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Diabetic retinopathy and health-related quality of life among Chinese with known type 2 diabetes mellitus

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Abstract

Purpose We aim to describe the impact of diabetic retinopathy (DR) on health-related quality of life (HRQOL) among community-dwelling Chinese adults who had been previously diagnosed with type 2 diabetes mellitus (T2DM).

Methods A community-based survey including 913 patients with T2DM was conducted in Suzhou, China. Retinopathy lesions were graded according to the Airlie House classification system of the Early Treatment Diabetic Retinopathy Study. The HRQOL was measured by the Chinese version of the EuroQol Group's five-level EuroQol five-dimensional questionnaire (EQ-5D-5L). A Gamma distribution with log link was incorporated into linear regression models to assess the associations between DR and EQ-5D-5L health utility score.

Results The mean EQ-5D-5L index scores were 0.971 ± 0.082 among individuals with unilateral DR and 0.970 ± 0.145 among those with bilateral DR, which were lower compared with those without DR (0.986 ± 0.045, $P = 0.02$). In multivariate analysis adjusting for confounders, people with bilateral DR reported lower the EQ-5D index scores compared with those without DR. The presence of DR was significantly associated with problems in usual activities (odds ratio [OR] = 0.16, $P = 0.02$, comparing participants with unilateral vs. no DR; OR = 0.11; $P = 0.01$, comparing participants with bilateral vs. no DR). No significant variations in EQ-5D-5L index scores as well as different domains of health problems between individuals with unilateral and bilateral DR were observed ($P > 0.05$).

Conclusion Chinese T2DM patients with bilateral DR tend to report lower HRQOL scores compared with those without DR, especially in health problems associated with usual activities.

Keywords Diabetic retinopathy · Health-related quality of life · EQ-5D · Chinese

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Introduction

It was reported that about 6% of people currently live with diabetes in the world and this estimate would double over the next few decades if proper interventions were not implemented [1]. In mainland China, the prevalences of diabetes and prediabetes were 9.7 and 15.5%, respectively, contributing 92.4 million adults with diabetes and 148.2 million adults with prediabetes [2]. Diabetic retinopathy (DR) is a major microvascular complication of diabetes. Furthermore, it is one of the major causes of visual impairment among people of working age (20–60 years) [3]. DR is prevalent in China. The Handan Eye Study estimated that the prevalence of DR was 43.1% among northern Chinese adults with type 2 diabetes mellitus (T2DM) [4]. DR also affected 35.2% of the diabetes patients in Beijing [5].

The impact of DR on quality of life has been well established. Individuals with DR tend to have a worse

vision-related quality of life [6, 7]. However, less is known about the impact of DR on general health-related quality of life (HRQOL), which measures the overall well-being of the individuals. To the best of our knowledge, current evidence examining the association of DR with generic HRQOL was mainly from western populations [7–10]. Considering that the perceptions of HRQOL are culture-specific and therefore results contextualized in western cultures cannot be directly extrapolated to Chinese populations, it is necessary to assess the impact of DR on HRQOL among local populations. Our previous work has assessed the influence of diabetic complications including DR on generic HRQOL with a sample of Chinese T2DM patients using the EQ-5D-5L (a new version of the EQ-5D). The significant impact was not observed [11]. The insignificance may be attributed to three limitations of the previous study, i.e., self-reported DR status, inadequate measurement of individual HRQOL domains, and index score estimated by EQ-5D-3L (the original version of EQ-5D).

Hence, we aimed to comprehensively assess the impact of DR on generic HRQOL as measured by the EQ-5D-5L in Chinese patients with T2DM. The study results would be valuable for the clinical management and health promotion of T2DM patients with DR in China.

Methods

Study population

The Gusu Diabetic Retinopathy Screening Study was a community-based survey on community-dwelling patients with T2DM in Suzhou, which was located in the eastern part of China. The detailed study design and some significant findings have been reported in previous publications [12, 13]. We retrieved health records from the local Center of Disease Control and Prevention and included all individuals with a previous diagnosis of T2DM living in Gusu district of Suzhou as the sampling frame. The capture rate of diabetes in the patient registry of local Center of Disease Control and Prevention is > 90%. For the recruitment of study participants, invitation letters were sent out first and telephone calls were made subsequently. If the potential participants could not be reached through telephone, we visited their home in person. Based on the health records, we identified a total of 1247 patients with known T2DM, among whom 913 (73.2%) participated in the study. Non-participants were younger ($P < 0.001$) than the sample analyzed.

