

**PREVALENCE AND ASSOCIATED FACTORS FOR UNDIAGNOSED  
DIABETES AMONG HYPERTENSIVE PATIENTS ATTENDING  
KIAMBU DISTRICT HOSPITAL, 2014**

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TECHNOLOGY**

**2017**

**PREVALENCE AND ASSOCIATED FACTORS FOR UNDIAGNOSED DIABETES  
AMONG HYPERTENSIVE PATIENTS ATTENDING KIAMBU DISTRICT HOSPITAL,  
2014**

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**A thesis submitted in partial fulfillment of the requirements for the award of the degree of  
Master of Science in Applied Epidemiology in the Jomo Kenyatta University of Agriculture  
and Technology.**

**2017**

## DECLARATION

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

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## **ACKNOWLEDGMENT**

I am deeply grateful to my supervisors Prof Zipporah Ng'ang'a, of JKUAT and Dr. Samuel Amwayi, of FELTP-K, for their guidance and contributions which have been invaluable throughout the whole process.

I thank the Hospital Management Team at Kiambu District Hospital for their cooperation and allowing me to conduct my work at their institution.

Special thanks to the Field Epidemiology and Laboratory Training Program-Kenya (FELTP-K) faculty and administration. They have been an invaluable source of inspiration and guidance in perfecting the needed skills.

I acknowledge Centers for Diseases Control and Prevention (CDC) for their financial contribution.

I wish to thank my family for the support and understanding they gave me as I undertook my thesis work.

# TABLE OF CONTENTS

<b>DECLARATION.....</b>	<b>i</b>
<b>ACKNOWLEDGMENT .....</b>	<b>ii</b>
<b>TABLE OF CONTENTS .....</b>	<b>iii</b>
<b>LIST OF TABLES .....</b>	<b>vii</b>
<b>LIST OF FIGURES .....</b>	<b>viii</b>
<b>APPENDICES .....</b>	<b>ix</b>
<b>ABBREVIATIONS AND ACRONYMS.....</b>	<b>x</b>
<b>DEFINITION OF OPERATIONAL TERMS.....</b>	<b>xii</b>
<b>ABSTRACT.....</b>	<b>xiii</b>
<b>CHAPTER ONE .....</b>	<b>1</b>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
1.1 Background Information .....	1
1.2 Statement of the Problem .....	4
1.3 Justification .....	5
1.4 Research Question(s).....	6
1.5 Objectives of the Study .....	6
1.5.1 General Objective .....	6
1.5.2 Specific Objectives .....	6
<b>CHAPTER TWO .....</b>	<b>7</b>

<b>2.0 LITERATURE REVIEW .....</b>	<b>7</b>
2.1 Hypertension .....	7
2.2 Epidemiology of Hypertension .....	7
2.3 Diagnosis of hypertension.....	8
2.4 Causes of hypertension.....	9
2.5 Management of hypertension.....	9
2.6 Complications of hypertension .....	9
2.7 Prevention of hypertension.....	10
2.8 Diabetes Mellitus.....	10
2.9 Causes of Diabetes Mellitus.....	10
2.10 Diabetes screening in hypertensive patients.....	11
2.11 Glycated Hemoglobin (HbA1c) in diagnosis of diabetes.....	12
2.12: Association between diabetes and hypertension .....	14
<b>CHAPTER THREE .....</b>	<b>16</b>
<b>3.0 MATERIALS AND METHODS .....</b>	<b>16</b>
3.1 Study Area.....	16
3.2 Study Design .....	17
3.3 Study Period .....	17
3.4 Study Population .....	17
3.4.1 Inclusion Criteria .....	17

3.4.2 Exclusion Criteria .....	18
3.5 Sampling.....	18
3.5.1 Sample size determination.....	18
3.5.2 Sampling procedure.....	19
3.5.3 Replacing refusals and reselected visits .....	19
3.6 Data Collection Tools.....	20
3.6.1 Questionnaire-based assessment.....	20
3.6.2 Anthropometric measurements.....	21
3.7 Blood pressure measurement .....	22
3.8 Screening for diabetes .....	23
3.9 Data management and analysis .....	23
3.9.1 Data entry and storage .....	23
3.9.2 Data analysis.....	23
3.10 Ethical considerations .....	24
<b>CHAPTER FOUR.....</b>	<b>26</b>
<b>4.0 RESULTS .....</b>	<b>26</b>
4.1 Prevalence of undiagnosed pre-diabetes and diabetes mellitus .....	26
4.2 Socio-demographic characteristics of participants.....	26
4.3 Behavioural characteristics of participants .....	29
4.4 Past medical history of participants .....	35

4.5 Anthropometric characteristics of participants .....	38
4.6 Blood Pressure among participants .....	39
4.7 Factors associated with Abnormal Glucose Regulation (AGR).....	42
<b>CHAPTER FIVE .....</b>	<b>45</b>
<b>5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>45</b>
5.1 Prevalence of undiagnosed pre-diabetic and diabetic states .....	45
5.2 Socio-demographic, behavioural and physical characteristics of participants.....	46
5.3 Factors associated with undiagnosed abnormal glucose regulation among participants ....	48
5.4 Study limitations .....	49
5.5 Study Delimitations.....	50
5.6 Conclusions .....	50
5.7 Recommendations .....	51
<b>REFERENCES.....</b>	<b>52</b>
<b>APPENDICES .....</b>	<b>60</b>



## LIST OF TABLES

<b>Table 2.1:</b> Comparison of WHO and ADA diagnostic criteria for diabetes and pre-diabetes.....	12
<b>Table 4. 1:</b> Prevalence of undiagnosed diabetic status among hypertensive participants.....	26
<b>Table 4.2:</b> Social-demographic characteristics of hypertensive adults .....	27
<b>Table 4.3:</b> Tobacco use among the participants.....	29
<b>Table 4.4:</b> Alcohol consumption among the participants .....	30
<b>Table 4.5:</b> Fruit and vegetable consumption among the participants .....	31
<b>Table 4.6:</b> Physical activity among participants .....	33
<b>Table 4.7:</b> Mean number of days per week participants engage in physical activity .....	34
<b>Table 4.8:</b> Mean number of minutes of total physical activity among participants.....	35
<b>Table 4.9:</b> History and knowledge of diabetes and hypertension among participants.....	36
<b>Table 4.10:</b> Anthropometric characteristics of participants.....	38
<b>Table 4.11:</b> Mean Systolic and Diastolic pressure of participants.....	40
<b>Table 4.12:</b> Blood pressure readings of participants.....	40
<b>Table 4.13:</b> Behavioral and anthropometric characteristics of hypertensive adults .....	41
<b>Table 4.14:</b> Factors associated with Abnormal glucose regulation among participants on bivariate analysis.....	43
<b>Table 4.15:</b> Factors associated with Abnormal glucose regulation among participants on logistic regression .....	44

## LIST OF FIGURES

<b>Figure 3.1:</b> Map of Kenya Showing Kiambu County and Kiambu District Hospital.....	16
<b>Figure 4.1:</b> Distribution of diabetic status by age group among participants .....	28
<b>Figure 4.2:</b> Type of oil used for cooking by the participants.....	32
<b>Figure 4.3:</b> Participants knowledge on risk factors for diabetes.....	37
<b>Figure 4.4:</b> Distribution of diabetic status by BMI among the participants .....	39

## APPENDICES

<b>Appendix 1:</b> Informed Consent Form .....	60
<b>Appendix 2:</b> Questionnaire .....	63
<b>Appendix 3:</b> Ethical Review Committee Authorization Letter.....	70
<b>Appendix 4:</b> Published Manuscript.....	72

## ABBREVIATIONS AND ACRONYMS

<b>ADA</b>	American Diabetes Association
<b>AGR</b>	Abnormal Glucose Regulation
<b>AHA</b>	American Heart Association
<b>BMI</b>	Basal Metabolic Index
<b>BP</b>	Blood Pressure
<b>CDC</b>	Centre for Disease Prevention and Control
<b>CVD</b>	Cardiovascular Disease
<b>DHIS</b>	District Health Information System
<b>DM</b>	Diabetes Mellitus
<b>EDTA</b>	Ethylene-diamine-tetra acetic acid
<b>FBS</b>	Fasting Blood Sugar
<b>FPG</b>	Fasting Plasma Glucose
<b>GPAQ</b>	Global Physical Activity Questionnaire
<b>HbA1c</b>	Glycated Hemoglobin
<b>HTN</b>	Hypertension
<b>IDF</b>	International Diabetes Federation
<b>ITROMID</b>	Institute of Tropical Medicine and Infectious Diseases
<b>JKUAT</b>	Jomo Kenyatta University of Agriculture and Technology
<b>JNC-7</b>	Joint National Committee Seventh report on Hypertension Management
<b>KDH</b>	Kiambu District Hospital
<b>KNH</b>	Kenyatta National Hospital
<b>KSTEPS</b>	Kenya STEPwise Survey for Non Communicable Diseases

<b>LMIC</b>	Low and Middle Income Countries
<b>MDG</b>	Millenium Development Goals
<b>NCD</b>	Non Communicable Disease
<b>NIH</b>	National Institute of Health
<b>NHLPI</b>	National Heart, Lung and Blood Institute
<b>NHBPEP</b>	National High Blood Pressure Education Program
<b>OGGT</b>	Oral Glucose Tolerance Test
<b>RBS</b>	Random Blood Sugar
<b>SSA</b>	Sub-Saharan Africa
<b>SDG</b>	Sustainable Development Goals
<b>USA</b>	United States of America
<b>WHO</b>	World Health Organization

## DEFINITION OF OPERATIONAL TERMS

**Hypertension (HTN):** Condition in which the blood vessels in the body have persistently raised pressure. Also known as raised/high blood pressure WHO has defined hypertension as a systolic blood pressure  $\geq 140$  mm Hg and/or diastolic blood pressure  $\geq 90$  mm Hg (BP  $\geq 140/90$ mmHg).

**Diabetes Mellitus (DM):** A chronic disease that occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces (WHO, 2006; 2010). The current WHO diagnostic criteria for diabetes defines diabetes as fasting plasma glucose  $\geq 7.0$ mmol/l (126mg/dl), a 2-hour plasma glucose  $\geq 11.1$ mmol/l (200mg/dl) or a glycated haemoglobin A1C  $\geq 6.5\%$  ( $\geq 48$  mmol/mol).

**Pre-diabetes:** An intermittent stage of overt diabetes where the blood glucose level is higher than the normal value but not high enough to meet the criteria for the diagnosis of diabetes mellitus. fasting plasma glucose (FPG) level of 6.1-6.9mmol/l and/or from an Oral Glucose Tolerance Test (OGTT) as a 2-hour post-load plasma glucose level of 7.8-11mmo/l to determine Impaired Glucose Tolerance (IGT) or glycated haemoglobin A1C (HbA1c) level of 6.0.-6.4% (42-47mmol/mol) (WHO/IDF, 2006)

**Abnormal Glucose Regulation (AGR):** Term used to define the two glycometabolic states, that is diabetes mellitus and pre-diabetes collectively. (Pétur, 2012)

## ABSTRACT

Non-Communicable Diseases (NCD) are a leading cause of mortality globally and in 2012 were responsible for 68% of deaths worldwide. Hypertension (HTN) and Diabetes Mellitus (DM) are two common non-communicable diseases (NCDs) that are closely linked. The aim of this study was to determine the prevalence of undiagnosed diabetic states that is abnormal glucose regulation (AGR) and factors associated with it among hypertensive patients in Kiambu Hospital, Kenya. A cross-sectional study was conducted from February to May 2014. Hypertensive patients above 18 years attending the out-patient medical clinic were included in the study. Pregnant and known diabetic patients were excluded. Data was collected on socio-demographics, behavior, and anthropometric measurements. Diabetes status was based on glycated haemoglobin (HbA1c) classification of  $\geq 6.5\%$  for diabetes, 6.0-6.4% for pre-diabetes and  $\leq 6.0\%$  for normal. AGR was the dependable variable and included two diabetic categories; diabetes and pre-diabetes. 334 participants were enrolled into the study. The mean age was 59 years (Standard deviation (SD) 14.3). Of these participants 254 (76%) were women. Thirty two percent (107/334) were found to have AGR, with 14% (46) having un-diagnosed DM and 18% (61) with pre-diabetes. Factors associated with AGR were age  $\geq 45$  years (Odds Ratio (OR) = 3.23; 95% Confidence Interval (95% CI) 1.37 – 7.62), body mass index (BMI)  $\geq 25$  Kg/M<sup>2</sup> (OR= 3.13; 95% CI 1.53 - 6.41), low formal education (primary/non-formal) (OR= 2; 95% CI 1.08 - 3.56) and family history of DM (OR=2.19; 95% CI 1.16 - 4.15). In conclusion this study found a high prevalence of undiagnosed AGR among hypertensive patients in the clinical setting highlighting missed opportunities for diagnosis. Risk factors for AGR were; age greater than 45 years, BMI  $>25$  kg/m<sup>2</sup> and a family history of DM. Targeted screening for DM in patients with such a risk profile would lead to early diagnosis and management..

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background Information

Globally, non-communicable diseases (NCDs) are the leading cause of morbidity and mortality and are responsible for 68% of deaths. Three quarters (70%) of NCD related deaths, occur in low- and middle-income countries (WHO, 2014). NCDs are chronic health conditions that include cardiovascular diseases (CVDs) such as hypertension and stroke, diabetes mellitus (DM), cancer, chronic respiratory conditions and mental disorders. The global burden of NCDs is on the rise in both developed and developing countries. and is projected to increase by 20% in low and middle income countries (LMIC) by the year 2020 (WHO, 2010b).

Hypertension (HTN) or raised blood pressure is the leading and known key risk factor for developing CVDs (Hendriks *et al.*, 2012; WHO, 2010b;2013). Globally, HTN is estimated to affect one billion people and approximately 40% of adults aged above 25 years have been diagnosed with hypertension (WHO, 2013). The prevalence of HTN is highest in the African region at 46% (WHO, 2013). Diabetes Mellitus (DM) is the 5<sup>th</sup> leading cause of mortality globally (WHO, 2014). The world prevalence of DM among adults was approximately 6.4% in 2012, affecting 285 million adults, and by 2030 it is estimated to be 7.7% with 439 million adults affected if no interventions are put in place (Hall *et al.*, 2011; IDF, 2012; WHO, 2014). Globalization, population growth, an ageing population, urbanization, adoption of unhealthy lifestyles and physical inactivity are the main reasons for the rise in NCDs in Sub Saharan Africa (WHO, 2011a).

In Kenya, the estimated prevalence of hypertension and diabetes is 24% and 3.1% respectively. (KSTEPS Ministry of Health, 2015). These prevalence's range depending on the region from



19.1% to 32% for hypertension (Jenson *et al.*, 2011; Vijver *et al.*, 2013) and from 4.2 % to 5% for DM (Ayah *et al.*, 2013; Christensen *et al.*, 2009).

Hypertension and diabetes are closely linked NCDS, and one cannot be properly managed without attention to the other (WHO, 2010b). Patients presenting with hypertension should have a cardiovascular risk assessment, including tests for Diabetes Mellitus.

