*IOSR Journal Of Humanities And Social Science (IOSR-JHSS)*
*Volume 28, Issue 2, Series 2 (February, 2023) 06-21*
*e-ISSN: 2279-0837, p-ISSN: 2279-0845.*
*www.iosrjournals.org*

# Prevalence and Risk Factors of Undiagnosed Diabetes among Hypertensive Patients Attending St. Orsola Catholic Mission Hospital, Tharaka Nithi County, Kenya

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**ABSTRACT**
**Background**: 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 and risk factors of undiagnosed diabetic states that is abnormal glucose regulation(AGR) and factors associated with it among hypertensive patients in St. Orsola Hospital, Kenya.
**Methodology**: Across-sectional study was conducted from June to August 2022 with 384 hypertensive patients attending the out-patient medical clinic. Pregnant and known diabetic patients were excluded. Data was collected on socio-demographics, behavior, and diabetes status was confirmed based on glycated haemoglobin (HbA1c) classification of ≥ 6.5% for diabetes, 6.0-6.4% for pre-diabetes and ≤ 6.0% for normal. The data was analyzed using SPSS version 20.0 and looking at statistical significant at p value less than 0.05.
**Results**: The age ranged between 20-89 years, with majority being below 50 years. Of these participants 254 (76%) were women while 130 (24%) were male. Seventy-five percent (288/384) of participants were found to be non-diabetic, with 21 (5%) having un-diagnosed DM and 75 (19.5%) being pre-diabetes. Factors associated with undiagnosed diabetic were age ($\chi^2$ = 32.958, p = .01), body mass index (BMI) ≥ 25 Kg/M$^2$ ($\chi^2$ = 45.838, p = .000), ethical group ($\chi^2$ = 35.590, p = .000) and marital status ($\chi^2$ = 15.096,p = .020).
**Conclusion:** In conclusion this study found a high prevalence of undiagnosed diabetic among hypertensive patients in the clinical setting, highlighting missed opportunities for diagnosis. Risk factors for AGR were; age, BMI >25 kg/m$^2$, ethical group and marital status. Targeted screening for DM in patients with such a risk profile would lead to early diagnosis and management.

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Date of Submission: 18-01-2023 Date of Acceptance: 05-02-2023

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## I. Background

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$^{th}$ 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 affectedif 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 andphysical inactivity are themain 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). This 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

withoutattention to the other (WHO, 2010b). Patients presenting with hypertension should have acardiovascular 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 toidentify 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 characterizedby a fasting plasma glucose (FPG) level of 6.1- 6.9mmol/l and/or from an Oral Glucose ToleranceTest (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 undiagnosedpre-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 $\geq 6.5\%$ ($\geq$ 48mmol/mol) is appropriate for diagnosis of diabetes mellitus in individuals. Various studies have been in agreement with thiscut-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 isdiabetes 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 publicawareness and earlydetection 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.

**STATEMENT OF 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 whenthey 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 diabeteswas 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 theprevious 3 years. Among them, 10.7% had pre- diabetes and 19.6% had undiagnosed diabetes (Kidney *et al.*, 2014) Therefore, due to increased evidence of prevalence of diabetic in hypertension persons and overwhelming burden of coexistence of these diseases then, interventions need to be put in place to control the morbidity and mortality of these conditions.

**STUDY JUSTIFICATION**

Data concerning prevalence of diabetes in hypertension patients is of importance in planning a well-coordinated management of these patients. Early detection of diabetes in patients with hypertension will help in

the design and implementation of appropriate interventions to arrest the progression of diabetes among patients with hypertension and also reduce morbidity and mortality from cardiovascular disease. It's important also to identify associated risk factors especially the ones which are easily identified in our local health delivery system, and more so those that are modifiable.

Despite Kenya being undergoing an epidemiological transition such as population growth, urbanization and adoption of unhealthy lifestyles, there is limited documented data on the prevalence of undiagnosed diabetes among the hypertensive patients in clinical setup in Kenya. This study sought to establish the prevalence of diabetes among the hypertension patients that are in contact with a healthcare system and if they miss the opportunity for diagnosis of their diabetic status

**MAIN OBJECTIVE**

To determine the prevalence and factors associated with undiagnosed diabetes among hypertensive patients attending St. Orsola hospital.

