statements*, *29*(1), 1–31.

Williams C.B., Iqbal S., Zawacki C.M., Yu D., Brown M.B., & Herman W.H. (1999). Effect of selective screening for gestational diabetes. *Diabetes Care*, *22*(3), 418–421.

World Health Organization. (2013a). *Diagnostic Criteria and Classification of Hyperglycaemia First Detected in Pregnancy*. 1–62.

World Health Organization. (2013b). Global action plan for the prevention and control of noncommunicable diseases 2013-2020. *World Health Organization*, 102. https://doi.org/978 92 4 1506236

World Health Organization. (2016). *WHO recommendations on antenatal care for a positive pregnancy experience*. World Health Organization. (2016). WHO recommendations on antenatal care for a positive pregnancy experience. World Health Organization.

Zhu, Y., & Zhang, C. (2016). Prevalence of Gestational Diabetes and Risk of Progression to Type 2 Diabetes: a Global Perspective. *Current Diabetes Reports*, *16*(1), 1–11. https://doi.org/10.1007/s11892-015-0699-x

APPENDICES

Appendix I: Informed Consent Form

Informed Consent Form for pregnant women attending AIC Kijabe Hospital Antenatal Clinic, and who we are inviting to participate in research titled:

"Screening Strategies to detect Gestational Diabetes Mellitus in AIC Kijabe Hospital, Kenya"

Principal Investigator: Sarah Wanjiku Kiptinness

Organizations: Kabarak University and AIC Kijabe Hospital

Prior to making a decision to take part in this study, you should understand the reason the research is being done and what it will involve.

You are excluded from this study if any of the following apply to you.

Exclusion Criteria	Y(Yes) or N (No)
Have you been diagnosed with diabetes mellitus before pregnancy?	
Are you using oral drugs for diabetes (sulfonylureas), HAART (protease inhibitors, stavudine), beta-agonists (propranolol, carvedilol), thiazide diuretics (HCTZ) and steroids (prednisolone, dexamethasone)	
Are you Caucasian, Hispanic or Asian?	

Please take time to read and ask for clarifictation on the information provided.

This Informed Consent Form consists of two parts:

1. Information Sheet
2. Certificate of Consent

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

PART I: Information Sheet

Introduction

I am Sarah Kiptinness a medical doctor currently doing my Masters in Family Medicine at Kabarak University and AIC Kijabe Hospital. I am conducting a study on gestational diabetes, which is a disease that is increasingly affecting pregnant women in Kenya. As a pregnant woman attending the antenatal clinic in Kijabe Hospital and Naivasha Medical Centre, I would like to invite you to be a participant in the research.

Purpose of the research.

During pregnancy, the body is unable to producean adequate amount of insulin (a hormone that controls blood glucose) to meet the additional demandsof the preganant body. As a result, blood glucose levels increase and develop gestational diabetes mellitus (GDM). GDM usually starts in in the 5^{th} month of pregancy. It is a common pregancy complication and may affect up to 1 in 10 preganct women in Kenya. Most women who are diagnosed withGDM have uncomplicated pregnancies and deliver healthy babies, howeverGDM can occassionally cause serious problems, especially if it remains undiagnosed.

Elevated blood glucose levels in the mother's body cause the growing baby to produce more insulin, which can make him/her bigger than normal which increases the chance of being induced during labour, delivering by caesarean section, serious birth complications and stillbirth. After delivery, these babies may have low blood glucose levels and will need to be admitted in the neonatal unit. Controlling blood sugar levels during pregnancy reduces the risks of developing these problems for the mother and baby. In order to diagnose GDM, we need to perform a test to check if the blood glucose levels are within the normal ranges. This research is to help find out how many pregnant women in AIC Kijabe Hospital are affected with gestational diabetes and inform us on how to better manage the pregnant women attending the antenatal clinic.