The study adhered to the Declaration of Helsinki and ethics approval was obtained from the Institutional Review Board of the Soochow University. Written inform consent was obtained from each participant at the recruitment stage of the study.

Measurement of diabetic retinopathy

DR was diagnosed following a widely used protocol in epidemiologic studies [14]. For each participant, two retinal fundus photographs (one centered at the optic disk and the other on the macula) were taken for both eyes using a digital retinal camera (Canon Inc., Japan) upon pupil dilation. Retinopathy lesions were independently graded by two staffs based on the fundus photographs while inter-grader disagreement was solved by the third party of retinal specialist. The severity of DR was graded as: Grade 1: no DR (levels 10–13); Grade 2: mild non-proliferative DR (levels 14–20); Grade 3: moderate non-proliferative DR (levels 31–43); Grade 4: severe non-proliferative DR (levels 47–53); and Grade 5: proliferative DR (levels 60–85). Eyes with severe cataract were excluded because accurate grading of retinal fundus photographs was impossible.

Measurement of HRQOL

HRQOL of the participants was measured by the Chinese version of the EQ-5D-5L. The EQ-5D instrument included five dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. Each dimension describes a participant's health status on the day of the survey at 1 of 5 severity levels: 1-no problems, 2-slight problems, 3-moderate problems, 4-severe problems, and 5-extreme problems. The participants were asked to select from 1 to 5 severity levels using the aforementioned scale for different statements. The participant's response can be formed into a multi-attribute health state which can be converted to a health utility score ranging from −0.391 (worst health) to 1.0 (full health) according to the Chinese value set [15]. The interviewer recorded the participants' responses as part of the interview.

Definitions and measurement of risk factors

All participants underwent a detailed interview using a predesigned questionnaire. Data on socioeconomic status (e.g., education, income), lifestyle risk factors (e.g., smoking), medication intake and self-reported history of systemic diseases were collected. Body mass index (BMI) was defined as weight in kilograms divided by the square of height in meters (kg/m^2). Blood pressure was measured using a digital automatic monitor (Dinamap, Norderstedt, Germany). Hypertension was defined as a systolic pressure of 140 mmHg or more or a diastolic pressure equal to or higher than 90 mmHg, or the use of antihypertensive medications. Non-fasting venous blood samples were used for biochemistry tests, including analysis of hemoglobin A1c (HbA1c). HbA1c was measured

by high-performance liquid chromatography. Each subject's refractive status was assessed by an autorefractor (Canon, Inc., Ltd., Tokyo, Japan), after which subjective refraction was performed. Myopia was defined as spherical equivalent (SE) < -0.5 diopters (D).

Statistical analyses

Participants were divided into three groups by DR status: unilateral DR, bilateral DR, and no DR. The differences in characteristics among three groups were analyzed using the Chi-square test for categorical variables and the analysis of variance (ANOVA) for continuous variables, as appropriate. Using "no DR" as the reference group, we built series of generalized linear regression models to explore the association between DR and EQ-5D-5L utility score. The first model adjusted for age, gender, and socioeconomic status such as education level and marriage status. In the second model, we additionally adjusted for lifestyle risk factors such as tea drinking, smoking and alcohol drinking. The third model, besides all the covariates in the second model, added in clinical data and disease histories such as HbA1c, hypertension, hyperlipidemia, myopia, diabetic foot disease, heart disease, and diabetic nephropathy. As the EQ-5D index score is highly skewed in the study, a Gamma distribution with log link was incorporated into the aforementioned models. Multivariate logistic regression models were used to establish the associations of DR with EQ-5D five dimensions health problems (with vs. without problems) controlling the variables adjusted in the third model.

All analyses were performed using SAS (version 9.3) and Stata (version 13.0) at a significance level of 0.05.

