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Original Research Article

Prevalence and factors associated with diabetic retinopathy among type 2 diabetic patients in Bangladesh: a hospital based cross-sectional study

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ABSTRACT

Background: Diabetes mellitus is a major health problem in Southeast Asia and diabetic retinopathy is one of its most debilitating complications. Nevertheless, fundoscopy and systematic evaluation of non-adherence to drug therapy are not regularly done in individuals with diabetes in Bangladesh due to limited resources. Therefore, the prevalence of diabetic retinopathy and its determinants with non-adherence to drug therapy are not known. We, therefore, screened for diabetic retinopathy, non-adherence to drug therapy and other associated factors at a tertiary care hospital in Bangladesh.
Methods: Between May 2017 to September 2017, we conducted a cross-sectional study of 489 systematically recruited asymptomatic, at least one-year type-2 diabetic individuals on medication and attending the outpatient department of the BIHS tertiary care centre in Dhaka, Bangladesh. We obtained a medical history, physical examination, routine laboratory tests, questionnaires, and fundus photography.
Results: The prevalence of diabetic retinopathy among T2DM patients was 18.8%. Clinical factors associated with the presence of diabetic retinopathy were uncontrolled fasting blood glucose, known duration of diabetes of ≥10 years and self-reported non-adherence to drug therapy. With a known duration of diabetes of 15 years or more, the prevalence of diabetic retinopathy rose to 40%.
Conclusions: Undiagnosed diabetic retinopathy is still common among patients in Bangladesh, even at tertiary care centres. It is associated with longer disease duration, poor metabolic control and self-reported non-adherence to therapy. Regular screening for diabetic retinopathy should therefore be implemented also in resource-limited settings and further efforts should be made to improve the patients' drug adherence and metabolic control.

Keywords: Diabetes, Diabetic retinopathy, Drug adherence, Fundus photography

INTRODUCTION

The prevalence of diabetes mellitus has been steadily increasing for the past three decades and its economic, social and healthcare impacts will be seen mainly in low and middle-income countries.[1] Diabetic Retinopathy (DR) is the most common microvascular complication of diabetes and the leading cause of blindness worldwide.[2]

In 2010, almost 2% of individuals with diabetes worldwide were legally blind and 10.2% had visual impairment.[3] The World Health Organization (WHO) has estimated that every individual who had diabetes for over 20 years will have some form of DR and that DR is responsible for 4.8% of the 37 million cases of blindness throughout the world.[4] With this, DR is the most frequent cause of acquired blindness among adults aged 20–74 years.[5] However, appropriate treatment can reduce the risk of blindness and also moderate vision loss because of DR by at least 90%.[4]

The prevalence of DR differs between patient populations in different countries and settings. It ranges from 14% to 40%.[6] Some previous studies even showed that individuals with impaired glucose tolerance could also show signs of DR.[7,8]

Among South Asians, secondary complications of diabetes start early and progress rapidly.[9,10] In Bangladesh, it is therefore expected that diabetic secondary complications, like DR, will increase along with the rising trend of diabetes mellitus. One nationally representative survey evaluating the extent of blindness and the main causes of visual impairment in Bangladeshi adults found a low level of DR as the primary cause of visual impairment.[11] However, in a recent population-based study in rural Bangladesh by Afroza Akther et al, the prevalence of DR among diabetic, pre-diabetic and non-diabetic subjects was 21.6% (95% CI 11.2–32.0%), 13% (95% CI 3.4–22.6%) and 3.5% (95% CI 2.2–4.8%), respectively.[12] Furthermore, in 2008, a retrospective study at the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorder (BIRDEM) by Rumana Ahamed et al. found a cumulative incidence of DR over 15 years of 50.6%.[13]

The major risk factors for DR are chronic hyperglycemia and hypertension and one possible reason for both of these factors is non-adherence to the prescribed drug therapy, which, in turn, may e.g. be due to insufficient patient education or financial reasons.[14-16] In Bangladesh, many individuals with diabetes still experience chronic hyperglycemia and severe diabetic complications.[9,17] Although very few studies conducted on the prevalence of DR. But there is no previous study conducted to find the determinants of DR with non-adherence to drug therapy. We, therefore, conducted a study among outpatients of a tertiary diabetes care centre in Bangladesh and screened for DR, non-adherence to drug therapy and other clinical characteristics.