Type of Research Intervention

This study will require you to take a 2-hour blood test involving 3 blood samples and needs to be done in the morning before taking any breakfast. Results will be available immediately after the test is done and will be explained to you by the researcher or the clinician in the antenatal clinic during your visit.

Participant Selection

We are inviting all pregnant women who attend the AIC Kijabe antenatal clinic to take part in the study.

Voluntary Participation

Participation in the study is completely voluntary. You have a choice on whether or not you would like to be part of the study. If you decide to take part or not, you will receive all the ANC services as usual without discrimination. You are free to change your mind and stop participating in the study even if you agreed to do so earlier.

Procedures and Protocol

If you choose to take part you will be asked to give consent to participate in the study, and you will be invited to take part in the study. During one of your antenatal clinic visits between the 24th and 32nd week of your pregnancy, you will be asked to take a blood test to check your blood glucose levels. You will be asked to not take any food after midnight on the day of your blood test. The test will need to be done in the morning before taking breakfast at the hospital laboratory. You will be given a glucose drink and blood tested for glucose levels over 2 hours. Your blood will be tested 3 times in order to get the correct test results. You are free to stop the testing process or withdraw from the research at any time and you do not have to provide a reason.

As soon as you have done the test, a small breakfast snack will be provided, and you will proceed to see your clinician at the family clinic. When you see the clinician, he will ask you a few questions to fill into a questionnaire and provide you with your test results. The researcher and/or clinician will be available to answer all your questions and concerns.

Test Result Interpretation & Follow-up

If you test negative for gestational diabetes, you will continue your usual antenatal clinics as advised by your primary clinician, and no further testing will be required. If you test positive for gestational diabetes, the clinician will enrol you the AIC Kijabe high-risk antenatal clinic where pregnant women with gestational diabetes and other conditions needing close monitoring during pregnancy attend. The doctor at the clinic will advise you on dietary changes and medication that you may have to start to control your blood sugars, and you will need to have frequent visits and blood sugar test during

follow up. This is according to routine hospital and national guidelines for the management of pregnant women with gestational diabetes.

Duration

The research takes place on 1-day between the 24th and 32nd week of your pregnancy for 2 hours in the morning before your routine antenatal clinic if you have risk factors for gestational diabetes mellitus. If you do not have any risk factors of GDM, the test takes 1-hour after drinking a glucose drink.

Risks

No risk is anticipated while participating in this study. However, during the withdrawal of blood for investigation, you will feel minor discomfort, which is normally felt when blood is drawn routinely and with no additional discomfort anticipated.Gastric irritation may lead to nausea and vomiting of some participants. Therefore, offering the solution in a small yet palatable volume of 250ml and chilled will reduce the effects of nausea and vomiting. You will be advised to drink it slowly over 5 to 10 minutes to further reduce the risk of these unwanted effects.

Benefits

If you participate in this study and test positive for gestational diabetes, you will have the benefit of being treated for the disease which will reduce your risks of experiencing complications during delivery as well as health risks to your baby as a new born and in the future. If you test negative for gestational diabetes, you may not directly benefit from this study, however your results will likely to help us understand who is at risk for gestational diabetes and determine what percentage of women are affected with gestational diabetes attending the AIC Kijabe hospital antenatal clinic.

Reimbursements

We will give you a snack voucher from the Kijabe cafeteria as a breakfast snack because of having fasted for the test. There are no gifts or monetary benefits if you take part in this study.

Confidentiality

All information collected from this research study is confidential. Personal information collected during the study will be kept in a secure electronic file and no-one, except the researcher will be able to see it. Your name and identification details will be removed

and concealed by an identification number. The researcher will store the information in a secure cabinet and/or passcode-protected electronic file. Information will not be shared with or given to anyone except Sarah Kiptinness, the principal investigator and your primary clinician and/or doctor at the antenatal clinic.

Sharing the Results

Your lab results will be shared with you on the same day on your clinic visit by your doctor. The overall information we gain from this study will be shared in medical forums in order to assist policy decision-making. Confidential information will not be shared.

