INSTITUTE OF TROPICAL INFECTIOUS DISEASES

UNIVERSITY OF NAIROBI

TO DETERMINE THE SIGNIFICANT RISK FACTORS OF HYPERTENSION AMONG TYPE 2 DIABETES PATIENTS: A CASE STUDY OF KENYATTA NATIONAL HOSPITAL

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A Research Project report submitted in partial fulfilment for the Masters of Science in Medical Statistics

DECLARATION

I……. do hereby declare that this project has not been presented before to any institution for the purpose of obtaining any award.

Signed……..

Date…….……

APPROVAL

This project has been submitted as a part fulfillment for the Masters of Science in Medical Statistics (Msc. MedStat) of the University of Nairobi with the approval of:

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ABBREVIATIONS

ACEIs	Angiotensin Converting Enzyme Inhibitors
ADVANCE	Action in Diabetes and Vascular Disease: Preterax and Diamicron MR Controlled Evaluation
BMI	Body Mass Index
BP	Blood pressure
CHD	Coronary Heart Disease
CKD	Chronic Kidney Disease
IDF	International Diabetes Federation
DM	Diabetes
GLM	Generalized linear models
HDL	High Density Lipoprotein
HTN	Hypertension
KNH	Kenyatta National Hospital
LDL	Low density lipoprotein
LUTS	lower urinary tract symptoms
NCDs	Non-communicaable diseases
NSAIDs	Non-steroidal Anti-inflammatory Drugs
OHAs	Oral hypoglycemic agents

OR	Odds ratio
PCI	Percutaneous Coronary Intervention
UKPDS	United Kingdom Prospective Diabetes Study
UTI	Urinary Tract Infections
WHO	World Health Organization

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ABSTRACT

Hypertension among type 2 Diabetes patients has grown and it is a public problem in Kenya, Africa and worldwide. My study was done to explore the risk factors associated with Hypertension among Type 2 Diabetes patients at Kenyatta National Hospital Diabetes Outpatient Clinics.

A hospital based cross-sectional survey was conducted among type 2diabetes patients over a six-month period . A total of 200 patients were recruited based on inclusion criteria. The associations between binary outcome variable and demographic and clinical explanatory variables was done by use of binary logistic regression analysis. Among risk factors consider are age, gender, marital status, obesity, blood pressure, lower urinary tract infections , highest education level and smoking status.

Both univariate and multivariate logistic regression analyses revealed that age had a significant positive influence on hypertension status(p-value <0.01). A type 2 diabetes patient is 7% more likely to develop hypertension for every additional year in age after adjusting for all other risk factors.

1.0 INTRODUCTION

1.1 Background

Non-communicable diseases (NCDs) kill 38 million people each year. Seventy five percent of these deaths, approximately 28 million deaths, occur in countries designated as low- and middle-income countries. NCDs are caused primarily by chronic respiratory diseases, diabetes (DM), cancer, and cardiovascular diseases,(1). Eighty two percent of deaths due to NCDs are caused primarily by these four diseases. In Africa, NCDs are rising rapidly and are expected to surpass communicable, perinatal and maternal diseases as the most common cause of death by the year 20130.(1). The leading cause of diabetes seen worldwide is Type 2 diabetes(2).By definition, diabetes is characterized as a metabolic disease with hyperglycemia occurring due to defects in insulin secretion, insulin action or both(3)

The term cardiovascular disease as a diagnostic category consisting of the following four major diseases: coronary heart disease (CHD), cerebrovascular disease, peripheral artery disease, and aortic atherosclerosis/thoracic or abdominal aortic aneurysm. CHD accounts for upto one-half of the total cases of cardiovascular disease worldwide (4).

The INTERHEART study of patients done from 52 countries, 9(nine) modifiable actors accounted for over 90 per cent of the population-attributable risk of a first myocardial infarction: dyslipidemia, psychosocial factors, smoking, hypertension, regular alcohol consumption, abdominal obesity, diabetes, daily consumption of fruits, vegetables, and regular physical activity (5).

Hypertension occurs twice as frequently type 2 DM patients as compared to normal people. (6). Macro and microvascular disease of DM accelerate presence of HTN (7). Early detection and treatment of HTN and DM has been recommended. (8).

The prevalence of diabetes in Kenya is estimated to be 4.2% (9).

In a recent study conducted in Nairobi, the estimates of Hypertension in an urban setting were found to be 22.8%(10).

The diabetes epidemic has increased worldwide due to a rise in obesity as a result of rapid urbanization, nutrition transition and increasing sedentary lifestyles(11). The greatest percentage increase in the prevalence of diabetes will occur within developing nations (12). According to a report by the International Diabetes Federation (IDF), 366 million people worldwide have diabetes and this number is expected to grow to552 million by the year 2030 (13). The vast majority of diabetic population live in the least developed and developing countries with the largest proportion being between the ages of 40 – 59 years. It has been estimated that 11% of total healthcare expenditure in adults is related to management of diabetes(14). The management of the complications of diabetes is putting a strain on the health budgets of resource-poor countries.For example a recent estimate in Tanzania showed that treatment of diabetes complications represented 31% of total outpatient costs in the main hospital in Dar es Salaam; with a yearly cost of $138 per person. This was 19 times more than the average outpatient costs perperson(15).

1.2 Statement of Problem

Itis known that there is coexistence between diabetes and hypertension. The frequency of hypertension in patients with diabetes is twice as much, compared to non-diabetic individuals (18). Therefore due to increased evidence of prevalence of hypertension in diabetic persons and overwhelming burden of coexistence of these diseases then if interventions are put in place as regards modifiable risk factors like BMI, literacy level, smoking status, blood pressure control, glycaemic control,the morbidity and mortality of this conditions can be alleviated.

1.3 Study Justification

Data concerning hypertension prevalence in type 2 diabetes patients is of importance in planning a well-coordinated management of these patients.

