Risk factors for Diabetic Retinopathy among patients with Diabetes Mellitus in Ilorin, Nigeria

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Abstract

Diabetes mellitus increases the risk of eye diseases. Literature is scanty on the risk factors for diabetic retinopathy in Nigeria. This study aims to identify the risk factors for diabetic retinopathy among diabetic patients in Ilorin.

This was a hospital-based cross-sectional study, carried out at the Diabetic and Ophthalmology clinics of University of Ilorin Teaching Hospital, Nigeria from November 2011 to July 2012. Questionnaires were administered to 365 diabetic patients to obtain information on socio-demographic characteristics, and diabetes mellitus. General physical and ocular examinations, and laboratory investigations were carried out. Three hundred and sixty-five patients were recruited, with a mean age of 45.8 ±16.3 years. Of the 365 patients, 44 of them had diabetic retinopathy; 17(38.6%) had HbA1c equal or below 7.0%, while 27(61.4%) had HbA1c above 7.0%. There was a positive relationship between diabetic retinopathy and longer disease duration, glycosuria, proteinuria, and micro-albuminuria. (OR=0.36, p=0.039), (OR=0.23, p=0.0008), (OR=0.19, p=0.0007), and (OR=0.18, p=0.004) respectively.

However, there was no significant relationship between diabetic retinopathy and HbA1c, serum cholesterol, triglycerides, HDLc and LDLc levels. (OR=1.03, p=0.936), (OR=0.13, p=0.227), (OR=0.00, p=0.679), (OR=0.20, p=0.112), and (OR=0.72, p=1.000) respectively. There was also no significant relationship between diabetic retinopathy and systemic hypertension, obesity, and being on treatment for kidney disease (OR=0.82, p=0.541), (OR=0.92, p=0.815), and (OR=0.82, p=0.595) respectively.

In conclusion, longer disease duration, glycosuria, proteinuria, and micro-albuminuria were significantly associated with diabetic retinopathy. However, age, gender, type of diabetes, age at diagnosis of diabetes, degree of glycaemic control, serum lipids, systemic hypertension, obesity, presence of kidney disease and leg wound were not.

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Introduction

Diabetes mellitus(DM) is associated with various forms of both acute and chronic complications, which often lead to premature death.[1] Due to better management, patients with DM now live longer. There is now a larger population of DM patients who are at a higher risk of developing the chronic DM complications such as neuropathy, nephropathy, vascular diseases (cerebral, cardiac and peripheral) and retinopathy.[2] Diabetes mellitus increases the risk of a range of eye diseases including cataract, but the main cause of blindness associated with DM is diabetic retinopathy (DR).[3] DR is a progressive increase in vascular permeability and proliferation of fragile, new retinal blood vessels.[4] It can be broadly categorized into non-proliferative and proliferative DR. Non-proliferative DR may impair vision if the macula is involved. Proliferative DR is a serious eye complication of DM that can result in blindness.[5]

Diabetic retinopathy is increasingly becoming a major cause of blindness throughout the world. The associated loss of productivity and quality of life for the patient with DR will lead to an additional socioeconomic burden on the community.[6] Everyone with DM will develop some degree of DR eventually. DR usually develops 10-20 years after the onset of DM, and develops faster when DM is undiagnosed and untreated.[6] DR develops in nearly all persons with type 1 DM, and in more than 77.0% of those with type 2 DM who survive over 20 years with DM.[7,8] Certain risk factors have been documented as being significantly associated with the development and progression of DR; these include long duration of DM, poor glucose control, high blood pressure(BP), obesity, elevated blood lipids, micro-albuminuria, smoking, advance age and gender (female sex).[7-10]