Table 1 Characteristics of study participants according to DR (diabetic retinopathy)

Characteristics	NO DR[a] ($n=722$)	Unilateral DR ($n=56$)	Bilateral DR ($n=102$)	P value
Women (%)	411 (56.9)	31 (55.4)	50 (49.0)	0.32
Age (years) (SD)	67.9 (8.2)	68.9 (7.4)	65.3 (8.7)	0.005
Education level (%)				0.99
High school or below	415 (57.5)	32 (57.1)	58 (56.9)	
College or above	307 (42.5)	24 (42.9)	44 (43.1)	
Married (%)	659 (91.3)	51 (91.1)	91 (89.2)	0.79
Body mass index (SD)	24.4 (3.1)	24.1 (3.3)	23.8 (2.6)	0.08
Hemoglobin A1c (%) (SD)	7.1 (1.3)	7.4 (1.4)	7.5 (1.6)	0.01
Tea drinking (%)	367 (50.8)	31 (55.4)	92 (60.8)	0.15
Smoking (%)	138 (19.1)	9 (16.1)	30 (29.4)	0.04
Alcohol drinking (%)	74 (10.2)	3 (5.4)	13 (12.7)	0.34
Duration of diabetes (years) (SD)	10.3 (7.0)	12.2 (8.3)	11.0 (7.0)	0.03
Diabetic nephropathy (%)	93 (13.1)	9 (16.1)	11 (11.3)	0.71
Myopia (%)	186 (27.2)	24 (43.6)	27 (27.0)	0.03
Hypertension (%)	425 (59.1)	28 (50.0)	60 (58.8)	0.41
Hyperglycemia (%)	202 (28.0)	13 (23.2)	32 (31.4)	0.55
Heart disease (%)	211 (29.2)	19 (33.9)	27 (26.5)	0.62
Diabetic foot disease (%)	40 (5.5)	8 (14.3)	10 (9.8)	0.02
Mean EQ-5D score (SD)	0.986 (0.045)	0.971 (0.082)	0.970 (0.145)	0.02
EQ-5D problems (yes vs. no) (%)				
Mobility problem	51 (7.1)	7 (12.5)	8 (7.8)	0.37
Self-care problem	8 (1.1)	3 (5.4)	4 (3.9)	0.01
Usual activities problem	5 (0.7)	3 (5.4)	6 (5.9)	<0.001
Pain/discomfort problem	57 (7.9)	9 (16.1)	10 (9.8)	0.10
Anxiety/depression problem	23 (3.2)	5 (8.9)	6 (5.9)	0.05

P values indicated overall significance of each comparison. A post hoc Dunnett's test was used to adjust type 1 error rate at an overall significance level of 0.05 at analysis of variance or Chi-square

EQ-5D European Quality of Life-5 Dimensions, *SD* standard deviation

[a]Reference group

Results

Table 1 presents the characteristics of the study participants. Of the 913 T2DM patients in the initial screening, 880 had gradable retinal photographs. The prevalence of DR in this sample was 17.95% by person. The mean age was 67.7 ± 8.3 years and 55.91% of participants were women. Compared with participants free of DR, those with DR had higher HbA1c levels, longer durations of diabetes, and higher rates of diabetic foot diseases. The mean EQ-5D health utility score was 0.983 ± 0.067 for the sample and 771 (87.6%) participants reported full health. Patients who have not developed DR achieved significantly ($P = 0.02$) higher EQ-5D scores than those already with one or two eyes affected. However, the mean HRQOL was comparable between unilateral DR group (0.971 ± 0.082) and bilateral DR group (0.970 ± 0.145).

The associations between DR and EQ-5D health utility score modeled by generalized linear regression are displayed in Table 2. Patients with bilateral DR reported lower EQ-5D index scores than those with no DR, after controlling for multiple covariates. In the full model (model 3), the regression coefficient for comparing bilateral DR vs. no DR was −0.019 (95% CI −0.037, −0.002). Models did not find significant differences when comparing bilateral DR vs. unilateral DR or unilateral DR vs. no DR.

The associations of DR with individual EQ-5D domains were assessed in five logistic regression models (Table 3). We found that, after adjusting for a wide range of covariates, the presence of DR was significantly associated with problems in usual activities (odds ratio [OR] = 0.16, $P = 0.02$, unilateral DR vs. no DR; OR = 0.11; $P = 0.01$, bilateral DR vs. no DR). But DR was not significantly associated with other domains. There were no significant variations in all EQ-5D self-reported problemsbetween individuals with unilateral DR and bilateral DR (all $P > 0.05$).