Majority of diabetic patients go through a pre-diabetes phase for several years (Chatterjee *et al.*, 2013; Iloh *et al.*, 2013; Mayega *et al.*, 2013; Pétur, 2012), during which there is an opportunity to identify them and initiate timely prevention. Pre-diabetes is an intermittent stage of overt diabetes where the blood glucose level is higher than the normal value but not high enough to meet the criteria for the diagnosis of diabetes mellitus (Pétur, 2012; Unwin *et al.*, 2002). It is characterized by a fasting plasma glucose (FPG) level of 6.1- 6.9mmol/l and/or from an Oral Glucose Tolerance Test (OGTT) as a 2-hour post-load plasma glucose level of 7.8 – 11mmo/l to determine Impaired Glucose Tolerance (IGT) (WHO/IDF, 2006) or glycated haemoglobin A1C (HbA1c) level of 6.0.- 6.4% (ADA, 2010) or 6.1 –6.4% (Kumar *et al.*, 2010; Nathan *et al.*, 2009; Zemlin *et al.*, 2011). Pre-diabetes increases the risk of diabetes mellitus in hypertensive patients and both undiagnosed pre-diabetes and diabetes are associated with diabetic complications (Singleton *et al.*, 2003; Sowers *et al.*, 2001).

In 2011, the World Health Organization (WHO) experts accepted glycated haemoglobin (HbA1c) as an additional diagnostic test for Diabetes Mellitus (WHO, 2011b). HbA1c is a specific type of hemoglobin that until the year 2010 was only used to measure the glycemic control levels in a diabetic individual. HbA1c measures the average glucose levels in the previous 8-12 weeks (WHO, 2011b). WHO recommends that an HbA1c cut - off point of  $\geq 6.5\%$  ( $\geq 48\text{mmol/mol}$ ) is appropriate

for diagnosis of diabetes mellitus in individuals. Various studies have been in agreement with this cut-off point for diagnosis of diabetes mellitus (Kumar *et al.*, 2010; Zemlin *et al.*, 2011).

Abnormal glucose regulation (AGR) is a term used to define the two glycometabolic states, that is diabetes mellitus and pre-diabetes (Pétur, 2012). In most studies AGR assessment is based on random blood sugar, FPG or OGTT. However, studies have shown that use of HbA1c is a convenient alternative test (Edelman *et al.*, 2004; Rohlfing *et al.*, 2000; Wang *et al.*, 2014) as it is highly standardized, exhibits low intra-individual variation, can be obtained at any time, requires no patient preparation, and samples are relatively stable at room temperature after collection (Cowie *et al.*, 2010; Jia *et al.*, 2012). There is also a strong correlation between average plasma glucose and HbA1c in predicting diabetes development in patients with cardiovascular disease such as hypertension, coronary artery disease and stroke (Alqahtani *et al.*, 2013; Exebio *et al.*, 2012; Selvin *et al.*, 2010; Yu *et al.*, 2012).

Management of hypertensive and diabetes complications has a negative economic impact on individuals and families. Complications such as chronic renal failure or heart disease are expensive to manage thereby leading to draining of resources. The end result is aggravation of poverty and reduction in the progress of countries and economies towards achieving the Sustainable Development Goal (SDG) 1 of No poverty (Hendriks *et al.*, 2012; WHO, 2010b). Increasing public awareness and early detection of hypertension and diabetes are key steps to controlling and preventing this disease (Almas *et al.*, 2012; Ashfaq *et al.*, 2007; Campbell *et al.*, 2005). Global efforts to tackle the challenge of NCDs have gained momentum since 2011 when the United Nations called for a High-level General Assembly meeting and made a Political Declaration on the prevention and control of NCDs (WHO, 2013). One of the key targets in this declaration is a substantial reduction in the number of people with raised blood pressure and diabetes.

## 1.2 Statement of the Problem

Globally, hypertension (HTN) and diabetes mellitus (DM) are one of the world's leading causes of expenditure, premature mortality, disability and lost economic growth (WHO, 2010b). This is due to the impact of medical complications such as stroke, chronic renal failure or blindness that are associated with late diagnosis of DM or HTN.

Patients who are on follow-up for hypertension are more likely to get screened for diabetes when they present to the health facility. However from the two studies by Kidney, 2014 and Mutebi, 2012 there was a high prevalence of undiagnosed diabetes and pre-diabetes among patients with HTN in the clinical setting indicating a missed opportunity for early diagnosis and management.

In a large prospective cohort study that included 12 550 adults, the development of type II diabetes was almost 2.5 times as likely in persons with hypertension than in their normotensive counterparts (Gress *et al.*, 2000). According to data from the 2011 Minnesota Behavioral Risk Factor Surveillance System, 30% of hypertensive adults had not received a blood glucose test within the previous 3 years. Among them, 10.7% had pre-diabetes and 19.6% had undiagnosed diabetes (Kidney *et al.*, 2014). A cross sectional study conducted among hypertensive patients at Mulago National Referral Hospital, Uganda in 2012 found AGR in 237 (74%) patients – 50% were pre-diabetic and 24% were undiagnosed diabetic (Mutebi *et al.*, 2012). Failure to screen for AGR among hypertensive patients and lack of awareness about the importance of screening by health providers may indicate missed opportunities for early detection, clinical management, and prevention of diabetes (Kidney *et al.*, 2014).

Targeted screening of diabetes mellitus in hypertensive patients in clinical setting reduces morbidity and mortality because of early diagnosis and interventions that can be put into place. (Hall *et al.*, 2011; Hendriks *et al.*, 2012; Mathenge *et al.*, 2010; Williams, 2012; WHO, 2010b).

### **1.3 Justification**

Kenya is one of the many countries in Africa undergoing an epidemiological transition such as population growth, urbanization and adoption of unhealthy lifestyles. Information regarding the magnitude of undiagnosed diabetes mellitus and its associated factors within the hospital setting is crucial to advocate for opportunistic screening of patients in contact with a healthcare worker.

In 2012, Kiambu Sub County reported 48,943 hypertensive cases to the district health information system (DHIS). This figure constituted 33% of all hypertensive cases reported in Kenya that year. This is a high rate despite similar reporting rates of 88% in Kiambu and other urban sub-counties like Starehe and Langata in Nairobi, according the Division of Non communicable diseases. The demographic, social and clinical characteristics such as co-morbidities like diabetic status of these cases are not known. While the prevalence of undiagnosed diabetes in community populations is well known, there is limited documented data on the prevalence of undiagnosed pre-diabetes and DM among high risk groups, such as hypertensive patients in clinical settings in Kenya. This study sought to establish the clinical characteristics and risk factors of hypertensive patients who are in contact with a healthcare system and if they miss the opportunity for diagnosis of their diabetic status. .

## **1.4 Research Question(s)**

1. What is the prevalence of undiagnosed pre-diabetes and diabetes mellitus among adult hypertensive patients seeking care at Kiambu District hospital?
2. What are the socio-demographic and behavioural characteristics of adult hypertensive patients with undiagnosed pre-diabetes and diabetes mellitus seeking care at Kiambu District hospital?
3. What are the factors associated with undiagnosed abnormal glucose regulation (diabetes and pre-diabetes) among adult hypertensive patients seeking care at Kiambu District hospital?

## **1.5 Objectives of the Study**

### **1.5.1 General Objective**

To determine the prevalence and factors associated with undiagnosed pre-diabetes and diabetes mellitus among hypertensive patients seeking health care at Kiambu District Hospital (KDH), Kiambu County, 2014.

### **1.5.2 Specific Objectives**

1. To determine the prevalence of undiagnosed pre-diabetes and diabetes mellitus among adult hypertensive patients seeking care at Kiambu District Hospital.
2. To establish the socio-demographic and behavioral factors associated with undiagnosed abnormal glucose regulation (diabetes and pre-diabetes) among adult hypertensive patients seeking care at Kiambu District Hospital.

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

Hypertension (HTN) is a common co-morbid condition in Diabetes Mellitus (DM) and vice versa. DM and HTN coexist in approximately 40% to 60% of patients with type 2 DM (Mohan *et al.*, 2013). In a large prospective cohort study that included 12 550 adults, the development of type II diabetes was almost 2.5 times as likely in persons with hypertension than in their normotensive counterparts (Gress *et al.*, 2000).

#### 2.1 Hypertension

The blood circulatory system (cardiovascular system) consists of the heart and the blood vessels running through the entire body. Each time the heart beats, blood is forced into the vessels and travels to all parts of the body. The force that is created by the blood as it is pushing against the blood vessels (arteries) is known as the blood pressure. Blood pressure (BP) is measured in millimetres of mercury (mm Hg) and is recorded as two numbers usually written one above the other. The upper number is the systolic BP and occurs when the heart contracts, or beats. The lower number is the diastolic BP and occurs when the heart muscles relax.

#### 2.2 Epidemiology of Hypertension

Hypertension has been identified as the leading risk factor for premature death and cardiovascular disease leading to multiple organ damage (WHO, 2013). Hypertension is estimated to cause 7.5 million (12.8%) deaths globally (WHO, 2014). About 40% of the one billion people affected by hypertension worldwide are above the age of 25 years (WHO, 2010b) and 46% reside in Africa. Contrary to belief, Sub Saharan Africa (SSA) has experienced an increase in hypertension due to

the epidemiological and nutritional transition such as globalization, rise in urbanization, adoption of unhealthy lifestyle and lack of physical activity (Agyei-Mensah *et al.*, 2010; Kengne *et al.*, 2007; Thorogood *et al.*, 2007) and the number is expected to increase by 20% by the year 2030 (WHO, 2014). Because of this transition, Africa has experienced a rise in the four main behavioural risk factors for hypertension: tobacco use, physical inactivity, harmful use of alcohol and unhealthy diet (Hall *et al.*, 2011; Kengne *et al.*, 2007; WHO, 2010b).

Hypertension is a silent, invisible killer that rarely causes symptoms. Its prevention is far less costly and safer for patients than interventions like dialysis or cardiac surgery that may be needed when complications develop due to missed diagnosis or lack of prompt treatment (Hendriks *et al.*, 2012; WHO, 2013).

### **2.3 Diagnosis of hypertension**

Hypertension also known as “the silent killer” is a dangerous disease as a person does not present with symptoms in early stages of the disease. In most individuals the disease is silent and nonspecific symptoms may begin to manifest when the disease has progressed undetected for a number of years (Campbell *et al.*, 2005; Chobanian *et al.*, 2003; WHO, 2007). Hypertension is usually diagnosed during health checkups via use of a blood pressure machine. In addition, blood pressure measuring devices need to be validated, maintained and regularly calibrated to ensure that they are accurate (WHO, 2005). The Joint National Committee Seventh report on Hypertension Management (JNC7), American Heart Association (AHA) and WHO International Society of Hypertension (WHO/ISH) guidelines are widely used and have been adopted for measurement and diagnosis of hypertension in various countries (Almas *et al.*, 2012; Chobanian *et al.*, 2003; Ong *et al.*, 2007).

## **2.4 Causes of hypertension**

Hypertension is a known metabolic/physiological risk factor for the development of CVDs. Risk factors associated with development of hypertension can be broken down into non-modifiable factors and modifiable factors (CDC 2010; WHO, 2010b). Non-modifiable factors are risk factors that cannot be reduced or changed by an intervention in an individual such as age, race, genetic predisposition and family history of hypertension. Studies conducted in genetics have supported this finding (Geller, 2004; Kato, 2012). Also as age increases, so does the risk for development of hypertension (WHO, 2007). Modifiable risk factors on the other hand are those that can be reduced or changed by use of an intervention. They are strongly associated and causally linked with four particular behaviours: tobacco use, physical inactivity, unhealthy diet and the harmful use of alcohol (WHO, 2010b). Studies have shown a strong association of tobacco use, harmful alcohol consumption and the development of hypertension (Ôunpuu, *et al.*, 2001).

## **2.5 Management of hypertension**

Hypertension management requires a multidisciplinary approach. Individuals who have HTN can be managed by a combination of antihypertensive drug therapy, diet therapy, exercise and lifestyle modification to reduce behavioural risk factors. Each individual is unique and requires an individualized management plan and proper regular follow-ups (Almas *et al.*, 2012; Campbell *et al.*, 2005; Jaddou *et al.*, 2011). Proper follow up and adherence to treatment reduces the development of complications associated with hypertension such as stroke and heart failure (Sekokotla *et al.*, 2003; WHO, 2007).

## **2.6 Complications of hypertension**

Hypertension is one of the leading causes of health care expenditure globally (WHO, 2014). It is a disease that affects all organs in the body and if poorly managed it causes end organ damage like



stroke, kidney or heart failure. Most individuals will present to hospitals with these complications due to late diagnosis or poor management of hypertension. Lack of awareness of the disease is implicated as a major contributing factor to development of complications (Jaddou *et al.*, 2011; Ong *et al.*, 2007).

## **2.7 Prevention of hypertension**

Prevention of hypertension is far less costly and safer for patients than management of its complications using interventions such as dialysis or cardiac surgery. Prevention strategies targeted at creating awareness of the disease and reduction of the modifiable behavioural risk factors are more effective. Developed countries have implemented strong health strategies such as policies for reduction of salt in food commodities, integration of NCD surveillance at the primary health care level and educational programs on the prevention of hypertension and other NCDs. Despite progress in prevention, detection, treatment and control of high blood pressure, hypertension remains an important public health problem (Almas *et al.*, 2012; Mutseyekwa *et al.*, 2013; NIH 2002).

## **2.8 Diabetes Mellitus**

Diabetes can cause serious health complications including heart disease, blindness, kidney failure, and lower extremity amputations. The most common form is Type 2 diabetes that represents more than 85% of the cases (WHO, 2006). Other forms are less common such as Type 1 (10% of cases) and gestational diabetes (5% of cases).

## **2.9 Causes of Diabetes Mellitus**

The risk factors that affect the onset of diabetes are classified into modifiable and non-modifiable factors. Non-modifiable factors are old age (over 45 years of age), family history, and

physiological changes during pregnancy. Modifiable risk factors for diabetes are obesity, physical inactivity, poor diet and excessive consumption of alcohol (WHO, 2014).

### **2.10 Diabetes screening in hypertensive patients**

Hypertension and type 2 diabetes mellitus (DM) are closely linked, and one cannot be properly managed without attention to the other (WHO, 2013). With the knowledge that hypertension and diabetes mellitus have similar risk factors such as tobacco smoking, harmful use of alcohol, poor diet and lack of physical activity, individuals with hypertension would benefit from DM screening as well. According to WHO recommendations hypertensive patients are to undergo diabetes screening based on their risk profile (WHO/ISH, 2003). The American Diabetes Association (ADA) recommends that adults at normal risk for diabetes undergo screening every 3 years and adults at high-risk based on a family history of the disease, hypertension, overweight or obesity, or other factors of diabetes should undergo screening every 1 to 2 years (ADA, 2010). However the optimal universally acceptable interval for diabetes screening of healthy adults or adults with hypertension or hyperlipidemia is not known according the 2008 U.S. Preventive Services Task Force (USPSTF) (USPSTF, 2008). Clinical judgment and risk profile of the patient should determine when to screen individual patients for diabetes (ADA, 2010; USPSTF 2008).

Glucose can be measured in several different ways but venous plasma glucose is the standard method for measuring and reporting glucose concentration in blood. The advantages of plasma glucose measurements include inexpensive assays that are widely available. A number of screening tests have been recommended by WHO and the American Diabetes Association (ADA) for patients at risk of developing type 2 DM. These tests include random blood glucose (RBS), oral glucose tolerance test (OGGT), fasting blood sugar (FBS) and glycated haemoglobin A1C (HbA1c) (Table 2.1).

