Risk factors associated with the severity of diabetic retinopathy in Qingdao

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青岛地区糖尿病视网膜病变严重程度的相关危险因素

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摘要

目的:调查和分析青岛地区糖尿病视网膜病变的发病率及其严重程度的危险因素。

方法:该调查研究分两部分:调查青岛地区2859名60岁以上的社区居民和4275名30岁以上的2型糖尿病住院患者。对所有研究对象进行眼科检查,血压及糖化血红蛋白测定,并通过调查问卷获得其年龄,性别,糖尿病病程,血糖控制情况及他们对糖尿病视网膜病变的了解情况。对所有的糖尿病视网膜病变(DR)患者进行眼底检查并照相,按EDTR标准对DR严重程度分级。重度非增殖期及增殖期DR,有临床意义的糖尿病黄斑水肿患者均归为需治疗组;而轻中度非增殖期DR及无临床意义的糖尿病黄斑水肿均归为需观察组。对所得数据进行相关和回归分析以确定糖尿病视网膜病变的需治疗率和危险因素。Logistic回归模型用于估计调整患者年龄,性别,病程后的优势比(*OR*)和95%可信区间(*CI*)。

结果:2859名60岁以上居民中有334例(11.68%)患有糖尿病视网膜病变,其中48(14.81%)名居民需治疗;4275名住院2型糖尿病患者中,1097例(25.66%)患有糖尿病视网膜病变,172(15.68%)例住院患者需要接受眼底激光或手术治疗。单变量和多变量回归分析显示,以下因素与糖尿病视网膜病变的需治疗率明显相关,包括:年龄(51~60岁:*OR*, 1.68; 95% *CI*: 1.21~1.72; 61~70岁:*OR*, 1.55; 95% *CI*: 1.38~1.76);病程(11~15年: *OR*, 2.61; 95% *CI*:1.51~4.72;超过15年病程:*OR*, 4.15; 95% *CI*: 2.32~5.77);血糖控制情况:(血糖控制一般:*OR*, 2.51; 95% *CI*: 1.98~3.92;血糖控制差:*OR*, 4.69; 95% *CI*: 3.39~6.95);对糖尿病视网膜病变的了解情况(完全不了解:*OR*, 1.45; 95% *CI*: 1.21~1.95)。而性别,31~50岁及70岁以上年龄,<10年的糖尿病病程,高血压和胰岛素治疗均与DR的需治疗率无关。

结论:青岛地区糖尿病视网膜病变的发病率和需治疗率较高。51~70岁年龄,超过10年的糖尿病病程,血糖控制欠佳,对糖尿病视网膜病变不了解是DR患者视网膜病变需治疗率的潜在危险因素。加强对51~70岁的2型糖尿病患者关于糖尿病视网膜病变的宣传教育,建立规范的社区糖尿病筛查系统,对早期防控DR的高发病率和致盲率至关重要。

关键词:糖尿病视网膜病变;糖尿病;发病率;病程;年龄

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Abstract

• AIM: To investigate and analyse the prevalence and risk factors associated with diabetic retinopathy severity in Qingdao.

• METHODS: This survey consisted of the 2 following parts: 2859 community residents aged >60 years old and 4275 patients with T2DM who were older than 30 years old in Qingdao. Ophthalmic examinations were performed on all patients. A questionnaire was used to obtain the patient's age and gender, the duration of diabetes mellitus (DM), glycaemic control and their knowledge of diabetic retinopathy (DR). Blood pressure and haemoglobin levels were recorded. All included patients underwent a comprehensive ophthalmic examination that included a fundus examination and retinal photographs and that assigned a grade for the severity of retinopathy according to the Early Treatment Diabetic Retinopathy Study (ETDRS) severity scale. Patients with severe non-proliferative or proliferative diabetic retinopathy and clinically significant macular edema (CSME) required ophthalmic therapy were assigned to the need-treatment group, while the remaining patients with DR were assigned to the need-observation group. Correlation and regression analyses were performed to determine the required-treatment rate and risk factors for DR. Logistic regression models were used to estimate odds ratios (*OR*) and 95% confidence intervals (*CI*) after adjustment for age, gender and the duration of diabetes.