**SPECIFIC OBJECTIVES**

i) To determine the prevalence of undiagnosed diabetes among hypertensive patients attending St. Orsola hospital.
ii) To establish the socio-demographic characteristic of hypertensive patients with undiagnosed diabetes attending St. Orsola hospital.
iii) To establish the behavioral characteristic of hypertensive patients with undiagnosed diabetes attending St. Orsola hospital.

**RESEARCH QUESTION**

i) What is the prevalence of undiagnosed diabetes among hypertensive patients attending St. Orsola hospital?
ii) What are the socio-demographic characteristics of hypertensive patients with undiagnosed diabetes attending St. Orsola hospital?
iii) What are the behavioral characteristics of hypertensive patients with undiagnosed diabetes attending St. Orsola hospital?

**RESEARCH HYPOTHESIS**

i) There is no prevalence of undiagnosed diabetes among hypertensivepatients attending St. Orsola hospital.
ii) There are no socio-demographic characteristics of hypertensive patients with undiagnosed diabetes attending St. Orsola hospital.
iii) There are no behavioral characteristics of hypertensive patients with undiagnosed diabetes attending St. Orsola hospital.

## II. LITERATURE REVIEW

**Introduction**

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 IIdiabetes was almost 2.5 times as likely in persons with hypertensionthan in their normotensive counterparts (Gress *et al*., 2000).

**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 millimeters 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.

**Epidemiology of hypertension**

Hypertension has been identified as the leading risk factor for premature death and cardiovasculardisease 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, adoptionof 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 behaviouralrisk factors for hypertension: tobacco use, physical inactivity, harmful use of alcohol and unhealthydiet (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 neededwhen complications developdue to missed diagnosis or lack of prompt treatment (Hendriks *et al*.,2012;WHO, 2013).

**Diagnosis of hypertension**

Hypertension also known as "the silent killer" is a dangerous disease as a person does not presentwith 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, bloodpressure measuring devices need to be validated, maintained and regularly calibrated to ensure thatthey 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 anddiagnosis of hypertension in various countries (Almas *et al*., 2012; Chobanian *et al*., 2003; Ong *etal*., 2007).

**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 factorsthat 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 ofhypertension (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).

**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 anindividualized 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).

**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).

**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 behavioral risk factors are more effective. Developed countries have implemented strong health strategies such aspolicies for reduction of salt in food commodities, integration of NCD surveillance at the primaryhealth 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).

**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 morethan 85% of the cases (WHO, 2006). Other forms are less common such as Type 1 (10% of cases) and gestational diabetes (5% of cases).

**Causes of diabetes mellitus**

The risk factors that affect the onset of diabetes are classified into modifiable and non – modifiablefactors. 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).

**Smoking**

Smoking is one of the modifiable risk factors for many chronic conditions, such as cardiovascular disease (CVD), cancer, chronic obstructive lung disease, asthma and diabetes. Smoking cessation is one of the few interventions that can safely and cost-effectively be recommended for individuals with diabetes. In the guidelines from the American Diabetes Association, smoking cessation is recommended as one of the most important steps in preventing the complications of diabetes. Many studies have shown that the adverse effects of smoking on diabetes mellitus are not only related to macrovascular complications but also microvascular disease (WHO, 2010b).

**Weight**

Being overweight or obese increases the risk of developing diabetes. Losing 5% to 10% of the body weight, in addition to getting regular physical activity can significantly reduce the risk of developing diabetes. The risk decreases even more as one loses more weight. For most people, a body mass index calculator will provide a good projection of diabetes (WHO, 2010b).

**Physical activity**

Physical inactivity is a key modifiable risk factor for prediabetes and Type 2 diabetes. Regular physical activity helps lower insulin resistance. This means that body can use its own insulin more effectively. Even a brisk 30- minute walk at least five days a week has been shown to significantly reduce the risk of diabetes and heart disease. For the overall cardiovascular health, aim for at least 150 minutes per week of moderate-intensity aerobic physical activity or 75 minutes per week of vigorous-intensity aerobic physical activity (or a combination of the two) and muscle-strengthening at least two days per week (WHO, 2010b).

