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Research Article

Risk Factors for Diabetic Complications among Diabetic Patients, Chirumanzu District, Zimbabwe, 2011

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Abstract

Introduction: Diabetic complications are largely a result of elevated blood sugar and are responsible for most deaths due to diabetes mellitus. Strict blood sugar control, achieved through adherence to treatment and lifestyle modifications such as physical activity and eating a healthy diet, is critical in the reduction of the incidence of these complications. This study assessed the factors associated with diabetic complications in both outpatients and hospitalized patients.

Methods: We conducted a 1:1 unmatched case-control study among diabetic patients attending hospitals in Chirumanzu District, Midlands Province, Zimbabwe. Structured interviewer administered questionnaires were used to collect data on socio-demographic, knowledge and practices, treatment and health services risk factors. Univariate descriptive statistics such as proportions, means and medians were calculated. Bivariate and stratified analyses were done before stepwise logistic regression to identify independent risk factors. Data were analyzed using Epi-INFO

Results: We enrolled 68 cases and 68 controls with a median ages of 51.5(Q1=43, Q3=61) and 52.5(Q1=43.5, Q3= 60.5) respectively. The majority were females 86 (63.3%). The major diabetic complication was severe hyperglycemia 44/68 (64.7%). Socio-demographic factors associated with diabetic complications were: Being unmarried [OR=3.68, 95%CI(1.70-8.07)], being widowed [OR=2.93,CI(1.14-7.68)], Having attained at most primary education [OR=2.83, 95%CI(1.29-6.25)] and urbanized residence [OR=2.48; 95%CI,(1.17-5.28)]. A significant practice factor was: Eating sugar containing diet[OR=3.9, 95%CI(1.86-8.18)].Treatment risk factors were: Insulin therapy [OR=3.83, 95%CI(1.78-8.34)], Missing doses [OR=6.63, 95%CI(3.08-14.29)] and co-morbidity with hypertension [OR=4.10, 95%CI(2.01-8.39)]. Distance from hospital >5km [3.97, 95%CI 1.77-9.00)] and failure to get drugs [OR=3.12, 95%CI (1.54-6.32)] were significant health services factors associated with complications. Health education [OR=0.274, 95%CI (0.134-0.56)], being already on treatment [OR=0.36, 95 %CI (0.165-0.779)] and having a treatment supporter [OR=0.24, 95%CI (0.115-0.49)] were protective factors. Independent risk factors were: Insulin therapy (p-value0.018), missed treatment doses (p-value=0.0113), co-morbidity with hypertension (p-value=0.0019) and failing to get drugs (p-value<0.001).

Conclusion: The major socio-demographic and treatment related risk factors are largely functions of the patients' knowledge and practices which can be mitigated by simple and inexpensive interventions. The health services factors found are a reflection of the coverage and efficiency of health services in the district which need to be addressed at national level. We therefore recommend the inclusion of health education in the treatment package for diabetic patients, community health education and the decentralization of diabetes care and treatment to rural health centres.

Keywords: Diabetes; Complications; Blood sugar; Patients; Risk

Introduction

The World Health Organization (WHO) estimates that more than 220 million people worldwide have diabetes, 80% of which live in low and middle income countries. Most people with diabetes in low and middle income countries are middle-aged (45-64), not elderly (65+). This has serious adverse socio-economic effects as this is a productive age group [1].

According to WHO, diabetes causes about 5% of all deaths globally each year. In 2004, an estimated 3.4 million people died from consequences of high blood sugar. More than 80% of diabetes deaths occur in low and middle-income countries. It is projected that diabetes deaths are likely to increase by more than 50% in the next 10

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years, and to double between 2005 and 2030 without urgent action [1]. In Africa, an estimated seven million Africans (out of 1billion) suffer from this disease which is now ranked as the fourth main cause of death in most developing countries [2].

Diabetes mellitus is a chronic condition that can lead to complications over time. The long-term complications of diabetes are caused by the effect of high blood sugar levels on blood vessels. Although complications of diabetes are mostly consequences of hyperglycemia, hypoglycemia, if not recognized and corrected early is fatal [1].

Diabetic complications can be prevented (or delayed) by tight blood sugar control achieved through medical treatment and simple lifestyle changes.