**Table 2.1: Comparison of WHO and ADA diagnostic criteria for diabetes and pre-diabetes**

	WHO	ADA
<b>Diabetes</b> Fasting plasma glucose 2-h glucose* HbA1c (DCCT)	$\geq 7.0$ mmol/l <b>or</b> $\geq 11.1$ mmol/l <b>or</b> $\geq 6.5\%$	$\geq 7.0$ mmol/l <b>or</b> $\geq 11.1$ mmol/l <b>or</b> $\geq 6.5\%$
<b>Impaired Glucose Tolerance (IGT)</b> Fasting plasma glucose 2-h glucose*	$< 7.0$ mmol/l <b>and</b> $\geq 7.8$ and $< 11.1$ mmol/l	$\geq 7.8$ and $< 11.1$ mmol/l
<b>Impaired Fasting Glycaemia (IFG)</b> Fasting plasma glucose	$\geq 6.1$ and $< 7.0$ mmol/l	$\geq 5.6$ and $< 7.0$ mmol/l

\*Plasma glucose 2 hours after the ingestion of a 75g oral glucose load

OGGT, RBS and HbA1c are used in various countries for diagnosis of DM. In developed countries HbA1c is used more commonly to screen and diagnose diabetes in individuals with risk factors like hypertension and it will also identify those at higher risk for developing diabetes in the future such as pre-diabetic states (ADA, 2010). In a community-based study of black and white adults without diabetes, baseline HbA1c was a stronger predictor of subsequent diabetes and cardiovascular events than was fasting glucose (Selvin *et al.*, 2010).

### **2.11 Glycated Hemoglobin (HbA1c) in diagnosis of diabetes**

Plasma glucose binds irreversibly to the haemoglobin in the red blood cells and forms a glycosylated haemoglobin molecule known as Haemoglobin A1c (HbA1c). Since red blood cells have about a 120 day life span, HbA1c reflects mean glycaemia for the previous two to three months (Nathan *et al.*, 2007). It can be performed at any time of the day and does not require any special preparation such as fasting.

In 2011, the World Health Organization (WHO) accepted glycated haemoglobin (HbA1c) as an additional diagnostic test for Diabetes Mellitus (WHO, 2011b). WHO recommends that an HbA1c cut - off point of  $\geq 6.5\%$  ( $\geq 48$  mmol/mol) is appropriate for diagnosis of diabetes mellitus. Community based HbA1c study findings agree with a cut- off point of 6.1% for screening and a cut-off point of 6.5% for diagnosis (Kumar *et al.*, 2010; Zemlin *et al.*, 2011). However some studies dispute this cut off point (Cohen, 2007).

The convenience of using HbA1c is that it avoids day-to-day variability of glucose values, and importantly it avoids the need for the person to fast and to have preceding dietary preparations. However, HbA1c may be affected by a variety of genetic, haematologic and illness-related factors such as haemoglobinopathies, certain anemias and disorders associated with accelerated red cell turnover like pregnancy or malaria (Gallagher *et al.*, 2009).

Although limited epidemiological studies have been conducted to determine the association between abnormal glucose metabolism and hypertension, some studies have shown that a significant relationship exists between HbA1c and HTN (Britton *et al.*, 2011; Chu *et al.*, 1993; Myint *et al.*, 2007; Singer *et al.*, 1992). Increasing levels of HbA1c, even within the normal range of HbA1c  $< 6.5\%$ , are associated with an increasing risk of incident HTN among non- diabetics (Britton *et al.*, 2011).

HbA1c can be used as a predictor of development of DM in hypertensive patients so that they are informed of their increased risk for diabetes as well as cardiovascular disease and counseled about effective strategies, such as weight loss and physical activity to lower their risks.

## **2.12: Association between diabetes and hypertension**

Hypertension and diabetes are closely linked NCDS, and one cannot be properly managed without attention to the other (WHO, 2010b). Patients presenting with hypertension should have a cardiovascular risk assessment, including tests for Diabetes Mellitus.

DM and HTN have similar risk factors which may be classified into modifiable and non-modifiable risk factors that contribute to the high prevalence rates of both chronic diseases. Modifiable risk factors include eating unhealthy diet such as food containing too much salt and fat, inadequate intake of fruits and vegetables, overweight and obesity, harmful use of alcohol, physical inactivity, tobacco use, socioeconomic determinants, and inadequate access to health care (WHO, 2014).

There is a causal relationship between harmful use of alcohol and the morbidity and mortality associated with diabetes, cardiovascular diseases like hypertension (Berraho *et al.*, 2012; WHO, 2014). Health professionals have an important role to play in reducing the harmful use of alcohol, by identifying hazardous and harmful drinking or alcohol dependence in their patients and by providing brief interventions and treatment as appropriate.

Tobacco use increases the risk of hypertension, diabetes and chronic respiratory disease, diabetes and premature death. Tobacco use is currently one of the leading causes of preventable deaths in the world. Risks to health result from both direct consumption and exposure to second hand smoke (Ayah *et al.*, 2013; Mutebi *et al.*, 2012).

Sedentary lifestyle leads to increased weight gain, which increases an individual's BMI and obesity, consequently leading to the development of diabetes and hypertension. Regular physical activity – at least 150 minutes of moderate- intensity physical activity per week for adults – reduces

the risk of hypertension, diabetes and cancer related mortality (WHO, 2010a). This recommendation will contribute to attainment of targets on reducing the prevalence of hypertension, on a 0% increase in diabetes and obesity and, ultimately, on reducing premature mortality from NCD.

Overweight and obesity – i.e. BMI  $\geq 25$  kg/m<sup>2</sup> and  $\geq 30$  kg/m<sup>2</sup> respectively increases the likelihood of diabetes and hypertension. Overindulgence in high calorie food, high salt intake and indoor leisure activities (e.g. television viewing, internet, and computer games) alone or in combination with factors that dissuade walking and other outdoor activities, contribute to obesity (WHO, 2015).

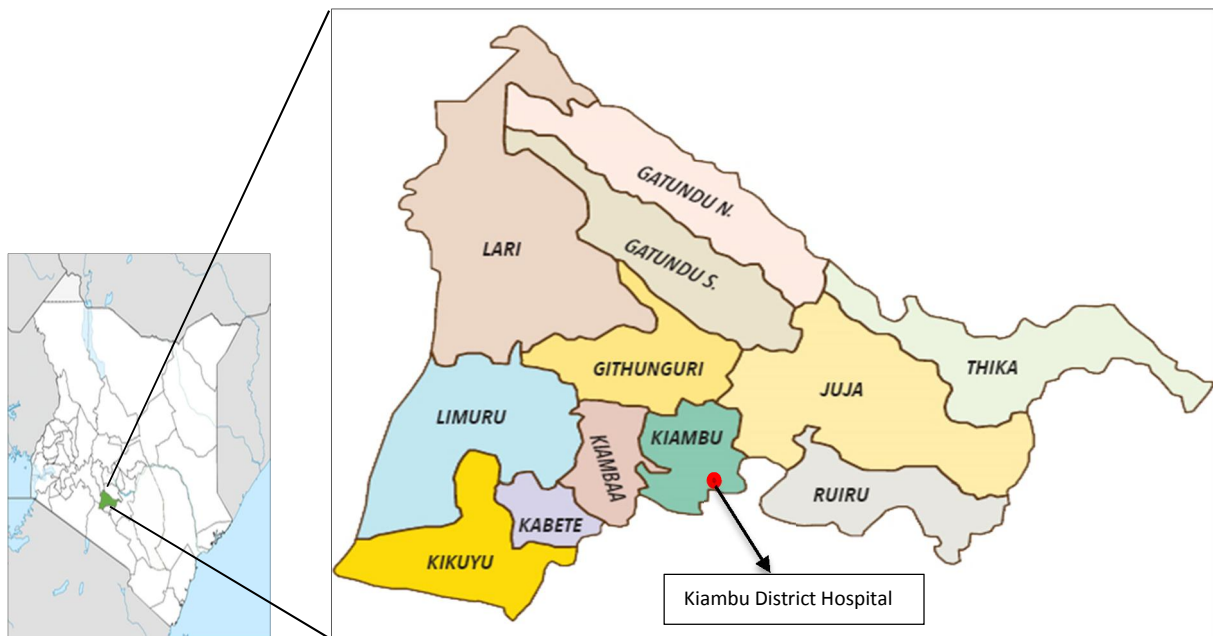
It is known that various anti-hypertensive drugs have different effects on glucose metabolism (Eleftheriadou *et al.*, 2011; Rizos and Elisaf 2014). The use of thiazide diuretics and beta-blockers is associated with impaired glucose metabolism leading to increased incidence of new onset diabetes and other metabolic abnormalities such as impaired insulin sensitivity, decreased islet cell insulin secretion, altered lipid metabolism and weight gain (Manrique *et al.*, 2010). However a study in Nigeria showed that anti-hypertensives that affected glucose metabolism did not significantly affect the prevalence of pre-diabetic states in hypertensive patients (Essien *et al.*, 2007; Iloh *et al.*, 2013). This highlights the complex and important interconnections among drugs, metabolic factors, including HbA1c, body weight, and HTN.

## CHAPTER THREE

### 3.0 MATERIALS AND METHODS

#### 3.1 Study Area

The study was conducted in Kiambu District Hospital (KDH). Kiambu Hospital is located in Kiambu town which is the commercial and administrative hub of Kiambu County (Fig 3.1). Kiambu County is adjacent to the northern border of Nairobi County. This County covers an area of 2,543.42 square kilometers and has a population of 1,623,282. The county is 40% rural and 60% urban owing to Nairobi's consistent growth northwards. The major economic activities are coffee and dairy farming, food processing, and manufacturing.



Map Source; Kiambu County Government website, <http://www.kiambu.go.ke/about/administrative-political-units>

**Figure 0.1: Map of Kenya Showing Kiambu County and Kiambu District Hospital (Scale 1:100,000)**

Kiambu district hospital offers general services with a catchment population of approximately 101,596 and bed capacity of 316 and 67 cots. The hospital holds specialized medical out-patient

clinics. Patients enrolled into this out-patient clinic comprise of those with HTN and other medical conditions that require regular follow-up by a specialized physician. Depending on their medical condition, patients are seen on appointment scheduled on average every 2-3 months for routine checkup and drug refill. At every visit routine tests include blood pressure (BP) reading and body mass index (BMI) calculations. Diabetes testing is done at the initial visit. Any subsequent diabetes tests are requested based on the patients presenting symptoms at the time of the visit and discretion of the clinician.

### **3.2 Study Design**

This was a facility based cross sectional study. The study described the prevalence of undiagnosed pre-diabetes and diabetes mellitus among patients seeking services at KDH medical outpatient clinic and associated this to their socio-demographic and behavioral characteristics.

### **3.3 Study Period**

The study was carried out from February to May 2014.

### **3.4 Study Population**

The study population comprised of adult patients seeking health care at Kiambu District Hospital (KDH) medical outpatient specialized clinic (MOPC).

#### **3.4.1 Inclusion Criteria**

- Patient  $\geq$  18 years who has been diagnosed as having hypertension by a health worker and/or is on prescribed antihypertensive medication
- Gives consent to participate in the study



### 3.4.2 Exclusion Criteria

- Has been diagnosed as having Diabetes Mellitus by a health worker and/or is on prescribed anti-diabetic medication
- Declines to give consent
- Pregnant

## 3.5 Sampling

### 3.5.1 Sample size determination

Assuming a sample size of 74% (Mutebi *et al.*, 2012) and using Cochran's formula (1977), the sample size was calculated as shown below.

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

Where;

n = Sample size

z = (1 -  $\alpha$ )/2 percentile of a standard normal distribution

d = Absolute precision

p = Expected proportion

q = 1 - p

Non-response rate (10%)

Assumptions;

z = 1.96, p = 0.74 (Mutebi *et al.*, 2012), q = 0.26, d = 0.05

$$\begin{aligned} n &= \frac{1.96^2 \times 0.74(0.26)}{0.05^2} = (296) \\ &= 296 + (10/100 \times 296) \\ &= 296 + 38 \\ &= \mathbf{334} \end{aligned}$$

Considering the above assumptions, a sample size of 334 was used.

### 3.5.2 Sampling procedure

Systematic random sampling was employed to recruit the hypertensive study subjects. Using this procedure, each hypertensive patient had a known probability of being selected.

The sampling frame consisted of hypertensive patients attending the medical outpatient clinic. Review of the hospital records indicated the hospital medical outpatient clinic saw on average 18 hypertensive patients daily. The average return date given for a patient on follow-up was 3 months (90 days).

The  $k^{\text{th}}$  unit was selected from the sampling frame, where  $k$ , the sampling interval was calculated as:

$$k = N/n$$

$k$ = sampling interval

$N$ =Average number of adult hypertensive patients every 3 months (both new and old)

$n$ =Sample size required

Assumptions

$$N = 1620 \quad n = 334$$

$$k = (1620/334) = 5$$

A number equal to or less than the  $k$  unit = 5 unit was randomly selected for the starting number using a table of random numbers. An adult with hypertension was selected after every 5<sup>th</sup> adult until the required sample size was achieved.

### 3.5.3 Replacing refusals and reselected visits

The sample size encompassed both new and revisiting clients on follow-up. In case a client declined to participate or a revisit was reselected to be interviewed, then the next client in the queue was picked as a replacement. After replacement the original systematic pattern was

maintained in reference to the client who declined or was reselected. After each patient was interviewed, a small sticker indicating the date of interview was put on the back of their file. This sticker was used to identify the revisits who were already interviewed.

### **3.6 Data Collection Tools**

The WHO STEPS instrument for collecting surveillance data for non-communicable diseases (NCD's) was adapted for this study (Appendix 2). The WHO STEP wise approach instrument has been validated to collect information on NCD's in resource poor settings. It is a sequential process made up of three main sections, which are the risk stratification questionnaire (step 1), anthropometric measurements (step 2) and biochemical measurements (step 3) and incorporates the Global Physical Activity Questionnaire (GPAQ) to assess physical activity (WHO, 2008). The questionnaire had a screening section to determine whether to enroll participants into the study. The questionnaire was pre-tested in Kiambu District Hospital and adjusted accordingly and was administered by a trained interviewer to each study participant during the data collection.

#### **3.6.1 Questionnaire-based assessment**

The pre-coded questionnaire (Appendix 2) consisted of questions that cover demographic, medical/ health history and behavioral characteristics such as smoking habits, alcohol use, diet and physical activity pattern, history of prior evaluation for diabetes and hypertension, and if any, the medication and lifestyle counseling that had been given. The initial questions comprised a screening section to address the selection criteria to determine whether to enroll a participant who gave consent into the study.

Dietary practices was assessed by asking participants about their fruit and vegetable intake in a typical week and how many servings of fruits and vegetables they consumed on those days. The

World Health Organization (WHO) recommends at least 400g (5portions) of fruit and vegetables per day (WHO, 2014).

Physical activity was assessed in three domains (occupational physical activity, transport-related physical activity, and physical activity during leisure time) by asking participants if they undertook 'vigorous-intensity activities' or 'moderate-intensity activities' for at least 10 minutes in a typical week.. 'Vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, (for example: lifting heavy loads, cutting firewood, digging, construction work) and 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate (for example: brisk walking, carrying light loads, milking cows, washing clothes, riding a bicycle, light recreational activities) (WHO, 2008). Pictorial show cards were used to describe these activities to participants. Time spent on these activities in a typical week was recorded. Metabolic Equivalents (METs) are commonly used to express the intensity of physical activities. Four METs were assigned to the time spent in moderate activities, and 8 METs to the time spent in vigorous activities. Participants were classified into those that met the WHO minimum recommendations for physical activity (at least 75 minutes of vigorous-intensity, or 150 minutes of moderate-intensity activities per week or an equivalent combination of moderate- and vigorous-intensity physical activity achieving at least 600 MET-minutes ) and those that did not (WHO, 2008).