In Nigeria, the national prevalence of DM is 2.2%,[11] which means that about 3.3 million Nigerians have DM; 50.0% of the affected individuals (about 1.65 million Nigerians) do not even know they have the disease. As the prevalence of DM increases, so will the risk of developing DR.[12] In 2002, the global average risk of blindness from DR amongst people with DM was calculated as 0.75% i.e. one person out of every 133 people with DM will go blind. However, the average risk of blindness from DR tends to be higher in

resource poor regions. An important reason for this is that the infrastructure and resources required to effectively address DR are either inadequate or absent.[3] DR is the leading cause of new-onset blindness in industrialized countries and a more and more frequent cause of blindness in middle-income countries. The World Health Organization(WHO) estimated that DR is responsible for 4.8% of the 37million cases of blindness throughout the world.[12]

In the recently concluded Nigerian Blindness Survey, DR accounted for 0.02% of the total blindness in Nigerian adults 40years and above.[13] Fortunately, DR has a 10-20 year delay before onset allowing a small window of opportunity for early detection through regular and routine screening and treatment.[3] In our institution, University of Ilorin Teaching Hospital (UITH), Ilorin, Nigeria, with the availability of Laser equipment and the human resources to deliver Laser photocoagulation, the goal is to reduce blindness from DR by providing prompt treatment (laser photocoagulation). This study was therefore designed to identify the risk factors for DR among DM patients.

Materials and Method

This was a cross-sectional hospital-based study, carried out at the Diabetic and the Ophthalmology clinics of UITH, Ilorin, Nigeria from November 2011 to July 2012. A total of 365 diabetic patients had questionnaires administered to obtain information on socio-demographic characteristics, and clinical information on DM. General physical and ocular examinations, and laboratory investigations such as fasting plasma glucose, glycated haemoglobin (HbA1c), fasting serum lipids and urinalysis etc were carried out. Patients with confirmed diagnosis of DM (based on a fasting plasma glucose $\geq$7mmol/L or oral glucose tolerance test $\geq$11.1mmol/L), and those on treatment for DM attending the Diabetic clinic were enrolled. Patients with significant medial opacity in the corneal or crystalline lens (cataract) dense enough to preclude the visualization of the anterior and or posterior segments of the eye, and eligible patients who decline consent were excluded.

Approval for the study was obtained from the Ethics and Research Committee of the UITH, Ilorin. Verbal and informed consent was also obtained from all the enrolees.

About 10ml of venous blood was drawn from the antecubital vein using a vacutainer needle into fluoride oxalate, lithium heparin and EDTA vacuum tubes for fasting blood glucose, fasting serum lipids and HbA1c levels respectively. The blood samples were analysed in the hospital laboratory on the day of collection. About 2ml of urine sample was also collected into a sterile universal sample bottle from the patients for urinalysis. The enrolees were given an identification tally to bring to eye clinic that same day where they had both general and ocular examination

Distant visual acuity was carried out with an illuminated wall mounted Snellen's chart at six meters. Anterior segment examination was carried out with a slit lamp (Haag streit, Bern, Switzerland). Particular attention was paid to anterior chamber depth, presence or absence of significant corneal and/or lens opacity and rubeosis irides. Intra-ocular pressure was measured with Perkins hand held tonometer. The patients thereafter had their pupils dilated with 1% Tropicamide (MydriacylR) and 2.5% phenylephrine. For those with elevated BP, their pupils were dilated with only Mydriacyl.R Dilated funduscopy was carried out with indirect slit lamp bio-microscopy with non contact +90Diopter Volk lens. Direct ophthalmoscopy was also carried out for a full retina and macular examination.

A diagnosis of DR was made where a subject had a minimum of one micro-aneurysm in any field, as well as exhibiting haemorrhages (dot, blot, or flame-shaped) and or hard exudates, or presence of macular oedema. Proliferative DR was diagnosed when there was neo-vascularisation (on the disc or elsewhere), or pre-retinal haemorrhage or vitreous haemorrhage.The patients were graded based on the more severely affected eye using the international clinical diabetic retinopathy disease severity scale.[14] All patients with media opacity significant enough to preclude the retinopathy evaluation were excluded from the analysis. The instruments (Tonometer and weighing scale) were calibrated at the beginning of each day of study.