Right to Refuse or Withdraw

You are free to refuse to participate in this study when approached and you will receive clinic services as usual. You may stop taking part in the study at any time after enrolment and your ANC care will not be affected in any way.

Who to Contact?

You are free to ask questions now or later, even after the study has started. If you wish to seek clarifications later, you may contact Sarah Kiptinness on 0722427138 or email skiptinness@kijabehospital.org.

This proposal has been reviewed and approved by the Ethics and Research Committee of both Kabarak University and AIC Kijabe Hospital., which are committees that ensure research participants are protected from harm during research projects. For more information about these ethics and research committees, contact Carol Mwangi from the AIC Kijabe Hospital Research and Ethics committee on 0720896182 or Dr James Kay 0724887431 from the Kabarak University Research and Ethics committee.

PART II: Certificate of Consent

I confirm that I have read and understood the purpose of this research project as explained in the information sheet. I have asked questions and got satisfactory answers about the study.

I know that taking part in this study is voluntary and that I am free to stop participating at any time without any repercussions.

I recognize that my results are confidential. I permit the research team to have access to my anonymized results. I appreciate that my name will be concealed, and I will not be identified in the documentation produced from this research.

I approve my participation in the above study.

Participant Name: _____

Signature of Participant _____ Date _____

If illiterate

(A literate witness selected by the participant with no relation to the research team must sign. Illiterate participants should include their thumb-print as well.)

I have witnessed this consent form being read to the potential participant, and the individual has been able to ask questions. I confirm that the individual has given consent freely.

*Witness Name*_____ *AND* *Thumb print of participant*

Signature of witness _____

Date _____

Statement by the researcher/person taking consent

I have read the information sheet to the potential participant, and ensured that the participant understand that the following will take place: 1) oral Glucose Tolerance Test between 24-32 weeks gestation; 2) fasting from midnight on the day of the test; 3) results will be interpreted to the participant, and 4) counselling and treatment to anyone who tests positive will be provided.

I confirm that the participant has asked questions about the study, and all their questions have been answered correctly and to the best of my ability. I confirm that there was no coercion into giving consent, and the consent has been given freely and voluntarily.

A copy of this ICF has been provided to the participant.

Person taking the consent Name:_____

Signature of person taking the consent_____Date _____

Fomuya Makubaliano

Fomu ya makubaliano kwa ajili ya wanawake wajawazito wanaohudhuria kliniki ya wajawazito katika Hospitali ya AIC Kijabe, na tunaowaalika kushiriki katika utafiti uitwao:

"Viwango vya ueneaji vya kisukari cha ujauzito na sababu hatari zinazoambatana katika Hospitali ya AIC Kijabe na Zahanati ya Kijabe katika Naivasha, Kenya"

Mtafiti Mkuu: Sarah Wanjiku Kiptinness
Mashirika: Chuo Kikuu cha Kabarak na Hospitali ya AIC Kijabe

Kabla ya kuamua ikiwa utashiriki katika mafunzo haya, ni muhimu kwako kufahamu kwa nini utafiti unafanyika na utahusisha nini.
Unazuiwa kutoshiriki katika mafunzo haya ikiwa yoyote yafuatayo yanakuhusu

Kanuni za uzuiaji	N (Ndiyo) au H (Hapana)
Umegunduliwa kuwa na kisukari kabla ya ujauzito?	
Unatumia tembe kwa ajili ya ugonjwa wa kisukari (sulfonylureas), HAART (protease oxidative, stavudine), beta-agonists (propranolol, carvedilol), thiazide diuretics (HCTZ) na steroids (prednisolone, dexamethasone)	
Una asili ya kizungu, kihispania au asia?	

Tafadhali chukua muda kusoma na kujadili habari ifuatayo na uulize ikiwa kuna chochote ambacho hukielewi au ikiwa ungependa habari zaidi. Chukua wakati kuamua ikiwa ungetaka kushiriki au la.
Asante kwa kuyasoma haya.