### **3.6.2 Anthropometric measurements**

Physical assessments included height, weight, waist and hip circumference measurements and calculation of body mass index (BMI) and waist-hip ratio. Body mass index (BMI), calculated as weight (kg)/height (m<sup>2</sup>) was used as a measure of total body obesity. BMI<18.5 was recorded as underweight, 18.5-24.9 as normal, 25–29.9 as overweight and >30 as obesity. Waist-Hip ratio

(waist circumference/hip circumference) was used as a measure of central/abdominal obesity:  $>0.85$  in women and  $>0.95$  in men. Waist hip ratio is an index used to identify individuals at increased risk of obesity related morbidity due to accumulation of abdominal fat.

The waist circumference was measured using a flexible tape-measure. Measurement was made in the line midway between the last rib and the superior iliac crest and the recording was at the point of normal expiration. The hip measurement was made using a flexible tape-measure placed horizontally at the point of maximum circumference over the buttocks. Measurement was made to the nearest 0.5 cm.

Height was measured with the subject standing upright against a wall on which was affixed a height measuring device. Measurements were made with the subject barefoot, standing with the back against the wall and head in the Frankfort position with heels together. The subject was asked to stretch to the fullest and then exhale. When appropriately positioned, the measurements were taken to the nearest 0.5 cm. Weight measurements were taken on a pre-calibrated weighing scale. Subject was weighed while dressed in light clothing and barefoot. Measurements were made to the nearest 0.5 kg.

### **3.7 Blood pressure measurement**

Blood pressure (BP) measurements was done using a mercury sphygmomanometer blood pressure device (Reisterdiplomat-presameter®) and taken after the patient had been sitted for 5 minutes and relaxed. The Seventh report of the Joint National Committee guideline for Hypertension measurement and management was used. Three intermittent readings were taken with the BP machine cuff placed mid - arm and an average of the last two readings used for the study.

Hypertension was defined as being systolic BP  $\geq 140$  mmHg and/or diastolic BP  $\geq 90$  mmHg or use of prescribed antihypertensive medication (WHO, 2007).

### **3.8 Screening for diabetes**

A blood sample was collected from the study participants by drawing 2ml (Venipuncture) into an Ethylene-diamine-tetra acetic acid (EDTA) bottle and HbA1c measured using an National Glycohemoglobin Standardization Program (NGSP) analyser (Roche Cobas®Integra HbA1c Analyser) in a NGSP accredited laboratory. Classification of abnormal glucose regulation (AGR) was based on the revised WHO criteria and studies suggesting HbA1c cut-off points with high specificity and sensitivity for pre-diabetes screening (Kumar *et al.*, 2010; WHO 2011b; Zemlin *et al.*, 2011). HbA1c was grouped into diabetic (HbA1c  $\geq 6.5$  %), pre-diabetic (HbA1c of 6.1 % - 6.4%) and non-diabetic (HbA1c  $< 6.1$ %). Abnormal glucose regulation included two categories 1) those with diabetes and 2) those with pre-diabetes.

### **3.9 Data management and analysis**

#### **3.9.1 Data entry and storage**

Epi-info version of 3.5.4 (CDC, Atlanta, USA) was used to create a make view of the questionnaire form for data entry. The data was saved as a file in access database and data security ensured using a user restricted password protected computer. Data validity was ensured through cleaning and editing of the data before analysis was performed. USB flash disk, an external hard disk and personal e-mail were used to provide back-up storage.

#### **3.9.2 Data analysis**

Data was entered into version 3.5.4 of Epi-Info (CDC, Atlanta, USA) and analysed. Specific descriptive variables were analysed using frequencies, proportions and means to describe the

social-behavioural and clinical characteristics. Prevalence of undiagnosed diabetes and pre-diabetes was sought.

Bivariate analyses were performed to compare independent factors of hypertensive patient who had undiagnosed AGR and those that did not. Odds Ratio (OR) was used to compare factors such as age  $\geq 45$ , BMI  $\geq 25\text{kg/m}^2$  and family history associated with undiagnosed AGR among hypertensive patients. An OR of  $> 1$  was taken to be a risk factor while that  $< 1$  was taken to be a protective factor. Confidence interval (CI) of 95% and  $P < 0.05$  was used to assess variability and significance of the OR. A confidence interval which included 1 was interpreted as not significant.

Multivariate logistic regression was used to identify significant factors associated with undiagnosed AGR in hypertensive patients. Variables that had a P value  $\leq 0.2$  at bivariate level were included in the multivariate logistic regression model. The magnitude of the adjusted odds ratio (AOR) for each significant factor was estimated while simultaneously controlling for other confounding factors. The AOR of significant factors and 95% confidence intervals (CI) were computed using the stepwise backward elimination process. A variable with  $P < 0.05$  was taken to be significantly associated with undiagnosed AGR.

### **3.10 Ethical considerations**

Ethical approval was obtained from Kenyatta National Hospital (KNH) Ethical Review committee (Appendix 3), and clearance sought from Kiambu District Hospital administrative authorities prior to commencement of the study. A written informed consent was obtained from each participant after a detailed explanation of the purpose, risks and benefits of the study (Appendix 1). A blood specimen was collected from participants who voluntarily agreed to participate in the study. Study subjects who had an AGR category of newly diagnosed diabetes were referred to the diabetic clinic

for further management and follow-up. Pre-diabetic subjects were put on lifestyle interventions such as nutritional counselling to reduce the risk of progression to diabetes. All information collected from participants was treated with utmost confidentiality and questionnaires kept under lock and key in a secure location away from the research site. Access to this information was restricted to principal investigator and the supervisors.



## CHAPTER FOUR

### 4.0 RESULTS

#### 4.1 Prevalence of undiagnosed pre-diabetes and diabetes mellitus

A total of 334 hypertensive participants were enrolled into the study: Fourteen percent (46/334) of the participants had a HbA1c of  $\geq 6.5\%$  and were newly diagnosed as diabetic; while 18 % (61/334) had a HbA1c of 6.1 % - 6.4% and were classified as pre-diabetic (Table 4.1). More than a third (32%; 107/334) of the participants had abnormal glucose regulation (diabetes and pre-diabetes).

**Table 4. 1: Prevalence of undiagnosed diabetic status among hypertensive participants**

HbA1c status	Frequency (N=334)	Percentage (%)
Normal < 6.1%	227	(68)
Pre-diabetic 6.1-6.4%	61	(18)
Diabetic $\geq 6.5\%$	46	(14)

\*HbA1c – glycated haemoglobin

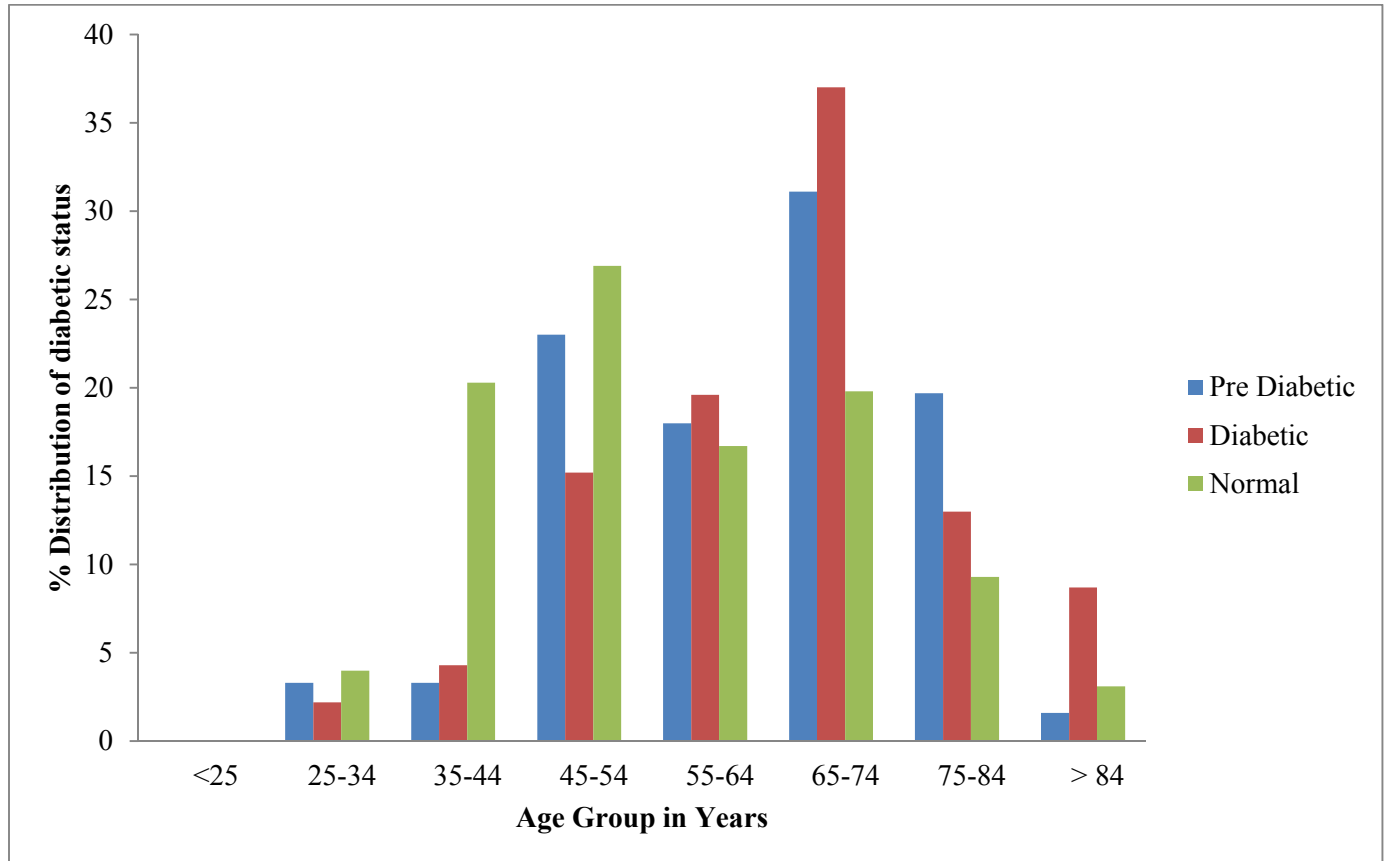
#### 4.2 Socio-demographic characteristics of participants

The mean age of the participants was 58.6 years (Standard deviation SD = 14.3). Seventy six percent (254/334) were women. Majority 38.9% (133/334) of the participants had no formal education (Table 4.2).

**Table 4.2: Social-demographic characteristics of hypertensive adults**

	<b>Diabetic n (%)</b>	<b>Pre-Diabetic n (%)</b>	<b>Normal (%)</b>	<b>n</b>	<b>All Participants N (%)</b>
<b>Sex</b>					
Male	7 (15.2)	13 (21.3)	60 (26.4)	80	(24)
Female	39 (84.8)	48 (78.7)	167 (73.6)	254	(76)
<b>Age group (years)</b>					
< 25	0 (0)	0 (0)	0 (0)	0	(0)
25-34	1 (2.2)	2 (3.3)	9 (4)	12	(3.6)
35-44	2 (4.3)	2 (3.3)	46 (20.3)	50	(15)
45-54	7 (15.2)	14 (23)	61 (26.9)	82	(24.6)
55-64	9 (19.6)	11 (18)	38 (16.7)	58	(17.4)
65-74	17 (37)	19 (31.1)	45 (19.8)	81	(24.3)
75-84	6 (13)	12 (19.7)	21 (9.30)	39	(11.7)
85 and above	4 (8.7)	1 (1.6)	7 (3.1)	12	(3.6)
<b>Level of education</b>					
Non-formal	27 (58.7)	31 (50.8)	75 (33.1)	133	(39.8)
Primary	9 (19.6)	19 (31.7)	72 (31.7)	100	(29.9)
Secondary (4 years)	9 (19.6)	7 (11.5)	67 (29.5)	83	(24.9)
University/college(2-4 years)	1 (2.2)	4 (6.6)	13 (5.7)	18	(5.4)
<b>Ethnicity</b>					
Kikuyu	43 (93.5)	59 (96.7)	208 (91.6)	310	(92.8)
Others	3 (6.5)	2 (3.3)	19 (8.4)	24	(4.2)
<b>Marital status</b>					
Married	23 (50)	36 (59)	145 (63.9)	204	(61.1)
Divorced	2 (4.3)	3 (4.9)	8 (3.5)	13	(3.9)
Never married	3 (6.5)	4 (6.6)	34 (15)	41	(12.3)
Widowed	18 (39.1)	18 (29.5)	40 (17.6)	76	(22.8)
<b>Occupation</b>					
Farmer	23 (50)	31 (50.8)	75 (33)	129	(38.6)
Housewife	3 (6.5)	4 (6.6)	12 (5.3)	19	(5.7)
Retired	3 (6.5)	6 (9.8)	17 (7.5)	26	(7.8)
Unemployed (able to work)	1 (2.2)	1 (1.6)	5 (2.2)	7	(2.1)
Unemployed (unable to work)	6 (13)	4 (6.6)	26 (11.4)	36	(10.8)
Skilled formal	3 (6.5)	3 (4.9)	21 (9.3)	27	(8.1)
Informal	5 (10.9)	8 (13.1)	49 (21.6)	62	(18)
Self employed	2 (4.3)	3 (4.9)	22 (9.7)	27	(8.10)
Casual labourer	0 (0)	1 (1.6)	0 (0)	1	(0.3)

Among participants who were diagnosed as diabetic or pre-diabetic, majority were in the age range of 45-74 years (figure 4.1).



**Figure 0.1: Distribution of diabetic status by age group among participants**

### 4.3 Behavioural characteristics of participants

#### 4.3.1 Tobacco Use

Current tobacco use was defined as use of any tobacco product within the past 30 days from the day of interview. Overall, 3% (11/334) of the participants reported they are current tobacco smokers, among whom 82% (9/11) are current daily smokers. Among those who did not currently use tobacco, 8% (28/323) were former smokers of tobacco. Eighty eight percent (296/334) of the participants reported they have never smoked tobacco (Table 4.3).

**Table 4.3: Tobacco use among the participants**

	Diabetic n (%)	Pre Diabetic n (%)	Non- Diabetic n (%)	All Participants N (%)
<b>Currently smoke tobacco (N=334)</b>				
Yes	2 (4.3)	0 (0)	9 (4)	11 (3.3)
No	44 (95.7)	61 (100)	218 (96)	323 (96.7)
<b>Currently smoke tobacco daily (N=11)</b>				
Yes	2 (100)	0 (0)	7 (78)	9 (81.8)
No	0 (0)	0 (0)	2 (22)	2 (18.9)
<b>Smoked tobacco in the past (N=323)</b>				
Yes	2 (4)	4 (6.6)	22 (10)	28 (8.4)
No	42 (96)	57 (93.4)	197 (90)	296 (88.9)
<b>Never smoked tobacco (N=334)</b>				
Yes	42 (91.3)	57 (93.4)	197 (93.4)	296 (88.6)
No	4 (8.7)	4 (6.6)	30 (13.2)	38 (11.4)
<b>Mean No. of manufactured cigarettes smoked daily (SD)</b>	4.5 (0.71)	0 (0)	3.8 (0.9)	3.7 (0.67)
<b>Mean age started smoking tobacco daily (SD)</b>	17 (1.2)	17 (0.2)	22 (9.6)	21 (9.2)
<b>Mean age stopped smoking tobacco daily (SD)</b>	47 (1.4)	45 (23.07)	44 (17.24)	45 (17.02)

\*SD = Standard deviation; \*No.= Number

### 4.3.2 Alcohol Consumption

The distribution of alcohol consumption among the participants is shown in Table 4.4. Thirty percent (102/334) had consumed an alcoholic drink in their lifetime. Among them 34% (35/102) had consumed alcohol in the past 12 months and 51% (35/102) consumed at least one drink every 1-4 days per week. Seventy percent (232/334) had never consumed alcohol in their life time.