**Diet**

It's important to eat healthy foods in the right amounts. Diet is one of the most important modifiable risk factors for prediabetes and Type 2 diabetes. The American Heart Association recommends an eating plan that includes fruits and vegetables, whole grains, skinless poultry, fish, legumes, non-tropical vegetable oils and unsalted nuts and seeds. A healthy diet should also replace saturated fats with monounsaturated and polyunsaturated fats, avoid trans fats, reduce cholesterol and sodium (salt) and limit red and processed meats, refined carbohydrates and sweetened beverages (WHO, 2010b).

**Alcohol**

Heavy use of alcohol can cause inflammation in the pancreas and limit its ability to produce enough insulin. Alcohol can cause liver damage and adds more sugar and starch to the diet that must either be used or stored as fat (WHO, 2010b).

**Association between diabetes, hypertension and factors**

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 healthcare (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- intensityphysical 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 ≥25 kg/m2 and ≥30 kg/m2 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 havedifferent 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.

**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 screeningas 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), fasting blood sugar (FBS) and glycated hemoglobin (HbA1c).

## III. METHODOLOGY

**STUDY AREA**

The study was conducted at St. Orsola hospital hypertensive outpatient clinic. The hospital is located in Tharaka south sub-county, serving an average population of 8000 patients per month and have a bed capacity of

216. The hospital holds specialized medical out-patient clinics. Patients enrolled into this out-patient clinic comprise of those with HTN (an average of 150 per month) 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, body mass index (BMI) calculations and diabetes testing. Any further diabetes tests e.g. HbA1c are requested by physician based on the patients RBS level (above 8mmol/l) at time of visit. This apply to all undiagnosed diabetes patient withHTN.

Therefore, the above taken measures by the facility HTN clinic facilitated the data collection during the patient visit, where all undiagnosed diabetes patient with HTN are screened for random blood sugar, and those

with higher level are sent for HbA1c test.

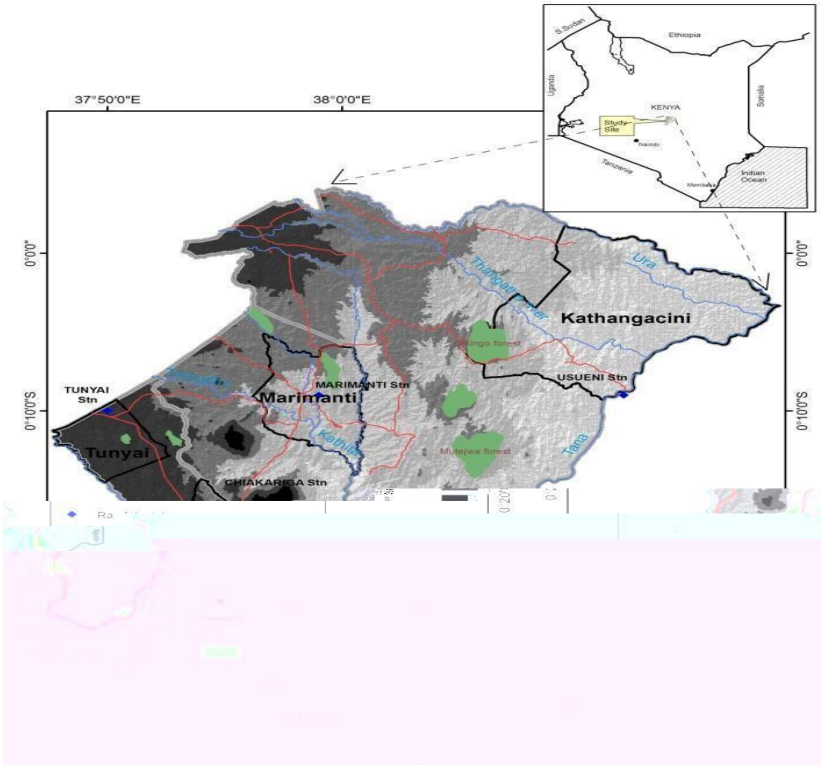


*Figure 3.1: A map of Kenya showing the study area of patients attending St. OrsolaHospital*

**STUDY DESIGN AND SAMPLING**

This was a facility based cross sectional study involving 384 hypertensive patients. The study population was sampled through consecutive random sampling (every patient was sampled)

**STUDY POPULATION**

The target population was patients suffering from hypertension.