METHODS

Study setting

A cross-sectional, observational study was conducted in the outpatient department of the Bangladesh Institute of Health Science (BIHS) in Dhaka, Bangladesh. BIHS is a tertiary care hospital (23047’51.216’’ N; 90021’10.8’’ E) located in Dhaka, which is the capital city of Bangladesh.

Sample size and sampling technique

The sample size was determined using a single population proportion formula with the assumption of the unknown prevalence of Retinopathy, 95% confidence level, and a 5% margin of error. Therefore, final sample size after the addition of 25% nonresponse was 512. However, due to time constraints, we managed 489 patients. Study participants were selected using a systematic random sampling technique based on daily attendance in the hospital.

Data collection

Adults with type 2 diabetes for at least one year, on antidiabetic medication and free from acute concomitant diseases, such as heart attack or stroke, who attended the clinic for a routine visit were included consecutively between May and September 2017.

Socio-demographic and clinical characteristics were collected using a pretested, semi-structured and interviewer-administered questionnaire. The patient’s self-reported adherence to drug therapy was collected by a face-to-face interview technique. Blood pressure, height, weight, waist to hip ratio, fasting plasma glucose (FPG) and 2 hours after postprandial glucose (2hPPG) were recorded for every participant. Retinal fundus photography was obtained from all participants.

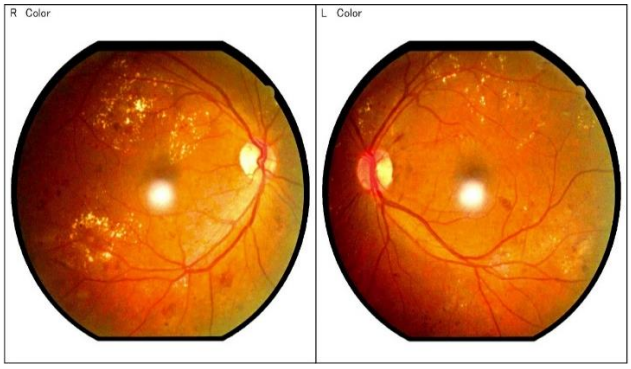

Figure 1: Retinal fundus photographs of right and left eye of a patient with severe NPDR.

Assessment of DR

The detection of DR by retinal photography has been validated previously.[18] Digital colour images were captured from each eye (Figure 1) and the severity of DR was categorized according to the international clinical DR severity scales recommended by the Global Diabetic Retinopathy Project Group.[19] The photographs were evaluated by a senior ophthalmologist and graded as no retinopathy (NDR), mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR and

PDR. HbA1c, Lipid status, and Serum Creatinine were recorded as available

Assessment of non-adherence to drugs, diet and physical activities

Non-adherence to the prescribed drug therapy was self-reported via a questionnaire.[20] Each medicine was checked separately according to the prescription by the attending physician. Non-adherence was recorded if the study participant indicated the following statements regularly (1) changes the prescribed amount and dose of medicine, (2) doesn't observe the time the medicine should be taken, (3) takes more than the prescribed dose and (4) takes less than the prescribed dose. In our study, a participant was classified exercise-adherent if she or he reported exercising for at least 30 minutes per day and at least 5 days a week, corresponding to 150 minutes per week.[21]

Regarding dietary adherence, the patient was considered non-adherent if they did not follow the recommended diet chart (total kcal/day ±10%) provided by a nutritionist or dietitian. Moreover, not following specific meal times and recommended quality and quantity of food was also considered dietary non-adherence.[20] Food consumption and daily calory intake were assessed using the 72-hour dietary recall method.[22,23]

Data management and statistical analysis

A standard data entry interface was designed using Microsoft Office Access for entering study data. Data were checked and cleaned before analysis. IBM SPSS version 24.0 was used in the analysis. Metric variables are represented as mean±standard deviation and categorical variables as numbers and percentages.