Early detection of hypertension in patients with type 2 diabetes will help in the design and implementation of appropriate interventions to arrest the progression of hypertension among patients with type 2 DM 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.

Public health interventions can be put in place to try to ameliorate the effect of these modifiable risk factors.

Internal audit of an aspect of a disease at repeated intervals will help in detecting emerging trends.

1.4Objectives of The Study

Broad objectives

To identify the significant risk factors associated with hypertension among type 2 diabetes patients.

Specific objectives

(i) To test if there is association between hypertension status and each of risk factors to be considered.

(ii) To fit a multiple logistic model to determine which of the risk factors are statistically significant.

1.5 Research Hypothesis

The following hypotheses were created in order to aid achieve the above objectives: H_0 – there is no statistical association between having hypertension among type 2 diabetes and factors like age, gender, lower urinary tract infections, education, marital, and smoking status, blood sugar, BMI, systolic BP and diastolic BP versus

H_1 - there is statistical association between having hypertension among type 2 diabetes and factors like age, gender, lower urinary tract infections, education, marital, and smoking status, blood sugar, BMI, systolic BP and diastolic BP. To test those hypotheses the chi- square test of independence and logistic regression model were used.

2.0 LITERATURE REVIEW

2.1 Introduction

Hypertension and diabetes frequently coexist(16). The frequency of hypertension in diabetic population is almost twice that of the non-diabetic general population (17). There is considerable evidence for an increased prevalence of hypertension in diabetic persons (18).

Hypertension in patients with diabetes is a recognized cardiovascular risk factor. HTN prevalence type 2 diabetes patients is between 1.5 and 2.3 times greater than for those with no diabetes (19).

The state of the coexistence of diabetes and HTN are greater than those caused by each condition independently. Between 70% and 80% of people with DM die due to cardiovascular complications, and 75% can be attributed to HTN (20).

Joint National Committe(JNC 7) 7th report suggested the following definitions for hypertension where properly measured(21):

Normal BP: systolic BP less than 120 mmHg and diastolic BP less than 80 mmHg

Pre hypertension: systolic BP between 120-139 mmHg or diastolic BP 80-89 mmHg

Hypertension:

Stage 1: systolic BP 140-159mmHg or diastolic BP 90-99 mmHg

Stage 2: systolic BP greater than or equal to 160 mmHg

Or Diastolic BP greater than or equal to 100 mmHg

The systolic pressure is the greatest predictor of risk in patients over the age of 50-60 years(22).

Factors associated with the pathogenesis of hypertension in diabetes include nephropathy, hyperinsulinemia, extracellular fluid volume expansion, and increased arterial stiffness.

Hyperinsulinemia may incease systemic BP. This effect may be mediated by concurrent weight gain and by the prohypertensive effect of insulin(23). Also insulin can increase sympathetic activity and promote renal sodium retention(24).

DM patients have increased stiffness in their vascular, and this is thought to be due to consequence of high protein glycation atheromatous disease in later stages. This can contribute to the increased systolic BP and risk of death (25).

2.2 Pathogenesis of cardiovascular disease

Atherosclerosis is the underlying disease process that affects medium-sized and large arteries in the peripheral circulation (26).

The pathogenesis of atherosclerosis is dependent on an overlap between dyslipidemia, inflammatory and immunological dysregulation, endothelial dysfunction, smoking and plaque disintegration. Many of the traditional risk factors of cardiovascular disease such as hypercholesterolemia, diabetes, hypertension, cigarette smoking, result in endothelial dysfunction. It can be improved by correction of dyslipidemia by dietary means or therapy with a statin and angiotensin converting enzyme inhibitors(ACEIs)(27).

The development of atherosclerosis is strongly associated with lipid anomalies (dyslipidemia). High levels LDL cholesterol and low levels HDL cholesterol are associated with high risk of atherosclerosis (28).

Development of atherosclerosis can be caused by hypertension, especially cerebral vascular beds and bed of coronary arteries (29)

Diabetes is the other major CVD risk factor due to the atherogenic effects of diabetes related dyslipidemia i.e. elevated triglycerides, low level of HDL-C, and small/dense LDL particles. In addition many clinical and experimental studies reveal that high levels of insulin precede development of arterial diseases(30).

2.3 Benefits of Treatment of Hypertension In Diabetes

Early treatment of hypertension is important in diabetes patients to prevent cardiovascular disease and minimize progression of renal disease. Among patients with type 2 diabetes, the benefits of tight blood pressure control may be as great or greater than the benefit of strict glycemic control(31). Since hypertension places diabetes patients at a high risk for cardiovascular complications, all diabetes patients with persistent blood pressures above 140/90 mmHg should be started on anti-hypertensive drug therapy. In the UKPDS trial, type 2 diabetes treated to lower targets of blood pressure had a 24% reduction in diabetes related end-points (32). The ADVANCE trial demonstrated that lowering blood pressure targets was associated with reduced events of cardiovascular disease in type 2 diabetes (33).

3. 0 METHODOLOGY

3.1 Introduction

Ideally the sampling should have included several level 5 hospitals in the country to strengthen the quality of the results. Kenyatta National Hospital was the only institution sampled for the study.

3.1.1 Study Site

Secondary data was used for this study. The data was collected during a previous study that was conducted at the Kenyatta National Hospital Diabetes Outpatient clinics.

Kenyatta National Hospital is situated in Nairobi, Kenya. It is the largest referral and teaching hospital in Kenya. Between Monday and Thursday, a total of between 20 to 40 patients are seen at the diabetes mini-clinic which is located in clinic number 17. This clinic is conducted by trained clinical officers, nurses, podiatrists and nutritionists. On Friday mornings there is a main diabetes clinic which is conducted by the Endocrinologists with the assistance of the residents in the department of clinical medicine and therapeutics. This clinic sees between 80 to120 patients on every clinic day.