Table 2 Association between DR (diabetic retinopathy) and the EQ-5D index score

	Model 1		Model 2		Model 3	
	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
Gender (female vs. male)	−0.005 (−0.013, 0.002)	0.174	−0.010 (−0.019, −0.001)	**0.036**	−0.009 (−0.017, 0.001)	0.052
Age (years)	−0.004 (−0.008, 0.0001)	0.108	−0.005 (−0.009, 0.000)	**0.045**	−0.003 (−0.001, 0.0001)	0.154
Education (high school or below vs. college or above)	−0.005 (−0.012, 0.003)	0.233	−0.006 (−0.013, 0.002)	0.146	−0.005 (−0.013, 0.002)	0.136
Married (yes vs. no)	0.008 (−0.005, 0.020)	0.245	0.008 (−0.004, 0.021)	0.204	0.008 (−0.005, 0.020)	0.228
Tea consumption (yes vs. no)	–		0.003 (−0.005, 0.011)	0.477	0.003 (−0.005, 0.010)	0.524
Smoking (yes vs. no)	–		−0.004 (−0.016, 0.008)	0.506	−0.006 (−0.017, 0.05)	0.273
Alcohol drinking (yes vs. no)	–		−0.051 (−0.077, −0.024)	**<0.001**	−0.049 (−0.074, 0.023)	**<0.001**
Durations of diabetes (years)	–		–		−0.004 (−0.001, 0.0001)	0.152
HbA1C (%)	–		–		−0.001 (−0.004, 0.0001)	0.655
Hypertension (yes vs. no)	–		–		−0.005 (−0.008, 0.007)	0.897
Hyperglycemia (yes vs. no)	–		–		−0.002 (−0.010, 0.006)	0.628
Heart disease (yes vs. no)	–		–		−0.008 (−0.016, −0.001)	**0.003**
Diabetic foot disease (yes vs. no)	–		–		−0.070 (−0.085, −0.055)	**<0.001**
Diabetic nephropathy (yes vs. no)	–		–		−0.003 (−0.013, 0.008)	0.594
DR status						
Unilateral DR versus no DR	−0.019 (−0.041, 0.002)	0.178	−0.017 (−0.038, 0.005)	0.194	−0.013 (−0.029, 0.005)	0.372
Bilateral DR versus no DR	−0.027 (−0.047, −0.006)	**<0.001**	−0.024 (−0.044, −0.006)	**0.003**	−0.019 (−0.037, −0.002)	**0.009**
Unilateral DR versus bilateral DR	0.008 (−0.024, 0.036)	0.427	0.006 (−0.019, 0.031)	0.546	0.006 (−0.018, 0.032)	0.584

Model 1: adjusted for age, gender, education level, marriage status

Model 2: covariates in model 1 plus lifestyle habits: tea drinking, smoking, alcohol drinking

Model 3: covariates in model 2 plus health conditions: HbA1C, durations of diabetes, hypertension, hyperlipidemia, diabetic foot disease, heart disease, and diabetic nephropathy

HbA1C hemoglobin A1c, *DR* diabetic retinopathy, *EQ-5D* European Quality of Life-5 Dimensions, β regression coefficient, *CI* confidence interval

Boldness: $P < 0.05$

Table 3 Odds ratios (95% confidence interval) of diabetic retinopathy in predicting EQ-5D health problems