• RESULTS: DR was present in 334 (11.68%) of the 2859 community residents aged > 60 years old and 1097 (25.66%) of the 4275 hospital patients with T2DM, and 48 (14.81%) of the residents and 172 (15.68%) of the hospital patients required ophthalmic therapy. In univariate and multivariate logistic analyses, factors including the age of the patients (51-60 years old: *OR*, 1.68; 95% *CI*, 1.21-1.72; 61-70 years old: *OR*, 1.55; 95% *CI*, 1.38-1.76), the duration of diabetes (11-15 years: *OR*, 2.61; 95% *CI*, 1.51-4.72; >15 years: *OR*, 4.15; 95% *CI*, 2.32-5.77), glycaemic control (medium: *OR*, 2.51; 95% *CI*, 1.98-3.92; poor: *OR*, 4.69; 95% *CI*, 3.39-6.95), and knowledge of DR (did not understand: *OR*, 1.45; 95% *CI*, 1.21-1.95) were significantly associated with the required-treatment rate in DR, while gender, low and advanced age (31-50 years old and >70 years old), duration of disease (<10y), hypertension, and insulin treatment did not.

• CONCLUSION: The prevalence rate and the required-treatment rate in DR in Qingdao are relatively high. Being aged 51-70 years old and having a duration of diabetes >10y, poor glycaemic control and a lack of knowledge of DR were found to be potential risk factors that increased the rate of required ophthalmic therapy in patients with DR. In patients with T2DM who were aged 51-70 years old, we found that focusing on using science and education to strengthen the patients' knowledge of DR, establishing specifications for a community DR screening system, and effectively implementing early intervention in the community of DR-affected individuals were particularly important for preventing and controlling the high DR prevalence and the high rate of DR-associated blindness

• KEYWORDS: diabetic retinopathy; diabetes; prevalence; duration of the disease; age
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INTRODUCTION

Diabetic retinopathy (DR) is the most common chronic diabetic microvascular complication and the leading cause of blindness among people aged 20-64 years old. Over the past decade, in parallel with rapid economic growth and clear improvements in lifespans, the prevalence of diabetes mellitus (DM) in China has increased from 2.6% to 9.7%, and the risk of developing DR has increased in this population[1-2]. In mainland China, it is estimated that more than 92 million adults (9.7% of the total population) have type 2 diabetes mellitus (T2DM)[3]. We have found in our clinical work that diabetic patients tend to be younger and that many DR patients need ophthalmic therapy. Hence, it is necessary to study the epidemiology of DR. Through this investigation, confirmed DR cases received timely and effective treatment. It is significant for patients in the census who have diabetes to improve their understanding and pay attention to the disease, and early intervention is a vital step toward improving the quality of life of diabetic patients. It is important to reduce the rate of blindness in the study region, and our investigation and the promotion of education regarding DR will help to achieve this goal.

SUBJECTS AND METHODS

Investigation Sites Jimo is located in the northern part of Qingdao in eastern China. The economic conditions are average for mainland China. The population of Jimo is relatively stable and the resident population consists of more than 1 million people. The Jimo municipal government provides physical examinations free of charge and establishes annual health records for residents who are aged >60 years old. The first part of the survey was obtained from government residents' physical examination data, and the second part of the survey contained data that was obtained during tests performed in the Jimo Traditional Chinese Medicine Hospital, which is the main local grassroots medical institution and is well-equipped for treating diabetes and for diagnosing and treating DR.

