e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2024; 16(4); 535-543

Original Research Article

A Retrospective Assessment of Prevalence and Identify the Variables Related with Diabetic Retinopathy in Individuals Diagnosed with Type 2 Diabetes

Tulika Singh[1], Priyambada Priyadarshini[2]

[1]Tutor, Department of Community Medicine, NMCH, Patna, Bihar, India

[2]Tutor, Department of Community Medicine, JNKTMCH, Madhepura, Bihar, India

Received: 10-02-2024 / Revised: 12-03-2024 / Accepted: 26-04-2024
Corresponding Author: Dr Priyambada Priyadarshini
Conflict of interest: Nil

Abstract

Aim: To determine the prevalence and identify the variables related with diabetic retinopathy in individuals diagnosed with type 2 diabetes.

Material and Methods: A retrospective study was conducted in the department of Community Medicine, NMCH, Patna, Bihar, India from June 2022 to May 2023.Total 489 patients were included in this study. Study participants were selected using a systematic random sampling technique based on daily attendance in the hospital. 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. 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.

Results: 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%;). 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. Higher drug non-adherence was observed in individuals with DR compared to those without DR.

Conclusion: 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.

Keywords: Variables, Diabetic retinopathy, Type 2 diabetes

Introduction

Diabetic retinopathy (DR) is a serious microvascular complication of diabetes mellitus and remains a leading cause of visual impairment and blindness worldwide. Type 2 diabetes mellitus (T2DM), characterized by insulin resistance and relative insulin deficiency, predisposes individuals to various complications, including DR. Understanding the factors associated with the development and progression of DR among patients with T2DM is crucial for early detection, intervention, and prevention strategies. The pathogenesis of DR involves complex mechanisms influenced by chronic hyperglycemia, oxidative stress, inflammation, and vascular dysfunction. Prolonged exposure to high glucose levels leads to biochemical and structural changes in the retinal vasculature, initiating a cascade of events that result in capillary basement membrane thickening, microaneurysm formation, and eventually, ischemia and neovascularization. [1-7] DR affects approximately one-third of patients with T2DM globally, with prevalence rates varying based on ethnicity, duration of diabetes, glycemic control, and other risk factors. As the diabetic population continues to grow, particularly in low- and middle-income countries, the burden of DR is expected to rise, posing significant challenges to healthcare systems and society as a whole. Several factors contribute to the development and progression of DR among patients with T2DM. Duration of

diabetes is a critical determinant, with longer disease duration correlating with increased prevalence and severity of DR. The degree of glycemic control, as indicated by elevated hemoglobin A1c (HbA1c) levels, plays a pivotal role in the pathogenesis of DR. Poor glycemic control promotes microvascular complications by exacerbating oxidative stress and endothelial dysfunction. [8-15] Hypertension is another established risk factor for DR, contributing to accelerated vascular damage and worsening retinopathy. The presence of nephropathy in patients with T2DM, characterized by microalbuminuria or overt proteinuria, serves as a marker of systemic vascular involvement and is strongly associated with the development of DR. Dyslipidaemia, characterized by elevated triglycerides and low high-density lipoprotein (HDL) cholesterol levels, has been implicated in the pathophysiology of DR, although its exact role remains under investigation. Other factors such as smoking, genetic predisposition, and ocular factors like myopia and cataract surgery have also been linked to an increased risk of DR. Regular screening for DR using fundoscopic examination and retinal imaging is essential for early detection and timely intervention. Guidelines recommend annual retinal evaluations for all patients with T2DM, beginning at the time of diagnosis, to facilitate early diagnosis and appropriate management of DR. [15-20]

Material and Methods

A retrospective study was conducted in the department of Community Medicine, NMCH, Patna, Bihar, India from June 2022 to May 2023. Total 489 patients were included in this study. Study participants were selected using a systematic random sampling technique based on daily attendance in the hospital. 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. 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. The detection of DR by retinal photography has been validated previously.18 Digital colour images were captured from each eye 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 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] 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. 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.