**STUDY VARIABLE**

**i) DEPEDENT VARIABLE**

Diabetes

**ii) INDEPEDENT VARIABLE**

Age, sex, education, marital status, occupational, hypertension, smoke,BMI, Nutritional status.

**CASE DEFINITION**

Hypertension – average of two readings of systolic BP of >140 anddiastolic BP of >90 mmHg as recorded in the patient`s file.

**INCLUSION CRITERIA**

Patient who has been diagnosed as having hypertension by a health workerand/or is on prescribed antihypertensive medication.

**EXCLUSION CRITERIA**

i) Has been diagnosed as having Diabetes Mellitus by a health worker and/oris on prescribed anti-diabetic medication

ii) Expectant mothers due to gestation related diabetes and HTN which maydisappear after delivery.

**SAMPLE SIZE**

The sample size was determined by the following formula:$N = (z)^2 p (1- p) / d^2$

$$N = 1.96^2 \text{ x}0.5\ (1\text{-}0.5)/0.052$$

Where n = desired minimum sample size;

z = standard normal distribution value (1.96)

p = known prevalence rate for the factor of interest under study (50%)d = the level of desired precision (0.05).

Prevalence of 50% will be used as assumed prevalence of undiagnosed diabetics' state among hypertensive patients.
d = 0.05, z = 1.96, p = 0.85 1-p= 0.5 n =384.

**DATA COLLECTION**

**QUESTIONNAIRE-BASED ASSESSMENT**

The pre-coded questionnaire consisting 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 was issued to patients. 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 or not, where all patient with known diabetes, pregnant or under diabetes medication were excluded from the study.

**BIOCHEMICAL DATA COLLECTION**

The data was collected from the HTN clinic record book. The facility having a measure in place where all patient visiting HTN clinic have to be tested for Random blood sugar (RBS), BMI and blood pressure, the data was collected from the HTN clinic record book and entered in every patient questionnaire. The facility classify the abnormal glucose regulation (AGR) based on the revised WHO criteria of diabetic (HbA1c ≥ 6.5 %), pre- diabetic (HbA1c of 6.1 % - 6.4%) and non-diabetic (HbA1c < 6.1%) (WHO2011b).

**ANALYSIS OF DATA**

This was done using SPSS software version 20.0 by carrying out both descriptive and inferential statistical analysis. Bivariate analysis was performed to examine some of the factors related with contraction of diabetes while the Chi-square test of statistical significance was used to determine any association between diabetes, hypertension and various exposure variables. Risk factor with value $p<0.05$ was considered significantly having association with hypertension.

## IV. RESEARCH FINDINGS, ANALYSIS AND PRESENTATION

**Introduction**

The core objective of this study was to determine the prevalence and factors associated with undiagnosed diabetes among hypertensive patients attending St. Orsola Hospital, Kenya. The research applied cross-sectional survey design. A sample of 384 hypertensive patients was collected to participate in this study. However, patients below 18 years, pregnant women, and known diabetic patients were excluded from this research. The data was collected on hypertensive patients' social-demographics, behaviour, and diabetes status. Diabetes status was confirmed based on HbA1c classification of ≥ 6.5% for diabetes, 6.0-6.4% for pre-diabetes and ≤ 6.0% for normal.