Statistical analysis

Data collation and editing were done manually to detect omission and ensure uniform coding. The data was entered into a computer and statistical analysis was carried out with Epi-Info Version 6.1 Statistical Software. Frequency tables were generated for all the variables. Quantitative variables were expressed as mean and standard deviation.Cross tabulations were generated between the variables and DR changes. Chi-square was used to determine the significance. Statistical significance was said to have been achieved when the p value is equal to or less than 0.05. The relationship between the variables and DR were also expressed in term of odd ratio (OR) with their 95% confidence interval (95% CI)

Results

Three hundred and sixty-five patients with DM were enrolled in the study. The age of patients ranged from 19 and 90 years with a mean age of 45.8 ±16.3 years. Majority of the patients were in their sixth and seventh decades i.e. 51-70years. (Table 1)

Majority of the patients were females-

Table 1. Age distribution of respondents

Age distribution	Frequency	Percentage (%)
≤20	2	(0.5)
21-30	7	(1.9)
31-40	20	(5.5)
41-50	50	(13.7)
51-60	108	(29.6)
61-70	119	(32.6)
71-80	49	(13.4)
81-90	10	(2.7)
Total	365	(100.0)

Mean±SD = 45.83±16.28

250(68.5%). Type 2 DM was the main type of DM in 352 patients (96.4%). Twelve patients (3.3%) had type 1 DM, and 1 patient (0.3%) had gestational DM. (Figure 1)

Majority of the patients had DM for 1-10years. The mean duration of DM was 14.1 ±13.09 years. Two hundred and three patients (55.6%) had DM for 1-10yrs, 66 patients (18.1%) had DM for 11-20 years, 49 patients (13.4%) had DM for 21-30years, while 47 patients (12.9%) had DM for greater than 30years. (Figure 2)

The majority of the patients, 291(79.7%) were on oral drugs with dietary modification for their blood glucose control. Forty four patients (12.1%) were on oral drugs with dietary modification and insulin. Twenty-one patients(5.8%) were on dietary modification only. Nine patients (2.5%) were on diet with insulin only.

Prevalence of diabetic retinopathy among DM patients

Out of the 365 patients enrolled for the study, 44(12.1%) had features of DR in either or both eyes while 321(87.9%) did not have.

Grades of Diabetic Retinopathy

Out of the 44 patients who had DR, 24 (6.6%) had diabetic macular oedema with and without other features of DR. Mild, moderate, and severe non proliferative DR was seen in 20 (5.5%), 11(3.0%), 1(0.2%) patients respectively while 5 (1.3%) had proliferative DR.

Relationship between respondents' bio-data and diabetic retinopathy

Diabetic retinopathy was not seen in any DM patient 30years and below. However, DR was seen in 12.1% of patients above 30 years (OR=0.0, p=0.607). No significant relationship was observed between the age of respondents and the presence of DR. More females, 31(12.4%) had DR compared to males, 13 (11.3%), though it was not significant. (OR=0.9, p=0.765). Diabetic retinopathy was seen in 3(25%) patients with type 1 DM, and in 41 (11.6%) patients with type 2 DM. No significant relationship was found between the type of DM and the presence of DR. (OR=3.13, p=0.113). A total of 8 (25.0%) patients who had DM for greater than 35years had DR, while 36 (10.8%) who had DM for 35years or less had DR. A significant relationship was observed between the duration of DM and the presence of DR. (OR=0.36, p=0.039). There was no significant relationship between DR and the treatment of DM with insulin, high blood pressure, obesity, and being on treatment for kidney disease, and leg wound (OR=2.21, p=0.06), (OR=0.82, p=0.541), (OR=0.92, p=0.815), (OR=0.82, p=0.596), (OR=0.0, p=0.093) respectively. (Table 2)