Fomuyamakubalianoinasehemumbili:

1. Karatasi ya habari (Kujuliana habari kuhusu utafiti nawe)
2. Cheti cha makubaliano (kwa sahi hii kiwautakubalikushiriki)

Utapewanakala yote yafomuyamakubaliano.

SEHEMU YA KWANZA: Karatasiya Habari

Utangulizi

Mimi ni Sarah Kiptinness, daktari ni naye fanya Digrii yangu ya uzami fukwa sasa katika tiba ya familia Chuo Kikuu cha Kabarak na Hospitali ya AIC Kijabe. Ninafanya utafiti kuhusu kisukari cha uja uzito, ambalo ni ugonjwa linalo ongezeka kudhuru wanawake waja wazito nchini Kenya. Kama mwanamke mja mzito anayehudhuria kliniki ya uja uzito katika Hospitali ya Kijabe na zahanati ya Naivasha, ningependa kuwa karibisha kuwa mshirika katika utafiti.

Kusudi la utafiti

Kisukari ambacho huanza wakati wa ujauzito kinajulikana kama kisukari cha ujauzito. Kinatokea wakati mwili haiwezi kutengeneza "insulin" kutosha (homoni muhimu ya kudhibiti sukari damuni) kutosheleza mahitaji yake muhimu katika ujauzito. Hii husababisha viwango vya juu vya sukari damuini. Kisukari cha ujauzito kwa kawaida huanza katikati (wiki ya 24) au kuelekea mwisho wa ujauzito. Kisukari cha ujauzito ni cha kawaida. Kinaweza kudhuru hadi mwanamke mmoja (1) kati ya wanawake kumi (10) wakati wa ujauzito nchini Kenya. Wanawake wengi wanaopata kisukari wakati wa ujauzito, wana ujauzito uliu na afya na watoto wenye afya, lakini mara kwa mara kisukari cha ujauzito kinaweza kusababisha matatizo makubwa, hasa kisipogunduliwa.

Wakati viwango vya sukari mwilini viko juu zaidi, mtoto anayekua atatoa *insulin* zaidi, ambayo itamfanya kunenepa na kuongeza uwezekano wa kulazimika kuzaliwa upasuaji, matotiza makubwa ya kujifungua na kijusu kilichokufa. Mtoto anayetengezwa *insulin* ya ziada, aweza kuwa na viwango vya sukari vya chini damuini na kuna uwezakano kulitaji utunzaji wa zaidi katika vitengo vya watoto waliozaliwa kabla ya wakati. Kudhibiti viwango vya sukari wakati wa ujauzito na leba hupunguza hatari zote za matatizo haya kwa ajili ya mama na mtoto. Ili kujua ikiwa mwanamke mjamzito ana kisukari cha ujauzito, tunahitaji kumpima kuangalia ikiwa viwango vya sukari viko katika hali ya kawaida. Utafiti huu ni kusaidia kupata ni wanawake wangapi wajawazito katika Hospitali ya AIC Kijabe na Zahanati ya Kijabe katika Naivasha wanaodhurika na kisukari cha ujauzito na kutuarifu jinsi bora ya kuwanfunzawanawake wajawazito wanaohudhuria na kliniki ya ujauzito.

Ainayautafitiingilivu

Utafitihu uutahusisha kipimo kimoja cha masaa mawili cha damu kikihusisha sampuli tatu ya damu na kinahitaji kufanyika asubuhi kabla ya kula kiamshakinywa. Matokeo yatapatikana baada ya kipimo kufanyika nautaelezwa na mtafiti au mhudumu wakliniki ya ujauzito wakati wa kuja kwako.

Uchaguzi wamshirika

Tunawaalika wanawake wote wajawazito kati ya wiki 24 na 32 ya ujauzito wanao hudhuria Hospitali ya AIC Kijabe na Zahanatiya Kijabe katika Naivasha kliniki ya ujauzito kushiriki katika utafiti.