3.1.2Study Design

The study was a hospital-based cross-sectional descriptive study.

3.1.3 Study Population

The target population was patients suffering from type 2 diabetes .

3.1.4 Case definition

1. Type 2 diabetes – file diagnosis of type 2 diabetes
2. Hypertension – average of two readings of systolic BP of >140 and diastolic BP of >90 mmHg

3.5 Inclusion and exclusion criteria

3.1.5.1 Inclusion Criteria

All patients diagnosed as type 2 diabetes patients who were ambulant.

An informed written consent from the patient was obtained for inclusion in the study

3.1.5.2 Exclusion criteria

Refusal of consent.

Patients known to have CKD or on follow-up in the renal clinic.

3.1.6 Sampling technique

Systematic random sampling was used to recruit patients who satisfied the inclusion criteria during the study period. After perusal of all the files at the beginning of the clinic, the principal investigator and his assistants would select those that satisfied the inclusion criteria. These files were allocated numbers such that every third patient was selected for inclusion in the study.

3.1.7 Sample Size

gggThe sample size was determined by the following formula:

$$n = \frac{z^2\, p\,(1-p)}{d^2}$$

Where *n* = desired minimum sample size;

z = standard normal distribution value (1.96)

p = known prevalence rate for the factor of interest under study

d = the level of desired precision (0.05).

Prevalence of 15% for diabetic nephropathy as was used as prevalence rate estimated as reported in the 1989 study by Ngugi P(33)

When this formula was applied at d = 0.05, z = 1.96, p = 0.85 1-p= 0.15

n = 196.

3.1.8 Study period

Patients were recruited over a six-month period between September 2013 and February 2014.

3.1.9 Screening and recruitment

The study was conducted at the diabetes mini- and outpatient clinic. The principal investigator and his assistants perused all the files at the beginning of the clinic and selected those diagnosed with type 2 diabetes and not on follow-up in the renal clinic. Systematic random sampling was used in selecting the cases for inclusion in the study. Patients identified were then called

individually to the consultation room for explanation of the study procedure. Signed informed consent was then sought from the patient.

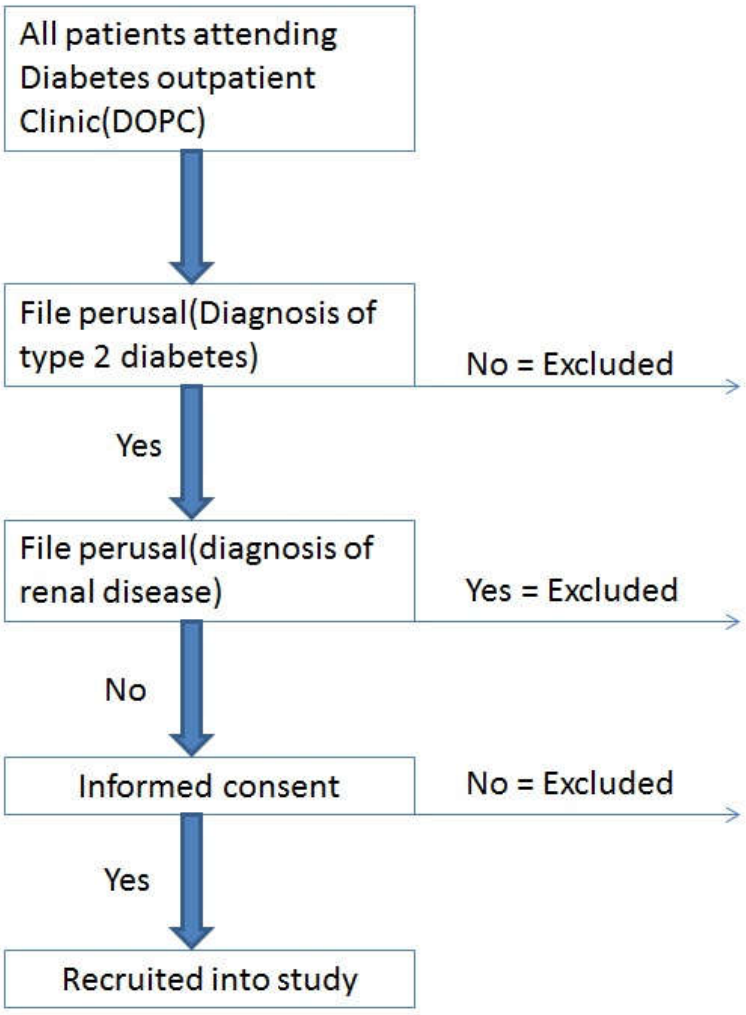

Figure 1: Flow chart of Screening and Recruitment

3.1.10 Ethical considerations

Permission to carry out the study had been granted by the Kenyatta National Hospital-University of Nairobi Scientific and Ethical Review Committee.

Patients were enrolled after prior explanation as to the nature of the study and tests to be carried out.

The patients were informed that the study is entirely voluntary in nature and no treatment was to be denied those who declined to enroll in the study.

Consent was duly witnessed and signed.

Patient usual care was not interrupted and where necessary it was facilitated.

Patient confidentiality was maintained at all times.

Data was entered into a password protected data base under the custody of the principal investigator.

Results obtained were made available in the patient records and appropriate interventions recommended where need arose.

3.2 Data Collection

Clinical Methods

A study proforma was used to obtain demographic data and a complete medical history.

Presence of lower urinary tract symptoms including frequency, nocturia, urgency, feeling of incomplete emptying, intermittency, straining, weak stream was recorded.

Blood pressure

The blood pressure was then measured with the patient having rested for 5 minutes.