Relationship between DR and respondents' biochemical parameters

Out of the 44 patients with DR, 17(12.2%) had HbA1c level equal or below 7.0%, while 27(11.9%) of them had HbA1c values above 7.0%. There was no significant relationship between DR and HbA1c level, serum cholesterol, triglycerides, HDLc and LDLc levels. (OR=1.03, p=0.936), (OR=0.13, p=0.227), (OR=0.00, p=0.679), (OR=0.20, p=0.112), and (OR=0.72, p=1.000) respectively. (Table 3) However, there was a positive relationship between DR and the presence of glycosuria, proteinuria, and micro-

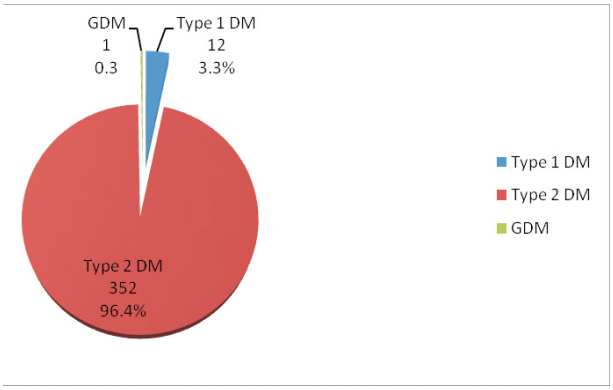

Figure 1: Pie chart showing types of diabetes mellitus in respondents

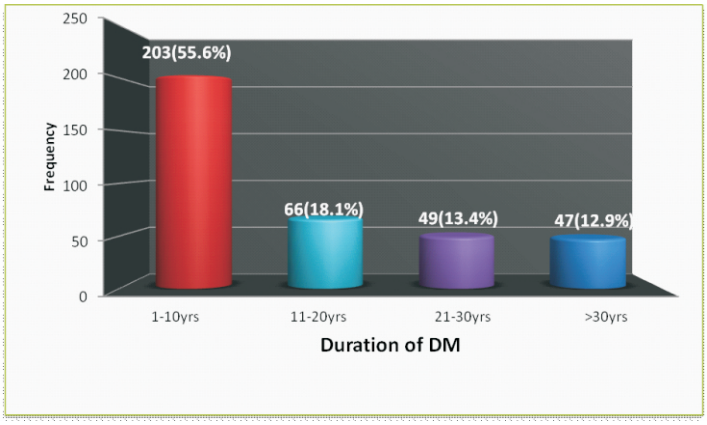

Figure 2: Bar chart showing duration of Diabetes Mellitus in respondents

Table 2: Relationship between respondents' bio-data and DR.

Variable	Diabetic retinopathy					
	Yes (%)	No (%)	χ^2	OR	95%CI	p value
Age of respondents(yrs)						
=30	0(0.0)	9(100.0)				
>30	44(12.4)	312(87.6)	1.26	0.00	0.00-4.36	0.607
Gender						
Male	13(11.3)	102(88.7)				
Female	31(12.4)	219(87.6)	0.09	0.90	0.43-1.88	0.765
Types of DM						
Type I	3(25.0)	9(75.0)				
Type II	41(11.6)	312(88.4)	2.97	3.13	0.63-13.71	0. 113
Age at first diagnosis(yrs)						
=30	14(18.4)	62(81.6)				
>30	30(10.4)	259(89.6)	3.67	1.95	0.92-4.09	0.055
Duration of DM(yrs)						
=35	36(10.8)	297(89.2)				
>35	8(25.0)	24(75.0)	5.54	0.36	0.14-0.95	0.039
Mode of treatment						
With insulin	11(20.8)	42(79.2)				
Without insulin	33(10.6)	279(89.4)	4.43	2.21	0.97-4.98	0.06
Blood pressure						
Normal	28(11.3)	219(88.7)				
Hypertension	16(13.6)	102(86.4)	0.37	0.82	0.40-1.66	0.541
BMI(Kg/m^2)						
Obese	12(11.4)	93(88.6)				
Non-obese	32(12.3)	228(87.7)	0.05	0.92	0.43-1.95	0.815
Treatment for kidney disease						
Yes	1(14.3)	6(85.7)				
No	43(12.0)	315(88.0)	0.854	0.82	0.09-6.96	0.596
Leg wound						
Yes	0(0.0)	18(100.0)				
No	44(12.7)	303(87.3)	0.215	0.00	0.00-0.00	0.093

