BMC Ophthalmology

RESEARCH Open Access

Prevalence of diabetic retinopathy and its risk factors in rural patients with type 2 diabetes referring to Beijing Huairou Hospital, China

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Abstract

Background China has the largest population of diabetic patients worldwide. A diverse population and regional discrepancy in access to health care and diabetes management may lead to unique risk factors for diabetic retinopathy (DR) in different regions of China. This study aimed to evaluate the prevalence and risk factors of DR in rural patients with type 2 diabetes.

Methods This hospital-based cross-sectional study recruited a sample of 704 type 2 diabetic patients from rural areas referred to Beijing Huairou Hospital, China, from June 1, 2022, to June 1, 2023. The medical history, demographic information, and results of laboratory examinations of patients were collected and analyzed. The diagnosis of DR were performed by experienced ophthalmologists using mydriatic fundus photography.

Results Out of all patients, 53.8% were male and 46.2% were female. The mean age of patients and duration of diabetes were 54.9 ± 13.0 and 6.2 ± 4.5 years, respectively. The DR prevalence was 16.8%. The independent risk factors for DR in multivariate analysis were diabetes duration > 10 years (OR = 9.16, 95%CI = 5.49–15.30), fasting plasma glucose ≥ 7.2 mmol/L (OR = 3.25, 95%CI = 1.42–7.42), glycosylated hemoglobin ≥ 7% (OR = 6.49, 95%CI = 2.59–16.23), hypertension (OR = 1.59, 95%CI = 1.05–2.40), hyperlipidemia (OR = 2.16, 95%CI = 1.30–3.59), diabetic nephropathy (OR = 1.95, 95%CI = 1.17–3.23), high uric acid level (OR = 3.57, 95%CI = 1.56–8.15), high albumin to creatinine ratio (OR = 2.48, 95%CI = 1.06–5.82), and insulin treatment (OR = 1.79, 95%CI = 1.12–2.88).

Conclusions This study evaluated the DR prevalence and its associated risk factors among type 2 diabetic patients from rural areas in Beijing's Huairou District, China. Paying attention to these risk factors may be useful in screening high-risk diabetic patients for DR and adopting early preventive and therapeutic interventions.

Keywords Diabetic retinopathy, Prevalence, Risk factors, Rural patients

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Background

Diabetes mellitus (DM) is a systemic metabolic condition. In DM, insulin secretion in the body is insufficient to meet the metabolic demands, resulting in impaired metabolism of carbohydrates [1]. International Diabetes Federation has estimated that the prevalence of DM will increase from 537 million people in 2021 to 643 million people by 2030 and 783 million by 2045 [2]. Thus, DM has been identified as one of the most challenging public health issues of the present century [3]. DM is associated with disabling micro- and macrovascular complications. Diabetes-induced chronic hyperglycemia is thought to play a significant role in developing its vascular complications by causing impairments such as production of advanced glycation end-products, abnormal activation of signaling cascades (such as protein kinase C), increased production of C-reactive oxygen species (oxygen-contained molecules which can interact with other biomolecules and cause damage), and abnormal stimulation of hemodynamic regulation systems (such as renin-angiotensin system) [4, 5].

Diabetic retinopathy (DR) is one of the most common microvascular complication of diabetes and the main reason for visual impairment and blindness in diabetic patients [6, 7]. Diabetic macular edema, characterized by macular thickening and edema, is the most common contributing factor to vision loss in DR patients [8]. The risk of DR development depends on diabetes duration and severity of hyperglycemia [6]. Despite advances in optimal management of hyperglycemia and hypertension, regarded as systemic risk factors for DR, the prevalence of DR is still high in diabetic patients [9]. Various factors contribute to the persistently high rate of DR, including its complex nature, which involves much more than hyperglycemia and hypertension; its late screening and diagnosis; and the lack of a comprehensive prevention approach consisting of regular ocular examinations, lifestyle modification, and patient education. The results of a comprehensive systematic review meta-analysis have indicated that the estimated prevalence of DR in diabetic patients was 28.4 overall (25.9% and 28.9% in women and men, respectively) [10]. DR is a progressive disease that is typically asymptomatic in its early stages. Thus, it can be easily overlooked by diabetic patients until later stages when the macula is affected and the vision has deteriorated. Moreover, when left untreated, DR can cause a gradual diminution of vision, ultimately leading to blindness due to its detrimental effects on the macula [6]. Fundus screening and early intervention are crucial to prevent vision deterioration and mitigate the likelihood of blindness in diabetic patients [11].