	Mobility		Self-care		Usual activities		Pain/discomfort		Anxiety/depression	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Gender (female vs. male)	0.51 (0.24, 1.06)	0.07	0.80 (0.19, 3.46)	0.77	0.59 (0.12, 2.88)	0.51	0.53 (0.26, 1.06)	0.07	0.42 (0.14, 1.23)	0.11
Age (years)	0.93 (0.89, 0.97)	**<0.001**	0.98 (0.92, 1.06)	0.64	1.01 (0.94, 1.09)	0.80	0.96 (0.92, 0.99)	**0.01**	0.99 (0.94, 1.05)	0.78
Education (high school or below vs. college or above)	0.81 (0.45, 1.43)	0.46	0.54 (0.18, 1.67)	0.28	0.98 (0.30, 3.21)	0.97	1.06 (0.61, 1.85)	0.84	0.47 (0.21, 1.07)	0.07
Married (yes vs. no)	1.35 (0.58, 3.18)	0.49	0.72 (0.08, 6.67)	0.77	0.74 (0.08, 6.46)	0.79	1.21 (0.52, 2.85)	0.66	1.96 (0.66, 5.82)	0.23
Tea consumption (yes vs. no)	1.17 (0.63, 2.18)	0.62	1.19 (0.32, 4.40)	0.79	0.65 (0.18, 2.42)	0.52	0.69 (0.38, 1.23)	0.21	1.25 (0.51, 3.06)	0.63
Smoking (yes vs. no)	0.65 (0.26, 1.58)	0.34	0.82 (0.164.34)	0.82	1.02 (0.15, 6.90)	0.98	1.49 (0.60, 3.72)	0.39	1.59 (0.41, 6.18)	0.50
Alcohol drinking (yes vs. no)	0.65 (0.23, 1.81)	0.41	0.29 (0.05, 1.59)	0.15	1.17 (0.11, 12.17)	0.90	0.69 (0.25, 1.96)	0.49	0.12 (0.03, 0.48)	**0.003**
HbA1C (%)	0.87 (0.71, 1.06)	0.17	1.07 (0.70, 1.64)	0.76	1.24 (0.77, 1.96)	0.37	0.88 (0.72, 1.07)	0.20	0.81 (0.63, 1.04)	0.09
Hypertension (yes vs. no)	1.14 (0.60, 2.14)	0.69	1.10 (0.31, 3.87)	0.89	0.40 (0.08, 1.95)	0.26	1.50 (0.83, 2.72)	0.18	1.72 (0.74, 4.01)	0.21
Hyperglycemia (yes vs. no)	1.11 (0.05, 2.10)	0.74	1.02 (0.29, 3.60)	0.98	0.63 (0.19, 2.13)	0.46	1.01 (0.54, 1.87)	0.98	0.93 (0.39, 2.21)	0.87
Heart disease (yes vs. no)	0.51 (0.28, 0.91)	**0.02**	0.63 (0.20, 2.05)	0.45	1.16 (0.31, 4.28)	0.83	0.59 (0.33, 1.05)	0.07	0.36 (0.16, 0.82)	**0.02**
Diabetic foot disease (yes vs. no)	0.11 (0.05, 0.21)	**<0.001**	0.10 (0.03, 0.33)	**<0.001**	0.25 (0.06, 0.94)	**0.04**	0.11 (0.05, 0.22)	**<0.001**	0.19 (0.06, 0.58)	**0.004**
Diabetic nephropathy (yes vs. no)	0.54 (0.27, 1.07)	0.07	1.97 (0.35, 11.12)	0.44	1.76 (0.29, 10.62)	0.54	0.66 (0.33, 1.30)	0.23	0.50 (0.19, 1.31)	0.16
DR status										
Unilateral versus no DR	0.93 (0.35, 2.45)	0.84	0.25 (0.56, 1.19)	0.08	0.16 (0.03, 0.77)	**0.02**	0.75 (0.31, 1.83)	0.77	0.32 (0.10, 1.04)	0.06
Bilateral versus no DR	0.92 (0.38, 2.17)	0.88	0.30 (0.08, 1.19)	0.09	0.11 (0.03, 0.40)	**0.01**	0.88 (0.38, 2.03)	0.53	0.77 (0.24, 2.43)	0.66
Unilateral versus bilateral DR	1.01 (0.19, 3.46)	0.98	0.84 (0.15, 4.95)	0.85	1.53 (0.30, 7.85)	0.61	0.85 (0.27, 2.64)	0.77	0.41 (0.09, 1.84)	0.25

HbA1C hemoglobin A1c, *DR* diabetic retinopathy, *EQ-5D* European Quality of Life-5 Dimensions, *OR* odds ratio, *CI* confidence interval

Boldness: $P < 0.05$

Discussion

Our study investigated the impacts of DR on HRQOL in community-dwelling patients with T2DM in urban China. We found that adults affected by DR in both eyes reported lower EQ-5D health utility scores compared with those free of DR after adjusting for a wide range of covariates. The difference in EQ-5D scores between T2DM patients with unilateral DR and without DR was not significant. It appears that only DR in more severe stage could worsen the HRQOL among T2DM patients. We did not detect significant differences in EQ-5D health utility scores when comparing individuals with unilateral and bilateral DR, indicating that daily HRQOL may be dependent on the vision of the better-seeing eye. With regard to individual domains of HRQOL, we found the presence of bilateral DR was associated with problems in usual activities. As for mobility, self-care, pain/discomfort, and anxiety/depression, significant differences were not observed. The explanation for these non-significant observations could be that these four domains domain may not rely so much on good vision compared to usual activities.