**Table 4.4: Alcohol consumption among the participants**

	<b>Diabetic n (%)</b>	<b>Pre Diabetic n (%)</b>	<b>Non- Diabetic n (%)</b>	<b>All Participants N (%)</b>
<b>Ever consumed Alcohol (N=334)</b>				
Yes	13 (28.3)	14 (23)	75 (33)	102 (30.5)
No	33 (71.7)	47 (77)	152 (67)	232 (69.5)
<b>Consumed alcohol in past 12 months (N=102)</b>				
Yes	3 (21.4)	2 (14.3)	30 (40)	35 (34)
No	11 (78.6)	12 (85.7)	45 (60)	68 (66)
<b>Frequency of atleast 1 alcoholic drink in the past 12 months (N=35)</b>				
Daily	0 (0)	0 (0)	2 (6.7)	2 (5.7)
1-4 days per week	1 (33.3)	1 (50)	16 (53.3)	18 (51.4)
1-3 days per month	1 (33.3)	0 (0)	8 (26.7)	9 (25.7)
less than once a month	1 (33.3)	1 (50)	4 (13.3)	6 (17.1)
<b>Consumed alcohol in past 30 days (N=35)</b>				
Yes	3 (100)	1 (50)	25 (83.3)	29 (82.9)
No	0 (0)	1 (50)	5 (16.7)	6 (17.1)
<b>Mean minimum number of standard drinks consumed in one occasion (SD)</b>	2.3 (1.53)	3 (0.1)	3.3 (1.72)	3.2 (1.67)
<b>Mean maximum number of standard drinks consumed in one occasion (SD)</b>	2.7 (2.01)	6 (0.1)	5.2 (2.8)	4.9 (2.78)

\*SD = Standard deviation

### 4.3.3 Dietary Habits

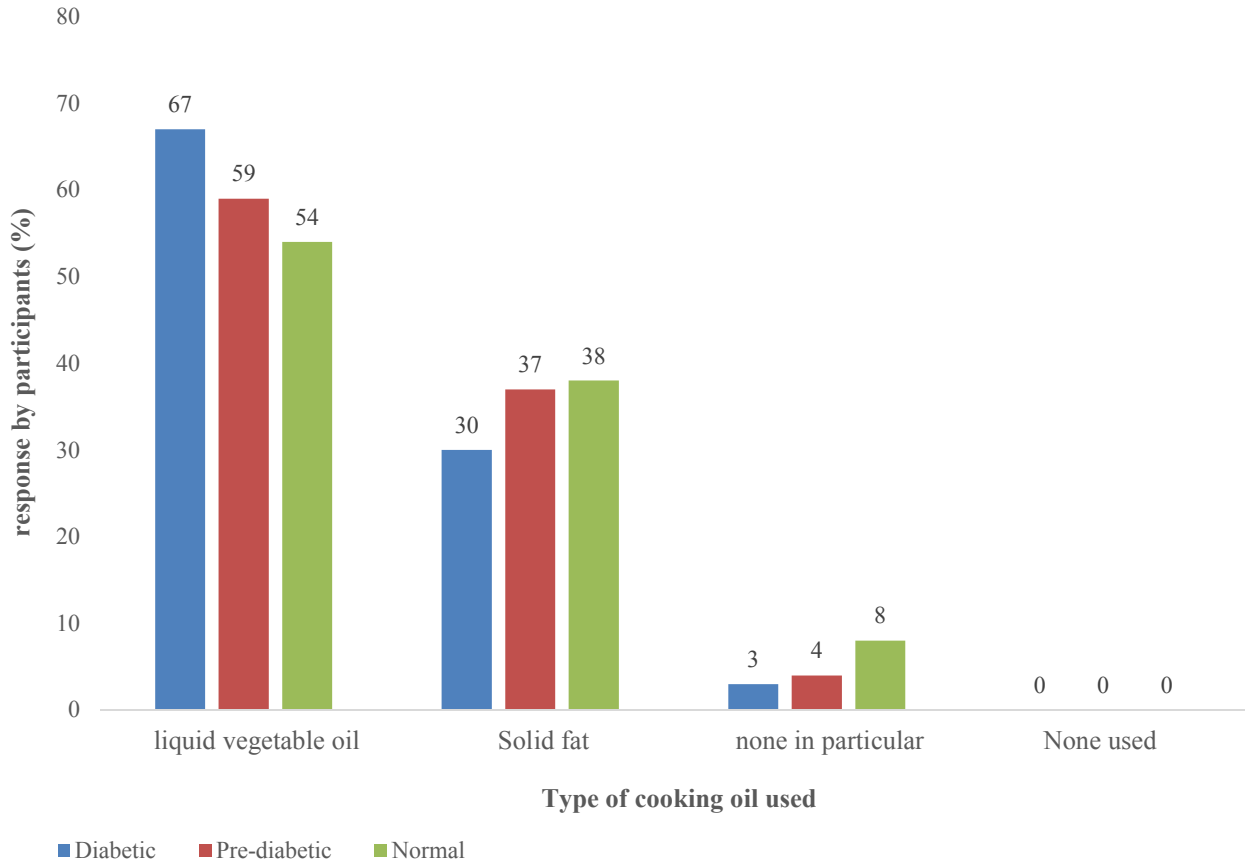
Table 4.5 shows the fruit and vegetable consumption practices of the participants. The mean number of days of fruit consumption in a typical week was 3.1 days. The mean number of days of vegetable consumption in a typical week was 4.1 days. The participants reported an average daily consumption of two servings (1.8) of fruit and an average daily consumption of one serving (1.4) of vegetables. The World Health Organization (WHO) recommends at least 5 portions of fruit and vegetables servings per day (WHO, 2014).

**Table 4.5: Fruit and vegetable consumption among the participants**

	<b>Diabetic (n=46)</b>	<b>Pre Diabetic (n=61)</b>	<b>Non- Diabetic (n=227)</b>	<b>All Participants (N=334)</b>
<b>Mean No. of days of fruit consumption in a 7 day week (SD)</b>	2.9 (2.15)	2.7 (2.38)	3.2 (2.77)	3.1 (2.62)
<b>Mean No. of fruits servings in a day (SD)</b>	2 (1.13)	1.9 (0.93)	1.8 (0.89)	1.83 (0.94)
<b>Mean No. of days of vegetable consumption in a 7 day week (SD)</b>	4.5 (2.20)	4.3 (1.8)	4.1 (2)	4.14 (2)
<b>Mean No. of vegetable servings in a day (SD)</b>	1.5 (0.34)	1.3 (0.27)	1.4 (0.57)	1.4 (0.48)
<b>Mean No. of meals/ week eaten that are not cooked at home (SD)</b>	0.2 (1.0)	0.4 (1.0)	1 (1.6)	1 (1.6)

\*SD = Standard deviation

More than half, 57% of the participants reported using vegetable oil to cook their meals at home while 37% used solid fat and 6% used none in particular (Figure 4.2).



**Figure 0.2: Type of oil used for cooking by the participants**

#### 4.3.4 Physical Activity

Participants were asked if they undertook ‘vigorous-intensity activities’ or ‘moderate-intensity activities’ for at least 10 minutes in a typical. Almost half of the participants engaged in moderate work activities (45%; 151/334), however majority did not engage in moderate recreational (94%; 314/334) or vigorous recreational (99%; 329/334) activities. Sixty eight percent (228/334) of participants reported walking as the commonest mode of transport (Table 4.6).

**Table 4.6: Physical activity among participants**

	<b>Diabetic n (%)</b>	<b>Pre Diabetic n (%)</b>	<b>Non- Diabetic n (%)</b>	<b>All Participants N (%)</b>
<b>Work involves vigorous activity</b>				
Yes	5 (10.9)	8 (13.1)	48 (21.1)	61 (18.3)
No	41 (90)	53 (86.9)	179 (78.9)	273 (81.7)
<b>Work involves moderate activity</b>				
Yes	20 (43.5)	30 (49)	101 (44.5)	151 (45.2)
No	26 (56.5)	31 (51)	126 (55.5)	183 (54.5)
<b>Mode of travel</b>				
Walking	29 (63)	43 (70.5)	156 (68.7)	228 (68.3)
Vehicle	16 (34.8)	15 (24.6)	60 (26.4)	91 (27.2)
Motorcycle	1 (2.2)	2 (3.3)	10 (4.4)	13 (3.9)
Bicycle	0 (0)	1 (1.6)	1 (0.4)	2 (0.6)
<b>Moderate recreational activity</b>				
Yes	1 (2.2)	0 (0)	4 (1.8)	20 (6)
No	45 (97.8)	61 (100)	223 (98.2)	314 (94)
<b>Vigorous recreational activity</b>				
Yes	2 (4.3)	2 (3.3)	16 (7)	5 (1.5)
No	44 (95.7)	59 (96.7)	211 (93)	329 (98.5)



The mean number of days spent walking or cycling in a week was 6 days. Participants spent on average more days carrying out work related physical activities (5 days) compared to the average time spent on recreational activities like sports (3 days) (table 4.7).

**Table 4.7: Mean number of days per week participants engage in physical activity**

	<b>Diabetic (n=46)</b>	<b>Pre Diabetic (n=61)</b>	<b>Non- Diabetic (n=227)</b>	<b>All Participants (N=334)</b>
<b>Mean days/week vigorous work activity (SD)</b>	5.5 (1.5)	5.5 (1.3)	4.8 (1.98)	4.9 (1.86)
<b>Mean days/week moderate work activity (SD)</b>	4.7 (2.08)	5.2 (1.59)	5.28 (1.74)	5.2 (1.76)
<b>Mean days/ week cycling/walking (SD)</b>	6.45 (1.23)	5.94 (1.86)	6.34 (1.38)	6.3 (1.47)
<b>Mean days/week vigorous recreational activity (SD)</b>	7 (0)	0 (0)	2 (0.82)	3 (2.35)
<b>Mean days/week moderate recreational activity (SD)</b>	2 (1.41)	4.5 (1.86)	3 (2.36)	3 (2.3)

\*SD= Standard deviation

Respondents spent in total, across all three domains of physical activities, a mean of 261 minutes per day on physical activity with non-diabetics spending more time (259 minutes) than diabetics (240 minutes). Sixty four percent (212/334) met the WHO minimum criteria for adequate physical activity which is an equivalent combination of moderate- and vigorous-intensity physical activity achieving at least 600 MET-minutes (or at least 75 minutes of vigorous-intensity, or 150 minutes of moderate-intensity activities per week) (Table 4.8).

**Table 4.8: Mean number of minutes of total physical activity among participants**

	<b>Diabetic (n=46)</b>	<b>Pre Diabetic (n=61)</b>	<b>Non- Diabetic (n=227)</b>	<b>All Participants (N=334)</b>
<b>Mean minutes of Physical activity per day across all 3 domains (SD)</b>	240.8 (132.8)	293.5 (171.04)	263.1 (155.7)	266.3 (155.8)
<b>METs minutes per week (SD)</b>	380.3 (152.6)	418.7 (161.3)	422.9 (163.5)	419.3 (161.4)
<b>Adequate physical activity(≥600 MET-minutes/week)</b>	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>	<b>N (%)</b>
Yes	25 (54)	39 (64)	148 (65)	212 (64)
No	21 (46)	22 (36)	79 (35)	122 (36)

\* MET= Metabolic Equivalent minutes per week

#### 4.4 Past medical history of participants

##### 4.4.1 History of hypertension

Participants were asked if they were aware that they had hypertension and whether they were on medication. Majority of the participants 88.9% (297/334) were aware they had hypertension, among whom most 90.9% (270/334) were on prescribed anti-hypertensive medication (Table 4.9).

##### 4.4.2 Knowledge on diabetes and diabetes status

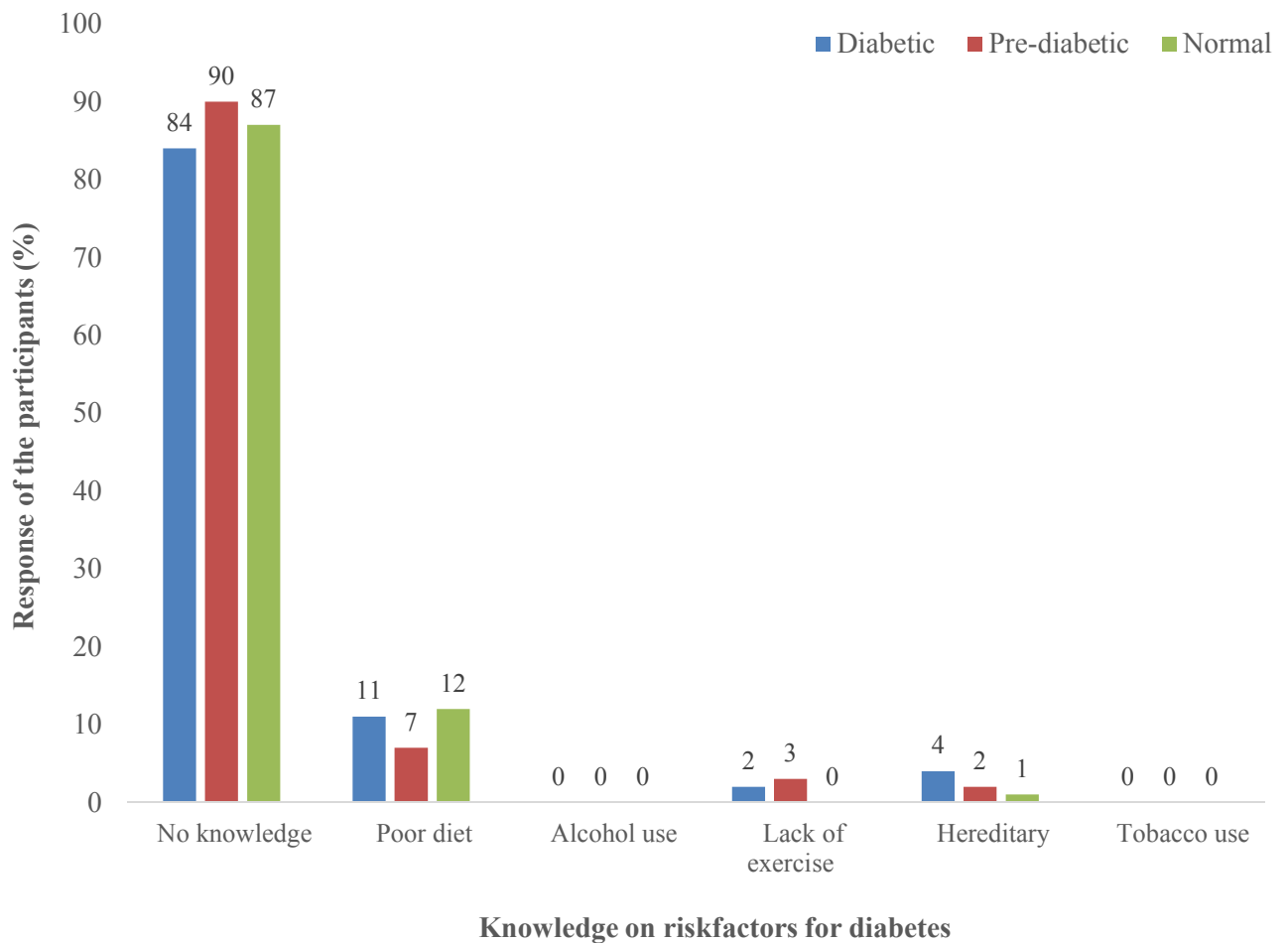
Sixty percent (202/334) of the participants had a positive history of having their blood sugar levels measured by a health worker, among whom majority 67.8% (137/202) had it measured within the past 12 months. Almost a quarter of the participants (21.3%; 71/334) reported a history of familial diabetes. Only 13% (39/334) of participants were receiving advice from a health worker on how to prevent development of diabetes. (Table 4.9).