It was measured in the supine position using a mercury sphygmomanometer with the standard adult cuff. Systolic blood pressure was recorded on appearance of the first sounds (Korotkoffs phase 1) while diastolic pressure corresponded to the disappearance of the sounds. Two readings were taken from the top of the meniscus and to the nearest 5mmHg. The blood pressure was then recorded as the mean of the 2 readings.

Weight

Measured with the patient in light clothing and wearing no shoes using a standard weighing machine in the clinic. Half a kilogram was recorded.

Height

Measured using a vertical scale and recorded to the nearest half a centimeter(cm).

Body Mass Index

The World Health Organization(WHO) formula was used to calculate the Body Mass Index(BMI).

Waist circumference

Waist circumference was assessed between the subcostal margin and iliac crest to the nearest centimeter.

Examination of the pulses

The peripheral pulses were then examined. This included the carotid arteries, femoral, popliteal, posterior tibial and dorsalis pedis. It was then recorded whether the pulses were felt or not. The carotid, renal and femoral arteries were then auscultated for the presence of bruits. Any anomaly detected was taken as evidence for the presence clinically of peripheral arterial disease.

3.3 Laboratory Methods

The patient provided 10mls of a midstream specimen of urine in a sterile bottle. Dipstick urinalysis was then carried out on the specimen. If urinalysis detected leucocytes and nitrites then these were considered as indices for infection and subsequently the albuminuria test would be invalidated. The patient suspected to have urinary tract infection(UTI) would be offered empiric treatment in addition to referral to the laboratory for culture of the urine specimen.

If the sample was acceptable, calculation of urinary albumin to creatinine ratio was done by Clinitek® Microalbumin Analyzer in the University of Nairobi Clinical Chemistry department.

2 mls of venous blood was drawn into an plain specimen bottle and taken to the clinical chemistry department for determination of creatinine levels using the Mindray® Clinical Chemistry Analyzer

3.4 Quality Control Measures

The recommended procedures for specimen collection were adhered to at all times, including proper phlebotomy site cleaning and the use of appropriate vacutainers. Proper labelling of the specimens and storage ensured minimal pre-analytical sources of errors. The Mindray® Clinical Chemistry Analyzer and ClinitekMicroalbumin Analyzer were calibrated according to manufacturer's recommendations. The University of Nairobi Department of Clinical Chemistry laboratory runs daily internal quality control on all tests before sample analysis to validate the results obtained.

3.5 Study Variables:

The variables considered in the study include:

Blood pressure

Age

Gender

Obesity

Level of education

BMI

Lower urinary tract symptoms (LUTS)

Smoking status

3.6 Categorical variables

These are variables that place an individual into categories and cannot be qualified in a meaningful way. Example would be like diseases like HTN, DM etc.

To analyse categorical data requires one to use a two way table.

3.7 Logistic regression models

3.7.1 Introduction

It is the mathematical equation used to determine if relationship exists between a binary categorical outcome and a set of predictor variables. Logistic regression combines a set of predictor variables to estimate the probability that a particular event will occur. It estimates the likelihood of a subject being a member of the category of interest. It also gives information on how much an increment in a given predictor variable affects the odds of the response variable. Logistic regression analysis is handy in its application to medical research because it can measure associations, predict outcomes, and control for confounding variable effects.

Logistic regression methods have become an integral component of any data analysis concerned with description of relationship between a response and explanatory variables

This model can handle more complicated situations and analyse the simultaneous effect of multiple variables, including combination of both categorical and continuous variables.

The difference between logistic and linear regression is described in the choice of parametric models and its assumptions. In all regression cases the key quantity is the mean value of the

outcome variable, given independent variables. This quantity is known as conditional mean (expressed as E(Y/x).

Where Y is outcome variable and x is independent variable.

3.7.2 Response and predictor variables

For logistic regression model, response is binary categorical variable, and the predictor variable can be either categorical are continuous. Predictor variables include exposure variables and potential confounders. Predictor variables are also called risk factors in medical research.

3.7.3 Odds ratio

It is a measure of the odds of an event happening in one group compared to the odds of the same event happening in another group. Example lets say A and B,the odds ratio is given by:

$$O.R = \frac{odds\ \ of\ \ event\ \ for\ \ group\ \ A}{odds\ \ of\ \ event\ \ for\ \ group\ \ B} \ or\ \ O.R = \frac{odds\ \ of\ \ event\ \ for\ \ group\ \ B}{odds\ \ of\ \ event\ \ for\ \ group\ \ A}$$

Odds ratio(O.R.):

$$O.R = \frac{\text{odds of event for exposed group}}{\text{odds of event for unexposed group}}$$

3.7.3.1 Interpreting the odds ratio

An odds ratio of less than one means that the event of interest is less likely to occur for those in group A compared to those in group B.

An odds ratio of more than one means that the event of interest is more likely to occur for those in group A compared to those in group B.

An odds ratio of one means that both groups had the same odds of the event of interest occurring.

3.7.4 Binary logistic regression

Binary logistic model can either be simple or multiple. Simple logistic model is used to explain association between one response variable and one predictor variable.

Simple model is of the form:

$$\ln\left(\frac{\text{p}}{\text{1-p}}\right) = \ln(\text{odds of event}) = \beta_0 + \beta_1 X$$

β_0 and β_1 are regression coefficients.

p = probability of event occuring

1 - p = probability of event not occurring

The multiple logistic regression model is used to explore associations between one response variable and more than one predictor variable simultaneously.

The model is of the form:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k$$

3.7.5 Interpretation of regression coefficients

Regression coefficients represent the mean change in the response variable for one unit of change in the predictor variable while holding other predictors in that model constant. The statistical control that is provided by the regression is important because it isolates the role of one variable from all the other from the model. Sometimes the key variable of understanding the coefficients is to think of them as slope coefficients.

When doing interprtation or more than one coefficient in regression equation, we us appropriate methods for multiple inference, rather than using just the individual confidence intervals. One technique for multiple inferences in regression is using confidence regions.