Univariate and multivariate logistic regression models were used to identify factors associated with the presence of DR.

P values were calculated for each of the test statistics and estimates using appropriate methods and a p value equal to or greater than 0.05 was used as the standard to declare an estimate or test statistic to be non-significant.

Ethical consideration

Informed written consent was obtained from all participants after a full explanation of the nature, purpose, and procedures of the study. Ethical approval was obtained from the Ethics and Research Review Committee of BUHS in Dhaka, Bangladesh. The Ethics Committee of LMU in Munich, Germany, also consented to this study.

RESULTS

A total of 489 participants with a complete retina evaluation were included in this study. Among them, 280 were female (57%) and 209 were male (43%). The mean age of the participants was 52.4±11.2 years. The mean duration of diabetes was 9.7±7.0 years. More than half of the study subjects were housewives (51.1%). 16.0% of the participants came from the high-income class and 31.5% had a lower middle income. 19.6% of the study subjects were obese, 47.5% were overweight and 1.4% were underweight. Based on FPG, 339 (69.3%) of the participants had uncontrolled diabetes, whereas 150 (30.7%) had adequate metabolic control. The full baseline data are portrayed in Table 1. We detected diabetic retinopathy in 92 individuals (18.8%; Table 1).

The prevalence of the different types of DR is depicted in Figure 2. Overall, the prevalence of DR increased with the known duration of diabetes, from 3% with less than 3 years to 40% with 15 years or more (Figure 3). Higher drug non-adherence was observed in individuals with DR compared to those without DR (Figure 4).

In univariate logistic regression analyses, higher age, FPG, PPG, HbA1c and duration of diabetes, as well as the presence of chronic kidney disease, uncontrolled blood pressure and non-adherence to drug therapy were associated with diabetic retinopathy (Table 2). In a multivariate logistic regression analysis, uncontrolled fasting plasma glucose [adj. OR 2.57 (1.3-5.08); p=0.007], a known diabetes duration of 10 years or more [adj. OR 9.51 (3.85-23.46); <0.001] and non-adherence to drug therapy [adj. OR 1.82 (1.07-3.10); p=0.027] remained independently associated with diabetic retinopathy (Table 3).

Table 1: Baseline characteristic of study subjects (n=489).

Characteristics	N	%
Gender		
Male	209	42.7
Female	280	57.3
Age (years)		
≤40	88	18.0
41-55	211	43.1
>56	190	38.9
Mean±SD	52.4±11.2	

Continued.

Characteristics	N	%
Education		
Illiterate	85	17.4
Secondary and below	219	44.8
Higher secondary and above	185	37.8
Occupation		
Unemployed/retired	84	17.2
Service	89	18.2
Business	66	13.5
Housewife	250	51.1
Family income		
Low-middle income (<Tk.21271)	154	31.5
Upper-middle income (Tk. 21271- Tk.65761)	257	52.5
High Income (>Tk.65761)	78	16.0
Mean±SD	19970.6±11.2	
BMI		
Underweight (<18.5 kg/m^2)	7	1.4
Normal (18.5-24.99 kg/m^2)	154	31.5
Overweight (24.99-29.99 kg/m^2)	232	47.5
Obese (≥30.0 kg/m^2)	96	19.6
Mean±SD	26.9±3.9	
WHR		
Normal (male ≤0.90 and female ≤0.85)	11	2.2
Health risk (male >0.90 and female >0.85)	478	97.8
Family history of diabetes		
Yes	313	64.0
No	176	36.0
FPG		
Uncontrolled (>7.2)	339	69.3
Control (≤7.2)	150	30.7
Mean±SD	9.3±3.5	
2h-PPG		
Uncontrolled (>10)	351	71.8
Control (≤10)	138	28.2
Mean±SD	12.8±4.5	
SBP		
Uncontrolled (>140 mm of hg)	123	25.2
Control (≤140 mm of hg)	366	74.8
Mean±SD	128±15.5	
DBP		
Uncontrolled (>90 mm of hg)	98	20.0
Control (≤90 mm of hg)	391	80.0
Mean±SD	79.9±8.5	
Duration of diabetes		
Less than 10 years	280	57.3
10 years or more	209	42.7
Mean±SD	9.7±7.0	
Drug adherence		
Adherence	252	51.5
Non-adherence	237	48.5
Physical activities (n=464)		
Adherence	197	42.5
Non-adherence	267	57.5
Dietary adherence (n=484)		
Adherence	133	27.5

Continued.