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). 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. Higher drug non-adherence was observed in individuals with DR compared to those without DR. 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	
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
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
Non-adherence	351	72.5
Fundus photography		
NDR	397	81.2
DR	92	18.8

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)	
Female	47 (16.79)	233 (83.21)	0.184
Age (years)			
≤40	9 (10.23)	79 (89.77)	
41-55	33 (15.64)	178 (84.36)	0.002
>56	50 (26.32)	140 (73.68)	
Education			
Illiterate	12 (14.12)	73 (85.88)	
Secondary and below	45 (20.55)	174 (79.45)	0.436
Higher secondary and above	35 (18.92)	150 (81.08)	
Occupation			
Unemployment	20 (23.81)	64 (76.19)	
Service	17 (19.1)	72 (80.9)	0.343
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)	
Upper-middle income (Tk. 21271-Tk.65761)	41 (15.95)	216 (84.05)	0.125
High income (>Tk.65761)	14 (17.95)	64 (82.05)	
BMI			
Underweight (<18.5 kg/m^2)	2 (28.57)	5 (71.43)	
Normal (18.5-24.99 kg/m^2)	38 (24.68)	116 (75.32)	0.117
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)	
No	41 (17.6)	192 (82.4)	0.511
Uncontrolled (>7%)	60 (23.26)	198 (76.74)	

FPG			
Uncontrolled (>7.2)	78 (23.01)	261 (76.99)	
Control (≤7.2)	14 (9.33)	136 (90.67)	<0.001
2hPPG			
Uncontrolled (>10)	81 (23.08)	270 (76.92)	
Control (≤10)	11 (7.97)	127 (92.03)	<0.001
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)	
DBP			
Uncontrolled (>90 mm of hg)	19 (19.39)	79 (80.61)	
Control (≤90 mm of hg)	73 (18.67)	318 (81.33)	0.871
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)	
Non-adherence	53 (19.85)	214 (80.15)	0.396
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				
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.

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. 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 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.

Conclusion

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.

References

1. Leasher JL, Bourne RRA, Flaxman SR, et al. Global estimates on the number of people blind or visually impaired by diabetic retinopathy: a meta-analysis from 1990 to 2010. *Diabetes Care*. 2016;39(9):1643-1649. Doi:10.2337/dc15-2171
2. Cheung N, Mitchell P, Wong TY. Diabetic retinopathy. *Lancet*. 2010;376(9735):124-136. doi:10.1016/S0140-6736(09)62124-3
3. Saeedi P, Petersohn I, Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Research and Clinical Practice*. 20 19;157:107843. doi:10.1016/j.diabres.2019.107843
4. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL. The Wisconsin Epidemiologic Study of Diabetic Retinopathy: III. Prevalence and risk of diabetic retinopathy when age at diagnosis is 30 or more years. *Archives of Ophthalmology*. 1984;102(4):527-532. doi:10. 1001/archopht.1984.01040030319012
5. Wong TY, Cheung CMG, Larsen M, Sharma S, Simó R. Diabetic retinopathy. *Nature Reviews Disease Primers*. 2016;2:16012. doi: 10.1038/nrdp.2016.12
6. van Dijk HW, Verbraak FD, Kok PHB, et al. Early neurodegeneration in the retina of type 2 diabetic patients. *Investigative Ophthalmology & Visual Science*. 2012;53(6):2715-2719. doi: 10.1167/iovs.11-8997
7. Yau JW, Rogers SL, Kawasaki R, et al. Global prevalence and major risk factors of diabetic retinopathy. *Diabetes Care*. 2012;35(3):556-56 4. doi:10.2337/dc11-1909
8. Wilkinson CP, Ferris FL 3rd, Klein RE, et al. Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. *Ophthalmology*. 200 3;110(9):1677-1682. doi:10.1016/S0161-6420 (03)00475-5
9. Antonetti DA, Klein R, Gardner TW. Diabetic retinopathy. *New England Journal of Medicine*. 2012;366(13):1227-1239. doi:10.10 56/NEJMra1005073
10. Fenwick EK, Pesudovs K, Rees G, et al. The impact of diabetic retinopathy: understanding the patient's perspective. *British Journal of Ophthalmology*. 2011;95(6):774-782. doi:10.1 136/bjo.2010.186049