Subjects We first randomly selected 2859 residents aged >60 years old from Jimo city for inclusion in the investigation. A questionnaire survey was performed in patients with diabetes to assess visual acuity and the anterior segment. A fundus examination was performed and the data were recorded. The second part of the study was performed in the diabetes department of Jimo Traditional Chinese Medicine Hospital. A questionnaire survey and ophthalmic examination were performed on 4275 newly diagnosed diabetic patients aged >30 years old who were enrolled from April 2015 to August 2016. The questionnaire was used to determine the DR patients' ages, genders, durations of DM, level of glycaemic control and knowledge of DR. Blood pressure and glycosylated haemoglobin levels were recorded. All included patients accepted a comprehensive ophthalmic examination that included a fundus examination and retinal photographs. The severity of retinopathy was graded according to the Early Treatment Diabetic Retinopathy Study (ETDRS) severity scale. Appropriate and timely treatment was performed in patients with severe non-proliferative DR and more severe lesions.

Methods During the first part of the investigation, two experienced ophthalmologists were drafted to perform on-site investigations with a team of general practitioners. The residents filled in the questionnaire themselves or with the help of a physician, who also recorded the age, gender, height, weight, blood pressure, history of diabetes, family history, body disease, diabetes diagnosis and glycaemic control. General practitioners were responsible for determining parameters including blood glucose levels, blood pressure. An eye doctor separately performed the front section examination and fundus examination using a hand-held slit lamp and a fundus camera. A standard far vision light box was used to record visual acuity. Another part of the survey was conducted in the hospital. Diabetes patients filled out a basic situation questionnaire. After we removed duplicate diabetes patients and those who refused an ophthalmic examination, 4275 diabetic patients were included. We recorded their age, sex, course of disease, blood glucose control and knowledge about DR. The clinical examination included the following: fasting blood glucose levels, 2-h postprandial blood glucose, glycosylated haemoglobin level; an ophthalmic examination that included a general visual inspection (standard visual acuity light box), computer optometry (NIDEK-510), a non-contact tonometer examination (NIDEK-510), a slit lamp

examination (BM-900), an examination performed using a direct ophthalmoscope (OCULAR 90D) after mydriasis with compound tropicamide eye drops (Mydrin) or indirect ophthalmoscopy (HEINE omega-500), retinal photographs, fundus fluorescein angiography (FFA) when necessary and optical coherence tomography (OCT) to clearly determine the underlying retinopathy.

Measurement and Definition of Potential Risk Factors The following diagnostic criteria were used for DM: T2DM was diagnosed in patients with one of the following criteria: fasting serum glucose concentration ≥7.0 mmol/L, random blood glucose concentration ≥11.0 mmol/L, and receiving medical treatment for diabetes according to the 1999 World Health Organization (WHO) criteria.

DR assessment: retinal examinations were performed using a Canon CR-DGI non-mydriatic retinal camera and a Canon digital camera after the pupils were dilated using drops of 0.5% tropicamide. Retinal photographs were obtained that included the following five visual fields: the upper nasal (optic disc included), lower nasal (optic disc included), upper temporal and lower temporal quadrants and the macula (temporal area included). Photographs were taken of both eyes in all participants. DR severity was defined according to the ETDRS severity scale[4]. Retinopathy was considered if any of the following characteristic lesions were detected: microaneurysms, hard exudates, cotton wool spots, haemorrhages, new retinal vessels, proliferative vitreoretinopathy (PVR), photocoagulation scars, retinal detachment and vitreous haemorrhages.

Diabetic clinically significant macular oedema (CSME) included patients who metany of the following criteria: 1) retinal thickening within 500 μm of the fovea; 2) retinal hard exudates located within 500 μm of the fovea that were accompanied by retinal thickening; 3) the extent of retinal thickening was one or greater than the area of the optic papilla and the distance from the fovea was smaller than the diameter of the optic papilla (1500 μm).

The study subjects who were in need of ophthalmic therapy or had undergone the therapy previously were included in the required treatment group. Individual classifications were determined based on retinopathy, which was based on the retinopathological image of the worse eye in this investigation.