**Prevalence of undiagnosed diabetes among hypertensive patients**

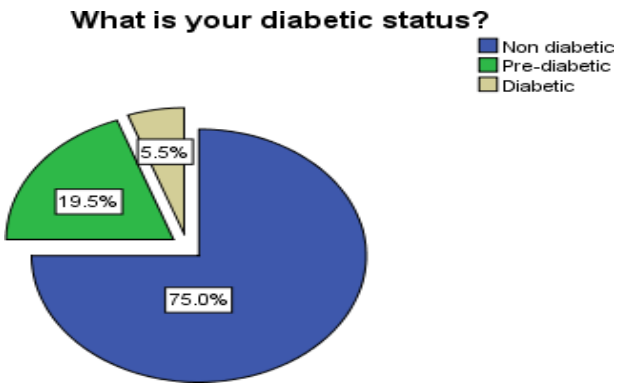

*Figure 4.2: Diabetes prevalence on undiagnosed diabetes among hypertensive patients attending St. Orsola Hospital*

Figure 1 shows that 5.5% (*n*=21) of undiagnosed diabetes hypertensive patients were diabetic, 19.5% (*n*=75) were Pre-diabetic and 75.0% (*n*=288) were non diabetic. From Table 1, 6.5% (*n*=25) of respondents had BMI less than 18 Kg/M$^2$, 39.8% (*n*=153) had BMI ranging between 18-24 Kg/M$^2$, and 53.6% (*n*=206) had BMI greater than 24 Kg/M$^2$.

Using bivariate correlation analysis, the study established that BMI had a positive moderate correlation with dependent variable 'Diabetes statuses' having *r*= .312. On the other hand, using Chi-square, it was established that participants BMI had a significant association with dependent variable 'Diabetes statuses' having a *p*=.000which is less than designated alpha level of .05.

*Table 4.1: BMI for undiagnosed diabetes among hypertensive patients attending St.Orsola Hospital*

**What is your BMI?**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| **Valid** | <18 | 25 | 6.5 | 6.5 | 6.5 |
| | 18-24 | 153 | 39.8 | 39.8 | 46.4 |
| | >24 | 206 | 53.6 | 53.6 | 100.0 |
| | Total | 384 | 100.0 | 100.0 | |

**Socio-Demographic Data**

According to the findings in Table 2, 33.9% (*n*=130) of the respondents were Male and 66.1% (*n*=254) were female. The age ranged between twenty years and eighty- nine years, with majority being below fifty 73.4% (*n*=282). On education, 8.6% (*n*=33) had no formal education, 3.1% (*n*=12) had less than primary education, 15.9% (*n*=61) had primary education, 41.1% (*n*=158) had secondary education, 23.7% (*n*=91) were up to college, and 7.6% (*n*=29) had post graduate as their highest education level. On ethnicity, 21.9% (*n*=84) were Kikuyu, 23.4% (*n*=90) were Embu, 33.1% (*n*=127) were Meru while the other communities comprised 21.6% (*n*=83) of the total participants. 62.5% (*n*=240) of the sampled were married, 6.8% (*n*=26) were divorced, 28.1% (*n*=108) were single, and 2.6% (*n*=10) were polygamous. On respondent's main work, 41.4% (*n*=159) were employed, 6.5% (*n*=25) were housewives, 6.5% (*n*=25) were retired, 36.5% (*n*=140) were unemployed, and 9.1% (*n*=35) were students.

*Table 4.2: Socio-Demographic Data for undiagnosed diabetes among hypertensivepatients attending St. Orsola Hospital*

| **Variables** | **n=384** | **Percentage** | **Pearson's r** | ***P* -value** |
|---|---|---|---|---|
| **Sex** | | | | |
| Male | 130 | 33.9 | -.072 | .367 |
| Female | 254 | 66.1 | | |
| **Age** | | | | |
| 20 - 29 | 85 | 22.1 | | |
| 30 - 39 | 112 | 29.2 | | |
| 40 - 49 | 85 | 22.1 | | |
| 50 - 59 | 36 | 9.4 | .107 | .001 |
| 60 - 69 | 42 | 10.9 | | |