Kushiriki kwa kujitolea

Kushiriki kwako katika utafiti huu ni wakujitolea kabisa. Ni chaguo lako ikiwa utashiriki au hapana. Ukichagua kushiriki au la, huduma zote unazopokea katika kiliniki hii zitaendelea na hakuna chochote kita kacho badilika. Unaweza kubadilisha akili yako baadaye nausimame kushiriki hata kama ulikubali awali.

Njia na Sheria

Ukichagua kushiriki, utaulizwa kupeana kibali kushiriki katika mafunzo nautaalikwa kushiriki katika mafunzo. Utakapo kuja kliniki ya ujauzito kati ya wiki 24 na 32 ya ujauzito wako, utaulizwa kupimwa damu kuangalia viwango vyasukari katika damu. Utaulizwa kuto kula chakula chochote baada ya saa sita za usiku, siku ya kuamkia kupimwa damu. Kupimwa kutahitaji kufanyika asubuhi kabla ya kiamsha kinywa katika maabara ya Hospitali. Utapewa kinywaji cha sukari na damu kupimwa kwaviwango vya sukari kwazaidi ya masaa mawili. Damu yako itapimwa mara tatu ilikupata matokeo sahihi. Una uhuru kusimamisha kupimwa au kujiondoa katika utafiti wakati wowote na huhitaji kuto sababu.

Punde tu baada ya kupimwa, utapewa chakula kidogo cha kiamsha kinywa na utaenda kumwona mhudumu wako wakiliniki ya familia. Unapomwona mhudumu wakliniki,

atakuuliza maswali machache kujaza katika fomu na kukupa matokeo yako ya vipimo. Mtafitina/au mhudumu wa kliniki wata kuwako kujibu maswali yako yote na wasiwasi wako.

Matokeo ya kipimo ufafanuzi na ufuatiliaji

Matokoeo ya kitoka kinyume kwa kisukari cha ujauzito utaendelea na kliniki zako za ujauzito za kawaida unavtoshauri wanamhudumu wako wakliniki na hakutakuwa na vipimo zaidi vitakavyo hitajika. Ukipatikana kuwanakisukari cha ujauzito, mhudumu wakliniki ata kuorodhesha katika kliniki ya hatari kuu ya ujauzito ya AIC Kijabe ambapo wanawake wajawazito waliona kisukari cha ujauzito nahali zingine wanaohitaji uangalizi wakaribu wakati wa ujauzito kuhudhuria. Daktari katika kliniki atakushauri kuhusu mabadiliko ya chakula na dawa ambazo labda wawezakuanza kudhibiti sukari yako damuni, naunahitaji utembelee kliniki mara nyingi na kuwa na vipimo ya sukari damu ni wakati wa ufuatiliaji. Haya ni kulingana na utaratibu wa Hospitali na mwongozo wa kitaifa kwa usimamizi wa wanawake wajawazito walio nakisukari cha ujauzito.

Muda

Utafiti hufanyika kwa siku moja kati ya wiki ya 24 na 32 ya ujuauzito wako kwa masaa mawili asubuhi kabla ya utaratibu wako wakliniki yaujauzito.

Hatari

Hakuna hatari yoyote inayotarajima unapo shiriki katika mafunzo haya. Hata hivyo, wakati wakutoa damu kwa uchunguzi, utahisi usumbufu mdogo, ambao kwa kawaida hulisiwa damu inapotolewa kwa utaratibu na bila usumbufu waziada kutarajiwa.

Faida

Ukishiriki katika utafiti huu na utapatikana na kisukari cha ujauzito, utakuwa na faida ya kutibu wagonjwa ambapo itapunguza hatari zako za kuwa na ugumu wakati wa kujifungua pamoja na hatari za afya kwa motto wako kama motto mpya na wakati ujao.