**Table 4.9: History and knowledge of diabetes and hypertension among participants**

	<b>Diabetic n (%)</b>	<b>Pre Diabetic n (%)</b>	<b>Non- Diabetic n (%)</b>	<b>All Participants N (%)</b>
<b>First time you have been told you have HTN</b>				
Yes	3 (6.5)	5 (8.2)	29 (12.8)	37 (11.1)
No	43 (93.5)	56 (91.8)	198 (87.2)	297 (88.9)
<b>On prescribed HTN medication (N=297)</b>				
Yes	38 (88.4)	54 (96.4)	178 (89.9)	270 (90.9)
No	5 (11.6)	2 (3.6)	20 (10.1)	27 (9.1)
<b>Seen traditional healer for HTN treatment (N=297)</b>				
Yes	1 (2.3)	0 (0)	7 (3.5)	8 (2.7)
No	42 (97.7)	56 (100)	191 (96.5)	289 (97.3)
<b>Taking herbal medication for HTN (N=297)</b>				
Yes	0 (0)	0 (0)	3 (1.5)	3 (1)
No	43 (100)	56 (100)	195 (98.5)	294 (99)
<b>Ever had blood sugar measured by health worker</b>				
Yes	30 (65.2)	42 (68.9)	130 (57.3)	202 (60.5)
No	16 (34.8)	19 (31.1)	97 (42.7)	132 (39.5)
<b>Blood sugar measured in past 12 months</b>				
Yes	21 (70.0)	29 (69)	87 (66.9)	137 (67.8)
No	9 (30.0)	13 (31)	43 (33.1)	65 (32.2)
<b>Family Member with diabetes</b>				
Yes	13 (28.3)	17 (27.9)	41 (18.1)	71 (21.3)
No	33 (71.7)	44 (72.1)	181 (79.7)	258 (77.2)
DK	0 (0.0)	0 (0)	5 (2.2)	5 (1.5)
<b>Receiving advice from health worker on DM prevention</b>				
Yes	1 (2.2)	13 (4.9)	9 (4)	13 (3.9)
No	45 (97.8)	58 (95.1)	218 (96)	321 (96.1)
<b>Aware of DM causes</b>				
Yes	7 (15.2)	6 (9.8)	29 (12.8)	42 (12.6)
No	39 (84.4)	55 (90.2)	198 (87.2)	292 (87.4)
<b>Knowledge on one DM risk factors</b>				
Tobacco use	0 (0)	0 (0)	0 (0)	0 (0)

Poor diet	5 (10.9)	4 (6.6)	29 (12)	38 (11.4)
Alcohol use	0 (0)	0 (0)	1 (0.4)	1 (0.3)
Lack of exercise	1 (2.2)	2 (3.3)	9 (0.4)	12 (3.6)
Hereditary	2 (4.3)	1 (1.6)	3 (1.3)	6 (1.8)

Majority, 87% (292/334) of the participants had no knowledge about a risk factor that causes diabetes mellitus (figure 4.3).



**Figure 0.3: Participants knowledge on risk factors for diabetes**

## 4.5 Anthropometric characteristics of participants

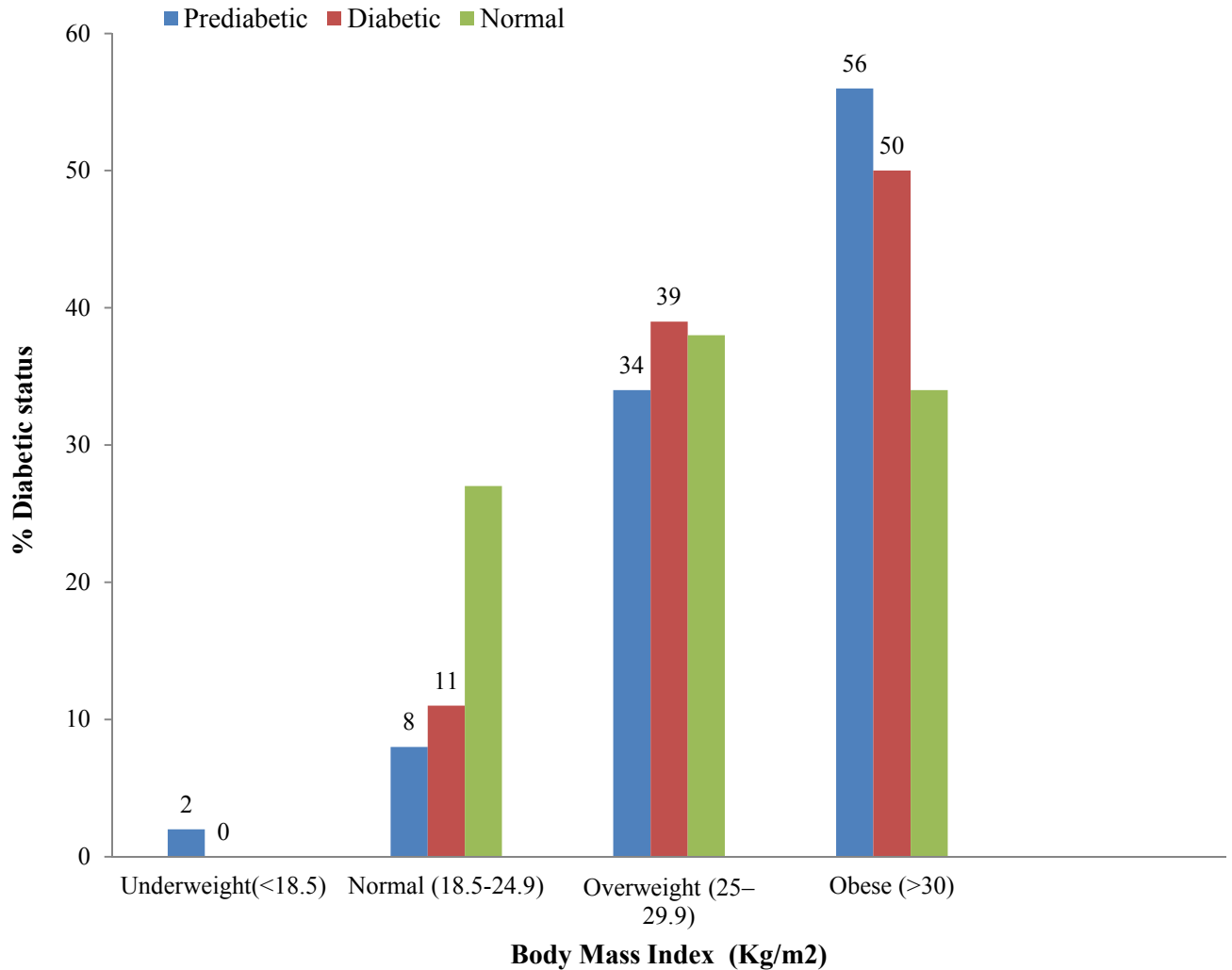
### 4.5.1 Body Mass index (BMI)

Over half (56.3%; 188/334) of the participants had truncal obesity and 40 % (134/334) were found to be obese according to their BMI (Table 4.10). Majority of obese patients were diagnosed as either diabetic (50%) or pre-diabetic (56%) (Figure 4.4).

**Table 4.10: Anthropometric characteristics of participants**

	<b>Diabetic (n=46)</b>	<b>Pre Diabetic (n=61)</b>	<b>Non- Diabetic (n=227)</b>	<b>All Participants (N=334)</b>
<b>Mean waist circumference in cm (SD)</b>	95.1 (14.5)	97.8 (14.6)	90 (14.9)	92.2 (15.1)
<b>Mean hip circumference in cm (SD)</b>	107 (17.74)	109 (15.67)	102 (15.66)	104 (16.19)
<b>Mean waist hip ration</b>				
Women (SD)	0.89 (0.09)	0.88 (0.10)	0.81 (0.07)	0.88 (0.08)
Men (SD)	0.95 (0.08)	0.89 (0.22)	89 (0,12)	0.9 (0.13)
<b>Mean height in cm (SD)</b>	154.2 (22.17)	157.2 (12.70)	159.7 (10.27)	158.5 (13.34)
<b>Mean weight in Kg (SD)</b>	75.35 (16.18)	79.83 (19.35)	74.72 (42.49)	75.74 (36.50)
<b>Truncal Obesity</b>	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>	<b>N (%)</b>
Yes	30 (65.2)	32 (52.5)	126 (55.5)	188 (56.3)
No	16 (34.8)	29 (47.5)	101 (44.5)	146 (43.7)
<b>BMI</b>				
Underweight(<18.5)	0 (0.0)	1 (1.6)	1 (0.4)	2 (0.6)
Normal (18.5-24.9)	5 (10.9)	5 (8.2)	62 (27.3)	72 (21.6)
Overweight (25-29.9)	18 (39.1)	21 (34.4)	87 (38.3)	126 (37.7)
Obese (≥ 30)	23 (50.0)	34 (55.7)	77 (33.9)	134 (40.1)

\*WHR= waist-hip ratio; \*BMI = Body mass index; \*SD = standard deviation



**Figure 0.4: Distribution of diabetic status by BMI among the participants**

#### **4.6 Blood Pressure among participants**

Overall the mean systolic blood pressure of the participants was 155.3 mmHg while the mean diastolic blood pressure was 96.3 mmHg (Table 4.11). Fifty six percent (188/334) had controlled blood pressure (systolic < 140mmHg and/or diastolic BP <90mmHg). (Table 4.12).

**Table 4.11: Mean Systolic and Diastolic pressure of participants**

	<b>Diabetic (n= 46)</b>	<b>Pre-Diabetic (n=61)</b>	<b>Non- Diabetic (n=227)</b>	<b>All Participants (N=334)</b>
<b>Mean Systolic BP (SD)</b>	155.4 (22.45)	150.54 (25)	156.3 (25.20)	155.2 (24.80)
<b>Mean Diastolic BP (SD)</b>	91.1 (13.7)	91.26 (14.28)	94.7 (13.1)	93.6 (2.62)

\*BP= blood pressure; SD= standard deviation

**Table 4.12: Blood pressure readings of participants**

	<b>Diabetic n (%)</b>	<b>Pre Diabetic n (%)</b>	<b>Non- Diabetic n (%)</b>	<b>All Participants N (%)</b>
<b>Systolic BP</b>				
Controlled (<140 mmHg)	10 (21.7)	23 (37.7)	50 (22)	83 (24.9)
Grade 1 (SBP 140-149)	16 (34.8)	16 (26.2)	80 (35.2)	112 (33.5)
Grade 2 (SBP 160-179)	11 (23.9)	12 (19.7)	55 (24.2)	78 (23.4)
Grade 3 (SBP > 180)	9 (19.6)	10 (16.4)	42 (18.5)	61 (18.3)
<b>Diastolic BP</b>				
Controlled (<90mmHg)	21 (45.7)	29 (47.5)	73 (32.2)	123 (36.8)
Grade 1 (DBP 90-99)	10 (21.7)	16 (26.2)	66 (29.1)	92 (27.5)
Grade 2 (DBP 100-109)	10 (21.7)	10 (16.4)	47 (20.7)	67 (20.1)
Grade 3 (DBP > 110)	5 (10.9)	6 (9.8)	41 (18.1)	52 (15.6)
<b>BP(SBP or DBP)controlled</b>				
Yes	24 (52)	27 (44)	137 (60)	188 (56.3)
No	22 (48)	34 (56)	90 (40)	146 (43.7)

\*SBP = Systolic Blood Pressure, DBP=Diastolic Blood Pressure

A combination of the behavioural and anthropometric characteristics such as tobacco use, alcohol consumption, BMI and physical activity among the participants are shown in table 4.13

**Table 4.13: Behavioral and anthropometric characteristics of hypertensive adults**

	Diabetic n (%)	Pre-Diabetic n (%)	Normal (%)	n	All Participants N (%)
<b>Currently smoke tobacco (N=334)</b>					
Yes	2 (4.3)	0 (0)	9 (4)	11	3.3
No	44 (95.7)	61 (100)	218 (96)	323	96.7
<b>Smoked tobacco in the past (N=323)</b>					
Yes	2 (4)	4 (6.6)	22 (10)	28	8.4
No	42 (96)	57 (93.4)	197 (90)	296	88.9
<b>Ever consumed Alcohol(N=334)</b>					
Yes	13 (28.3)	14 (23)	75 (33)	102	30.5
No	33 (71.7)	47 (77)	152 (67)	232	69.5
<b>Adequate Physical Activity</b>					
Yes	25 (54)	39 (64)	148 (65)	212	64
No	21 (46)	22 (36)	79 (35)	122	36
<b>Truncal Obesity</b>					
Yes	30 (65.2)	32 (52.5)	126 (55.5)	188	56.3
No	16 (34.8)	29 (47.5)	101 (44.5)	146	43.7
<b>BMI kg/m<sup>2</sup></b>					
Underweight(<18.5)	0 (0.0)	1 (1.6)	1 (0.4)	2	0.6
Normal (18.5-24.9)	5 (10.9)	5 (8.2)	62 (27.3)	72	21.6
Overweight (25-29.9)	18 (39.1)	21 (34.4)	87 (38.3)	126	37.7
Obese (≥ 30)	23 (50.0)	34 (55.7)	77 (33.9)	134	40.1
<b>On prescribed HTN medication (N=297)</b>					
Yes	38 (88.4)	54 (96.4)	178 (89.9)	270	90.9
No	5 (11.6)	2 (3.6)	20 (10.1)	27	9.1
<b>Blood sugar measured in the past 12 months</b>					
Yes	21 (70.0)	29 (69)	87 (66.9)	137	67.8
No	9 (30.0)	13 (31)	43 (33.1)	65	32.2
<b>Family Member with diabetes</b>					
Yes	13 (28.3)	17 (27.9)	41 (18.1)	71	21.3
No	33 (71.7)	44 (72.1)	181 (79.7)	258	77.2
Don't Know	0 (0.0)	0 (0)	5 (2.2)	5	1.5



#### **4.7 Factors associated with Abnormal Glucose Regulation (AGR)**

Table 4.14 shows the predictors of AGR. Abnormal glucose regulation included two categories 1) those with diabetes and 2) those with pre-diabetes. On bivariate analysis identified risk factors for AGR were age  $\geq 45$  years (OR = 4.57; (95% CI 2.00 - 10.42) BMI  $\geq 25$  Kg/M<sup>2</sup> (OR= 3.35; CI 1.68 – 6.67), low formal education (primary/none) (OR 2.23; 95% CI 1.27 – 3.86) and history of a first degree relative with DM (OR=2; 95% CI 1.11- 3.16). Having a controlled blood pressure below 140/90 mmHg was protective (OR = 0.59; 95% CI 0.38-0.95).