Hypertension was defined according to the WHO definition of hypertension as a systolic blood pressure ≥140 mmHg, a diastolic blood pressure ≥90 mmHg, or the current use of antihypertensive drugs. The duration of diabetes was defined as the period between the year of diagnosis and the year of DR examination, and the patients were classified into 4 groups with durations of <5y, 5-10y, 11-15y and >15y. The estimated normal range for HbA1c levels is 4.4%-6.4%, and <6.5% was used to reflect good glycaemic control; 6.5%-7.5% was considered medium glycaemic control and >7.5% was considered poor glycaemic control[5].

Glycaemic control was divided into the following groups: good, medium and poor. Good indicated that blood sugar was stable, fasting blood glucose was <6.10 mmol/L, and a 2-h postprandial blood glucose reading was <7.22 mmol/L. Medium reflected unstable blood sugar, levels, fasting glucose <8.33 mmol/L, and a 2-h postprandial blood glucose level <10.00 mmol/L. Poor indicated fluctuating blood glucose levels, a fasting blood glucose level >8.33 mmol/L, and a 2-h postprandial blood glucose level >10.00 mmol/L[6]. Knowledge of DR was assessed and used to divide the participants into the following groups: fully understand, understand a little, and do not understand. Fully understand: the participant could state what kind of disease DR was, knew its pathology and prevention and treatment strategies, and could roughly state that DR is a disease that can cause blindness. Understand a little: the participant could roughly state which disease DR is and knew that DR can cause blindness. Do not understand: knew nothing about DR.

Patients with DR were divided into the two following groups according to the severity of DR: the need-observation group (NOG) and the need-treatment group (NTG). The former referred to DR that did not involve severe non-proliferative DR (NPDR) and in which macular oedema had not yet reached CMSE. The retinopathy in this group did not require ophthalmic therapy but did require regular eye examinations. The NTG group included patients with DR who needed laser treatment or surgical intervention to avoid blindness and included those with severe non-proliferative and proliferative DR and CSME. The need-treatment rate in DR refers to the percentage of patients with DR who required ophthalmic therapy out of the total population of DR patients in the study.

Statistical Analysis The two parts of survey data were input by hand. Statistical analyses were performed using SPSS version 19.0 software. In the logistic regression models, the odds ratios (*OR*) and 95% confidence intervals (95% *CIs*) for putative risk factors that were associated with the required-treatment rate in DR patients, which included those who needed ophthalmic therapy. A P value <0.05 was considered significantly different.

RESULTS

Prevalence of DR in Qingdao A total of 2859 residents over the age of 60 years old were recruited into the first part of the present study. Of these, 334 cases (11.68%) were diagnosed with T2DM, while 10 cases were excluded because of lens opacities observed during retinal examinations. Consequently, 324 patients (male/female: 200/124) participated in the investigation. Among these 324 patients, retinopathy required ophthalmic therapy in 48 cases (14.81%). The duration and condition of DR are described in Table 1. There was a significant difference in the prevalence of DR between groups with different durations ($\chi^2_{DR}=35.41$, $P<0.05$). However, the required-treatment rate in DR was not significantly different between groups with different durations of DR ($\chi^2_{NTG}=0.56$, $P=0.91$).

Logistic Single Factor and Multiple Factor Correlation Analyses of the Required-Treatment Rate and Risk Factors for DR A total of 4275 patients who were diagnosed with T2DM were recruited into the study. The clinical data for the patients are shown in Table 2. A correlation analysis and univariate and multivariate logistic regressions were performed to analyse the required-treatment rate and potential risk factors for DR. Logistic regression models were used to estimate *OR* and 95% *CI* after the results were adjusted for age, gender and the duration of diabetes. Table 3 presents the associations that were found between various demographic and biochemical characteristics and DR among the 4275 patients with T2DM following the construction of logistic models during