11. Simó R, Hernández C. Advances in the medical treatment of diabetic retinopathy. *Diabetologia*. 2002;45(11):1617-1630. doi:10. 1007/s00125-002-1022-6
12. Liu Y, Yang J, Tao L, Lv H, Jiang X, Zhang M. Association between dyslipidemia and diabetic retinopathy: a systematic review and meta-analysis. *Endocrine*. 2020;70(1):46-55. doi:10.1007/s12020-020-02317-5
13. Ahmed KR, Karim MN, Bhowmik B, Habib SH, Bukht MS, Ali L, et al. Incidence of Diabetic Retinopathy in Bangladesh: A 15-Year Follow-up Study. J. Diabetes 2012;4(4): 386-91.
14. Ghanchi F, Bailey C, Chakravarthy U, Cohen S, Dobson P, Gibson J, et al. The Royal College of Ophthalmologists Diabetic Retinop-athy Guidelines. Diabet. Retin. Guidel. 2012; 2:1-47.
15. Flaxel CJ, Adelman RA, Bailey ST, Fawzi A, Lim JI, Vemulakonda GA, et al. Diabetic Retinopathy Preferred Practice Pattern®. Ophthalmology. 2020;127(1):66-145.
16. Jannuzzi FF, Cintra FA, Rodrigues RCM, São-João TM, Gallani MCBJ. Medication Adhere nce and Quality of Life among the Elderly with Diabetic Retinopathy. Rev. Lat. Am. Enferma gem. 2014;22(6):902-10.
17. Mohiuddin AK. Diabetes Fact: Bangladesh Perspective. Int. J. Diabetes Res. 2019;2(1):14-20.
18. Olson JA, Strachan FM, Hipwell JH, Goatman KA, McHardy KC, Forrester JV. A Comparative Evaluation of Digital Imaging, Retinal Photography and Optometrist Examination in Screening for Diabetic Retinopathy. Diabet Med. 2003;20(7):528- 34.
19. Wilkinson CP, Ferris FL, Klein RE, Lee PP, Agardh CD, Davis M, et al. Proposed International Clinical Diabetic Retinopathy and Diabetic Macular Edema Disease Severity Scales. Ophthalmology. 2003;110(9):1677-82.
20. Saleh F, Mumu SJ, Ara F, Hafez MA, Ali L. Non- Adherence to Self-Care Practices & Medication and Health Related Quality of Life among Patients with Type 2 Diabetes: A Cross-Sectional Study. BMC Public Health. 2014;14(1):431.
21. Mumu S, Saleh F, Ara F, Afnan F, Ali L. Non-Adherence to Life-Style Modification and Its Factors among Type 2 Diabetic Patients. Indian J. Public Health. 2014;58(1):40.
22. Mumu SJ, Merom D, Ali L, Fahey PP, Hossain I, Rahman AKMF, Allman-Farinelli M. Validation of a Food Frequency Questionnaire as a Tool for Assessing Dietary Intake in Cardiovascular Disease Research and Surveillance in Bangladesh. Nutr. J. 2020;19 :42.
23. Schröder H, Covas MI, Marrugat J, Vila J, Pena A, Alcántara M, et al. Use of a Three-Day Estimated Food Record, a 72-Hour Recall and a Food- Frequency Questionnaire for Dietary Assessment in a Mediterranean Spanish Population. Clin. Nutr. 2001;20(5): 42 9-37.
24. Paudyal G, Shrestha MK, Meyer JJ, Thapa R, Gurung R, Ruit S. Prevalence of Diabetic Retinopathy Following a Community Screening for Diabetes. Nepal Med. Coll. J. 20 08;10(3):160–3.