**Table 4.14: Factors associated with Abnormal glucose regulation among participants on bivariate analysis**

<b>Variable</b>	<b>AGR N(Col%)</b>	<b>Normal N (Col%)</b>	<b>Odds Ratio (95%CI)</b>	<b>P Value</b>
<b>Age ≥ 45 years</b>				
Yes	100 (94)	172 (75)	4.57 (2.00 - 10.42)	<b>*0.0001</b>
No	7	55		
<b>Level of Education</b>				
Non-formal/primary	86 (80)	147 (65)	2.23 (1.27 - 3.86)	<b>*0.0037</b>
Secondary/Tertiary	21	80		
<b>BP(SBP or DBP)controlled</b>				
Yes	51 (48)	137 (60)	0.59 (0.38 - 0.95)	<b>*0.03</b>
No	56	90		
<b>BMI</b>				
≥ 25kg/m2	96 (90)	164 (72)	3.35 (1.68 - 6.67)	<b>*0.0003</b>
< 25kg/m2	11	63		
<b>First degree relative with DM</b>				
Yes	25 (23)	30 (13)	2 (1.11 - 3.16)	<b>*0.02</b>
No	82	197		
<b>Truncal Obesity</b>				
Yes	62 (57.9)	126 (55.5)	1.1 (0.69 - 1.76)	0.68
No	45	101		
<b>Gender</b>				
Female	37 (81)	167 (74)	1.56 (0.89 - 2.76)	0.12
Male	20	60		
<b>Employment</b>				
Formal	6 (7)	21 (12)	0.56 (0.22 - 1.45)	0.23
Informal	80	158		
<b>Marital status</b>				
Married	59 (55)	145 (64)	0.7 (0.44 - 2.76)	0.12
Not Married/divorced/widowed	48	82		
<b>Tobacco Use</b>				
Yes	8 (8)	30 (13)	0.53 (0.23 - 1.20)	0.12
No	99	197		
<b>Alcohol Consumption</b>				
Yes	80 (75)	152 (67)	1.46 (0.87 - 2.45)	0.15
No	27	75		
<b>Adequate Physical Activity (≥ 600 MET-minutes)</b>				
Yes	64 (60)	148 (65)	0.79 (0.49 - 1.27)	0.34
No	43	79		
<b>Glucose level ever measured</b>				
Yes	72 (67)	130 (57)	1.53 (0.94 - 2.49)	0.08
No	35	97		
<b>Glucose level measured in past 12mths</b>				
Yes	50 (69)	87 (67)	1.12 (0.06 - 2.08)	0.71
No	22	43		

**NB: \* against P value indicates a significant factors**

Multivariate logistic regression was used to identify significant factors associated with undiagnosed AGR in hypertensive patients. On multivariate analysis significant factors for AGR were age  $\geq 45$  years (OR = 3.23; 95% CI 1.37 – 7.62), BMI  $\geq 25$  Kg/M2 (OR= 3.13; 95% CI 1.53 - 6.41), low formal education (primary/non-formal) (OR= 2; 95% CI 1.08 - 3.56) and history of a first degree relative with DM (OR=2.19; 95% CI 1.16 - 4.15) (Table 4.15).

**Table 4.15: Factors associated with Abnormal glucose regulation among participants on logistic regression**

<b>Variable</b>	<b>Crude OR</b>	<b>Adjusted OR</b>	<b>95% confidence interval</b>	<b>P Value</b>
<b>Age <math>\geq 45</math> years</b>				
Yes	4.57	3.23	1.37 -7.62	<b>0.0074</b>
No				
<b>Level of Education</b>				
Non-formal/primary	2.23	2.0	1.08 – 3.56	<b>0.027</b>
Secondary/Tertiary				
<b>BP(SBP or DBP)controlled</b>				
Yes	0.59	0.59	0.36 – 0.97	<b>0.037</b>
No				
<b>BMI</b>				
$\geq 25$ kg/m2	3.35	3.13	1.53 – 6.4	<b>0.0017</b>
$< 25$ kg/m2				
<b>First degree relative with DM</b>				
Yes	2	2.19	1.16 – 4.15	<b>0.011</b>
No				

## CHAPTER FIVE

### 5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Prevalence of undiagnosed pre-diabetic and diabetic states

The aim of this study was to determine the prevalence of undiagnosed diabetic and pre-diabetic states and factors associated with AGR (diabetic and pre-diabetic states) among out-patient hypertensive patients attending the out-patient department, in a hospital clinical setting, in Kenya. More than a third (32%) of the study participants had AGR (diabetes and pre-diabetes). Fourteen percent were newly diagnosed with DM, while 18% were pre-diabetic.

This study found a high prevalence (32%) of AGR (diabetes and pre-diabetes) among hypertensive patients in the clinical setting. Accumulating evidence reveals that AGR is common among patients with cardiovascular diseases like hypertension in the hospital settings. In Uganda, Mutebi *et al.* (2012) screened 320 hypertensive patients in Mulago hospital and found 50% were pre-diabetic and 24% had undiagnosed diabetes. In Nigeria, Iloh *et al.*, (2013) screened 320 hypertensive patients in a primary healthcare facility where 33% had undiagnosed diabetes. Kidney *et al.* (2014) demonstrated that out of 3847 hypertensive patients in Minnesota 10.7% had pre-diabetes and 19.6% had undiagnosed diabetes. The Euro Heart Survey on diabetes and the heart demonstrated that AGR is more common in patients with coronary artery diseases and hypertension as 36% had pre-diabetes and 22% had newly detected diabetes (Bartnik, 2004). In Germany, Luders *et al.* (2005) found that out of 260 hypertensive patients 39% had pre-diabetes and 12% had undiagnosed diabetes mellitus.

The findings of undiagnosed diabetes and pre-diabetes among hypertensive participants indicate the importance of screening for DM in the clinical setting as it leads to early diagnosis.

## **5.2 Socio-demographic, behavioural and physical characteristics of participants**

In the study, majority (85%) of the participants with undiagnosed diabetes were women. This is similar to the study conducted in Mulago hospital, Uganda by Mutebi *et al.* (2012) whereby 73% of the hypertensive patients who had undiagnosed diabetes were female. Findings from the study indicate that most of the participants (40%) had non-formal education among whom 58% were diabetic and 51% were pre-diabetic. University level of education was the least attained at 5%. This is similar to other study findings whereby most hypertensive patients with undiagnosed diabetes had no formal education (Mayega *et al.*, 2013; Mutebi *et al.*, 2012). Level of education has been shown to have an impact on patients understanding of their disease progression as shown by Shang *et al.* (2013) among diabetic patients in China whereby having a low educational level was associated with diabetes.

Tobacco use and alcohol use was not a common practice among the study participants as 97% did not smoke tobacco, 89% had never smoked tobacco in the past and 70% had never consumed alcohol at the time of the study. Similar findings were observed by Iloh *et al.*, (2013) in Nigeria, whereby 80% of undiagnosed diabetics had never smoked tobacco and 46% had never consumed alcohol.

For the findings of the current study, 68% of the participants reported having been screened for DM by a healthcare worker in the medical clinic. This is similar to Chatterjee *et al.*, (2013) study findings where 66% of patients in the clinical setting had undergone diabetes screening. Identifying diabetes in the pre-clinical stage by regular screening offers both the healthcare

provider and patient opportunities to modify long term risk before complications occur (van den Donk *et al.*, 2011).

Majority of participants (88%) were not knowledgeable on at least one risk factor that contributes to development of diabetes as only 13% (39/334) received advice from a health worker on DM prevention. These are patients who are on regular follow-up for hypertension at the medical clinic and should be educated on diabetes as it is a comorbidity for hypertension (Almas *et al.*, 2012; Ashfaq *et al.*, 2007). Health care providers play a big role in educating and enhancing the patients knowledge on diabetes and hypertension management and prevention (Kidney *et al.*, 2014).

Over half (56.3%) of the participants had truncal obesity, among whom 65% were undiagnosed diabetic and 53% were pre-diabetic. Forty percent of the participants were classified as obese according to their BMI. Among them 50% were undiagnosed diabetic and 56% were pre-diabetic and is similar with study findings in Nigeria by Iloh *et al.*, (2013) whereby 63% of hypertensive patients with undiagnosed DM were obese. Other study findings in Germany and Uganda ( Lüders *et al.*, 2005; Mayega *et al.*, 2013) more than half of the patients with undiagnosed diabetes were obese. Obesity is a proven modifiable risk factor for development of diabetes ((KSTEPS Ministry of Health, 2015; WHO, 2014). More than half the participants with obesity were at the pre-diabetic stage. Pre-diabetes increases their risk of developing diabetes and its associated complications later in life (Chatterjee *et al.*, 2013). Patients with a BMI above normal ( $\geq 25$  kg/m<sup>2</sup>) should be given appropriate education and counseling on how to reduce their BMI.

Majority of the participants (91%) were on prescribed anti-hypertensive medication, among whom 88% were undiagnosed diabetic and 96% were pre-diabetic. Data on the specific category of anti-hypertensive medication patients were on was not collected. Although majority were on

antihypertensive medication, blood pressure was controlled (systolic < 140mmHg and/or diastolic BP <90mmHg) in only 56% of the study participants.

### **5.3 Factors associated with undiagnosed abnormal glucose regulation among participants**

The study findings show that abnormal glucose regulation (AGR) is significantly associated with age over 45 years and BMI above 25kg/m<sup>2</sup> as demonstrated in Nigeria (Iloh *et al.*, 2013), Uganda (Mayega *et al.*, 2013; Mutebi *et al.*, 2012) and Germany (Lüders *et al.*, 2005) among hypertensive patients. Having a low level of education was associated with DM in this study. In European countries lower levels of education have been used as predictors of developing DM (Agardh *et al.*, 2011; Sacerdote *et al.*, 2012; Shang *et al.*, 2013). In China, Shang *et al.* (2013) proved that low educational level was adversely associated with developing diabetes.

Family history of diabetes was a risk factor for AGR among hypertensive patients and similar findings were demonstrated by Mutebi *et al.* (2012) and Hilding *et al.* (2006) where those with a family history of DM had a 2.2 odds and a 2.8 odds of developing diabetes respectively. Family history of type 2 diabetes is not only a risk factor for the disease but could be used positively for risk awareness and risk-reducing behaviour. Family history of diabetes can also provide a useful tool for the screening and possible delay in progression, if not prevention, of diabetes.

This study found that patients with controlled blood pressure had reduced risk of developing AGR. A study done by the U.S. Preventive Services Task Force (USPSTF) evidenced that lowering blood pressure below conventional target blood pressure values reduces the incidence of cardiovascular events and cardiovascular mortality in adults who have hypertension and clinically detected diabetes (USPSTF, 2008).

Tobacco use, alcohol use and inadequate physical activity were not associated with AGR in this study. In this study tobacco use and harmful alcohol use was not a common practice among the study participants as 97% did not currently smoke tobacco, 89% had never smoked tobacco in the past and 70% had never consumed alcohol. Similar findings were observed by Iloh *et al.*, (2013) in Nigeria, whereby 80% of undiagnosed diabetics had never smoked tobacco and 46% had never consumed alcohol. In Uganda, *Mutebi et al.*, demonstrated similar findings of whereby 95% of participants did not smoke tobacco.

There is evidence that the prevalence of AGR is high among hypertensive patients with specific risk factors, therefore a strong justification for use of targeted diabetic screening as it offers the patients and healthcare providers an opportunity to modify long-term risk before serious complications occur (Chatterjee *et al.*, 2013; van den Donk *et al.*, 2011; Mayega *et al.*, 2013; Pastakia *et al.*, 2013). Patients with newly diagnosed DM will benefit from proper glycemic control and reduction of complications and those with pre-diabetes will benefit from strategies tailored to prevent or retard onset of diabetes.

#### **5.4 Study limitations**

This study was cross sectional and hospital based and as such it was not possible to generalize the study findings to the population. The study did not collect information on the duration of hypertension diagnosis and the specific antihypertensive medication used by participants. The study findings would have been strengthened by availability of conclusive dietary and socio-economic data. The physical activity data may suffer from bias of respondent's perception of vigorous and moderate activity which is subjective.



## 5.5 Study Delimitations

Patients who were pregnant were excluded from the study. The study was not able to determine if patients had hemoglobinopathies or certain anemia's which are associated with accelerated red cell turnover.

## 5.6 Conclusions

- Despite participants being on follow-up for hypertension at the outpatient clinic, there was a high prevalence of undiagnosed diabetes and pre-diabetes highlighting missed opportunities for diagnosis.
- Factors associated with undiagnosed DM were age  $\geq 45$  years, BMI  $\geq 25\text{kg/m}^2$ , level of education and DM family history
- Patients with control of BP  $<140/90$  mmHg had a reduced odds of developing diabetes mellitus
- Majority of the participants with undiagnosed diabetes and pre-diabetes were obese.
- Majority of the hypertensive patients had no knowledge on a risk factors that causes diabetes mellitus and few were receiving advice from a healthcare worker on diabetes prevention.

## 5.7 Recommendations

- There is need of frequent screening for DM among hypertensive patients in the clinical setting as it leads to early diagnosis.
- Health workers should use the identified independent factors such as age greater than 45 years,  $BMI \geq 25 \text{ kg/m}^2$  and a family history of DM as red flags to identify patients at increased risk of DM and ensure they undergo the appropriate screening and counseling.
- Health care workers should ensure BP is well controlled at  $<140/90 \text{ mmHg}$  among hypertensive patients as good control of BP reduces the odds of DM development.
- Health workers should emphasize on direct lifestyle interventions like BMI reduction and nutritional counselling among the pre-diabetic and diabetic patients who are obese.
- Patients on followup should be given health education at the facility level to increase their knowledge on diabetes risk factors.

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## APPENDICES

### Appendix 1: Informed Consent Form

**Study Title:** Prevalence and factors associated with undetected/undiagnosed diabetes among adult hypertensive patients seeking health care at Kiambu District Hospital, 2014.

#### Part I

##### **Purpose of the research:**

You are invited to participate in this research study. The main objective of this study is to determine the prevalence and factors associated with undetected/undiagnosed diabetes among hypertensive adults at Kiambu District Hospital. You have been selected as a participant. Kindly read the explanation of the study and feel free to ask questions that you may have.

The information gathered from this study will be used to inform policy and guide in developing strategic interventions for Non-Communicable Diseases like hypertension. This will go a long way to screening of individuals at risk and early diagnosis, providing them with prompt management thus reducing adverse outcomes and complications associated with hypertension.

##### **Study Procedures:**

If you agree to take part in this study, you will be asked to answer some questions that will take about 20 minutes of your time and to provide a blood specimen for testing. The blood specimen will be tested for glycated haemoglobin A1C (HbA1c) to determine your glucose level in the past 8-12 weeks. If your HbA1c is above the recommended cut off point of 6.5%, you shall be given a form to be followed up in the diabetic clinic for further management. If it is between 6.0-6.4% you shall be counseled on intervention strategies to prevent progression to DM.

**Risks of participating in this study:**

You may feel slight discomfort equivalent to a pinch during collection of the blood specimen. Specimen collection will be done by drawing 2ml of blood.

**Potential benefits:**

If you agree to participate in this study you will be interviewed and diabetic individuals will be referred for appropriate management. The information gathered in this study will be used to inform policy and in the development of guidelines for screening of individuals at risk of developing hypertension.

**Study costs:**

There will be no monetary payment or gain to you if you accept to participate in this study,

**Confidentiality:**

All information from this study will be kept private and confidential. Records will be stored in a lockable drawer with restricted access. Your name will not be used in any report of this study, or in any publications or presentations. This information will strictly be reviewed only by authorized persons and officials at the Institute of Tropical Medicine and Infectious Diseases (ITROMID) who will protect your privacy.