The HRQOL impact of DR discovered in the present study was not considered large: bilateral DR was associated with usual activities problems only. The difference in EQ-5D index score between no DR and bilateral DR (0.015) was less than the minimally clinical important difference (MCID) of EQ-5D (0.074). Also, the study sample had high overall HRQOL score even with high DR prevalence. The phenomena may not be so unexpected given the EQ-5D has long shown significant ceiling effect in assessing HRQOL in various populations in Asia including mainland China [16, 17]. The EQ-5D-5L, although a new version of EQ-5D, may still be infested with such drawback. One possible explanation is that face-saving is popular culture in China. The participants therefore tend to provide socially desirable responses. The characteristics of study sample could be another reason. First, the prevalence of VTDR was low (4.4%) with most being with mild to moderate DR. Their vision maintained at functional level, hence there was no reduction in their HRQOL [12]. Second, the small sample size of unilateral or bilateral DR may have limited the statistical power to detect the difference. In addition, the effect of response shift may mask the HRQOL differences caused by DR. Nevertheless, the small HRQOL impact does not imply insignificance from the perspective of public health. Given the huge T2DM patient population with DR in mainland China, even small impact as found in this study can lead to enormous HRQOL loss overall .

Existing studies have adopted both vision-specific (e.g., VFQ-25) and generic HRQOL (e.g., EQ-5D) measures to assess the relationships between eye diseases and HRQOL. The studies using the VFQ-25 instrument or other instruments including vision-specific domain found DR was associated with a worse HRQOL, while those using the EQ-5D showed inconsistent findings. The small yet significant decrements in HRQOL in T2DM patients with DR have been reported in several studies [18–20]. For example, Morgan et al. found that the EQ-5D-3L index score decline of − 0.029 in a UK sample of T2DM patients was due to DR [20]. However, other studies suggested a minimal and non-significant impact of DR on HRQOL [8, 21]. For instance, Fenwick et al. reported that neither presence nor severity of DR was associated with HRQOL scores as measured by the EQ-5D-3L in a cross-sectional study of 577 diabetes patients in Australia [8]. We previously also found EQ-5D-5L index score was not correlated with DR either [11]. Regardless of variations in methodology (e.g., study population, sampling and statistical methods) across these studies, the results were consistent that the impact of DR on HRQOL, if measured by the EQ-5D, was restricted. This indicates that the EQ-5D-3L or the EQ-5D-5L lacks sensitivity to capture the HRQOL loss due to DR. This may not be the case for other generic HRQOL instruments. A recent SF-6D study reported significant difference in mean SF-6D index score (0.071, which is greater than its MICD of 0.041) between diabetes patients with and without eye problems [22].

Our findings are useful in guiding clinical management of patients with DR in China. First, bilateral DR has significantly HRQOL impact underscoring the need to reduce the risk of its development among T2DM patients. Second, in order to improve HRQOL of patients with bilateral DR, intervention should be targeted at usual activities problems. Third, the utility loss due to bilateral DR could be used in research investigations to identify cost-effective therapies.

Our study was the first of its kind systematically investigating the potential impacts of DR on generic HRQOL. We adopted the Chinese value set to estimate the health utility values for EQ-5D-5L health states, which is more suitable to reflect utility value of the health states in Chinese population. Some limitations of this study need to be noted. First, DR grading was based on two digital images only. This is subject to an underestimation of DR prevalence, which may not be substantial [23]. In addition, we assessed HRQOL using the EQ-5D-5L only and were not able to link DR to other instruments measuring HRQOL. Finally, whether the presence of DR predated changes in HRQOL or to what extent self-reported HRQOL may affect the diagnosis of DR could not be determined due to the cross-sectional study design.

In summary, Chinese T2DM patients with bilateral DR tend to had lower EQ-5D health utility scores compared with those free of DR, especially in health problems relating to

usual activities. We recommend that efforts and resources be channeled to address not only vision-related quality of life but overall well-being among adults with bilateral DR for diabetes patients.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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