Characteristics	N	%
Non-adherence	351	72.5
Fundus photography		
NDR	397	81.2
DR	92	18.8

Note: BMI, body mass index; WHR, waist-hip ratio; FPG, fasting plasma glucose; PPG, postprandial glucose; HbA1c, Hemoglobin A1C; HDL, high density lipoprotein; LDL, low density lipoprotein; TG, triglyceride; eGFR, estimated glomerular filtration rate; SBP, systolic blood pressure, DBP, diastolic blood pressure.

Table 2: Association between socio-demographic, anthropometric and clinical variables with the presence (DR) vs. absence (NDR) of diabetic retinopathy.

Characteristics	DR N (%)	NDR N (%)	P value
Gender			
Male	45 (21.53)	164 (78.47)	0.184
Female	47 (16.79)	233 (83.21)	
Age (years)			
≤40	9 (10.23)	79 (89.77)	0.002
41-55	33 (15.64)	178 (84.36)	
>56	50 (26.32)	140 (73.68)	
Education			
Illiterate	12 (14.12)	73 (85.88)	0.436
Secondary and below	45 (20.55)	174 (79.45)	
Higher secondary and above	35 (18.92)	150 (81.08)	
Occupation			
Unemployment	20 (23.81)	64 (76.19)	0.343
Service	17 (19.1)	72 (80.9)	
Business	15 (22.73)	51 (77.27)	
Housewife	40 (16.0)	210 (84.0)	
Monthly family income			
Low-middle income (<Tk.21271)	37 (24.03)	117 (75.97)	0.125
Upper-middle income (Tk. 21271- Tk.65761)	41 (15.95)	216 (84.05)	
High income (>Tk.65761)	14 (17.95)	64 (82.05)	
BMI			
Underweight (<18.5 kg/m^2)	2 (28.57)	5 (71.43)	0.117
Normal (18.5-24.99 kg/m^2)	38 (24.68)	116 (75.32)	
Overweight (24.99-29.99 kg/m^2)	37 (15.95)	195 (84.05)	
Obese (≥30.0 kg/m^2)	15 (15.63)	81 (84.38)	
WHR			
Normal (male≤0.90 and female≤0.85)	2 (18.18)	9 (81.82)	0.999
Health risk (male>0.90 and female>0.85)	90 (18.83)	388 (81.17)	
Family history of diabetes			
Yes	51 (19.92)	205 (80.08)	0.511
No	41 (17.6)	192 (82.4)	
Uncontrolled (>7%)	60 (23.26)	198 (76.74)	
FPG			
Uncontrolled (>7.2)	78 (23.01)	261 (76.99)	<0.001
Control (≤7.2)	14 (9.33)	136 (90.67)	
2hPPG			
Uncontrolled (>10)	81 (23.08)	270 (76.92)	<0.001
Control (≤10)	11 (7.97)	127 (92.03)	
No CKD (eGFR>60 ml/min/1.73 m²)	40 (18.52)	176 (81.48)	
SBP			
Uncontrolled (>140 mm of hg)	31 (25.2)	92 (74.8)	0.036
Control (≤140 mm of hg)	61 (16.67)	305 (83.33)	

Continued.

