Original Article

Prevalence and risk factors for diabetic retinopathy in north-central Nigeria

Rita O. Ewuga[1], Olukorede O. Adenuga[2], Patricia D. Wade[2] and Jemimah O. Edah[3]

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[1]Department of Ophthalmology, Dalhatu Araf Specialist Hospital, Lafia, Nasarawa State, Nigeria
[2]Department of Ophthalmology, Jos University Teaching Hospital, Jos, Plateau State, Nigeria
[3]Department of Medicine, Jos University Teaching Hospital, Jos, Plateau State, Nigeria

Corresponding author: Dr. Olukorede O. Adenuga **E-mail:** korexmed@yahoo.com
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SUMMARY

Background: To determine the prevalence, pattern and risk factors of Diabetic Retinopathy (DR) among patients with Diabetes Mellitus (DM) in a tertiary hospital in north-central Nigeria.
Settings and Design: This was a hospital-based cross-sectional study conducted in Jos, north-central Nigeria.
Materials and Methods: Consecutive adult patients with DM attending the endocrinology clinic who consented to the study were examined over a six-month period. Demographic data, duration of diabetes and history of any systemic disorder were obtained for each patient. A detailed ocular examination and fundus photography were performed and results of blood investigations such as Fasting Blood Glucose (FBG), Glycosylated Haemoglobin (HbA1c) and serum lipid profile were analysed. Data analysis was done with Statistical Package for Social Sciences (SPSS) version 16.0 software.
Results: Three hundred and fifty-six patients were examined comprising of 120 (33.7%) males and 236 (66.3%) females giving a male to female ratio of 1:2. The mean age of the study population was 56.6 ± 12.3 years. Diabetic retinopathy and macular oedema were present in 66 (18.5%) and 51 (14.3%) patients respectively. Diabetes diagnosis of 10 years and above, FBG and HbA1c all had a statistically significant association with DR with p values <0.001.
Conclusion: The prevalence of DR was 18.5% in a hospital cohort of diabetic patients in north-central Nigeria with long duration of diabetes and poor glycaemic control being the major risk factors for retinopathy. These findings highlight the need for regular eye screening and good glycaemic control in individuals with diabetes in our environment.

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Keywords: Diabetic retinopathy, diabetes mellitus, macular oedema, prevalence, blindness

INTRODUCTION

Diabetic Retinopathy (DR) is the most common microvascular complication of Diabetes Mellitus (DM) and the most common cause of blindness in the working-age population in industrialized nations.[1] The World Health Organisation (WHO) has estimated that DR is responsible for 1% of the 39 million cases of blindness worldwide.[2]

Different studies have shown considerable variability in the prevalence of DR among diabetic patients with rates ranging from 17.6% in India[3] to 33.2% in the United States of America.[4] In West Africa, the prevalence of DR was found to be 17.9% in patients with type 2 diabetes.[5] Nearly 50 years ago, DR was thought to be rare in Nigeria with an incidence of 4.6%.[6] This has increased over the years with hospital-based studies now reporting a range of 15%-42%.[7-10]

With the increasing number of people with diabetes, the number of DR and vision-threatening DR, which includes severe Non-proliferative Diabetic Retinopathy (NPDR), Proliferative Diabetic Retinopathy (PDR) and Diabetic Macular Oedema (DMO), has been estimated to rise to 191 million and 56.3 million, respectively by 2030.[11]

Development of DR correlates well with the duration of DM.[12] More than 77% of patients who have had diabetes for more than 20 years will have some form of retinopathy.[13] Thus with increasing life expectancy, DR and its ensuing blindness will also increase.[14] The aim of this study, therefore, was to determine the prevalence, pattern and risk factors of DR among persons with DM attending the endocrinology clinic of a tertiary hospital in north-central Nigeria.

This would provide a data base that will aid in the planning and establishment of DR screening and treatment services across the region.

METHODS

This was a cross-sectional, descriptive hospital-based study carried out at a tertiary hospital in Jos, Plateau state, north-central Nigeria. The study adhered to the tenets of the Declaration of Helsinki and approval was obtained from the Ethics Committee of the hospital. The study population included consecutive new and old adult patients (≥18years) with DM seen in the endocrinology clinic over a period of 6 months from October 2015 to March 2016. Patients who were not willing to participate in the study and patients with ocular media opacities that precluded posterior segment examination after full mydriasis were excluded.