Ukiwe na matokeo ya kinyume kwa kisukari cha ujauzito, hakuta kuwa labda faida yoyote kwako, lakini kushiriki kwako kutaweza kutusaidia kufahamu ni nani yupo hatarini kupata kisukari chaa ujauzito nakutathmini niasilimia ya wanawake wanodhurikana kisukari cha ujauzito katika Hospitali ya AIC Kijabe.

Marudisho

Tutakupa vocha ndogo ya chakula kutoka mkahawawa Kijabe kama kiamsha kinywa kwa sababu yakuto kula wakati wa kipimo. Hutapewa pesa zingine zozote au zawadi kushiriki katika utafiti huu.

Siri

Habari tunazo kusanya kutoka kwa mradi huu wautafiti zitawekwa siri. Habari kukuhusu zitakakusanywa wakati wautafiti zitawekwa mbalina hakuna yoyote, ilawatafiti wataweza kuziona. Habari zozote kukuhusu zitakuwa na nambari juu yake badala ya jina lako. Watafiti tu watajua nambari yako ni gani natutafungia habari hizo kwa kufuli. Hazitapeanwa kwa yeyote ila Sarah Kiptinness, mchunguzi mkuu na mhudumu wako wakliniki na/au daktari katika kliniki ya ujauzito.

Kujulishwa Habari

Maarifa tunayopata kwa utafiti huu yatajulishwa kwako kupitia mukutano uijijini kabla yakupeana kwa umma (raia). Habari ya siri hazitapeanwa. Kutakuwa na mekutano midogo uijijini, na hii hatangazwa. Baadaya mikutano hii, tutachapisha matokeo iliwatu walionahaja labda wanaweza kujifunza kutoka kwa utafiti wetu.

Haki yakukataa au kujiondoa

Hulitaji kushiriki katika utafiti huu ikiwa hungetaka kufanya hivyo na kukataa kushiriki hakuta dhuruma tibabu yako katika kliniki hii kwa vyovyote vile. Bado utakuwa na faida zote zileambazo ungekuwa nazo katika kliniki hii. Waweza kuwacha

kushiriki katika utafiti wakati wowote unaotakabila kupote za haki zako zozote kama mgonjwa hapa. Matibabu yako katika kliniki hii hayatadhurika kwavyovote vile.

Utakao wasiliana nao

Ikiwa una maswali yoyote, waweza kuyauliza sasa au baadaye, hata baada ya utafiti umeanza. Ikiwa ungetaka kuyauliza maswali baadaye, waweza kumjulisha: Sarah Kiptinness kwa nambari 0722427138 au barua pepe skiptinness@kijabehospital.org.

Pendekezo hili limerudiwa nakutubali wana kamati ya utafiti (IRB) namaadili ya Chuo Kikuu cha Kabarak na Hospitali ya AIC Kijabe, ambayo nikamati nakazi yake nikuhaki kasha kwamba washiriki wautafiti wamekingwa na madhara. Ikiwa ungetaka kujua zaidi kuhusu IRB, mwone Carol Mwangi kutoka kamati yautafit ina maadili ya Hospitali ya AIC Kijabe kwa nambari 0720896182 au Dkt. James Kay 0724887431 kutoka kamati ya utafiti namaadili ya Chuo Kikuu cha Kabarak.

SEHEMU YA PILI: Cheti cha makubaliano

Nadhibitisha kwamba nimesoma na kufahamu madhumuni ya utafiti huu kama ilivyo katika karatasi ya habari. Nimeku wana nafasi ya kuuliza maswali nanikapata majibu ya kuridhisha kuhusu mafunzo.

Nina elewa kwamba kushiriki kwangu nikwakujitolea na nina uhuru kujiondoa wakati wowote bila kupeana sababu yoyote na bila kuweko matokeo ya kinyume. Pamoja na hayo, nikikosa kujibu swali lolote au maswali, nina uhuru kukataa.