Table 1 General characteristics of residents with different duration of diabetes

Duration of diabetes (y)	DM (n=324)	DR (n=48)	EDTRS Scores for DR	Need-treatment group	Need-observation group
<5	168	12 (7.14%)	0.67±0.28	1 (8.33%)	11 (91.67%)
5-10	87	10 (11.49%)	0.62±0.19	1 (10.00%)	9 (90.00%)
11-15	57	21 (36.84%)	0.51±0.23	3 (14.28%)	18 (85.72%)
>15	12	5 (41.67%)	0.40±0.21	1 (20.00%)	4 (80.00%)

$\chi^2_{DR}=35.41$, $P<05$; $\chi^2_{NTG}=0.56$, $P>0.05$; DM: Diabetes mellitus; DR: Diabetic retinopathy.

Table 2 Basic data for the included patients with diabetic retinopathy

Parameters	Total(n=4275)	With DR (n=1097)	DR required treatment(n=172)	EDTRS Scores for DR
Gender				
F	1983	495 (24.96%)	82	0.65±0.18
M	2292	602 (26.27%)	90	0.67±0.21
Age (y)				
31-40	336	85 (25.30%)	13	0.83±0.11
41-50	968	245 (25.31%)	37	0.85±0.19
51-60	1395	350 (25.09%)	68	0.67±0.18
61-70	841	221 (26.28%)	42	0.43±0.23
>70	735	196 (26.67%)	12	0.45±0.19
Duration of diabetes (y)				
<5	249	15 (6.02%)	1	0.77±0.18
5-10	1121	169 (15.08%)	11	0.69±0.18
11-15	1559	392 (25.14%)	61	0.57±0.15
>15	1346	521 (38.71%)	99	0.39±0.28
Hypertension				
No	2993	739 (24.69%)	108	0.77±0.18
Yes	1282	358 (27.93%)	64	0.67±0.18
Insulin treatment				
No	3703	947 (25.57%)	149	0.65±0.18
Yes	572	150 (26.22%)	23	0.54±0.28
Glycaemia control				
Good	1523	302 (19.83%)	15	0.57±0.14
Medium	1900	480 (25.26%)	68	0.51±0.18
Poor	852	315 (36.97%)	89	0.45±0.28
Knowledge of DR				
Fully understand	350	12 (3.43%)	2	0.77±0.14
Understand-a-little	2262	895 (39.57%)	127	0.67±0.28
Do-not-understand	1663	190 (11.43%)	43	0.62±0.12

DR: Diabetic retinopathy; HbA1c: Glycosylated haemoglobin.

the second part of the investigation. Factors including the age of the patient (51-60 years old: *OR*, 1.68; 95% *CI*, 1.21-1.72; 61-70 years old: *OR*, 1.55; 95% *CI*, 1.38-1.76), the duration of diabetes (11-15y: *OR*, 2.61; 95% *CI*, 1.51-4.72; >15y: *OR*, 4.15; 95% *CI*, 2.32-5.77), glycaemic control (medium: *OR*, 2.51; 95% *CI*, 1.98-3.92; poor: *OR*, 4.69; 95% *CI*, 3.39-6.95), and knowledge of DR (do not understand: *OR*, 1.45; 95% *CI*, 1.21-1.95) were significantly associated with the required-treatment rate in DR. While the other risk factors analysed in our study were not significantly associated with the required-treatment rate in DR. Gender, low and advanced age (31-50 years old and >70 years old, respectively), the duration of disease (<5y and 5-10y), hypertension and insulin treatment did not appear to be associated with its rate of development.