4.0 DATA MANAGEMENT AND STATISTICAL ANALYSIS

The data used for this study was entered into MS access computer data base. The data was cleaned and verified. Statistical analysis was done using STATA version 12. Descriptive statistics was presented using percentages and frequencies for categorical or nominal data while mean, standard deviation, median, minimum and maximum for continuous/discrete variables. Logistic regression analysis was carried out to determine if hypertension can be predicted based on age, gender, BMI, smoking status, marital status, blood sugar, diastolic and systolic blood pressure.

5.0 DATA ANALYSIS AND RESULTS

5.1 Introduction

Between February 2013 and August 2013, 200 ambulant diabetic patients at KNH were enrolled in a prevalence study and screened for hypertension. This study research data consist of 11 variables i.e. age, gender, obesity, lower urinary tract infections education, marital status, smoking status, systolic blood pressure, diastolic blood pressure, blood sugar

The characteristics of participating patients are summarized in Table 1below. Of the 200 patients 122 (61%) were female. The mean age of ambulatory diabetic patients was 59.4 years (SD 10.6). Most patients were aged 50 years and above with 33.5% in the age group 50-59 years and 31% aged between 60 and 69 years (Table 1). Three-quarters of the patients were married and most had primary, secondary or tertiary education (39%, 26.5% and 22%, respectively).

Table 1: Characteristics of ambulant type 2 diabetes patients attending KNH clinic

	N	**%**
Age category		
30-39 years	6	3.0
40-49 years	30	14.5
50-59 years	67	33.5
60-69years	62	31.0
70 years and above	35	17.5
Gender		

Male	78	39.0
Female	122	61.0
Education		
None	21	10.5
Primary	78	39.0
Secondary	53	26.5
Tertiary	44	22.0
Adult education	4	2.0
Marital status		
Single	15	7.5
Married	150	75.0
Divorced	3	1.5
Widowed	25	13.0
Separated	6	3.0

5.2 Medical history of ambulatory diabetic patients

Table 2: presents the history of diabetes illness among the ambulatory patients in the study. On average patients were diagnosed with diabetes at 50 years, and the mean duration of diabetes among patients was 9.3 years (SD = 7.3). Seventy-eight percent of patients were on OHAs, and 78 (39%) were on both OHA and insulin. Lipid lowering agents were being administered to 59 (29.5%) patients and diuretics in 63 (31.5%) patients.

Table 2: History of diabetes illness and co-	**n (%)***

morbid conditions in patients attending diabetic clinic at KNH	
Age at diagnosis (years)[†]	50 ± 11.2
Diabetes duration (years)	9.3 ± 7.3
Anti-hyperglycemic treatment, n (%)	
OHA, n (%)	**157 (78.5)**
Metformin	145 (72.5)
Sulfonyureas	58 (29.0)
OHA + insulin	78 (39.0)
Insulin	116 (58)
Other treatment, n (%)	
Lipid lowering agents	59 (29.5)
Herbal treatments	11 (5.5)
Antihypertensives	
Diuretic	63 (31.5)

Figure 2:presents key findings in patient medial history related to hypertension. Fifty-four (27%) patients had already been diagnosed with hypertension by a clinician, and 2% and 4% had suffered myocardial infarction and stroke, respectively. Thirteen (6.5%) patients had a family history of kidney disease and of 13 these patients, 4 reported that a single parent had kidney disease, 3 reported renal disease in a sibling and the remaining 6 were in other relatives.

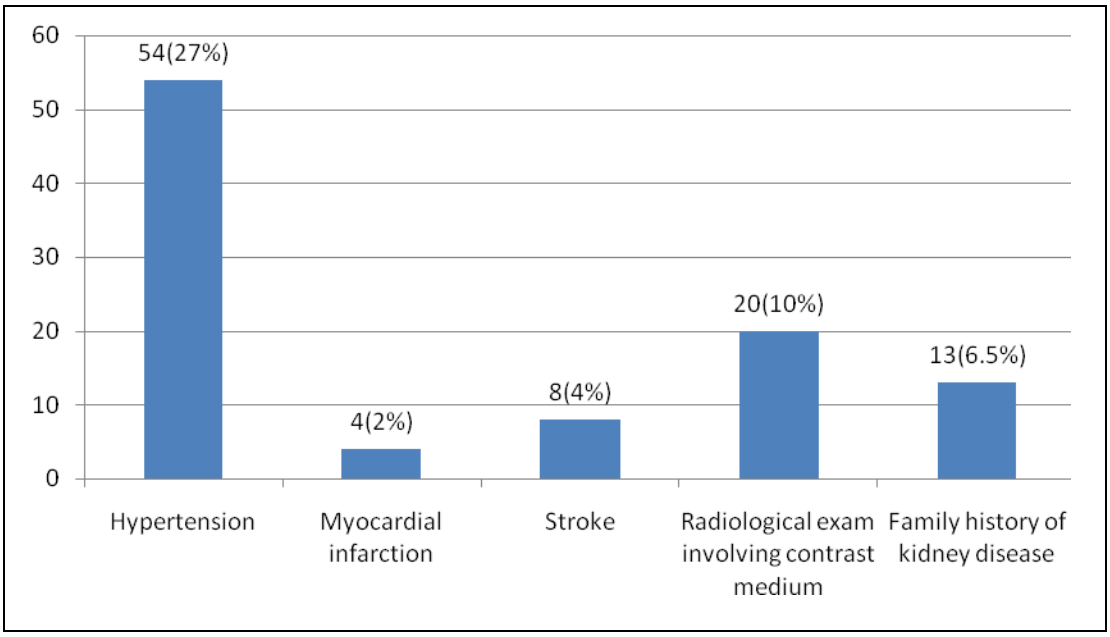

Figure 2: Medical and family history of ambulatory type 2 diabetes patients at KNH

5.3 Smoking habits

Fifty (25%) patients were either current (10, 5%) or former (40, 20%) smokers (Table 3). Among the current smokers 4 (16.7%) were heavy smokers at least 12 cigarettes per day compared to 10 (35.7%) former smokers who also reported that they were former heavy smokers.