Table 3. Relationship between DR and respondents' laboratory parameters

Variable	Diabetic retinopathy					
	Yes (%)	No (%)	χ^2	OR	95%CI	p value
Glycated haemoglobin (%)						
= 7	17(12.2)	122(87.8)				
>7	27(11.9)	199(88.1)	0.01	1.03	0.51-2.05	0.936
Cholesterol						
Normal	43(11.8)	320(88.2)				
High	1(50.0)	1(50.00	2.73	0.13	0.00-5.02	0.227
Triglycerides						
Borderline	0(0.0)	3(100.0)				
Desirable	44(12.2)	318(87.8)	0.42	0.000	.00-0.00	0.679
HDL						
High	42(11.7)	318(88.3)				
Low	2(40.0)	3(60.0)	3.73	0.20	0.03-1.75	0.112
LDL						
High	2(9.1)	20(90.9)				
Normal	42(12.2)	301(87.8)	0.19	0.72	0.11-3.35	1.000
Glucose						
Positive	11(32.4)	23(67.6)				
Negative	33(10.0)	298(90.0)	14.57	0.23	0.10-0.52	0.0008
Protein						
Positive	9(37.5)	15(62.5)				
Negative	35(10.3)	306(89.7)	15.68	0.19	0.08-0.47	0.0007
Albumin						
Positive	6(40.0)	9(60.0)				
Negative	38(10.9)	312(89.1)	11.52	0.18	0.06-0.54	0.004

albuminuria (OR=0.23, p=0.0008), (OR=0.19, p=0.0007), and (OR=0.18, p=0.004) respectively. (Table 3)

Discussion

This was a cross sectional study that identified the risk factors for DR among DM patients attending the DM clinic of UITH. The mean age in this study population was lower than that in other Nigerian studies. Ashaye et al[15] and Omolase et al[2] in south west, Nigeria found the mean age of their DM patients to be 57.5 and 57.6 years respectively. Lawan and Mohammed[16] in Kano, north west Nigeria found the mean age of their DM patients to be 54.0years. Nwosu in Nnewi[17] in south east, Nigeria found a mean age of 57.2years. In this study, majority of the patients were in their sixth and seventh decades of life. This is different from that of Lawan and Mohammed[16] who found that majority of their DM patients were in their sixth decade. It is also different from that of Osunbokun in Ibadan, south west Nigeria who found that majority of their DM patients were in their fifth decade.[18] In this study, most of the subjects were females compared to males (68.5% vs. 31.5%). This is similar to the findings by Erasmus et al[19] in Ilorin, north central Nigeria of nearly three decades ago (54.6% vs. 45.4%), and Onakpoya et al[20] in Ile-Ife, south west, Nigeria (61.4% vs. 38.6%).

Similarly, Lawan and Mohammed[16] and Mumba et al[21] in Tanzania found more females than males in their studies (58.9% vs. 41.1%) and (53.5% vs. 46.5%) respectively. However, other authors in other regions of Nigeria(Ashaye et al, Omolase et al, and Nwosu) reported more males than females in their studies.[15,2,17] The higher number of female respondents is probably because the health seeking behaviour of females tends to be better than males, and this may explain the larger population of females in this study. Majority of the subjects with DR had non-proliferative DR. Proliferative DR was present in five patients (1.4%). This is similar to the 1.2% reported by Onakpoya et al[20] in a study of type 2 DM patients in Ile-Ife, and the 2.0% reported by Omolase et al.[2] One of the patients with proliferative DR had tractional retinal detachment, and was promptly referred to another centre for vitrectomy as she could not benefit from laser treatment only. The other four patients with proliferative DR were treated with pan-retinal photocoagulation. The detection of patients with un-treated vision threatening DR (defined by the presence of proliferative DR) is of concern as these people would have gone blind from a potentially treatable cause.