DISCUSSION

DR is the most serious ocular complication of diabetes. DR is caused by long-term damage to the small blood vessels in the retina and is very likely to cause blindness. As the largest developing country in the world, China has experienced a rapid increase in the prevalence of DM and prediabetes during the past three decades. A recent meta-analysis of the diabetes epidemic indicated that the prevalence of diabetes has reached 9.7% in mainland China, which corresponds to 92.4 million adults with diabetes. This has increased the risk for developing DR[2]. The prevalence of DR is influenced by the source sample size of the object of study. In the domestic literature, the prevalence of DR ranges from 24%-70%[7-10]. We knew that it would be of great significance if we could perform a general survey of diabetic patients and study the potential systemic risk factors associated with the development of DR in order to increase our ability to prevent and treat DR. The results of the first part of the survey administered in this study showed that the prevalence of DR in people aged >60y in the township of Jimo was 11.68%, and the prevalence of DM in the same age group was 26.46%. This difference may have resulted from the use of different research groups-the

Table 3 Correlation analysis of risk factors associated with DR in Qingdao

Parameters	Univariate analyses			Multivariate analyses		
	OR	95% *CI*	*P*	*OR*	95% *CI*	*P*
Gender						
F	1	–	–	1	–	–
M	0.89	0.69-1.13	>0.05	1.02	0.89-1.21	>0.05
Age(y)						
31-40	1	–	–	1	–	–
41-50	0.99	0.98-1.06	>0.05	1.12	0.92-1.24	>0.05
51-60	1.34	1.17-1.52	<0.05	1.68	1.21-1.72	<0.05
61-70	1.30	1.16-1.46	<0.05	1.55	1.38-1.76	<0.05
>70	0.36	0.23-0.57	<0.05	0.95	0.35-1.05	>0.05
Duration of diabetes(y)						
<5	1	–	–	1	–	–
5-10	0.96	0.95-0.97	>0.05	1.12	0.96-1.22	>0.05
11-15	2.58	1.49-4.47	<0.01	2.61	1.51-4,72	<0.01
>15	3.28	1.65-6.53	<0.01	4.15	2.32-5.77	<0.01
Hypertension						
No	1	–	–	1	–	–
Yes	1.27	0.91-1.79	>0.05	1.16	0.87-1.23	>0.05
Insulin treatment						
No	1	–	–	1	–	–
Yes	0.97	0.60-1.56	>0.05	1.15	0.91-1.39	>0.05
Glycaemia control						
Good	1	–	–	1	–	–
Medium	3.16	2.40-4.16	<0.01	2.51	1.98-3.92	<0.01
Poor	7.53	4.64-12.22	<0.01	4.69	3.39-6.95	<0.01
Knowledge of DR						
Fully understand	1	–	–	1	–	–
Understand a little	0.83	0.73-0.94	>0.05	0.94	0.89-1.12	>0.05
Do not understand	1.46	1.13-1.88	<0.05	1.45	1.21-1.95	<0.05

DR: Diabetic retinopathy; HbA1c: Glycosylated haemoglobin.

former involved a census of urban residents with newly diagnosed diabetes with no clinical symptoms, while the latter involved a hospital-based study and DM patients with worse conditions. The prevalence of DR in old people aged >60y in Jimo should not be ignored, and as DR prevalence and duration increase, more and more cases of retinopathy in urban residents will require clinical intervention.

In recent years, the incidence of diabetes has increased in younger populations, indicating that patients will have longer-term exposure to DR risk factors. According to the results of several previous studies[11-14], the duration of diabetes is independently associated with the development of DR in Chinese people with T2DM. However, patients with elderly onset diabetes have a lower prevalence of PDR than that observed in younger-onset patients with a similar diabetes duration[15]. In the present study, we show that having a duration of T2DM of more than 10y and an age of 51-70 years old are independent risk factors for requiring treat in DR. DR patients, and especially those aged 51-60 years old, should be pay more attention to preventing and controlling DR because this segment of the population is important to the labour force.