Chirumanzu District is located in Midlands Province of central Zimbabwe. Zimbabwe is a southern African country bordering with South Africa to the south, Botswana to the south west, and Namibia to the west, Zambia to the north and Mozambique to the east. The health care system in Zimbabwe is premised on the primary health care approach, with clinics (primary level) as the port of entry into the system. Clinics refer cases that they cannot manage to district hospitals (secondary level), district hospitals to provincial hospitals (tertiary level) and finally to central hospitals (quaternary level).

Information obtained from trends analysis of non-communicable disease (NCDs) in Midlands Province for the period 2000-2009 showed a general increase in these conditions. Surveillance data has also shown that NCDs remain a significant cause of morbidity and mortality contributing between 15 and 20% of all out patients department visits.

In Chirumanzu District, for the year 2010, diabetes mellitus was the leading cause of death, the second major cause of admission and the second major cause of out-patients visits among the NCDs, second to hypertension in both cases.

We hypothesized that there are socio-demographic factors, knowledge and practice factors, treatment factors and health services related factors associated with the high incidence of diabetic complications leading to admission and deaths among diabetic patients in Chirumanzu District, which if prevented or reduced, could reduce morbidity and mortality due to diabetes. We therefore investigated the risk factors for diabetic complications among both inpatients and outpatients in Chirumanzu District.

Methods

A 1:1 unmatched case control study among diabetes mellitus inpatients and outpatients in Chirumanzu District was conducted. A case was any person, 18 years and above, presenting to any of the 3 (three) hospitals in Chirumanzu District between 01 July 2010 and 30 June 2011 inclusive, with diabetes mellitus, previously diagnosed or newly diagnosed, and had severe hyperglycaemia, hypoglycaemia, diabetic foot or nephropathy. A control was any person, 18 years and above, presenting to any of the 3 (three) hospitals in Chirumanzu District between 01 July 2010 and 30 June 2011 inclusive, with diabetes mellitus, previously diagnosed or newly diagnosed and did not have severe hyperglycemia, hypoglycemia, diabetic foot or nephropathy.

A case of severe hyperglycemia was any patient with a fasting blood sugar greater than 7.0mmol/L or a random (casual) blood sugar greater than 11.1mmol/L, requiring admission for blood sugar control as determined by the clinician in charge. A case of hypoglycemia was any patient previously diagnosed with diabetes mellitus and put on treatment who had a blood sugar reading less than 3.5mmol/L.2 Diabetic foot was any patient with a chronic foot ulcer and/or gangrene attributed to diabetes mellitus by the clinician in charge and nephropathy was any patient previously diagnosed or newly diagnosed of diabetes mellitus who had persistent proteinuria (proteinuria on 2 occasions, at least 2weeks apart) and/or a serum creatinine greater than 132mmol/L. [3].

None consenting patients, those who had no documented clinical and/or laboratory evidence of complications of interest and could not be evaluated for the complications of interest during data collection were excluded from the study. Those who had not completed a month's treatment by 30 June 2011 were also excluded

The Statcalc function of Epi-info was used to calculate the minimum required sample size at 95% confidence level, 80% power and a case to control ratio of 1:1. Findings from a study done by Flores Rivera AR, in 1998, were used where the odds ratio for lack of out-patients diabetes education was 3.2 and the proportion of exposure in the control group was 15% [4].

A minimum sample size of 150 participants (75 cases and 75 controls) was required. Diabetic status was confirmed by checking medical records. A pretested interviewer administered questionnaire was used to collect data on socio-demographic factors, knowledge and practices of participants on diabetes, treatment factors and health services related factors. Hospital records were reviewed to determine the types of complications, type of treatment, co-morbidity with hypertension and measurements of interest and also to verify drug supplies.

Anthropometric measurements of weight and height were done using a calibrated digital scale and a standard height meter respectively and the Body Mass Index (BMI) of each participant was calculated using the formula: BMI = weight (Kg) /Height2 (m). Study participants whose renal function had not been tested had urine dipstick tests done and recorded.