Table 3: Ambulatory diabetic patients self-reported lifetime smoking habits

	N	**%**
Smoking habits		
Never been a smoker	150	75.0
Current smoker	10	5.0

Former smoker	40	20.0
Cigarettes smoked per day		
Current smokers (n = 10)		
<4	1	4.2
4 to 12	12	50.0
>12	4	16.7
Former smokers (n = 40)		
<4	4	14.3
4 to 12	10	35.7
>12	10	35.7

5.4 Summary of continuous variables

Table 4: summary of continuous

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	200	61.36	10.60721	36	90
Blood sugar	170	8.954118	3.935021	3.3	28.4

5.5 Chi-square test for independence

Tests for statistical association between hypertension status and each of the risk factors (where applicable) were carried out and results obtained are given below:

Gender:

Table5

gender	dxhbp 0	1	Total
1	26	52	78
	22.2	55.8	78.0
	33.33	66.67	100.00
2	31	91	122
	34.8	87.2	122.0
	25.41	74.59	100.00
Total	57	143	200
	57.0	143.0	200.0
	28.50	71.50	100.00

H_0 – There is no statistical association between having hypertension and gender

H_1 _ There is statistical association between having hypertension and gender gender

These results indicate that there is no relationship between hypertension among type diabetes and gender (p-value = 0.226).

Obesity status:

Table6

obesity	dxhbp 0	1	Total
0	18	24	42
	12.0	30.0	42.0
	42.86	57.14	100.00
1	39	119	158
	45.0	113.0	158.0
	24.68	75.32	100.00
Total	57	143	200
	57.0	143.0	200.0
	28.50	71.50	100.00

Pearson chi2(1) = 5.3778 Pr = 0.020

H_0 – There is no statistical association between having hypertension and obesity

H_1 _ There is statistical association between having hypertension and obesity

These results indicate that there is a relationship between hypertension among type diabetes and obesity (p- value = 0.020).

Lower urinary tract infections:

Table7

luts	dxhbp 0	1	Total
1	12	34	46
	13.1	32.9	46.0
	26.09	73.91	100.00
2	45	109	154
	43.9	110.1	154.0
	29.22	70.78	100.00
Total	57	143	200
	57.0	143.0	200.0
	28.50	71.50	100.00

Pearson chi2(1) = 0.1707 Pr = 0.679

H_0 – There is no statistical association between having hypertension and lower urinary tract infections.

H_1 – There is statistical association between having hypertension and lower urinary tract infections.

These results indicate that there is no relationship between hypertension among type 2 diabetes and lower urinary tract infections (p-value = 0.679).

Education level:

Table 8

education	dxhbp 0	1	Total
1	5	16	21
	6.0	15.0	21.0
	23.81	76.19	100.00
2	18	59	77
	21.9	55.1	77.0
	23.38	76.62	100.00
3	20	34	54
	15.4	38.6	54.0
	37.04	62.96	100.00
4	13	30	43
	12.3	30.7	43.0
	30.23	69.77	100.00
5	1	4	5
	1.4	3.6	5.0
	20.00	80.00	100.00
Total	57	143	200
	57.0	143.0	200.0
	28.50	71.50	100.00

Pearson chi2(4) = 3.3905 Pr = 0.495

H_0 – There is no statistical association between having hypertension and education

H_1 – There is statistical association between having hypertension and education

These results indicate that there is no relationship between hypertension among type 2 diabetes and education (p-value = 0.495).

Marital status:

Table 9

marital	dxhbp 0	1	Total
1	8	7	15
	4.3	10.7	15.0
	53.33	46.67	100.00
2	40	110	150
	42.8	107.3	150.0
	26.67	73.33	100.00
3	2	1	3
	0.9	2.1	3.0
	66.67	33.33	100.00
4	5	21	26
	7.4	18.6	26.0
	19.23	80.77	100.00
5	2	4	6
	1.7	4.3	6.0
	33.33	66.67	100.00
Total	57	143	200
	57.0	143.0	200.0
	28.50	71.50	100.00

Pearson chi2(4) = 8.0965 Pr = 0.088

H_0 – There is no statistical association between having hypertension and marital status

H_1 – There is statistical association between having hypertension and marital status

These results indicate that there is no relationship between hypertension among type 2 diabetes and marital status (p-value = 0.088).

Smoking status

Table 10

smoker1	dxhbp 0	1	Total
0	40	111	151
	43.0	108.0	151.0
	26.49	73.51	100.00
1	17	32	49
	14.0	35.0	49.0
	34.69	65.31	100.00
Total	57	143	200
	57.0	143.0	200.0
	28.50	71.50	100.00

Pearson chi2(1) = 1.2219 Pr = 0.269

H_0 – There is no statistical association between having hypertension and smoking status

H_0 – There is statistical association between having hypertension and smoking status

These results indicate that there is no relationship between hypertension among type 2 diabetes and smoking status, (p-value = 0.269).

5.6 Logistic modelling of hypertension among type 2 diabetes patients with categorical predictors and Analysis of MLE for model

Eleven predictor variables namely age, gender, blood sugar, obesity, lower urinary tract infections, education, marital status, smoking status, Diastolic BP and systolic BP. The response variable was hypertension.