Extensive research has established hyperglycemia, hypertension, hyperlipidemia, duration of diabetes, smoking, obesity, and genetics, among others, as risk factors for DR [12–14]. However, inconsistencies still exist in this regard, and their exact impact and significance vary across different studies and populations. China has the largest population of diabetic patients worldwide [2], which necessitates further research to understand the prevalence and risk factors specific to this population. In addition, a diverse Chinese population and regional discrepancy in access to health care and diabetes management may lead to unique risk factors for DR in different regions of China. Exploring these factors can enhance our insight into DR and help us design and implement effective interventions to improve outcomes in diabetic patients in China and other similar settings worldwide.

The present study evaluated the prevalence and risk factors for DR in a relatively large population ($n=704$) of rural patients with type 2 diabetes presented to Beijing Huairou Hospital in China.

Methods

Study design and period

This hospital-based cross-sectional study included 704 patients with type 2 diabetes from rural areas referred to Beijing Huairou Hospital in China from June 1, 2022, to June 1, 2023.

Ethical consideration

This study was conducted in accordance with the Declaration of Helsinki. The ethical approval was received from the Ethics Committee of Beijing Huairou Hospital (No. 2020-HRYY-203). Informed consent was obtained from all participants.

Study population

The target population included all ≥18-year-old patients with a prior diagnosis of type 2 diabetes who had medical records in the endocrinology clinic of Beijing Huairou Hospital and were living in rural areas. Diagnosis of type 2 diabetes was made according to American Diabetes Association criteria (fasting plasma glucose≥126 mg/dL; 2-h plasma glucose≥200 mg/dL during a 75-g oral glucose tolerance test; or A1C≥6.5%) [15].

Exclusion criteria

The exclusion criteria were: (1) patients with type 1 diabetes or gestational diabetes; (2) patients unable to undergo fundus examinations for any reason, such as severe illness or physical disability; (3) patients with pre-existing eye diseases such as glaucoma, cataract, corneal leukopenia, and uveitis among others; (4) patients with a history of ocular trauma or previous retinal surgery; and (5) unwillingness to participate in the study.

Sample selection

Given a prevalence rate of 18.2% for DR in rural diabetic patients in China [16], the required sample size was 749 for a margin of error or absolute precision of ±3% in estimating the prevalence with 95% confidence and assuming a potential loss of 15%. With this sample size, the anticipated 95% confidence interval (CI) was (15.2%, 21.2%). The sample size was calculated using a single population proportion formula using the Scalex SP calculator [17]. Study participants were selected based on a simple random sampling technique. A unique identifier ranging from 1 to 1928 was assigned to each of the 1928 diabetic patients with medical records in the hospital. Using SPSS software, 749 random numbers between 1 and 1928 were selected, which indicated the patients included in the study. Of these, 704 patients were eventually included in the study. Figure 1 demonstrates the sampling flowchart of this study.

Fundus examination

Two experienced deputy chief ophthalmologists trained in retina and DR screening performed fundus examination. In the event of a discrepancy in diagnosis, a chief ophthalmologist was consulted to reach a consensus on the presence of DR.

Three mydriatic 50-degree images from the macular-centered field, the disc/nasal field, and the superotemporal field were captured per eye using a standard Topcon tabletop fundus camera (Topcon TRC-50DX, Tokyo, Japan). Mydriasis was achieved in all patients using Tropicamide 1% drops. DR was diagnosed and graded by mydriatic fundus photography and was further classified into proliferative diabetic retinopathy (PDR) and non-proliferative retinopathy (NPDR) according to the International Clinical Disease Severity Scale for DR and the Early Treatment of Diabetic Retinopathy Study (ETDRS) [18].