Epi-info version 3.3.2 was used to analyze quantitative data to generate means, proportions and frequencies. Bivariate analyses to calculate odds ratios, 95% confidence intervals and p-values were also computed using Epi-info to test for associations between risk factor variables (exposure variables) and the development of diabetic complications (outcome variable). Stratified analysis was done to assess for possible effect modification and confounding. Chi square test was used to determine the significance of differing odds ratios. Logistic regression analysis was done to control for confounding and determine independent risk factors for developing diabetic complications. Variables with p-values less than 0.25 were included in the regression model. Qualitative data were analyzed manually.

Permission to carry out the study was obtained from the Health Studies Office, the Provincial Medical Director Midlands and the District Medical Officer for Chirumanzu District. Informed written consent was obtained from all study participants. Health education

Table 1: Socio-Demographic characteristics of complicated diabetic cases and controls, Chirumanzu District; 2011.

Variable	Cases n=68 (%)	Controls n=68 (%)	p-value
Median age in years	51.5 Q1=43; Q3=61 Min=20; Max=72	52.5 Q1=43,5; Q3=60.5 Min=21; Max=69	-
Sex			
Female	47(69.1)	39(57.4)	
Male	21(30.9)	29(42.6)	0.156
Education level			
None	4(5.9)	2(2.9)	
Primary	29(42.6)	15(22.1)	
Secondary	35(51.5)	51(75)	>0.05
Marital status			
Single	9(13.2)	4(5.9)	
Married	28(41.2)	49(72.1)	
Divorced	10(14.7)	6(8.8)	
Widowed	21(30.9)	9(13.2)	<0.005*#
Place of residence			
Urbanized	38(55.9)	23(33.8)	
Rural	30(44.1)	45(66.2)	0.01*
Employment			
Formal	19(27.9)	19(27.9)	
Informal	26(38.2)	19(27.9)	
Unemployed	23(33.8)	30(44.1)	>0.25#
Religion			
Christian	56(82.4)	63(92.9)	
Non-Christian	12(17.6)	5(7.1)	0.07
Type of treatment			
Dietary	2(2.9)	2(2.9)	
Oral tablets	20(29.4)	42(61.8)	
Insulin	46(67.6)	24(35.3)	<0.005*#
Median age at diagnosis	46.5 Q1=38; Q3=55 Min=16; Max=68	45.3 Q1=40; Q3=52 Min=20; Max=65	

was given to study participants after each interview. Ethical approval for the study protocol was obtained from the Medical Research Council of Zimbabwe.

Results

Out of the required sample of 150 (75cases and 75 controls) a total of 136 (90.1%) eligible study participants `managed to take part in the study. This consisted of 68 cases and 68 controls. Of the 75 cases we intended to interview, 5 (five) could not be located during the time of data collection and 2 (two) were too sick to participate in the study and these were excluded. Sixty-eight controls were therefore interviewed to maintain the 1:1 case: control ratio.

Out of the 136 successful study participants, 68 (50%) were on insulin, 46 (67,6%) cases and 24 (35.3%) controls, 64 (47.1) were on oral hypoglycemic tablets and 4 (2.9%) were on dietary control of diabetes. Of the 68 patients on insulin, 55 (80.9%) had been changed from oral hypoglycaemics to insulin.

The majority (78.7%) of cases and controls were aged between 40 and 69years and their ages were comparable, median ages of 51.5(Q1=43, Q3=61) and 52.5(Q1=43.5, Q3= 60.5) respectively. The majority of the study participants were female for both cases and controls, accounting for 63.3% of participants. There was however no significant gender difference between cases and controls. The highest level of education attained by cases and controls was comparable and so was religion.

Out of the 68 cases of diabetic complications, 44 (64.7%) had severe hyperglycemia, 36 (52.9%) had nephropathy, 12 (17.6%) had diabetic foot and 7 (10.3%) had hypoglycemia. Seventeen (25%) had both severe hyperglycaemia and nephropathy, 7(10.3%) had both nephropathy and diabetic foot and 6 (8.8%) had both severe hyperglycaemia and diabetic foot.

Only 81(59%) out of the 136 study participants were normal weight by Body Mass Index (BMI). Twelve (8.8%) were underweight, 30 (22.1%) were overweight and 13 (9.6%) were obese. Thirty-one (45.6%) of the cases were at least overweight (overweight plus obese) while 12 (17.6) of the controls were at least overweight. Nine (13.2%) of the cases were obese while 4 (5.9%) of the controls were obese.