Informed consent was obtained from each patient in the clinic before enrolment in the study. The patient's Fasting Blood Glucose (FBG) was then measured using a glucometer. Laboratory tests including Glycated Haemoglobin (HbA1c) and serum cholesterol which were routinely requested for by the endocrinologists (not exceeding 3 months) were retrieved from the patients' case notes. For those who did not have recent results, blood samples were taken for analysis at the hospital laboratory. As a measure of good control, FBG was taken as 3.9-7.0 mmol/L, HbA1c <7% and total serum cholesterol <5.2mmol/L.[15,16]

The Blood Pressure (BP) was taken with the subjects sitting quietly after resting for a few minutes. Hypertension was defined as BP ≥140/90 mmHg.[17] The weight and height were also measured using standard equipment. The weight was recorded to the nearest 0.1kg and the height to the nearest 0.01m. The Body Mass Index (BMI) was then calculated using the formula: weight (in kilograms) divided by height (in meters) squared. The BMI was classified using the WHO standard categories as underweight (< 18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2) or obese (≥ 30.0 kg/m^2).[18] A comprehensive ocular examination was performed on all the patients. The anterior segment was examined with a slit lamp and pupillary reaction assessed with a pen torch. The pupils were then dilated using 1% tropicamide and 5% phenylephrine eye drops. Posterior segment examination involved slit lamp biomicroscopy with a 78D lens and fundus photography.

Retinopathy was considered to be present if any characteristic lesion as defined by the International Clinical Diabetic Retinopathy Disease Severity Scale (ICDRDSS)[19] was present: microaneurysms, haemorrhages, hard exudates, venous beading, intraretinal microvascular abnormalities, and new vessels. The stage of DR was defined as either mild, moderate, severe NPDR or as PDR. Macular oedema was defined according to the International Clinical Diabetic Macular Oedema Disease Severity Scale[19] and includes presence of retinal thickening or hard exudates in the posterior pole.

Fundus photograph was taken with the Opto angiocam ADS 1.3 FA (Opto Electronica S/A, Sao Paulo, Brazil). Ocular examination was carried out by the first author. The data obtained was entered into Microsoft excel spread sheet and analysed with Statistical Package for Social Sciences (SPSS) version 16.0 software. Frequency distribution tables were generated for all data collected. The mean, median, range and standard deviations were determined for continuous variables. Qualitative variables were presented using tables, percentages and pie charts where appropriate.

Tests of significance were done using Pearson's chi-square test and Student's t-test. The chi square test was used to determine the association between qualitative variables (e.g. gender, control of BP, HbA1c and FBS) and DR while the Student's t-test was used to determine the association between quantitative variables (e.g. age, mean FBS, total cholesterol and HbA1c) and presence of DR. A p-value of <0.05 was considered as statistically significant.

RESULTS

A total of 370 diabetic patients were seen in the endocrinology clinic during the study period. Five patients refused pupillary dilatation and nine were excluded from the study after dilatation due to dense cataracts which precluded further view of the fundus. Three hundred and fifty-six patients made up of 120 (33.7%) males and 236 (66.3%) females (male:female ratio 1:2) therefore, met the study criteria and had detailed ocular examination. Six (1.7%) patients had type 1 DM while the remaining 350 (98.3%) had type 2 DM. Taking the presence or absence of DR in at least one eye, 66 patients (129 eyes) had some form of DR, giving a prevalence of 18.5%. These comprised of 24 (36.4%) males and 42 (63.6%) females. This gender difference was not statistically significant (p = 0.61). The mean age of the study population was 56.6 ± 12.3 years (range 21-89 years, median 57.0 years). Majority (89.9%) of the patients were 41 years and above with 185 (52%) between 41 and 60 years (Table 1).

The mean age of patients with DR was 55.6 ± 9.9 years while the mean age of patients without DR was 56.6 ± 12.8 years. This difference was not statistically significant with a p value of 0.97. One hundred and sixty-six (57.2%) patients without DR had diabetes for less than 10 years while most of the patients with DR (49, 74.2%) had DM for 10 years and above (Table 2).