Data collection

The gender, age, and medical history (diabetes duration, family history of diabetes, insulin therapy, history of hypertension, hyperlipidemia, and nephropathy) of patients were collected by questionnaires. The gender, age, and medical history (diabetes duration, family history of diabetes, insulin therapy, history of hypertension, hyperlipidemia, and nephropathy) for all patients were collected using data collection forms. In addition, the blood pressure, weight, and height were measured for all participants. Blood samples were obtained from each patient after 10-hour overnight fasting, and the levels of the fasting plasma glucose (FPG), glycosylated hemoglobin (HbAlc), systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting blood lipids (total cholesterol (TC), triglycerides (TG), high-density lipoprotein

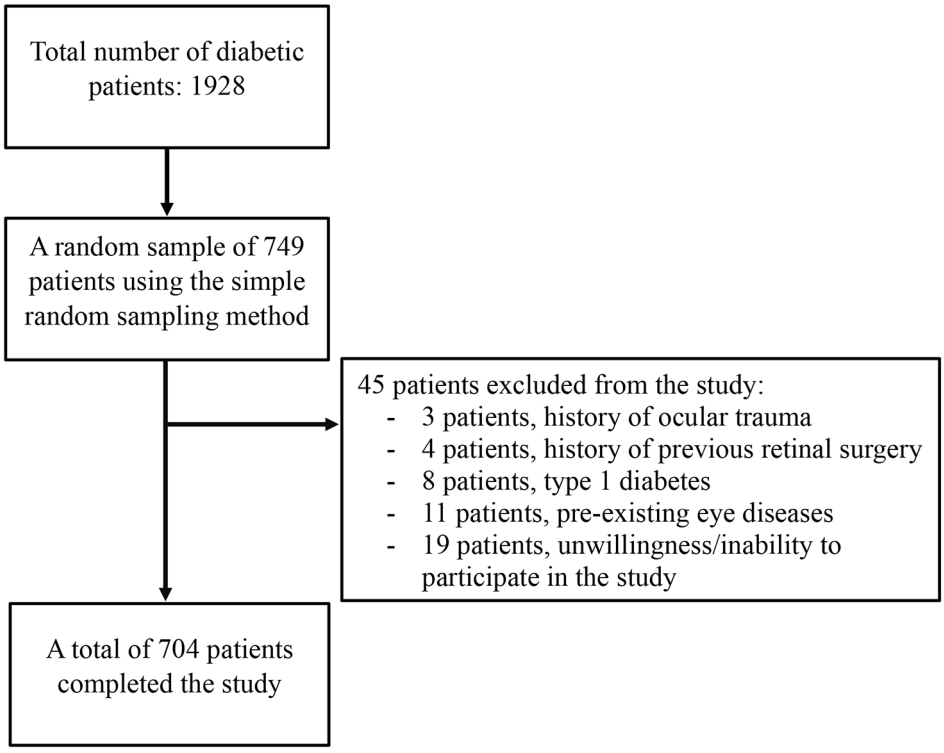

Fig. 1 flowchart of sampling procedure

cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C)), serum creatinine (CR), blood urea nitrogen (BUN), uric acid (UA), and albumin to creatinine ratio (ACR) were measured.

Statistics

Data are presented as mean±standard deviation for quantitative parameters and frequency and percentage for categorical parameters, respectively. The correlation between risk factors and DR was first estimated using the independent t-test and $\chi 2$ test. Then multivariate logistic regression analysis was performed to identify the risk factors for DR. All statistical analyses were conducted using SPSS statistical software version 21.0. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 704 patients with type 2 diabetes participated in this study; out of which, 379 (53.8%) were male and 325 (46.2%) were female. The mean age of patients was 54.9±13.0 years (range, 23–85 years), and the average diabetes duration was 6.2±4.5 years (range, 1–22 years). Out of all the patients, 118 were diagnosed with DR, yielding a prevalence rate of 16.8%. The prevalence rates of NPDR and PDR were 15.8% ($n=111$) and 1.0% ($n=7$), respectively.

The primary univariate analysis showed that the DR group had a longer diabetes duration ($P<0.001$) and higher levels of FPG ($P<0.001$), HbAlc ($P<0.001$), SBP ($P<0.001$), TC ($P=0.001$), TG ($P=0.049$), CR ($P=0.031$), UA ($P<0.001$), and ACR ($P<0.001$) than the non-DR group. In addition, DR patients showed more complications, including hypertension ($P=0.006$), hyperlipidemia ($P=0.002$), diabetic nephropathy ($P=0.008$), and insulin treatment ($P=0.002$). However, no significant difference was noticed between the two groups regarding age, gender, BMI, DBP, HDL-C, LDL-C, and BUN (Table 1).