Table 2: Factors associated with Diabetic Complications, Chirumanzu; District 2011.

Factor		Cases n=68 (%)	Controls n=68 (%)	Odds ratio	Confidence interval	p-Value
Given health education before	Yes	27 (39.7)	48 (70.6)			
	No	41(60.3)	20 (29.4)	0.274	0.134-0.56	0.0003
Eats sugar containing diet	Yes	36 (55.9)	16 (23.5)			
	No	30 (44.1)	52 (76.5)	3.9	1.859-8.181	0.00024
Smoking	Yes	17 (25)	9 (13.2)			
	No	51 (75)	59 (86.8)	2.19	0.897-5.325	0.082

Treatment and Disease Factors Associated with Developing Diabetic Complications, Chirumanzu District, Zimbabwe; 2011.

Factor		Cases n=68 (%)	Controls n=68 (%)	Odds ratio	Confidence interval	P-value
Treatment type	Insulin	46 (69.7)	24 (36.4)			
	Oral tablets	22 (30.3)	44 (63.6)	3.83	1.78-8.34	0.00017
Missed doses	Yes	43 (63.2)	14 (20.6)			
	No	25 (36.8)	54 (79.4)	6.63	3.08-14.29	<0.00001
Duration of treatment	5years^{+}	21 (51.2)	23 (41.8)			
	<5years	20 (48.8)	32 (58.2)	1.46	0.60-3.58	0.363
Diagnosis status	Already on treatment	41 (60.3)	55 (80.9)			
	Newly diagnosed	27 (39.7)	13 (19.1)	0.36	0.165-0.779	0.0087
Co-morbidity with hypertension	Yes	44 (64.7)	21 (30.9)			
	No	24 (35.3)	47 (69.1)	4.10	2.01-8.39	0.00008
Used alternative therapies	Yes	44 (64.7)	38 (55.9)			
	No	24 (35.3)	30 (44.1)	1.47	0.69-3.06	0.295
Treatment supporter	Yes	27 (39.7)	50 (73.5)			
	No	41 (60.3)	18 (26.5)	0.24	0.115-0.49	0.00007

Health Services Related Risk Factors for Diabetic Complications, Chirumanzu District, Zimbabwe; 2011.

Factor		Cases n=68 (%)	Controls n=68 (%)	Odds ratio	Confidence interval	P-value
Hospital authority	Government	33 (48.5)	20 (29.4)			
	Mission	35 (51.5)	48 (70.6)	2.26	1.117-4.584	0.023
Distance from hospital	5km^{+}	53 (87.9)	32 (47.1)			
	<5km	15 (22.1)	36 (52.9)	3.97	1.77-9.00	0.0002
Ever failed to get drugs	Yes	39 (58.2)	21 (30.9)			
	No	28 (41.8)	47 (69.1)	3.12	1.54-6.32	0.0015

Knowledge on the broader aspects of diabetes, diabetic care and complications was generally high among both cases and controls, only slightly higher among controls than cases except for the possible complications of diabetes mellitus. The majority (>94%) of cases and controls knew that diabetic patients should not take a sugar-containing diet, that DM was essentially elevated blood sugar, that DM treatment is taken for life and that DM is a non-communicable disease. A lower proportion (82.4%) of study participants knew that adherence to treatment is essential to minimize diabetic complications and an even lower proportion (67%) knew at least 2 (two) possible complications of DM.

The knowledge about the possible complications of diabetes was generally low among both cases and controls except for diabetic coma which was reported by three quarters (75.7%) of study participants. However, the knowledge of possible complications was slightly higher among controls than among cases for all possible complications reported by study participants except for renal failure which was reported by more cases than controls.

More controls (73%) used treatment supporters than cases (49%). Controls also used other therapies like prayers, herbs and/or traditional medicines more than their counterparts. However, more cases (63%) missed their doses than controls (20%) did and they also took sugar containing meals more than their counterparts (55% and 22% for cases and controls respectively). There were more smokers among the cases than the controls. Thus, more cases had bad practices than their controls.

Being unmarried (single, divorced or widowed) was positively associated with developing diabetic complications such that those who were unmarried were 3.68 times more likely to develop diabetic complications than those who were married and this was statistically significant with a p-value of less than 0.001. Being a widow was associated with a 2.93 times more risk of developing diabetic complication than their counterparts who were not widows and

Table 3: Independent risk factors associated with developing diabetic complications, Chirumanzu District, Zimbabwe; 2011.