**Voluntary Participation:**

Participation in this study is entirely voluntary. If at any time you wish to withdraw from participating in the study, you are free to do so and you shall not be penalized.

**Contacts and Questions:**

Any questions regarding the study may be directed to:

Dr. Nkatha Meme, Telephone number 0721341831, P.O Box 14037-00800, Nairobi,  
email:[nkathameme@gmail.com](mailto:nkathameme@gmail.com)

Or

Secretary, KNH/UoN-ERC, Tel: +2542726300-19 Ext: 44102E-  
mail:[knhuonerc@gmail.com](mailto:knhuonerc@gmail.com) Post address: P O BOX 20723-00202, Nairobi, Kenya

Or

Director, ITROMID, P.O Box 62000-00200 Nairobi. Telephone 254-67-52711/52181-4

**Part II:**

**Participant Consent form**

I..... hereby give consent to participate in this research study. I have read the information provided/the information has been read to me. I have fully understood the aim of this study and what will be required of me if I accept to take part in the study. The risks and benefits have been explained to me. Any questions I have concerning the study have been adequately answered and I am satisfied. I understand that I can withdraw from the study anytime if I so wish without giving any reason and this will not affect my access to normal health care and management.

Signature of the participant: ..... Date.....

Signature of investigator: ..... Date.....

Signature of Witness..... Date.....

## Appendix 2: Questionnaire

**Research Question: Prevalence and Factors Associated With Undetected/Undiagnosed Diabetes Mellitus Among Hypertensive Patients Seeking Care at Kiambu District Hospital, 2014**

Questionnaire number

Interview date \_\_\_/\_\_\_/\_\_\_

Interviewer name/code \_\_\_\_\_

Health Facility \_\_\_\_\_

File number \_\_\_\_\_

### SCREENING SECTION

Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?

Yes  No

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

If Female, Are you pregnant?  Yes  No

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

### DEMOGRAPHIC INFORMATION

1) Sex  Male  Female

2) What is your date of birth? dd /mm  year  *known, Go to Q4*  
*(Don't know 77/77/7777)*

3) How old are you? (Years)

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

1-No formal schooling  5- College/University completed

2-Less than primary school  6- Post graduate degree

3-Primary School

4-Secondary School

- 5) What is your ethnic group?
- Kikuyu  Embu
- Meru  Other (*specify*) \_\_\_\_\_
- 6) What is your **marital status**?
- 1-Never married  4-Divorced
- 2-Currently married  5-Widowed
- 3-Separated  6-Cohabiting
- 7) Which of the following best describes your **main work status** over the past 12 months?
- 1-Government employee/ skilled  6-Housewife
- 2-Non-government employee  7-Retired
- 3-Skilled formal  8-Unemployed (able to work)
- 4-Farmer  9-Unemployed (unable to work)
- 5-Student  Casual labourer
- informal

## **BEHAVIOURAL MEASUREMENTS**

### **Tobacco Use**

- 8) Do you currently smoke any **tobacco products**, such as cigarettes? (*If No, go to Q13*)
- Yes  No
- 9) Do you currently smoke tobacco products **daily**? (*If No, go to Q13*)
- Yes  No
- 10) How old were you when you **first started** smoking daily? (*Age in years*)   (*If known, go to Q12*) (*Don't Know 77*)
- 11) Do you remember how long ago it was? (**RECORD ONLY 1, NOT ALL 3**) (*Don't know 77*)
- In Years   *If known, go to Q12*
- OR In Months   *If known, go to Q12*
- OR In weeks
- 12) On average, **how many** of the following do you smoke each day? (**RECORD FOR EACH TYPE**) (*Don't know 77*)
- Manufactured cigarettes   Hand-rolled cigarettes
- Pipes full of tobacco   Other

If Other(*please specify*): \_\_\_\_\_ (*Go to Q16*)

13) In the past, did you **ever** smoke **daily**? (*If No, go to Q16*)  Yes  No

14) How old were you when you **stopped** smoking **daily**? (*Age in years*)   (*If known, go to Q16*) (*Don't Know 77*)

15) Do you remember how long ago it was? (**RECORD ONLY 1, NOT ALL 3**)(*Don't Know 77*)  
In Years   *If known, go to Q16*

OR In Months   *If known, go to Q16*

OR In weeks

16) Do you **currently** use any **smokeless tobacco** such as [*snuff, chewing tobacco,*]? (*If No, go to Q18*)  Yes  No

17) Do you **currently** use **smokeless tobacco** products **daily**? (*If No, go to Q18*)  
 Yes  No

18) In the past, did you **ever** use smokeless tobacco such as [*snuff, chewing tobacco*] **daily**?  
 Yes  No

### Alcohol Consumption

19) Have you **ever** consumed an alcoholic drink such as beer, wine, spirits, fermented cider or local brew? (*If No, go to Q25*)  Yes  No

20) Have you consumed an alcoholic drink within the **past 12 months**? (*If No, go to Q25*)  
 Yes  No

21) During the past 12 months, **how frequently** have you had at least **one alcoholic** drink?  
 Daily  1-3 days per month  
 5-6 days per week  Less than once a month  
 1-4 days per week

22) Have you consumed an alcoholic drink within the **past 30 days**? (*If No, go to Q25*)  
 Yes  No

23) During the past 30 days, what was the **least number** of standard alcoholic drinks you had on a single occasion, counting all types of alcoholic drinks together (*Don't know 77*)  
  Number



24) During the past 30 days, what was the **largest number** of standard alcoholic drinks you had on a single occasion, counting all types of alcoholic drinks together? (*Don't know 77*)

Number

## Diet

25) In a typical week, on how many days do you **eat fruit**? (*Don't know 77*)

Number of days  (*if zero days, go to 27*)

26) How many **fruits** do you eat on **one** of those days? (*Don't know 77*)

Number of fruits

27) In a typical week, on how many days do you **eat vegetables**? (*Don't know 77*)

Number of days  (*if zero days, go to Q29*)

28) How many **servings** of vegetables do you eat on one of those days? (*Don't know 77*)

Number of servings

29) What type of **oil or fat is most often** used for meal preparation in your household? (*Don't know 77*)

liquid oil

None in particular

solid fat

None used

Margarine

If other, specify \_\_\_\_\_

30) On average, how many meals per week do you eat that were not prepared at a home? By meal, I mean breakfast, lunch and dinner. (*Don't know 77*)

Number of Days

## Physical Activity

*Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, seeking employment. In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.*

### Activity at work

31) Does your work involve vigorous-intensity activity [*carrying or lifting heavy loads, digging or construction work*] that causes large increases in breathing or heart rate likefor at least 10 minutes continuously? (*USE SHOWCARD*)      Yes       No  (*if no, go to Q34*)

32) In a typical week, on how many days do you do vigorous-intensity activities as part of your work?  
Number of days

33) How much time do you spend doing vigorous-intensity activities at work on a typical day?  
Hours: Min

34) Does your work involve moderate-intensity activity, such as walking fast [*or carrying light loads*] that causes small increases in breathing or heart rate for at least 10 minutes continuously? (USE SHOWCARD)  Yes  No (*if No, go to Q37*)

35) In a typical week, on how many days do you do moderate-intensity activities as part of your work?  
Number of days

36) How much time do you spend doing moderate-intensity activities at work on a typical day?  
Hours: Min .

### ***Travel to and from places***

- *The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. [insert other examples if needed]*

37) What is your most common form of travel to and from places?  
 Walking  Bicycle (pedal cycle)  Vehicle  
 Other (*Specify*) \_\_\_\_\_

38) Do you walk or use a bicycle (*pedal cycle*) for at least 10 minutes continuously to get to and from places? (*if No, go to Q40*)  Yes  No

39) In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places? Number of days

### ***Recreational activities***

- *The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities.*

40) Do you do any vigorous-intensity sports, fitness or recreational [*running or football*] activities that cause large increases in breathing or heart rate like for at least 10 minutes continuously? (USE SHOWCARD)(*If No, go to Q42*)  Yes  No

41) In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational activities? Number of days

42) Do you do any moderate-intensity sports, fitness or recreational (*leisure*) activities that cause a small increase in breathing or heart rate such as brisk walking, for at least 10 minutes continuously?

(USE SHOWCARD)(If No, go to Q44)

Ye

Ne

43) In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities? Number of days

### **Sedentary behaviour**

- The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent [sitting at a desk, sitting with friends, travelling in car, bus, train, reading, playing cards or watching television], but **do not include time spent sleeping**. (USE SHOWCARD)

44) How much time do you usually spend sitting or reclining on a typical day? (**do not include time spent sleeping**) Hours: Min

### **History of Raised Blood Pressure**

45) Is this the first time you have been told by a doctor or other health worker that you have raised blood pressure or hypertension? (**If yes, go to Q49**)

Yes  No

46) Are you currently taking any prescribed antihypertensive medication for your raised blood pressure?  Yes  No

47) Have you ever seen a traditional healer for raised blood pressure or hypertension?

Yes  No

48) Are you currently taking any herbal or traditional remedy for your raised blood pressure?

Yes  No

### **History of Diabetes**

49) Have you ever had your blood sugar measured by a doctor or other health worker? (**If No, go to Q51**)  Yes  No  Don't Know

50) Has your blood sugar been measured in the past 12 months?  Yes  No

51) Are you aware of what behaviors or factors cause diabetes? (**If No, go to Q53**)  Yes  No

52) Can you list any risk factors that cause diabetes that you are aware of (*tick appropriate response and list other responses*)

Tobacco use

Alcohol use

Poor diet

Lack of exercise

Other \_\_\_\_\_

53) Do you have a family member with diabetes?  Yes  No  Don't Know

54) If yes to Q53, what is your relation? \_\_\_\_\_

55) Are you currently receiving any of the following advice for prevention of diabetes prescribed by a doctor or other health worker?

Advice or treatment to lose weight  Yes  No

Advice or treatment to stop smoking  Yes  No

Advice to start or do more exercise  Yes  No

### **PHYSICAL MEASUREMENTS**

56) Height in Centimeters (cm) \_\_\_\_\_.

57) Weight in Kilograms (kg) \_\_\_\_\_.

58) Waist circumference in Centimeters (cm) \_\_\_\_\_.

59) BP Reading 1            Systolic (mmHg) \_\_\_\_\_  
                                      Diastolic (mmHg) \_\_\_\_\_

60) BP Reading 2            Systolic (mmHg) \_\_\_\_\_  
                                      Diastolic (mmHg) \_\_\_\_\_

61) BP Reading 3            Systolic (mmHg) \_\_\_\_\_  
                                      Diastolic (mmHg) \_\_\_\_\_

62) Hip circumference in Centimeters (cm) \_\_\_\_\_.

63) BMI \_\_\_\_\_.

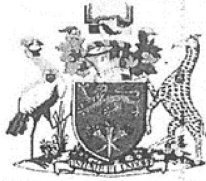
64) Time of day blood specimen taken (24 hour clock) Hours : minutes \_\_\_\_\_: \_\_\_\_\_

65) HbA1c blood results in % \_\_\_\_\_.

66) Hip waist ratio \_\_\_\_\_.

\*END\*

### Appendix 3: Ethical Review Committee Authorization Letter



UNIVERSITY OF NAIROBI  
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Ref: KNH-ERC/A/378      Link: [www.uonbi.ac.ke/activities/KNHUoN](http://www.uonbi.ac.ke/activities/KNHUoN)      26<sup>th</sup> November 2013

Dr. Nkatha Meme  
TM-312-0856-2012  
JKUAT

Dear Dr. Meme

**RESEARCH PROPOSAL: PREVALENCE AND FACTORS ASSOCIATED WITH UNDETECTED/UNDIAGNOSED DIABETES AMONG HYPERTENSIVE PATIENTS SEEKING CARE AT KIAMBU DISTRICT HOSPITAL, 2013 (P439/8/2013)**

This is to inform you that the KNH/UoN-Ethics & Research Committee (KNH/UoN-ERC) has reviewed and **approved** your above proposal. The approval periods are 26<sup>th</sup> November 2013 to 25<sup>th</sup> November 2014.

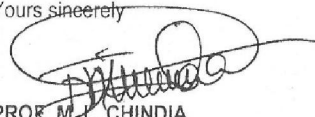
This approval is subject to compliance with the following requirements:

- a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
- b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH/UoN ERC before implementation.
- c) Death and life threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH/UoN ERC within 72 hours of notification.
- d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
- e) 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*).
- f) Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
- g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

For more details consult the KNH/UoN ERC website [www.uonbi.ac.ke/activities/KNHUoN](http://www.uonbi.ac.ke/activities/KNHUoN).

*"Protect to Discover"*

Yours sincerely



**PROF. M. L. CHINDIA**  
**SECRETARY, KNH/UON-ERC**

c.c. Prof. A.N.Guantai, Chairperson, KNH/UoN-ERC  
The Deputy Director CS, KNH  
The Principal, College of Health Sciences, UoN  
AD/Health Information, KNH  
Supervisors: Prof. Zipporah Ng'ang'a, Dr. Samuel Amwayi

*"Protect to Discover"*

## Research

### Prevalence of undiagnosed diabetes and pre-diabetes among hypertensive patients attending Kiambu district Hospital, Kenya: a cross-sectional study

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Key words: Diabetes, pre-diabetes, glycated haemoglobin, hypertensive patients

Received: 01/07/2015 - Accepted: 20/10/2015 - Published: 24/11/2015

#### Abstract

**Introduction:** Hypertension (HTN) and diabetes mellitus (DM) are two common non-communicable diseases (NCDs) that are closely linked: one cannot be properly managed without attention to the other. The aim of this study was to determine the prevalence of undiagnosed diabetic and pre-diabetic states that is abnormal glucose regulation (AGR) and factors associated with it among hypertensive patients in Kiambu Hospital, Kenya. **Methods:** We conducted a cross-sectional study from February 2014 to April 2014. Hypertensive patients aged  $\geq 18$  attending the out-patient medical clinic were included in the study. Pregnant and known diabetic patients were excluded. Data was collected on socio-demographics, behavior, and anthropometrics. Diabetes status was based on a Glycated Haemoglobin (HbA1C) classification of  $\geq 6.5\%$  for diabetes, 6.0-6.4% for pre-diabetes and  $\leq 6.0\%$  for normal. AGR was the dependable variable and included two diabetic categories; diabetes and pre-diabetes. **Results:** We enrolled 334 patients into the study: the mean age was 59 years (Standard deviation= 14.3). Of these patients 254 (76%) were women. Thirty two percent (107/334; 32%) were found to have AGR, with 14% (46) having un-diagnosed DM and 18%(61) with pre-diabetes. Factors associated with AGR were age  $\geq 45$  (OR = 3.23; 95% CI 1.37  $\geq$  7.62), basal metabolic index (BMI)  $\geq 25$  Kg/m<sup>2</sup> (OR= 3.13; 95% CI 1.53 - 6.41), low formal education (primary/none)(OR= 2; 95%CI 1.08 - 3.56) and family history of DM (OR=2.19; 95%CI 1.16 - 4.15). **Conclusion:** There was a high prevalence of undiagnosed AGR among hypertensive patients. This highlights the need to regularly screen for AGR among hypertensive patients as recommended by WHO.

Pan African Medical Journal. 2015; 22:286 doi:10.11604/pamj.2015.22.286.7395

This article is available online at: <http://www.panafrican-med-journal.com/content/article/22/286/full/>

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