On multivariate analysis, the independent risk factors for DR were diabetes duration > 10 years (OR=9.16, 95%CI=5.49–15.30), FPG≥7.2 mmol/L (OR=3.25, 95%CI=1.42–7.42), HbAlc≥7% (OR=6.49, 95%CI=2.59–16.23), hypertension (OR=1.59, 95%CI=1.05–2.40), hyperlipidemia (OR=2.16, 95%CI=1.30–3.59), diabetic nephropathy (OR=1.95, 95%CI=1.17–3.23), high UA (OR=3.57, 95%CI=1.56–8.15), high ACR (OR=2.48, 95%CI=1.06–5.82), and insulin treatment (OR=1.79, 95%CI=1.12–2.88) (Table 2).

Discussion

DR is one of the most significant and severe ocular complications in diabetes and is the primary cause of visual disturbance and vision loss among working-age people [11]. In addition to its negative impact on vision, DR can negatively affect the mental health of patients, resulting in anxiety, depression, and reduced overall well-being [19]. DR can contribute to emotional distress and reduce patient independence, impairing the quality of life in these patients [20]. Moreover, potential job and income loss due to DR-related vision impairment, on the one hand, and the huge costs of DR treatment, on the other hand, can pose a substantial economic burden on patients, their families, and society [21]. Careful understanding of contributing factors to DR is integral to its prevention and management. Thus, the present study aimed to identify DR prevalence and risk factors in a group of type 2 diabetic patients presenting to Beijing Huairou Hospital in China.

The present study found a prevalence rate of 16.8% for DR in patients with type 2 diabetes. The national prevalence of DR in China is yet to be reported. However, our finding corroborates those of previous regional studies in China by Pan et al. [13] and Cui et al. [16], reporting a prevalence rate of 18 and 18.2 for DR in type 2 diabetic patients. DR prevalence in patients with type 2 diabetes in other Chinese studies ranges from much lower (8.1% in Cui et al.'s study [22]) to much higher (43.1% in Xie et al.'s study [23]) than our finding, indicating a large discrepancy in the incidence of this event among various regions of China. This inconsistency in DR prevalence is also evident in the studies conducted in other countries. For instance, the results of a recent systematic review and meta-analysis reported a 22.27% global prevalence of DR. The highest rate was 35.9% for Africa, and the lowest rate was 13.37% for South and Central America [9]. The observed discrepancy among studies is partly due to demographic, socioeconomic, and environmental factors, as well as methodological factors, including differences in the study population, diagnostic criteria, sample size, sampling method, and variations in data collection methods. However, the regional prevalence rate of DR may reflect the diabetic burden and its inadequate management, inequality in accessing health care, lack of awareness of diabetes and its complications, and lack or deficiency in DR prevention and management plans in that region.

NPDR is the most common form of diabetic retinopathy [24]. In this regard, most DR cases in the present study were of NPDR type, and PDR constituted a much lower proportion of the cases (NPDR and PDR were 94.1% and 5.9% of all cases, respectively).

NPDR is an earlier stage of the disease characterized by alterations in retinal blood vessels, including microaneurysm, hemorrhage, and exudate. It can occur in many diabetic patients before progressing to a more severe proliferative stage. On the other hand, PDR is a more advanced stage of disease characterized by abnormal growth of blood vessels in the retina and occurs in a lower percentage of diabetic patients [25].