Table 11

				no. of obs = 170			
				LR chi2 (16) = 33.28			
				Prob>chi2 = 0.0068			
				pseudoR2 = 0.1590			
Log likelihood = -88.039259							
Dxhbp	Odds	Coef.	Std. Err.	Z	P>z	[95%	Interval]
Age	1.067377	0.0652047	0.0222411	2.93	0.003	0.021613	0.108797
Gender	1.69897	0.5300224	0.5429769	0.98	0.329	-0.53419	1.594238
Obesity	2.067324	0.7262551	0.4486873	1.62	0.106	-0.15316	1.605666
smoker1	0.449855	-0.79883	0.5330479	-1.5	0.134	-1.84359	0.245925
bloodsugar	0.9408509	-0.060971	0.0483618	-1.26	0.207	-0.15576	0.033817
Luts	1.05988	0.0581554	0.4775231	0.12	0.903	-0.87777	0.994084
sbp11	1.736288	0.5517494	0.4239271	1.3	0.193	-0.27913	1.382631
dbp11	1.043017	0.0421179	0.4773163	0.09	0.93	-0.8934	0.977641
Education							
2	1.808803	0.5926653	0.7199496	0.82	0.41	-0.81841	2.003741
3	1.336716	0.2902161	0.7343463	0.4	0.693	-1.14908	1.729508
4	3.762156	1.324992	0.8121632	1.63	0.103	-0.26682	2.916803
5	0.7661955	-0.266318	1.357977	-0.2	0.845	-2.9279	2.395268
Marital							
2	5.086637	1.626617	0.7778767	2.09	0.037	0.102007	3.151227
3	0.5989918	-0.512507	1.469817	-0.35	0.727	-3.3933	2.368281
4	4.575252	1.520662	0.9362548	1.62	0.104	-0.31436	3.355687
5	4.82167	1.57312	1.277186	1.23	0.218	-0.93012	4.076359
_cons	0.0021879	-6.124804	2.357757	-2.6	0.009	-10.7459	-1.50369

LR chi2 = 33.28 with a p-value 0.0068 and this means that the model is statistically significant and the variables included in the model are better.

Age – there is a statistically significant relationship between age and hypertension. From the above model. All other variables showed statistically non-significant relationship with hypertension.

Estimated parameters are shown in table 11 above. Coef. Column has the exponentiated estimated parameters. These values from Coef. Column may represent the odds ratio for the corresponding predictor variables. Estimates of odds ratio are represented in the same table 11.

In this study, age was a significant predictor (p-value=0.003).

Table 12

Number of obs = 170

Prob > chi2 = 0.0003

LR chi2(1) = 12.80

Log likelihood = -98.281225 Pseudo R2 = 0.0611

Dxhbp	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
age	.0596454	.017701	3.37	0.001	.024952	.0943388
_cons	2.764863	1.058196	-2.61	0.009	-4.83889	-.6908358

Chi-square is 20.48 and it is not significant. In this case the removed variable produced a reduced model giving a model which is a good fit and therefore should not be included in the model.

Dropping all non-significant factors from model fit using stepwise regression technique, a better fitting model with age only as risk factor was obtained. The results of the fit are given in Table 12.

Likelihood ratio test is LRchi2 (15) =20.48, and its assumed that the full model which is nested =0.1541

Multiple Logistic Regressions

This is the formula for the model:

For hypertension among type 2 diabetes, let Yi be the binary outcome hypertension among type 2 DM, (yes/no) for individual

Yi ~Bernoulli (πi)

Logit (P(Y=1/X)) = β_0+$\beta_1$age+$\beta_2$gender+ $\beta_3$obesity+ $\beta_4$smoker1 + $\beta_5$bloodsugar + $\beta_6$luts+ $\beta_7$sbp + $\beta_8$dbp + $\beta_9$education+ β_{910}marital.

and fitted model is:

Logit (P(Y=1/X)) = - 11.1607 +0.0673age+1.6989gender+ 2.0673obesity+ 0. + 0.4498smoker1 + 0.9409bloodsugar+ 1.0599luts + 1.7363sbp + 1.0430dbp

The fitted model with significant factors only yielded the following fit:

Logit (P(Y=1/X)) = -6.1248+1.0674age

A type 2 diabetes patient is 7% more likely to develop hypertension for every additional year in age after adjusting for all other risk factors.

6.0 CONCLUSION

I studied the risk factors of hypertension using logistic regression. The risk factors used were gender, age, BMI, glycaemic control, systolic and diastolic BP, marital status, education status and smoking status. Probability of presence of hypertension was estimated using binary logistic regression. Chi-square test of association between hypertension and predictor variables showed that obesity and hypertension had statistically significant relationship. This correlates with a study conducted by Hillier TA et al (35).

Secondly, logistic coefficient significance testing showed that age and hypertension were statistically significant. To assess for fitness of model, the maximum likelihood test was used. The fitted model showed that developing HTN in type 2 DM individuals did not depend on gender, education, smoking history, marital status, the presence of LUTs, and glycaemic control. This is contrary with findings reported by Tsai et al which reported non-significant relationship between hypertension and smoking status (36).

7.0 RECOMMENDATIONS

Since obesity is a modifiable risk factor associated with HTN in type 2 diabetes, it is important that measures to manage BMI are incorporated in the treatment of DM patients. The high number of individuals found to have elevated systolic BPs and yet were not on any treatment is an indicator that healthcare providers should be keen to optimize BP management in these patients. This would have an impact on the burden of CVD in this community of patients. Longitudinal studies to identify causative associations of CVD and DM would provide useful information for health policy formulation.

8.0 STUDY LIMITATIONS

This study was limited due to finances and time which necessitated the use of secondary data which I had no control over.