A longer duration of DM was associated with the development of DR in this study. This finding is similar to those of most studies reviewed in Nigeria, which have shown an increased prevalence of DR with increase duration of DM.[2,15,17,22] Studies in other parts of the world also indentified long duration of DM as a major risk factor to developing DR.[8,9,23-27] Comparatively, the duration of DM is known to reflect total glycaemic control and risk factor exposure over time.[26] While this may suggest avenues for primary prevention, the true prospects for that are currently unknown. For example, Aiello et al in a longitudinal study has shown that after 20 years duration, nearly all type 1 DM patients, and approximately two thirds of type 2 DM end up developing DR regardless of their DM control.[26,28] The presence of DR was also found to be associated with glycosuria, proteinuria and micro albuminuria in this study. Micro-albuminuria has been well established as being associated with the risk of DR.[15] Newman et al found a strong evidence for the independent prognostic significance of micro-albuminuria for the development of proliferative DR in type 1 DM but found no such evidence for type 2 DM.[29] Proteinuria is also a known predictor of the development of proliferative DR in type 1 DM, and gross proteinuria is associated with a 95.0% increased risk of developing diabetic macular oedema in type 1 DM.[30,31] Ashaye et al however found no association between DR and microalbuminuria.[15] This may be attributed to the relatively small number of patients they studied.

Several authors have reported poor glycaemic control as a significant risk factor for the presence of DR. Ashaye et al[15] reported elevated mean serial post-prandial plasma glucose level to be associated with an increased risk of developing DR. The Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR)[7,8] also found the presence and severity of DR to be related to higher HbA1c. In this study, poor glycaemic control was not significantly associated with the presence of DR. Majority of the patients (61.9%) had poor glycaemic control (HbA1c >7%), and DR was present in 11.9% of them. Similarly, in patients with good glycaemic control, (HbA1c ≤7) DR was observed in 12.2% of them. Although, out of the 44 patients with features of DR, 27 (61.4%) had elevated HbA1c. Similarly, Erasmus et al [19] in the same institution nearly three decades ago could not establish a significant relationship between the mean fasting plasma glucose levels and DR although the mean fasting plasma glucose was higher in their patients with DR. Al Maskari et al in Al-Ain, United Arab Emirates also did not find any significant association between the degree of glycaemic control and DR in their study population.[26] In USA, data from the Action in Diabetes and Vascular Disease (ADVANCE) trial[32] and the Veterans Affairs Diabetes Trial (VADT) study[33] showed that low HbA1c (<6.5%) did not significantly affect the development or progression of retinopathy.

In this study, insulin treated subjects appear to be more liable to develop DR compared to those not treated with insulin (20.8% vs 10.6%). There was a

positive relationship between the presence of DR and treatment with insulin although it was not statistically significant. Ashaye et al reported that the use of insulin was associated with a seven-fold increase in the risk of developing DR.[15] Al-sarraf et al in Kuwait also observed that insulin-treated patients were more liable to develop DR.[27] Possible explanation for this finding is that, the use of insulin therapy in type 2 DM is an indication of worsening of severity of the disease, as insulin therapy is usually started after failure of oral anti-diabetic drugs in type 2 DM.[34] Also, DR results from prolonged hyperglycaemia that is more likely to be seen in insulin treated type 2 DM patients because of poor acceptance of insulin and delay in the commencement of insulin. This delays better glycaemic control over years as the patient goes on oral drugs for a longer time to avoid insulin.

No significant relationship was demonstrated between the age of diagnosis of DM and retinopathy. Though DR was observed more frequently in patients diagnosed at the age of 30years or younger (18.4%) compared to those diagnosed with DM at greater than 30years of age (10.4%).The WESDR study found a significant association between the presence of DR and the age at diagnosis of DM. With younger age at diagnosis related to more severe DR.[8] Wong et al also demonstrated that a younger age of onset of DM is associated with an inherent susceptibility to DR independent of the duration of DM and glycaemic control.[35] The difference between this study and the aforementioned studies may be due to recall bias. Some of the patients were elderly, and may have had difficulty with recalling the dates of diagnosis of their DM correctly.