Characteristics	DR N (%)	NDR N (%)	P value
DBP			
Uncontrolled (>90 mm of hg)	19 (19.39)	79 (80.61)	0.871
Control (≤90 mm of hg)	73 (18.67)	318 (81.33)	
Duration of diabetes (years)			
<5	7 (5.19)	128 (94.18)	<0.001
5-10	20 (11.05)	161 (88.95)	
≥10	65 (37.57)	108 (62.43)	
Drug adherence			
Adherence	34 (13.49)	218 (86.51)	0.002
Non-adherence	58 (24.47)	179 (75.53)	
Physical adherence			
Adherence	33 (16.75)	164 (83.25)	0.396
Non-adherence	53 (19.85)	214 (80.15)	
Dietary adherence			
Adherence	24 (18.05)	109 (81.95)	0.904
Non-adherence	65 (18.52)	286 (81.48)	

Note: BMI, body mass index; WHR, waist-hip ratio; FPG, fasting plasma glucose; PPG, postprandial glucose; HbA1c, Hemoglobin A1C; HDL, high density lipoprotein; LDL, low density lipoprotein; TG, triglyceride; eGFR, estimated glomerular filtration rate; SBP, systolic blood pressure, DBP, diastolic blood pressure.

Table 3: Multivariate logistic regression to assess the factors associated with the presence (DR) vs. absence (NDR) of diabetic retinopathy as the dependent variable.

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Gender				
Male	1.00			
Female	0.74 (0.47-1.16)	0.185		
Age (years)				
≤40	1.00		1.00	
41-55	1.63 (0.74-3.56)	0.223	0.98 (0.41-2.35)	0.968
>56	3.14 (1.46-6.71)	0.003	1.16 (0.47-2.87)	0.748
Education				
Illiterate	0.70 (0.35-1.44)	0.336		
Secondary and below	1.11 (0.68-1.81)	0.682		
Higher secondary and above	1.00			
Occupation				
Unemployed/retired	1.64 (0.90-3.01)	0.109		
Service	1.24 (0.66-2.32)	0.502		
Business	1.54 (0.79-3.01)	0.202		
Housewife	1.00			
Monthly family income				
Low-middle income (<Tk.21271)	1.45 (0.73-2.87)	0.293		
Upper-middle income (Tk. 21271- Tk.65761)	0.87 (0.45-1.69)	0.677		
High Income (>Tk.65761)	1.00			
BMI				
Underweight (<18.5 kg/m^2)	1.22 (0.23-6.55)	0.816	1.68 (0.25-11.22)	0.595
Normal (18.5-24.99 kg/m^2)	1.00		1.00	
Overweight (24.99-29.99 kg/m^2)	0.58 (0.35-0.96)	0.035	0.59 (0.33-1.03)	0.065
Obese (≥30.0 kg/m^2)	0.57 (0.29-1.10)	0.091	0.71 (0.34-1.48)	0.363
WHR				
Normal (male ≤0.90 and female ≤0.85)	1.00			
Health risk (male >0.90 and female >0.85)	1.04 (0.22-4.91)	0.957		
Family history of diabetes				

Continued.

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Yes	1.17 (0.74-1.84)	0.511		
No	1.00			
FPG				
Uncontrolled (>7.2)	2.9 (1.58-5.32)	0.001	2.57 (1.30-5.08)	0.007
Control (≤7.2)	1.00		1.00	
2hPPG				
Uncontrolled (>10)	3.46 (1.78-6.73)	<0.001		
Control (≤10)	1.00			
SBP				
Uncontrolled (>140 mm of hg)	1.68 (1.03-2.75)	0.037	1.10 (0.63-1.92)	0.746
Control (≤140 mm of hg)	1.00		1.00	
DBP				
Uncontrolled (>90 mm of hg)	1.05 (0.60-1.84)	0.871		
Control (≤90 mm of hg)	1.00			
Duration of diabetes (years)				
<5	1.00		1.00	
5-10	2.27 (0.93-5.54)	0.071	2.03 (0.81-5.09)	0.130
≥10	11.00 (4.84-25.00)	<0.001	9.51 (3.85-23.46)	<0.001
Drug adherence				
Adherence	1.00		1.00	
Non-adherence	2.08 (1.30-3.31)	0.002	1.82 (1.07-3.10)	0.027
Physical activities				
Adherence	1.00			
Non-adherence	1.23 (0.76-1.99)	0.396		
Dietary adherence				
Adherence	1.00			
Non-adherence	1.03 (0.62-1.73)	0.904		

Note: BMI, body mass index; WHR, waist-hip ratio; FPG, fasting plasma glucose; PPG, postprandial glucose; HbA1c, Hemoglobin A1C; HDL, high density lipoprotein; LDL, low density lipoprotein; TG, triglyceride; eGFR, estimated glomerular filtration rate; SBP, systolic blood pressure, DBP, diastolic blood pressure.