REFERENCES

1. WHO global status report on non-communicable diseases 2014
2. Expert Committee on the Diagnosis & Classification of Diabetes. Diabetes Care 2003 26:3160-3167
3. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus. Geneva, World Health Organization, 1999 (WHO/NCD/NCS/99.2)
4. Laslett L, Alagona P J, Clark BA 3rd, et al. The worldwide environment of cardiovascular disease: prevalence, diagnosis therapy, and policy issues: a report from the American College of Cardiology. J Am CollCardiol 2012;60:S1
5. Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 contries(the INTERHEART study): case-control study. Lancet 2004 364:937

6. The National High Blood Pressure Education Program Working Group. National high blood pressure education program working group on hypertension in diabetes.Hypertension.1994; 23: 145-58.

7. National Diabetes Data Group. Summary. In: Harris MI, HammanRF, cds. Diabetes in America. Washington, DC: GPOUS Dept. of Health and Human Services, NIHpublication85-1468;1985:1-16.(7).

8. Bild D, Teutsch SM. The control of hypertension in persons with diabetes: a public health approach. Public Health Rep. 1987; 102: 522-529

9. Christensen DL, Friis H, Mwaniki DL, et al. Prevalence of glucose intolerance and associated risk factors in rural and urban populations of different ethnic groups in Kenya. Diabetes Res ClinPract. 2009; 84(3):303-10.

10. Joshi MD, Ayah R, Njau EK, et al. Prevalence of hypertension and associated cardiovascular risk factors in an urban slum in Nairobi, Kenya: A population-based survey. BMC Public Health 2014; 14:1177

11. Green A, Christian HN, Kroger PS. The changing world demography of type 2 diabetes. Diabetes Metab Res Rev 2003; 19(1): 3-7.

12. One adult in ten will have DM by 2030. IDF Nov. 14 2011

13. IDF diabetes atlas. 5th ed. Brussels. IDF 2011

14. Zhang P., Zhang X., Brown J, Victor D. Global Healthcare expenditure in Diabetes for 2010 & 2030. Diabetes Res ClinPract 2010, 87:293-301.

15. World Health Organization. Core Health indicators: the latest data from multiple WHO sources. United Republic of Tanzania. Geneva: WHO, 2006

16. Libby P, Nathan DM, Abraham K, Brunzell JD. Report of the National Heart, Lung and Blood Institute: National Institute of Diabetes and Digestive and Kidney Diseases Working Group on Cardiovascular Complications of DM. Circulation. 2005;111:3489–93.

17. Paul B, Sapra B, Maheswari S, Goyal RK. Role of Losartan therapy in the management of diabetic hypertension. The Journal of the Association of Physicians of India. 2000;48:514–7.

18. National High Blood Pressure Education Program Working Group report on hypertension in diabetes. Hypertension. 1994 Feb;23(2):145–58.

19. Simonson DC (1998) Etiology and prevalence of hypertension in diabetic patients. Diabetes Care11(10): 821–82

20. Sowers JR, Epstein M, Frohlich ED (2001) Diabetes, hypertension, and cardiovascular disease: an update. Hypertension 37(4): 1053–1059

21. Chobanian AV, Rakris GL, Black HR, et al. The 7th Report of the Joint National Committee on the Prevention, Detection, Evaluation and Treatment of High BP. JAMA 2003; 289:2560

22. Franklin SS, Larson MG, Khan SA, et al. Does the relation of BP to coronary heart disease risk change with aging? The Framingham Heart Study. Circulation 2001; 103:1245

23. Randeree H, Omar MA, Motala AA, et al. Effect of insulin therapy in BP in NIDDM patients with secondary failure. Diabetes Care 1992; 15:1258

24. Nosadini R, Sambataro M, Thomaseth K, et al. Role of hyperglycemia & insulin resistance in determining sodium retention in NIDDM. Kidney Int 1993; 44:139

25. Cruickshank K, Riste L, Anderson SG, et al. Aortic pulse-wave velocity and its relationship to mortality in diabetes and glucose intolerance: an integrated index of vascular function? Circulation 2002; 106:2085

26. Libby P, Ridker PM, Hanssori GK. Progress & challenges in translating the biology of atherosclerosis. Nature 2011; 473:317

27. Mancini GB, Henry GC, Macaya C, et al. The TREND(Trial on Reversing Endothelial Dysfunction) Study. Circulation 1996; 94:258

28. Gordon T, Castelli WP, Hjortland MC, et al. High density lipoprotein as a protective factor against coronary heart disease. The Framingham Heart Study. Am J Med 1977; 62:707

29. Assmann G, Cullen P, Schulte H. Simple scoring scheme for calculating the risk of acute coronary events based on the 10 year follow-up of the prospective cardiovascular Munster(PROCAM) study. Circulation 2002; 105:320

30. Ronemaa T, Laakso M, Pyorala K, et al. High fasting plasma insulin is an indicator of coronary heart disease in NIDDM patients and non-diabetic subjects. ArteriosclerThromb 1991; 11:80

31. Gaede P, Vedel P, Parving HH, et al. Intensified multifactorial intervention in patients with type 2 diabetes and microalbuminuria: the Steno type 2 randomized study. Lancet 1999; 353:667

32. Tight blood pressure control and risk of microvascular and macrovascular complications in type 2 diabetes patients: UKPDS 38. UK Prospective Diabetes Study Group. BMJ 1998;317:703

33. Ngugi p. Diabetes Mellitus Nephropathy as seen in KNH in 1989. M.med thesis University Of Nairobi.

34. aPatel A, ADVANCE Collaborative Group, Mac Mahon S, et al. Effects of a fixed combination of perindopril and indapamide on macrovascular and microvascular outcomes in patients with type 2 diabetes: A randomized control trial. Lancet 2007; 370:829

35. Hillier TA, Pedula KL. Characteristics of an adult population with newly diagnosed type 2 DM: the relation of obesity and age of onset. Diabetes Care. 2001;24(9):1522–7

36. Tsai AC, Liou JC, Chang MC. Interview to study the determinants of hypertension in older adults in Taiwan: a population based cross-sectional survey. Asia Pacific journal of clinical nutrition. 2007;16:338–45.