Risk factor	Odds ratio	95% C.I	Z statistic	P-value
Eating sugar containing diet	2.19	0.44-10.73	0.963	0.336
Type of treatment (Oral tablets/Insulin)	0.08	0.01-0.65	-2.36	0.018
Duration of diabetes(newly diagnosed/Already on treatment)	9.989	0.91-109	1.89	0.059
Uses treatment assistant (Yes/No)	0.621	0.156-2.641	-0.645	0.519
Missed treatment doses (Yes/No)	7.974	1.599-39. 78	2.532	0.0113
Age at diagnosis	1.1304	0.9556-1.331	-1.4305	0.1526
Co-morbidity with hypertension (Yes/No)	31.3664	3.5810-74.744	3.112	0.0019
Hospital used	3.7613	0.547-25.86	1.347	0.1781
Distance from hospital >5km	5.6652	2.404-13.35	3.7025	0.0001
Ever failed to pay for treatment (Yes/No)	46.5761	5.9891-362.23	3.670	0.0002

this was also statistically significant with a p-value of 0.013. Having attained at most primary education and residing in an urbanized residence were significant risk factors for developing diabetic complications with odds ratios of 2.83 and 2.48 respectively and p-values of 0.005 and 0.01 respectively.

Health education was protective against the development of complications of diabetes mellitus. Those who had been given health education were 73% less likely to develop diabetic complications than those who had not received it and this was statistically significant with a p-value of less than 0.001.

Eating a sugar containing diet was a significant risk factor for developing diabetic complications such that those who had a taken a sugar containing meal in the preceding month were 3.9 times likely to develop complications than those who did not. This was statistically significant with a p-value of less than 0.001.

There was a positive association between smoking and the development of diabetic complications with an odds ratio of 2.19 but this was not statistically significant (p-value 0.082)

The use of insulin as a treatment regimen was associated with the development of diabetic complications. Patients who were on insulin were 3.83 times more likely to develop complications than those who were on either dietary control or on oral tablets with a statistically significant p-value of less than 0.001.

Missing treatment doses was associated with a significant 6.63 times increase in the risk of developing complications with a p-value of less than 0.001. Diabetic patients who also suffered from hypertension had a 4.10 fold risk of developing diabetic complications as compared to their counterparts who did not have hypertension. This was significant, with a p-value of 0.001.

Being on treatment for diabetes was a protective factor such that those who were already on treatment were 64% less likely to develop complications than those who were newly diagnosed, with a significant p-value of 0.0087. Having a treatment supporter was also protective with an odds ratio of 0.24 and a p-value of less than 0.001.

Diabetic patients who used the government hospital for their treatment were 2.26 times more likely to develop complications than those who used mission hospitals. This was statistically significant with a p-value of 0.023. Distance from hospital was also significantly (p-value < 0.001) associated with the development of complications with patients residing 5km or more from the hospital where they get their supplies 3.97 times more likely to complicate than those who resided within 5km radius.

Those who had failed to get their supplies from their hospital had a 3.12 fold increased risk of complications than those who had never failed to get their supplies in the past 1year (p-value 0.0015)

The association between missing treatment doses and developing diabetic complications was modified by gender such that males who missed their doses were 15.6 times more likely to develop complications whereas females who missed their doses were 4.3 times more likely to develop complications.

The association between eating a sugar containing diet and developing diabetic complications was modified by having been given health education before such that those who received health education and those who did not were 1.7 and 5.9 times likely to develop diabetic complications respectively.

The association between the use of a treatment supporter and the development of diabetic complications was confounded by the type of treatment such that those who used a treatment supporter were 67% less likely to develop diabetic complications than those who did not. The protective effect of using a treatment supporter remained statistically significant in insulin users but non-significant in oral tablets users.

The association between distance from hospital and developing diabetic complications was modified by missing treatment doses such that patients staying 5km and more from the hospital who missed their treatment doses were 2.47 times more likely to complicate whereas those staying within 5km who missed their doses were 5times more likely to complicate than those who did not.