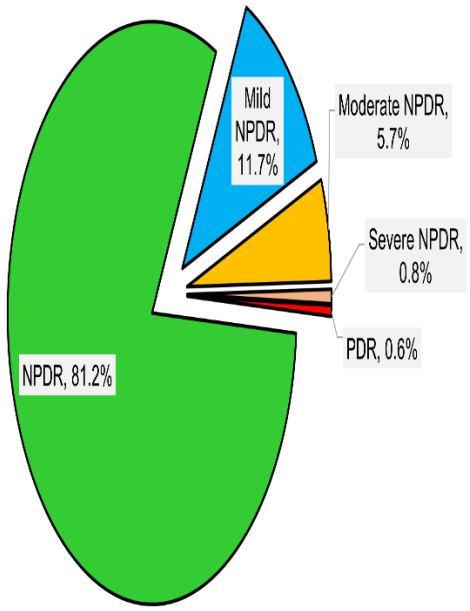

Figure 2: Percentage of NDR, mild, moderate, and severe NPDR and PDR.

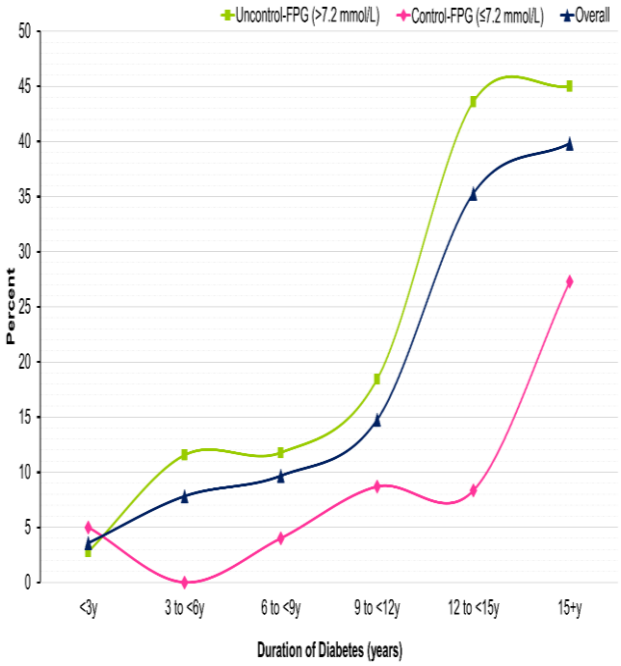

Figure 3. Relationship between prevalence of DR and diabetes duration within control and uncontrol FPG.

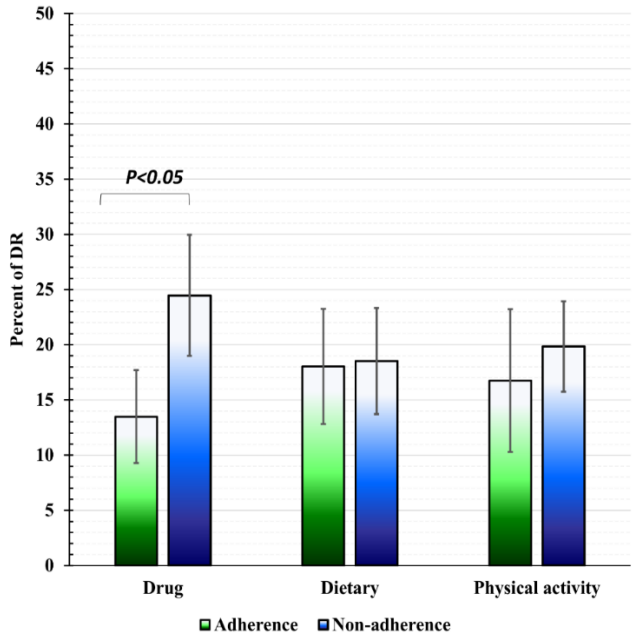

Figure 4: Prevalence of DR among drug, diet and physical activity adherence among the study participants.