Ninaelewa kwamba majibu yangu yatawekwa siri kabisa. Nawepa ruhusa washirika wa timu ya utafiti kuweza kufikia majibu yangu yasiyona jina. Ninaelewa kwamba jina langu halitahusishwa na dhana za utafiti, na sitatambuliwa katika ripoti zitakazo tokea kuhusu utafiti.

Nakubali kushiriki katika mafunzo haya.

Juna la Mshirika.....

Sahihi ya Mshirika.....

Tarehe..... (Siku/mwezi/mwaka)

Ukiwa hajui kusoma au kuandika

Shalidi anayeweza kusoma au kuandika nilazima aweke sahihi (ikiweze kana, mtu huyu anahitaji achaguliwe na mshirika na asiwena uhusiano natimuya utafiti). Washirika wasio weza kusoma au kuandikawa na hitaji waambatamshe alama ya kidole gumba pia.

Nimeshuhudia usomaji sahihi wa fomu ya makubaliano kwa mshirika mhusika, na mtu amekuwa na nafasi ya kuyauliza maswali. Nadhibitisha kwamba mtu amepeana makubaliano kwa uhuru.

Jina la Shahidi..... na kidole gumba cha mshirika

Sahihi ya shahidi.....

Tarehe.....

Siku/mwezi/mwaka

Taarifa ya mtafiti/mtu anaye toa makubaliano

Nimesoma kwa ufasaha karatasi iliyo na habari kwa mshirika na kwakadiri ya uwezo wangu, nimehakikisha kwamba mshirika anafahamu kwamba yafuateyo yatafanyika: 1) Kuvumilia kunywa kipimo cha kinywaji cha sukari kati ya wiki 24 hadi 32 za ujauzito; 2) Kutokulakuanziausikukatikatisikuyakipimo; 3) matokeo ya taelezwa mshirika; na 4) kushauri wana matibabu kwa yeyote atakaye patikana nakisukari kutolewa.

Nadhibitisha ya kwamba mshiriki alipewa nafasi ku ya ulizama swali kuhusu mafunzo, na maswali yaliyoulizwa na mshirika yamejibiwa vilivyo na kwa uwezo wangu. Nadhibitisha kuwa mtu hajalazimishwa kutoa makubaliano, na makubalianao ya metolewa kwa uhuru na kwa kujitolea.

Nakala ya hii fomu yamakubaliano imepewa mshirika.

Jina la mtafiti/mtu anaye toa makubaliano.....

Sahihi ya mtafiti/mtu ana yetoa makubaliano.....

Tarehe.....

Siku/mwezi/mwaka

APPENDIX II: Data Collection Tool

All sections of this data collection form MUST be completed

Biodata
Name: LNMP:
Age: EDD:
Patient Number: GBD:

Vitals
Blood Pressure: Respiration Rate:
Pulse: Pulse Oximetry:

Anthropometry
Pre-pregnancy weight: MUAC:
Current weight:

Kindly tick any of the following that apply

History of GDM in previous pregnancy	
History of baby with birth weight >4500g	
History of unexplained stillbirth	
Known hypertension	
History of pre-eclampsia or gestational hypertension	
First degree relative* with DM	

*First degree relative refers to biological mother, father and/or sibling

Completed By: _____ Date: _____
(Name & signature)

75g-OGTT RESULTS: **Date:**

Time (hours)	Glucose level result (mmol/L)	IADPSG*^ criteria for GDM (mmol/L)	IADPSG*^ criteria for overt DM (mmol/L)	Tick if above IADPSG threshold
0		**5.1**	**7**	
1		**10**	**-**	
2		**8.5**	**11.1**	

***** The International Association of Diabetes and Pregnancy Study Groups

^ One or more of these glucose values must be equal to or exceeded for the diagnosis of GDM or overt DM

DIAGNOSIS (circle appropriate): No GDM GDM Overt DM

APPENDIX III: Kabarak University IPGS Approval

KABARAK UNIVERSITY

Private Bag - 20157
KABARAK, KENYA
http://kabarak.ac.ke/institute-postgraduate-studies/