Table 1 Relationship between age and prevalence of diabetic retinopathy

Age (years)	DR Absent n (%)	DR Present n (%)	Total n (%)	X^2	p-value
21-30	9 (3.1)	0	9 (2.5)	12.61	0.05
31-40	23 (7.9)	4 (6.1)	27 (7.6)		
41-50	65 (22.4)	13(19.7)	78 (21.9)		
51-60	77 (26.6)	30 (45.5)	107 (30.1)		
61-70	79 (27.2)	14 (21.2)	93 (26.1)		
71-80	34 (11.7)	4 (6.1)	38 (10.7)		
≥81	3 (1.0)	1 (1.5)	4 (1.1)		
Total	290 (100)	66 (100)	356 (100)		

Table 2 Relationship between duration of diabetes mellitus and prevalence of diabetic retinopathy

Duration of DM (years)	No DR n (%)	DR n (%)	Total n (%)	X^2	p-value
0-4	99 (34.1)	11(16.7)	110 (30.9)	24.9	<0.001
5-9	70 (24.1)	6 (9.1)	76 (21.3)		
10-14	65 (22.4)	22 (33.3)	87 (24.4)		
15-19	26 (9.0)	14 (21.2)	40 (11.2)		
20-24	19 (6.6)	9 (13.6)	28 (7.9)		
25-29	8 (2.8)	3 (4.5)	11 (3.1)		
≥30	3 (1.0)	1 (1.5)	4 (1.1)		
Total	290 (100.0)	66 (100.0)	356 (100.0)		

The mean duration of diabetes was 9.53 ± 7.1 years (range: 0.08 to 35.0 years, median 8.0 years). Patients with and without DR had a mean duration of 13.2 ± 7.0 years and 8.7 ± 7.0 years respectively. This difference was statistically significant (p <0.001). The mean value for BMI (table 3) was 29.4 in patients without DR and 27.8 in patients with DR. This difference was statistically significant (p=0.02). The mean systolic BP of the cohort was 134.3 ± 21.4mmHg (range 80 – 240 mmHg). There were 199 (55.9%) patients who had systolic BP <140 mmHg. The mean diastolic blood pressure of the study subjects was 82.1 ± 12.2 mmHg (range 50 – 130mmHg). A total of 214 (60.1%) patients had diastolic BP < 90 mmHg (Table 4). The difference in BP control in patients with and without DR was not statistically significant as shown in Table 4.

Mean values for FBG, HbA1c and total serum cholesterol were higher in participants who had DR. These differences were statistically significant for FBG (p<0.001) and HbA1c (p<0.001) as shown in Table 3.

Table 3 Relationship between body mass index and laboratory investigations with prevalence of diabetic retinopathy

Variable	No DR	DR	T	p-value
Body mass index	29.4±5.1	27.8±4.8	2.34	0.02
Fasting blood glucose (mmol/L)	8.3±3.3	10.3±5.1	4.06	<0.001
Glycated haemoglobin (%)	8.7±2.7	10.5±2.7	4.87	<0.001
Total cholesterol (mmol/L)	5.1±1.5	5.3±1.6	1.01	0.31

Table 4 Risk factors and diabetic retinopathy

Parameters	DR Absent n (%)	DR Present n (%)	Total n (%)	X^2	p-value
Systolic BP					
Good control	164 (56.6)	35 (53.0)	199 (55.9)	0.27	0.60
Poor control	126 (43.4)	31 (47.0)	157 (44.1)		
Total	290 (100.0)	66 (100.0)	356 (100.0)		
Diastolic BP					
Good control	175 (60.3)	39 (59.1)	214 (60.1)	0.04	0.85
Poor control	115 (39.7)	27 (40.9)	142 (39.9)		
Total	290 (100.0)	66 (100.0)	356 (100.0)		
BMI					
Underweight	4 (1.4)	0	4 (1.1)	4.92	0.04
Normal weight	48 (16.6)	20 (30.3)	68 (19.1)		
Overweight	113 (39,0)	25 (37.9)	138 (38,8)		
Obese	125 (43.1)	21 (31.8)	146 (41.0)		
Total	290 (100.0)	66 (100.0)	356 (100.0)		
FBG					
Good control	133 (45.9)	21 (31.8)	154 (43.3)	4.32	0.04
Poor control	157 (54.1)	45 (68.2)	202 (56.7)		
Total	290 (100.0)	66 (100.0)	356 (100.0)		
HbA1c					
Good control	60 (20.7)	6 (9.1)	66 (18.5)	4.79	0.03
Poor control	230 (79.3)	60 (90.0)	290 (81.5)		
Total	290 (100.0)	66 (100.0)	356 (100.0)		
Total Cholesterol					
Normal	196 (67.6)	39 (59.1)	235 (66.0)	1.73	0.19
Abnormal	94 (32.4)	27 (40.9)	121 (34.0)		
Total	290 (100.0)	66 (100.0)	356 (100.0)		