DISCUSSION

Diabetic retinopathy is the most frequent microvascular complications of diabetes mellitus and the most common cause of vision loss, and blindness. Our study revealed that the overall prevalence of DR was 18.8% in the outpatient department of BIHS hospital in Dhaka, Bangladesh. This result is in line with a population-based study in rural Bangladesh, where the prevalence of DR was 21.6%.[12] The prevalence of DR found in our study is comparable to other neighboring countries, such as Nepal (19.3%), Sri Lanka (15%), and Pakistan (15%).[24-26]

The results of our hospital outpatient department study suggest that independent factors associated with DR in Bangladeshi patients include duration of diabetes, uncontrolled FPG, and non-adherence to drug therapy. Duration of diabetes is an independent risk factor for DR in many studies.[27,28] Over time, diabetes affects tiny blood vessels wall across the body, including the retina. Diabetic retinopathy develops when these small blood vessels leak blood and other fluids.[29] The retinal tissue swells as a consequence, causing foggy or impaired vision. In our study, the prevalence of DR was 3% with a known duration of diabetes of 3 years and rose to 40% with 15 years or more. This result is similar to previously published studies in populations of other ethnic groups.[30,31] Patients with diabetes should be regularly assessed by an ophthalmologist. Poor eyesight may lead to social isolation, aggravation of psychological distress, an increased risk of accidents, and a decline in metabolic control (due to difficulty administering insulin or other medications).[32] An early diagnosis with proper treatment may control eyesight.

In addition to the duration of diabetes, uncontrolled FPG was independently associated with DR in our study. A similar result was seen by Ahmed et al in a study conducted at the outpatient department of Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorder (BIRDEM) and also in another study in Bangladesh.[12,33] It is widely known that persistent hyperglycemia is linked to the initiation and progression of microvascular complications. Our finding is consistent with that of many other previous studies that showed fasting glucose variability as a significant risk factor for the onset of DR in type 2 diabetes.[34,35]

Drug adherence is a crucial part of diabetes care and, for most individuals, the foundation of metabolic control. Nevertheless, 50-60% of individuals with chronic diseases are non-adherent to their prescribed drug therapy.[36] In our study, we found that DR was independently associated with drug non-adherence. This finding contrasts with a previous study from Pakistan, which found no relationship between non-adherence to drug therapy with DR.[37]

Further data from Southeast Asia were not available. It is essential to use drugs on a timely basis to regulate glycemia and blood pressure levels to prevent DR manifestation and/or progression. This is especially concerning for the elderly, who have a propensity for non-compliance.[38] Furthermore, failure to adhere to drugs among persons with DR leads to improper management of glycemia and hypertension, the advancement of retinal complications, and a decrease in visual acuity.

The internet, smartphones, and wearable gadgets have vastly aided diabetes treatment because of advances in digital technology. Smartphone apps and wearable devices help people take better care of themselves by allowing them to track their health behaviours in real-time, such as diet, exercise, weight loss, sleep patterns, and health indicators like blood sugar and blood pressure; and by improving medication adherence with features like automated schedules, alerts, and reminders.

Limitations

Our study has several potential limitations. Firstly, all participants attended a single tertiary care hospital. However, the BIHS outpatient department serves as a referral center as well as a primary care facility for local residents, which may have reduced the potential sampling error. Secondly, we relied on self-reported information to estimate drug non-adherence. This approach may have led to a reporting bias but directly collecting information on drug adherence, e.g., through pill counting, would not have been possible with the resources available. The main strengths of our study are its consecutive recruitment

strategy, its relatively large sample size and its standardized approach to retinal examination.

CONCLUSION

Our study provides further evidence that undiagnosed DR among individuals with diabetes in Bangladesh outpatient tertiary care hospitals. Regular screening for DR should therefore be included in standard patient care, in particular with a longer duration of diabetes. Furthermore, adequate patient education and universal access to sufficient doses of medication should be supported to reduce the risk of non-adherence to drug therapy.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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