Table 1 Univariate analysis of DR-related factors in type 2 diabetes

Variables	DR			
	Positive (118)	Negative (586)	t/χ^2	*P*-value
Age (year)	56.9 ± 13.6	54.5 ± 12.8	1.80	0.070
< 50 years	34 (28.8)	223 (38.1)	3.62	0.057
≥ 50 years	84 (71.2)	363 (61.9)		
Gender				
male	55 (46.6)	324 (55.3)	2.98	0.084
female	63 (53.4)	262 (44.7)		
BMI (kg/m^2)	26.4 ± 3.5	26.1 ± 3.2	1.02	0.310
< 30 kg/m^2	101 (85.6)	514 (87.7)	0.40	0.527
≥ 30 kg/m^2	17 (14.4)	72 (12.3)		
Diabetes duration (year)	11.2 ± 4.9	5.5 ± 3.6	12.67	< 0.001
< 10 years	48 (40.7)	485 (82.8)	94.61	< 0.001
≥ 10 years	70 (59.3)	101 (17.2)		
FPG (mmol/L)	12.9 ± 4.5	9.6 ± 3.0	9.89	< 0.001
< 7.2 mmol/L	8 (6.8)	129 (22.0)	14.54	< 0.001
≥ 7.2 mmol/L	110 (93.2)	457 (78.0)		
HbAlc (%)	10.2 ± 2.2	8.5 ± 2.1	7.84	< 0.001
< 7%	6 (5.1)	149 (25.4)	23.67	< 0.001
≥ 7%	112 (94.9)	437 (74.6)		
Hypertension				
No	50 (42.4)	330 (56.3)	7.68	0.006
Yes	68 (57.6)	256 (43.7)		
SBP (mmHg)	142.5 ± 21.1	133.9 ± 19.5	4.31	< 0.001
DBP (mmHg)	82.2 ± 10.7	81.8 ± 10.4	0.33	0.741
Hyperlipidemia				
No	21 (17.8)	188 (32.1)	9.60	0.002
Yes	97 (82.2)	398 (67.9)		
TC (mmol/L)	4.9 ± 1.2	4.5 ± 1.2	3.33	0.001
TG (mmol/L)	2.3 ± 1.5	2.0 ± 1.3	1.98	0.049
HDL-C (mmol/L)	1.2 ± 0.2	1.2 ± 0.2	0.85	0.394
LDL-C (mmol/L)	2.6 ± 0.9	2.5 ± 1.0	0.59	0.554
Diabetic nephropathy				
No	92 (78.0)	512 (87.4)	7.13	0.008
Yes	26 (22.0)	74 (12.6)		
CR (umol/L)	65.1 ± 12.1	62.3 ± 12.6	2.16	0.031
normal	96 (81.4)	446 (76.1)	4.23	0.123
low	17 (14.4)	126 (21.5)		
high	5 (4.2)	14 (2.4)		
BUN (mmol/L)	5.6 ± 0.9	5.6 ± 1.1	0.36	0.716
normal	116 (98.3)	564 (96.2)	3.107	0.193
low	1 (0.8)	2 (0.3)		
high	1 (0.8)	20 (3.4)		
UA (umol/L)	320.9 ± 81.6	291.6 ± 75.4	3.60	< 0.001
normal	83 (70.3)	460 (78.5)	10.21	0.006
low	4 (3.4)	39 (6.7)		
high	31 (26.3)	87 (14.8)		
ACR (mg/g)	44.1 ± 64.1	27.8 ± 41.0	2.65	0.009
normal	92 (78.0)	481 (82.1)	1.10	0.301
low	-	-		
high	26 (22.0)	105 (17.9)		
Insulin treatment				

Table 1 (continued)

Variables	DR			
	Positive (118)	Negative (586)	t/χ^2	*P*-value
No	58 (49.2)	376 (64.2)	9.36	0.002
Yes	60 (50.8)	210 (35.8)		

ACR: albumin to creatinine ratio, BMI: body mass index, BUN: blood urea nitrogen, CR: serum creatinine, DBP: diastolic blood pressure, DN: diabetic nephropathy, FPG: fasting plasma glucose, HbAlc: glycosylated hemoglobin, HDL-C: high-density lipoprotein cholesterol, LDL-C: low-density lipoprotein cholesterol, SBP: systolic blood pressure, TC: total cholesterol, TG: triglycerides, UA: uric acid