The association between co-morbidity with hypertension and the development of diabetic complications was confounded by the type of treatment such that those who had hypertension were 11.45 times more likely to develop complications than those without hypertension.

After logistic regression, the independent risk factors for developing diabetic complications among diabetic were; type of treatment (Oral tablets or insulin), missed treatment doses, co-morbidity with hypertension and having failed to pay for treatment.

Diabetes mortality data was not available for the year 2011 because the hospitals had not submitted the data to the district. Two (2) of the 3 hospitals had not compiled the data by the time of data collection.

However for the year 2010, there were 410 patients recorded in the diabetic registers of the district. During the year, the district recorded 52 deaths due to diabetes and its complications. It was however not possible to disaggregate and quantify the actual causes of death among diabetic patients because the majority of deaths were not specified and had diabetes only as the direct cause of death.

Discussion

The majority of study participants were female (63.3%). This shows that in this group of patients, diabetes has a female bias, contrary to the WHO reports and many other studies that showed that there are few gender differences in the prevalence of diabetes mellitus. Among different studies, prevalence rates of diabetes are not consistently higher for women, with the ratio of the prevalence in women versus men varying among populations studied, probably due to different distributions of risk factors such as body mass index, physical activity, and genetic differences.

This finding was however consistent with Gale E.A.M. and Gillespie K.M. in 2001 who reported that the overall sex ratio is roughly equal in children diagnosed under the age 15 but while populations with the highest incidence all show male excess, the lowest risk populations, mostly of non-European origin, characteristically show a female bias. In contrast, male excess is a consistent finding in populations of European origin aged 15-40years, with an approximate 3:2. Male: Female ratio [5].

In this study however, the higher proportion of females could reflect their general excess in the Zimbabwean population, estimated to be 51% female against 49% male. The proportion of female was even higher among the cases at 69.1%, showing some association (though statistically insignificant) between female gender and diabetic complications, consistent with WHO reports that there are some gender differences seen in acute and chronic complications of the disease [5].

The United States National Hospital Discharge Survey of 1989-1991 showed that almost twice as many women were discharged with the diagnosis of nonketotic hyperosmolar coma than men [6] The number of women discharged with hypoglycemia was almost 1.5 times that of men [7]. In another population-based study, the rate of diabetic acidosis in females was 1.5 times that of males [8].

Half (50%) of study participants were on insulin while only 4(2.9%) were on dietary control. It was not possible to differentiate between those who had type 1 and type 2 diabetes because this was not recorded for most of the patients, some patients had been changed from oral hypoglycemics to insulin and the necessary definitive diagnostic tests were not available. However, it is expected that about 5-10% of patients are type 1 diabetics.

The majority (78.7%) of cases and controls were aged between 40-69 years with median ages of cases and controls of 51.5years and 52.5years. these findings are consistent with the WHO report which states that most people with diabetes in low and middle income countries are middle-aged (45-64years) and not the elderly (65+).3 This could have serious adverse effects on the patients, their families and the country at large since this is a productive age group which could suffer loss of considerable productive time due to morbidity and loss of family income in paying for their treatment which is relatively expensive and lifelong.

Ninety-five (95%) of diabetic patients under study attained at least primary level education. This could improve their understanding of their condition and treatment, possibly increasing cooperation and compliance, hence outcomes of management and reduction in incidence of diabetic complications. Those who attained at most primary education were more likely to develop complications compared to those who attained at least secondary education. This demonstrates the importance of education in the management and control of diabetes.

Being unmarried was significantly associated with the development of diabetic complications in this population. This suggests lack of family support, ranging from emotional, financial and treatment support and possible concomitant depression playing a role in the development of complications. A study done in the United States of America showed that the risks of comorbid myocardial infarction, hypertension, arthritis, and angina were significantly higher in the presence of concomitant depressive symptoms, as were the risks of diabetic complications, functional disability, incontinence, vision impairment, poorer perceived health status, and health service use among both diabetic and non-diabetic individuals [9].

Widowed patients were more likely to develop complications suggesting the effects of the loss of a life partner on diabetes care. This could be attributed to depression, anhedonia and the reduction in the support that used to be available from the partner.