Many previous studies have shown that there is an association between an elevated level of HbA1c and the development of DR[9,16] in that DR seems to develop more rapidly in patients with high levels of Hb1Ac. Previous studies have demonstrated that the progression of DR does not halt with good control of glucose, indicating the existence of a "metabolic memory" phenomenon[17]. The memory of prior exposure to high glucose leads to the persistence of the disease's harmful effects on target cells for long after glycaemic control is achieved[18]. In our survey, an elevated level of HbA1c and poor glycaemic control were both independent risk factors for requiring-treatment in DR.

Most patients with T2DM lack an understanding of DR, and most patients believe that as long as their blood glucose and blood lipid levels, blood pressure and diet are controlled and as long as they maintain an appropriate level of physical exercise, the eyes will not suffer from diabetes. They therefore do not go to the eye doctor, and this is problematic. Our survey showed that only 350 (8.19%) of the 4275 patients in the hospital with T2DM had a good understanding of DR, and 1663 (38.90%) of the patients had no knowledge of DR. If we can establish good publicity and a good educational approach along with a corresponding support system for patients with T2DM, perhaps including a screening every year after a diagnosis of DM in populations at high risk of DR, we may achieve timely screening of affected individuals[19]. Some elderly patients with diabetes had never been to the eye doctor before the census, and some proliferative DR patients have already lost their sight. If no timely improvements are made to increase our ability to recognize diabetic patients with DR and implement early interventions in these patients in the next few years, there will be an increase in the prevalence of DR in the community population, and the incidence of severe cases will also increase.

According to statistical data obtained from the WHO, in the United States, during the five years from 1987-1992, the cost of diabetes ranged from $21 billion to $92 billion. Indirect costs far outweighed the direct costs, with direct costs accounting for 80% of the cost of treatments for diabetic complications. Research conducted by Hu SL[20] in China showed the following: direct medical expenditures related to diabetes are increasing at an average annual rate of 19.90%, over the same period of GDP and the growth of the total national health expenditure. Outpatient and inpatient costs accounted for a large proportion of these costs, especially because there was a significant increase in hospital costs. Complications are the main factors that affect the economic burden of diabetes.

Although laser photocoagulation and surgical treatment can effectively reduce the risk of blindness in DR, the best treatment period is before visual impairment occurs. During the early stage of the DR, most patients cannot feel the progression of the disease until severe symptoms, such as blindness, appear. However, it is difficult to reverse the lesion by photocoagulation. Therefore, to prevent visual impairment in DR, which is the key to increase early screening and timely intervention[21].

In summary, the results of this study show that the prevalence of DR in eastern China is relatively high. Because the blindness caused by DR can be prevented, it is not enough for the government to implement health check-ups in residents aged >60 years old. We suggest that 51-60 years old is the key period in which DR develops and therefore a critical period for DR treatment. Paying attention to these people and establishing a set of characteristics for China's "national diabetes prevention and control strategy in China" is urgently needed. The purpose is not only to provide education to patients with diabetes, and in involves the training of diabetes-related medical personnel. Lowering the age at baseline screening in patients with T2DM will allow for the identification of lesions early enough for timely intervention, which will improve the life quality of patients while guaranteeing the quality of social labour. Reducing the rate of blindness will also save social medical cost. The financial and energetic costs of preventing complications in diabetes are much lower than the required treatment, early screening, and regular follow up. Treating diabetic ophthalmopathy in a timely manner is the key to reducing visual damage in DR patients and other affected individuals, and all of society will benefit from these efforts.

Several limitation of our study should be noted. First, our participants included a large sample that was recruited from a diabetic population of hospital patients and a sample that was recruited from the community. The latter group of individuals was not big enough. To achieve a better view of the present prevalence of DR in Qingdao, a wider population-based study is needed in the future. All patients were consecutively selected from Jimo Traditional Chinese Medicine Hospital, but they were not randomly selected. Therefore, a multicentre-based study consisting of randomly sampled cases should be conducted. Second, DR was diagnosed based on 5 digital images per eye, and some patients with peripheral lesions may have been excluded because of media opacities and inadequate dilation.

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