| | | | | |
|---|---|---|---|---|
| 70 - 79 | 16 | 4.2 | | |
| 80 - 89 | 8 | 2.1 | | |
| **Highest education level** | | | | |
| No formal schooling | 33 | 8.6 | | |
| Less than primary | 12 | 3.1 | | |
| Primary school | 61 | 15.9 | .006 | .221 |
| Secondary school | 158 | 41.1 | | |
| college | 91 | 23.7 | | |
| Post graduate | 29 | 7.6 | | |
| **Ethnic group** | | | | |
| Kikuyu | 84 | 21.9 | | |
| Embu | 90 | 23.4 | .171 | .000 |
| Meru | 127 | 33.1 | | |
| Others | 83 | 21.6 | | |
| **Marital status** | | | | |
| Married | 240 | 62.5 | | |
| Divorced | 26 | 6.8 | -.147 | .020 |
| Single | 108 | 28.1 | | |
| Polygamous | 10 | 2.6 | | |
| **Main work** | | | | |
| Employed | 159 | 41.4 | | |
| Housewife | 25 | 6.5 | | |
| Retired | 25 | 6.5 | -.125 | .099 |
| Unemployed | 140 | 36.5 | | |
| Student | 35 | 9.1 | | |

Bivariate analysis was performed to compare whether there was correlation between explanatory variables ('Sex', 'age', 'education level', 'ethnic group', 'marital statuses and 'main work') and response variable 'Diabetic status'. It was established that independent variables 'Sex', 'Marital status', and 'Main work' had a very week negative correlation with dependent variable 'Diabetic status' with $r$= -.072, $r$= -.147, and $r$=-.125 respectively. On the other hand, variables 'Age', and Ethnic group' had a very week positive linear correlation with $r$=.107 and $r$=.171 respectively. 'Highest education level' had no correlation with 'diabetic status' with$r$=.006.

Using chi-square, the study went further to investigate whether there was significant association between socio-demographic characteristics of hypertensive patients with undiagnosed diabetes with observed variable 'Diabetic status'. The research established that variables 'Age', 'Ethnic group' and 'Marital status' had a significant association with 'Diabetic status' having: $p$= .001, $p$=.000, and $p$=.020 respectively which are less than designated alpha level of .05. In this regard we reject the null hypothesis that 'There are no socio-demographic characteristics of hypertensive patients with undiagnosed diabetes attending St. Orsola Hospital associated with their diabetic statuses. On the other hand, variables 'Sex', 'Highest education level', and 'Main work' did not have a significant association with observed variable having; $p$= .367, $p$=.221, and $p$=.099 respectively; which is greater than designatedalpha level of .05.

**4.4 Behavioral Characteristics**

Table 3 shows that 19.5% ($n$=75) of undiagnosed diabetes among hypertensive patients attending St. Orsola Hospital were smokers. At the same time, 35.9% ($n$=138) of the respondents were consuming alcohol. On fruit consumption, the study established that majority of respondents 49.5% ($n$=190) take fruits twice a week, 3.1% ($n$=12) takes fruits on daily basis and 1.0% ($n$=4) do not take fruits.

The study also made it well-known that majority of participants takes vegetable once or twice in a week 71.8% ($n$=237), 0.5% ($n$=2) do not take vegetables at all, and only 2.3% ($n$=9) takes vegetables on each and every day of the week. Further, the study established that respondents' choice of fat varied from one to the other with 70.1% ($n$= 269) indicating that they use 'Liquid', 26.0% ($n$= 100) use 'Solid', and 3.9% ($n$= 15) use 'Margarine' fat.

*Table 4.3: Behavioural Characteristics for undiagnosed diabetes among hypertensive patients attending St. Orsola Hospital*

| **Variables** | **n=384** | **Percentage (%)** | **Pearson's r** | ***P* -value** |
|---|---|---|---|---|
| **Do you currently smoke?** | | | | |
| Yes | 75 | 19.5 | -.002 | .217 |
| No | 309 | 80.5 | | |
| **Do you consume alcohol?** | | | | |
| Yes | 138 | 35.9 | -.047 | .268 |
| No | 246 | 64.1 | | |
| **How many days do you eat fruits perweek?** | | | | |
| 0 | 4 | 1.0 | .082 | .014 |
| 1 | 51 | 13.3 | | |
| 2 | 190 | 49.5 | | |
| 3 | 89 | 23.2 | | |
| 4 | 25 | 6.5 | | |
| 5 | 10 | 2.6 | | |
| 6 | 3 | 0.8 | | |