Table 2 Multivariate analysis of DR-related factors in type 2 diabetes

Variables		OR (95%CI)	*p* Value
Age	< 50 years	refrence	
	≥ 50 years	0.82 (0.48–1.41)	0.482
Gender	male	refrence	
	female	0.61 (0.35–1.04)	0.072
BMI	< 30 kg/m^2	refrence	
	≥ 30 kg/m^2	1.19 (0.61–2.32)	0.612
Diabetes duration	< 10 years	refrence	
	≥ 10 years	9.16 (5.49–15.30)	0.0001
FPG	< 7.2 mmol/L	refrence	
	≥ 7.2 mmol/L	3.25 (1.42–7.42)	0.005
HbAlc	< 7%	refrence	
	≥ 7%	6.49 (2.59–16.23)	0.0001
Hypertension	No	refrence	
	Yes	1.59 (1.05–2.40)	0.027
Hyperlipidemia	No	refrence	
	Yes	2.16 (1.30–3.59)	0.003
DN	No	refrence	
	Yes	1.95 (1.17–3.23)	0.0.10
CR	normal	refrence	
	low	0.66 (0.34–1.29)	0.226
	high	3.51 (0.98–12.55)	0.053
BUN	normal	refrence	
	low	2.05 (0.18–23.07)	0.562
	high	0.21 (0.03–1.59)	0.130
UA	normal	refrence	
	low	0.59 (0.18–1.92)	0.377
	high	3.57 (1.56–8.15)	0.003
ACR	normal	refrence	
	high	2.48 (1.06–5.82)	0.037
Insulin treatment	No	refrence	
	Yes	1.79 (1.12–2.88)	0.016

ACR: albumin to creatinine ratio, BMI: body mass index, BUN: blood urea nitrogen, CR: serum creatinine, DN: diabetic nephropathy, FPG: fasting plasma glucose, HbAlc: glycosylated hemoglobin, UA: uric acid

Diabetic maculopathy develops as DR affects the macula, the central region of the retina responsible for sharp central vision. The leakage of macular blood vessels can cause swelling, known as macular edema, which distorts vision and can lead to permanent vision loss. International Clinical Disease Severity Scale criteria were utilized in this study to classify DR into NPDR and PDR types [18, 26]. In this classification system, mild NPDR is characterized by the presence of a few microaneurysms, while moderate NDPR is defined as the presence of microaneurysms, intraretinal hemorrhages, or venous beading. Severe NDPR is determined based on the 4:2:1 rule by any of the following findings: hemorrhages in all four quadrants of the retina, venous beading in two or more quadrants, or intraretinal microvascular abnormalities in one or more quadrants. PDR is defined by the presence of neovascularization at the disc, the retina, the iris, the angle, vitreous hemorrhage, or tractional retinal detachment [18]. DR screening results are categorized into non-referable and referable groups. Diabetic patients with no or mild DR fall into the non-referable category, meaning they do not need immediate referral to

an ophthalmologist. These patients will likely be able to continue with regular follow-up appointments with their optometrist or ophthalmologist. Referable DR refers to a situation in which the ocular condition has progressed to an extent (moderate, severe, or proliferative DR) that warrants referral to an ophthalmologist for further evaluation and management.

Concerning the risk factors for DR, the results of the present study suggested that diabetes duration, FPG, HbA1c, hypertension, hyperlipidemia, diabetic nephropathy, UA, ACR, and insulin therapy were independently associated with DR.

The results of this study verified the generally recognized independent risk factors of DR such as diabetic duration, FPG, and HbAlc [27]. It has been suggested that hyperglycemia leads to systemic microvascular lesions, increased vascular permeability, and leakage of intravascular liquid components into tissues. These alterations cause retinal edema, ischemia, and neovascularization, contributing to retinopathy and dysfunction [25].

The present study found no significant difference in BMI between the DR and non-DR groups, which contradicts the results of previous studies. Some studies have reported that DR is more likely to occur in people with lower BMI [28], while others suggested that high BMI is related to DR [12]. These inconsistencies are likely due to differences in research design, the size, and the nature of the study population. It seems that further research is required to establish the association between BMI and DR.

In consistent with previous studies [12, 29], the present study indicated that diabetic patients with hypertension were more prone to DR than those with normal blood pressure. Consistently, a study by Liu et al. [30] found a correlation between DR and elevated SBP in diabetic patients. Hypertension can cause further damage to retinal blood vessels, which are at risk due to diabetes, increasing the risk of diabetic retinopathy. Hypertension can also cause fluid leakage and swelling in the retina, exacerbating the diabetic-induced damage [31].

Our findings also demonstrated that hyperlipidemia was independently related to DR. Inconsistencies exist in the literature regarding the relationship between high serum lipid levels and DR.