25. Weerasuriya N, Siribaddana S, Dissanayak, A, Subasinghe Z, Wariyapola D, Fernando DJS. Long- Term Complications in Newly Diagnosed Sri Lankan Patients with Type 2 Diabetes Mellitus. QJM - Mon. J. Assoc. Physicians. 1998;91(6):439- 43.
26. Iqbal T, Zafar J. Frequency of Retinopathy in Newly Diagnosed Type 2 Diabetes Mellitus. Rawal Med J. 2009;34(2):167-9.
27. Ballard DJ, Melton LJ, Dwyer MS, Trautmann JC, Chu CP, O'Fallon WM. Risk Factors for Diabetic Retinopathy: A Population-Based Study in Rochester, Minnesota. Diabetes Care. 1986;9(4):334-42.
28. Klein R, Klein BEK, Moss SE. The Wisconsin Epidemiologic Study of Diabetic Retinopathy. XVI. The Relationship of C-Peptide to the Incidence and Progression of Diabetic Retinopathy. Diabetes. 1995;44(7):796-801.
29. Wilkinson-Berka J. Vasoactive Factors and Diabetic Retinopathy: Vascular Endothelial Growth Factor, Cycoloxygenase-2 and Nitric Oxide. Curr Pharm Des. 2005;10(27):3331-48.
30. He B-B, Wei L, Gu Y-J, Han J-F, Li M, Liu Y-X.Factors Associated with Diabetic Retinopathy in Chinese Patients with Type 2 Diabetes Mellitus. Int.J. Endocrinol. 2012:42 :1-8.
31. Pradeepa R, Rema M, Vignesh J, Deepa M, Deepa R, Mohan V. Prevalence and Risk Factors for Diabetic Neuropathy in an Urban South Indian Population: The Chennai Urban Rural Epidemiology Study (CURES-55). Diabet Med. 2008;25(4):407- 12.
32. Rubin RR, Peyrot M. Psychological Issues and Treatments for People with Diabetes. J Clin Psychol. 2001;57(4):457-78.
33. Ahmed KR, Karim MN, Bukht MS, Bhowmik B, Acharyya A, Ali L. Risk Factors of Diabetic Retinopathy in Bangladeshi Type 2 Diabetic Patients. Diabetes Metab Syndr Clin Res Rev. 2011;5(4):196-200.
34. Takao T, Ide T, Yanagisawa H, Kikuchi M, Kawazu S, Matsuyama Y. The Effect of Fasting Plasma Glucose Variability on the Risk of Retinopathy in Type 2 Diabetic Patients: Retrospective Long-Term Follow-Up. Diabetes Res. Clin. Pract. 2010;89(3):296-302.
35. Gimeno-Orna, JA, Castro-Alonso FJ, Boned-Juliani B, Lou-Arnal LM. Fasting Plasma Glucose Variability as a Risk Factor of

Retinopathy in Type 2 Diabetic Patients. J. Diabetes Complications. 2003;17(2):78-81.
36. Svarstad BL, Chewning BA, Sleath BL, Claesson C. The Brief Medication Questionnaire: A Tool for Screening Patient Adherence and Barriers to Adherence. Patient Educ Couns. 1996;37(2):113- 24.
37. Ishaq H, Ali M, Kazmi N, Naqvi BS, Shaikh D. Prevalence of Diabetic Retinopathy in Type II Diabetic Patients in a Health Facility in Karachi, Pakistan. Trop J Pharm Res. 2016;15 (5):1069-76.
38. Lau HS, Beuning KS, Postma-Lim E, Klein-Beernink L, De Boer A, Porsius AJ. Non-Compliance in Elderly People: Evaluation of Risk Factors by Longitudinal Data Analysis. Pharm World Sci. 1996;18(2):63-8.