Of the 712 eyes of 356 patients examined, 583 (81.9%) had no DR, 107 (15.0%) had NPDR while 22 (3.1%) had PDR. Twenty-four (6.7%) patients had bilateral mild NPDR, 22 (6.2%) bilateral moderate NPDR, two (0.6%) bilateral severe NPDR and seven (1.9%) bilateral PDR. Three (0.8%) patients had unilateral DR (one mild NPDR and two moderate NPDR) while eight had varying stages of DR in both eyes.

Diabetic macular oedema was present in 92 (12.9%) eyes of 51 (14.3%) patients and was bilateral in 41 (11.5%) patients. Forty (78.4%) of these patients with DMO also had associated DR. None of the six patents with type 1 DM had DR or DMO.

DISCUSSION

The mean age of the patients in this study (56.6 years) is in agreement with findings of similar studies in south west and north west Nigeria.[7,9,10] For countries classified by the World Bank as being high-income countries, most people with diabetes are aged over 60 years, whereas for low- and middle-income countries most people with diabetes are of working age, between 40 and 60 years.[20] It is, therefore, not surprising to find that more than 50% of the patients in this study were within this age group. Similar to the finding by Ashaye et al[10] in Ibadan, south west Nigeria we did not find any statistically significant difference between the mean age of patients with and without DR.

The prevalence of DR in this study was 18.5%. This compares favourably with 20.5% reported by the Nigerian Blindness and Visual Impairment Survey[21] and falls within the range of 15%-42% reported by previous hospital-based studies in the country.[7-10] In contrast to our finding, however, higher prevalence rates were reported in similar studies in Egypt,[22] Turkey,[23] and India.[24] These variations may be as a result of differences in sample size, classification system used to define the presence of DR and examination method used. Classification of DR was done using the ICDRDSS classification in this present study. This classification is simple to use, easy to remember and based on scientific evidence.[25]

About 11% of the patients with DR in this study had PDR. This contrasts with less than 4% reported in most studies in Nigeria [7,9,10] with the exception of the study by Nwosu[8] in south east Nigeria which found a prevalence of 26%. In studies in Egypt,[22] Turkey,[23] and India,[24] PDR accounted for 48%, 58% and 15% respectively of cases of DR. Without treatment 50% of all patients with PDR will become blind within 5 years of diagnosis.[26] Early detection and treatment is therefore essential as visual impairment from DR can compromise patients' ability to successfully manage their disease, resulting in a negative impact on the incidence of other DM complications and overall life expectancy of the patient.

Diabetic macular oedema occurs apart from the stage of DR and should be evaluated independently.[27] It is the most common cause of moderate or severe visual loss in diabetic patients and is invariably present in patients with type 2 DM with PDR.[27,28] The risk factors for DMO are, however, largely similar to DR.[28]
The prevalence of DMO in this study (14.3%) is in agreement with 14.8 % reported in Ekiti, south west Nigeria[29] but contrasts with 56% reported in Nnewi, south east Nigeria.[8] Differences in sample size may be a factor in this wide difference in prevalence rates of DMO in the country. Our observation also correlates well with findings in Egypt (16%)[22] and India (19%).[24] Diabetic macular oedema can substantially affect independence and quality of life of a patient as it affects central vision leading to decline in vision ranging from slight visual blurring to blindness.[30]

There was no significant association between gender and DR in this study. Previous reports have shown an inconsistent relationship between gender and DR. Some studies have reported the male gender as an independent risk factor for DR,[3,12] while others, in agreement with our observation did not find any statistically significant association between DR and gender.[19,23,26,27,31,32]