| | | | | |
|---|---|---|---|---|
| 7 | 12 | 3.1 | | |
| **How many days do you eat vegetableper week?** | | | | |
| 0 | 2 | 0.5 | | |
| 1 | 102 | 26.6 | | |
| 2 | 135 | 35.2 | | |
| 3 | 74 | 19.3 | | |
| 4 | 40 | 10.4 | .096 | .635 |
| 5 | 19 | 4.9 | | |
| 6 | 3 | 0.8 | | |
| 7 | 9 | 2.3 | | |
| **What type of fat do you use?** | | | | |
| Liquid | 269 | 70.1 | | |
| Solid | 100 | 26.0 | .053 | .178 |
| Margarine | 15 | 3.9 | | |

Bivariate analysis was performed to investigate whether there was correlation between independent variables 'smoking', 'taking alcohol', 'fruits intake', 'vegetable intake', and 'type of fat used' against dependent variable 'Diabetic status'. The research established that independent variables 'taking alcohol', 'fruits intake', 'vegetable intake', and 'type of fat used' had very week linear correlation
against 'Diabetic status' with $r$= -.047, $r$= .082, $r$=.096, and $r$=.053 respectively. However, smoking habit had no correlation with 'diabetic status' with $r$= -.002.

Chi-square was used to investigate whether behavioural characteristics of undiagnosed diabetes among hypertensive patients attending St. Orsola Hospital hada significant association with dependent variable 'Diabetic statuses. It was evident that number of days the respondents ate fruits had a significant association with diabetic status of undiagnosed diabetes among hypertensive patients with $p$=.014. In this regard we reject the null hypothesis that 'There are no behavioural characteristics of hypertensive patients with undiagnosed diabetes attending St. Orsola hospital associated with their diabetic statuses'. Conversely, from Table 3, independent variables 'smoking', 'taking alcohol', 'vegetable intake', and 'type of fat used' had $p$- values greater than designated alpha level of .05, hence they did nothave a significant relationship with patients' Diabetic statuses.

## V. DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

**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. A quarter (25%) of the study participants had AGR (diabetes and pre-diabetes). The 5.5% were newly diagnosed with DM, while 19.5% were pre-diabetic.

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.

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

In the study, majority (65%) 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 (41.1%) had secondary education while non formal education has 8.6% participant, among whom 38% were diabetic and 31% were pre-diabetic. University level of education had the least of those with undiagnosed diabetic. 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 diabeticpatients 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 80.5% did not smoke tobacco and 64.1% 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 66% 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).

Fifty-three percent (53.6%) of the participants were classified as obese according to their BMI. Among them 60% were undiagnosed diabetic and 36% 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 ((KSTEPSMinistry of Health, 2015; WHO, 2014). 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 (≥ 25 kg/m2) should be given appropriate education and counseling on how to reduce their BMI.

**Factors associated with undiagnosed abnormal glucose regulation amongparticipants**

The study findings show that abnormal glucose regulation (AGR) is significantly associated with age over 45 years and BMI above 25kg/m2 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 not associated with DM in this study. This was a contrary to European countries where 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.

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 80.5% did not currently smoke tobacco and 64.1% 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 66% 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.

**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, BMI ≥ 25kg/m2, marital status and ethnic group
Patients with control of BP <140/90 mmHg had a reduced odds ofdeveloping 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 advicefrom a healthcare worker on diabetes prevention.

**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, BMI ≥ 25 kg/m$^2$, marital status and ethnic group 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 mmHg among hypertensive patients as good control of BP reducesthe 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 follow-up should be given health education at the facility level to increase their knowledge on diabetes risk factors.

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Gerrald Njeruh. "Prevalence and Risk Factors of Undiagnosed Diabetes among Hypertensive Patients Attending St. Orsola Catholic Mission Hospital, Tharaka Nithi County, Kenya." *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, 28(2), 2023, pp. 06-21.