Metabolic factors such as blood pressure control, serum lipid and body mass index (BMI) were not significant determinants of the presence of DR in this study. Out of the 2 patients who had elevated serum cholesterol, one of them (50.0%) had DR. Three patients had borderline serum triglyceride level and none had features of DR. LDL was elevated in 22 patients, 2 of whom had features of DR. HDL which is protective against cardiovascular disease was low in 4 patients, 2 of whom had DR. No significant association was demonstrated between serum lipid and the presence of DR. This finding is similar to that of Wong et al in a study of DR in a multi-ethnic cohort in USA. They did not find any association between DR and plasma lipids.[10] However, data from the Early Treatment Diabetic Retinopathy Study (ETDRS) showed that higher levels of serum lipids (LDL, total cholesterol, and triglycerides) were associated with increased risk of hard exudates in the macula, and vision loss in persons with DM.

Less than half of the patients (45.8%) had BP in the hypertensive range. Most had BP within the mild hypertension category (i.e 140-159/90-99 mmHg). No association was demonstrated between their BP reading and the occurrence of DR in this study. This is similar to the findings of Ashaye et al who also reported the absence of association between BP reading and the occurrence of DR. However, several epidemiological studies have shown an association between poor BP control and the presence of DR.[7, 8, 36-38] The difference could be because this BP reading is an average of their BP at a single contact, and not a measure of their BP control over time. Obesity was also found not to be significantly associated with the presence of DR in this study, although majority of our patients were in the normal to overweight category of BMI.

Other factors studied but found not to be significantly associated with the presence of DR in this study were age, gender, the type of DM, presence of kidney disease and leg ulcer. No patient aged 30years and below had DR. All the patients with DR were above 30years of age. No association was found between the age of patients and the presence of DR. This is similar to the findings of Ashaye et al where no association was found between age and the occurrence of DR.[15]

In this study, gender was not significantly associated with the occurrence of DR. This is similar to the findings of Ashaye et al who found no association between the female gender and the occurrence of DR. However, this contrasts with the findings of Khandekar et al in Oman who actually reported a higher prevalence of DR in males.[23] Twenty-five percent of patients with type 1 DM had DR compared to 11.6% of those with type 2 DM with DR, although this was not significant. This may be due to the small number of patients with type 1 DM in this study (0.3%). Out of the seven patients with history of treatment for kidney disease, only one had DR. Although some studies reported relationships between DR and micro-albuminuria, proteinuria and nephropathy,[27,30,39] there was no relationship between the treatment for kidney disease and DR in this study. This could be because of recall bias in the study patients. They may actually not know if they are on treatment for kidney disease or in denial of it. It could also be because of the small number of patients who are on treatment for kidney disease accounting for the non significant association.

Out of the 18 patients with history of leg wound or amputated limp, none had DR. The presence of leg wound was not significantly associated with DR in this study. This could be explained by the small number of patients with leg ulcer. The main limitations of this study, was the possibility of recall bias as this study depended on the patients' ability to recall certain history such as age at first diagnosis of DM, duration of DM, history of kidney disease etc. The exclusion of patients with significant cataract from the analysis may miss out a significant proportion of patients as DM is a cause of cataract independent of DR. A Fundus photography which would have enhanced delineation

of subtle DR changes to be assessed, and objectively documented was not available for most part of this study.

In conclusion, in our patients with DM, longer duration of disease, glycosuria, proteinuria, and micro-albuminuria were significantly associated with DR. However, age, gender, type of DM, age at first diagnosis of DM, the degree of blood sugar control, serum lipids, systemic hypertension, obesity, and presence of kidney disease and leg wound were not.

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