For instance, Klein et al. [32] found a relationship between retinopathy and higher serum levels of total and LDL cholesterol in diabetic patients. In the study by Rema et al. [33], diabetic patients with DR had significantly higher levels of triglyceride compared to healthy people. In contrast, the results of Wong et al. [34] showed no significant association between DR and triglyceride, LDL cholesterol, and HDL cholesterol in diabetic patients. The underlying mechanism of the relationship between hyperlipidemia and DR in diabetic patients is yet to be discovered. It is thought that hyperlipidemia, in a hyperglycemic milieu, may play a role in blood vessel damage in the retina by inducing inflammation, oxidative stress, and mitochondrial damage [35, 36]. These results suggest that along with glycemic control, rigorous monitoring and control of blood pressure and lipid profile in diabetic patients can be beneficial in preventing or delaying DR.

Our results demonstrated insulin therapy as an independent risk factor for DR in type 2 diabetic patients. In contrast to our finding, Cepeda-Nieto et al. [37] reported an inverse relationship between insulin therapy and DR in patients with type 2 diabetes and cited insulin therapy as a protective factor for DR in diabetic patients. However, our result was consistent with a growing body of literature. A study by Jingi et al. [38] found that compared to oral hypoglycemic drugs, insulin use had a direct significant relationship with DR. Studies by Raman et al. [14], Javadi et al. [39], and Thomas et al. [40] identified insulin therapy as an independent factor that significantly increases the risk of DR development. It is thought that exogenous insulin can act synergistically with vascular endothelial growth factor (VEGF) expressed by the ischemic retina, which triggers vascular proliferation and aggravates DR [41].

Moreover, the present study found that higher serum levels of UA and ACR, as well as coexisting diabetic nephropathy, were significantly and independently associated with DR development in diabetic patients. Concomitance and association of diabetic retinopathy and nephropathy in diabetic patients is well-established. On the other hand, elevated serum levels of UA [42] and ACR [43] are known indicators of early diabetic nephropathy in type 2 diabetic patients. Hence, paying close attention to the changes in these indicators may be helpful in early diagnosis of DR.

Limitations

The present study had several limitations that affect its generalizability and should be considered when interpreting its results. The prevalence of DR was reported in this study based on patients with a confirmed diagnosis of diabetes presenting to the hospital. However, the diabetes status and or vision problems may be different in individuals with undiagnosed diabetes, those with diabetes diagnosis who do not refer to health centers for their disease, or diabetic patients who were unable or unwilling to participate in the present study. Therefore, the findings of the present study do not indicate the prevalence of DR in a general diabetic population. Other limitations of this study included its cross-sectional nature, lack of evaluation of intra-observer variation in DR diagnosis, and failure to consider all factors related to DR, including behavioral, environmental, or genetic factors.

Conclusions

In conclusion, we found that the prevalence of DR was 16.8% among patients with type 2 diabetes in rural areas of Beijing's Huairou District, China. Diabetes duration, FPG, HbA1c, hypertension, hyperlipidemia, diabetic nephropathy, UA, ACR, and insulin therapy were independently associated with DR. Paying attention to these risk factors may be useful in screening high-risk diabetic patients for DR and adopting early preventive and therapeutic interventions.

Abbreviations

ACR	Albumin to creatinine ratio
BMI	Body mass index
BUN	Blood urea nitrogen
CI	Confidence interval
CR	Creatinine
DBP	Diastolic blood pressure
DM	Diabetes mellitus
DR	Diabetic retinopathy
ETDRS	Early Treatment of Diabetic Retinopathy Study
FPG	Fasting plasma glucose
HbA1c	Glycosylated hemoglobin
HDL-C	High-density lipoprotein cholesterol
LDL-C	Low-density lipoprotein cholesterol
NPDR	Non-proliferative retinopathy
OR	Odds of ratio
PDR	Proliferative diabetic retinopathy
SBP	Systolic blood pressure
TC	Total cholesterol
TG	Triglycerides
UA	Uric acid
VEGF	Vascular endothelial growth factor

Acknowledgements

Not applicable.

Author contributions

Conceptualization: [JW, HZ]; Methodology: [JW, HZ]; Validation: [HZ]; Formal analysis: [HZ]; Investigation: [HZ]; Writing - Original Draft: [JW]; Writing - Review & Editing: [JW, HZ].

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. The ethical approval was received from the Ethics Committee of Beijing Huairou Hospital (No. 2020-HRYY-203). Informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 15 February 2024 / Accepted: 1 August 2024
Published online: 12 August 2024

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