The duration of diabetes was found to be significantly associated with the presence of DR in this report. This is consistent with findings from previous studies which showed that a longer diabetes duration was an independent risk factor for DR.[3,4,10,12] Long duration of diabetes has been described as the most important and strongest risk factor associated with development of DR.[33] Diabetes duration reflects total glycaemic control and risk factor exposure over time.[34]

Hypertension is another major risk factor for the development of micro-vascular as well as macro-vascular complications in diabetes.[35] The United Kingdom Prospective Diabetes Study (UKPDS) showed that, among patients with type 2 DM, tight BP control resulted in a significant reduction in progression of DR as well as a significant decrease in vision loss and need for laser photocoagulation compared to less control.[36] Most of the patients in this study including those with DR had achieved good BP control and hypertension was not found to be a risk factor. This is similar to the finding by Ashaye et al.[10]

Hyperglycaemia is one of the most important determinants of diabetic microvascular complications.[37,38] The Chennai Urban Rural Epidemiological Study[34] demonstrated a significant increase in the prevalence of DR with increasing HbA1c levels while the Diabetes Control and Complications Trial (DCCT) in type 1 diabetes[39] and the UKPDS in type 2 diabetes[40] highlighted the long-term benefits of glycaemic control.

The DCCT in type 1 DM and UKPDS in type 2 DM also demonstrated that intensive glycaemic control reduces both the development and progression of DR, with the beneficial effects persisting up to 10–20 years. Measurement of HbA1c is considered the test of choice for monitoring and management of diabetes as it provides a reliable measure of chronic glycemia and correlates well with the risk of long-term diabetes complications.[41] We found a significant association between poor glycaemic control and DR in this present study.

This is consistent with previous reports.[12,23,34] Only 18.5% had good glycaemic control using HbA1c compared to 43.3% using FBG. This disparity is probably due to patients becoming more compliant with their medications when they know they have a doctor's appointment giving rise to a normal FBG on clinic days.

A high total serum cholesterol has been shown to be associated with a higher prevalence of DMO.[42] Estimation of serum total cholesterol and lipids is therefore essential in DR, especially in patients with DMO. Previous studies have also demonstrated that total cholesterol and serum low-density lipoprotein cholesterol are associated with the presence of hard exudates in patients with DR.[43,44] Most of the patients in this study had good control of serum lipids though, patients with DR had higher mean serum cholesterol.

The effect of obesity on DR has been relatively well-studied but with inconclusive and conflicting findings.[45] In this present study, patients with and without DR were on the average overweight though the mean BMI was found to be higher among patients without DR. Similarly, studies in south west Nigeria,[10] China[46] and Singapore[47] also found an inverse relationship between BMI and DR.

The exact mechanisms underlying the inverse association between BMI and DR are uncertain.[48] It may not be that higher BMI is protective towards DR, but that individuals with lower BMI may have more severe DM (as patients with decompensated disease may undergo a catabolic phase resulting in unintentional weight loss) and thus have a higher risk of developing DR.[48] Lu et al also attributed this inverse relationship to better pancreatic β-cell function in overweight individuals.[46] In contrast to our observation, however, studies in Turkey[23] and Australia[49] found obesity to be an independent risk factor for DR with persons with higher BMI being more likely to have DR and more severe stages of DR.

The effect of obesity may be due to its correlation with HbA1c and systolic BP. Katusić et al[50] observed a significant deterioration of HbA1c and a significant increase in low density lipoprotein-cholesterol, systolic and diastolic BP with increase in BMI. The observation of a lower prevalence of DR in patients with a higher BMI in this study should therefore, be interpreted with caution as overweight and obesity have been associated with many health risks including DM as well as overall mortality.[48,51,52]

A limitation of this study was our inability to do optical coherence tomography and Fundus Fluorescein Angiography (FFA) due to lack of necessary equipment. Optical coherence tomography would have been helpful in evaluating the macula for oedema while FFA would have assisted in determining the presence or absence of neovascularization and macula ischaemia in doubtful cases.

CONCLUSION

Poor glycaemic control and duration of diabetes were the major risk factors for DR in our study. These findings further stress the need for regular screening for DR and good glycaemic control in individuals with diabetes in our environment.

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