Residing in an urbanized residence had a significant association with the development of diabetic complications, supporting the long standing fact that diabetes and its complications are problems of the more affluent although recent studies have shown an increasing incidence of these conditions in rural populations. Patients residing in urbanized residence tend to leave a more sedentary lifestyle with less physical activity as compared to those living in rural settings. Those living in rural settings tend to do more manual work in fetching firewood and water and in undertaking subsistence farming. There is also an increased likelihood of eating a high sugar and high cholesterol diet among the urbanized because of the ready availability of these foods and the use of refrigerators whereas rural residents eat a more natural food and vegetable based diet [10].

Employment was however not associated with developing diabetic complications. The major form of employment in this population, mainly farms, mines and small scale enterprises are largely manual in nature, increasing physical activity which reduces the risk of developing complications.

Being at least overweight (overweight or obese) was significantly associated with developing diabetic complications. Excess body fat and obesity increases the incidence and extent of insulin resistance. This, coupled with the likely lack of exercise and physical activity, and co-morbid conditions like hypertension which are more common in the overweight and obese, exacerbate the effects of elevated blood

sugar, increasing the likelihood of developing diabetic complications. There was an insignificant association between obesity alone and diabetic complications. This is probably because of the small number of patients who were obese. A larger sample size would perhaps yield a significant positive association.

Insulin therapy was strongly associated with the development of diabetic complications as compared to oral hypogycemic therapy. It is known that insulin therapy is necessitated by the severe deficiency of insulin in the body but the exact levels, which are difficult to determine and to monitor, vary between individuals. This makes it difficult to titrate the amount of insulin required by individuals, resulting in unstable glycaemic control leading to either hypoglycaemia or hyperglycaemia. As such, patients are prone o under-dosage and over-dosage alike, predisposing them to complications. Missed treatment doses also lead to complications more commonly with insulin therapy than with oral drugs. Studies in Kenya also revealed similar findings, were patients on insulin were more likely to develop diabetic ketoacidosis and hypoglycaemia [11,12].

The lack of health education on diabetes was significantly associated with the development of complications probably largely because of the lack of understanding of their condition and the requirements for proper care and treatment. Similar findings were reported by Gayle E. et al in 1992 and Flores Rivera in 1998 where lack of previous outpatient health education was significantly associated with amputation in patients with diabetes mellitus [13].

Patients who were non-compliant with the diabetic diet were more likely to develop complications than those who were compliant. Eating a sugar containing in diabetic patients overwhelms the already depleted insulin levels and adversely affects glycaemic control, increasing the risk of developing diabetic complications. Studies in South Africa, Tanzania and Kenya have shown that strict dietary control significantly reduces the risk of developing diabetic complications.

Matthew E. Kahn reported that diet adherence is a key determinant in minimizing the risk of diabetic health complications. Diabetics who ignore their doctor's advice, concerning diet, smoking and exercise, are taking a gamble. Food product innovation, improved understanding about the benefits of tight diabetic compliance, and increased information dissemination all provide incentives for diabetics to modify their behavior [14].

The control of diabetes is hinged on dietary control and strict adherence to treatment. Missing treatment doses was significantly associated with the development of complications as this affects glycaemic control, leading to persistent hyperglycaemia, hence diabetic complications. Otieno C.F. and Kayima J.K et al in Kenya in 2005 found that missing insulin doses was significantly associated with diabetic ketoacidosis. They also found out those who were newly diagnosed were more likely to develop diabetic complications than those on treatment. In this, study, newly diagnosed patients were more likely to develop severe hyperglycaemia. This is mainly because most patients have diabetes but are unaware of it and already have one of the diabetic complications at presentation to a health facility where the diagnosis can be made [11].

Diabetic patients who were also hypertensive had an increased risk of diabetic complications compared to their non-hypertensive counterparts. Although high blood pressure causes few symptoms, it has two negative effects: it stresses the cardiovascular system and speeds the development of diabetic complications of the kidney and eye [1].

Accessibility of health services remains a problem especially in rural settings were patients have to travel long distances to access health care. This increases the chance of them delaying to seek health care services and defaulting treatment, particularly chronic disease patients. Diabetic patients who live more than 5km away from the hospital were more likely to complicate probably because of these factors.

Failures to pay for treatment services and to get drugs from health facilities are likely to have caused patients to miss their doses, increasing their risk of developing diabetic complications.

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