Tel: 0773 265 999
E-mail: directorposteraduate@kabarak.ac.ke

BOARD OF POSTGRADUATE STUDIES

28th April 2020

The Director General
National Commission for Science, Technology & Innovation (NACOSTI)
P.O. Box 30623 – 00100
NAIROBI

Dear Sir/Madam,

RE: SARAH KIPTINESS (GMMF/M/1362/09/16)

The above named is a Masters Student at Kabarak University pursuing Master of Medicine in Family Medicine. School of Medicine and Health Sciences. She is carrying out a research entitled "*Prevalence of Gestational Diabetes Mellits and Associated Risk Factors in AIC Kijabe Hospital and Naivasha Medical Centre, Kenya*". She has defended her proposal and has been authorized to proceed with field research.

The information obtained during this research will be used for academic purposes only and will be treated with utmost confidentiality.

Please provide her with a research permit to enable her to undertake the research.

Thank you.

Yours faithfully,

Dr. Wilson Shitandi
AG. DIRECTOR, INSTITUTE OF POSTGRADUATE STUDIES

APPENDIX IV: Kijabe Hospital IREC Approval

Hospital

KIJABE HOSPITAL INSTITUTIONAL ETHICS AND RESEARCH REVIEW COMMITTEE

PO Box 20 Kijabe 00220, Kenya
Tel: 0709728200/637
Fax: 020-3246335
E-mail:researchcoord@kijabehospital.org
Website:

REF: Date: 2 nd JULY2019

TO: Dr. Sarah Kiptinness -Principal Investigator

Dear Madam,

RE: STUDY TITLE: PREVALENCE OF GESTATIONAL DIABETES MELLITUS AND ASSOCIATED RISK FACTORS IN AIC KIJABE HOSPITAL AND AIC KIJABE NAIVASHA MEDICAL CENTRE

This is to inform you that **KH IERC** has reviewed and approved your above research proposal. Your application approval number is KH IERC-02718/0047/2019 .The approval period is ***2nd July, 2019 – 3rd July, 2020.***

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 KH IERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KH IERC within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KH IERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.

vii. Submission of an executive summary report within 90 days upon completion of the study to KH IERC.

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

Please do not hesitate to contact the AIC Kijabe Hospital IERC Coordinator ( ) for any clarification or query.

We wish you all the best in the study.

Thank you.

Yours sincerely,

for Peter Halestrap

BMBCh, MRCGP, DCH, DRCOG, MA (OXON)

Chair, AIC Kijabe Hospital IERC

A.I.C KIJABE HOSPITAL
INSTITUTIONAL ETHICS REVIEW COMMITTEE (IERC)
02 JUL 2019
APPROVED
P.O BOX 20-00220, KIJABE
TEL: 020-3246300/637

APPENDIX V: NACOSTI Research License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: **609319**

Date of Issue: **27/August/2019**

RESEARCH LICENSE

This is to Certify that Dr.. Sarah Kiptinness of Kijabe Hospital, has been licensed to conduct research in Kiambu, Nakuru on the topic: PREVALENCE OF GESTATIONAL DIABETES MELLITUS AND ASSOCIATED RISK FACTORS IN AIC KIJABE HOSPITAL AND AIC KIJABE NAIVASHA MEDICAL CENTRE, KENYA for the period ending : 27/August/2020.

License No: **NACOSTI/P/19/121**

609319

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

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THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is Guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014

CONDITIONS

1. The License is valid for the proposed research, location and specified period
2. The License any any rights thereunder are non-transferable
3. The Licensee shall inform the relevant County Governor and County Commissioner before commencement of the research
4. Excavation, filming and collection of specimens are subject to further necessary clearence from relevant Government Agencies
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7. The Licensee shall submit one hard copy and upload a soft copy of their final report (thesis) within one of completion of the research
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