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Barriers to annual diabetic retinopathy screening and subsequent recommended follow-up adherence among Chinese diabetics: a cross-sectional and longitudinal study

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ABSTRACT

Objectives Adherence to routine annual eye evaluations for diabetes is frequently insufficient on a global scale. We evaluated the adherence to annual diabetic retinopathy screening (DRS) and recommended follow-up among Chinese patients with diabetes, and we also identified the associated risk variables.

Design This was a cross-sectional and longitudinal study.

Setting Patients with diabetes were inquired about their completion of DRS within the preceding year. All participants were required to complete the Compliance with Annual Diabetic Eye Exams Survey.

Participants Participants with diabetes who initially sought eye examination from November 2021 to October 2023 at He Eye Specialist Hospital, Shenyang, China.

Outcome measures Logistic regression analyses defined the risk factors associated with poor compliance with the annual DRS and recommended follow-up.

Results There were 468 patients registered, with a mean age of 67.42±10.66 years. A total of 308 (65.8%) participants had DRS in the previous year. Rural residents (OR 1.704, 95% CI 1.019 to 2.850, p=0.042), vision-threatening diabetic retinopathy (VTDR) (OR 1.948, 95% CI 1.145 to 3.313, p=0.014), item 7 (over the past 4 weeks, I have felt blue, downhearted or depressed) (OR 0.624, 95% CI 0.401 to 0.971, p=0.037) and item 42 (I receive a reminder from my eye doctor's office when it is time to schedule an exam) (OR 0.618, 95% CI 0.387 to 0.989, p=0.045) were associated with non-adherence to annual DRS. The compliance with DRS improved to 80.9% in the second year after health education and reminders of follow-up. VTDR (OR 3.063, 95% CI 1.852 to 5.066, p<0.01) was found to be the risk factor for poor compliance with scheduled follow-up.

Conclusions About one-third of diabetics did not complete annual DRS; that rate decreased to one-fifth after health education and follow-up reminders.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study was based on cross-sectional and longitudinal diabetes data from China, linked to annual diabetic retinopathy screening (DRS) and recommended follow-up.
⇒ This study used the Compliance with Annual Diabetic Eye Exams Survey questionnaire to identify the associated factors with non-adherence to annual DRS. The compliance with DRS was improved in the second year after the associated factors were corrected.
⇒ The study's limitations included a small sample size and the possibility of selection bias due to all participants coming from a single centre.
⇒ The population in this study was predominantly type 2 and appeared to be relatively older, so it was not representative of the adherence characteristics of type 1 diabetes.
⇒ Since the included participants were those seeking an ophthalmic examination, it may have resulted in higher adherence rates to the results of this study than the actual adherence rates.

INTRODUCTION

Diabetes retinopathy (DR) is one of the most common complications of diabetes mellitus (DM). Among individuals with diabetes, global prevalence was 22.27% for DR, 6.17% for vision-threatening diabetic retinopathy (VTDR) and 4.07% for clinically significant macular oedema.[1] It is crucial to detect DR early to prevent severe visual impairment, as treatment can reduce the condition by up to 90%.[2 3] To this end, routine eye exams are advised for diabetics to detect DR in its early stages; patients with VTDR should be promptly referred for treatment.[4]

The American Academy of Ophthalmology and the American Diabetes Association (ADA) advise diabetes patients to undergo diabetic retinopathy screening (DRS) at least annually and every 2 years, respectively.[5 6] The National Health and Medical Research Council (NHMRC) in Australia has established guidelines that suggest that Indigenous Australians undergo annual retinal screening and visual acuity assessments, while

non-Indigenous Australians with diabetes undergo biennial assessments. The Australian government has allocated funds for non-mydriatic fundus photography for patients with diabetes in primary healthcare institutions. Additionally, general practitioners regularly incorporate fundus photography into their diabetes management protocols.[7] The National Screening Committee is responsible for the administration of DRS in the UK. Through 57 regional Diabetic Eye Screening Programmes, the National Diabetic Eye Screening Programme in England conducts screenings for all individuals with diabetes who are 12 years of age or older.[8] Denmark possesses a government-funded countrywide screening programme for DR. Patients are advised to undergo screening in either a practising ophthalmologist's office or a hospital-based screening facility. Financial reimbursement is granted irrespective of the screening location, and patients diagnosed with proliferative diabetic retinopathy (PDR) or diabetic macular oedema (DME) are sent for treatment in public hospital ophthalmology departments.[9] China demonstrates the highest prevalence of diabetes, along with a rising incidence rate.[10] Nonetheless, fewer than 10% of persons obtain an early diagnosis of DR.[11–17] The Chinese recommendations for the clinical diagnosis and management of diabetic retinopathy advocate for annual DRS. Despite the Chinese government's endorsement of the DRS for patients with DM, participation in it is not compulsory. Numerous primary healthcare centres are deficient in equipment for fundus examination, and certain primary care physicians are unable to perform the DRS or capture fundus photographs. Additionally, certain regions' medical insurance does not cover the cost of DRS, and different healthcare centres cannot directly share medical information. Compliance with routine DRS is often insufficient and inconsistent across nations, as demonstrated by annual examination adherence rates ranging from 23% to 65% in various studies.[18–21]

Numerous studies examined potential factors contributing to non-compliance with DRS guidelines among countries. The associated factors with non-adherence to DRS guidelines include diabetes duration, younger age, diabetes-related visual impairments, financial constraints, access to care, insufficient awareness, etc.[14 16 18–22] There is a lack of research on the follow-up behaviour of diabetics after screening, despite the fact that the recommended follow-up intervals for DR can vary depending on the disease conditions.

The Compliance with Annual Diabetic Eye Exams Survey (CADEES) is a questionnaire developed based on the health belief model (HBM).[22] The assessment demonstrated strong content, structural validity and predictive validity when administered to individuals in the USA who have diabetes. To improve attendance, it is recommended to offer counselling to individuals just diagnosed and those with uncontrolled blood glucose levels. This counselling should emphasise the importance of annual eye examinations and address any perceived obstacles or misunderstandings. The Chinese version of CADEES was also attested to have high validity and reliability in predicting attendance at annual eye exams for diabetics in China.[23]

This study aimed to investigate the barriers affecting diabetics' adherence to DRS in a tertiary eye hospital in Northeast China and identify the factors leading to non-attendance at scheduled follow-up appointments.

METHODS

Design and participants

This study used a cross-sectional and surveillance design, conducted from November 2021 to October 2023. The participants with diabetes who initially sought eye examination at He Eye Specialist Hospital were recruited using a convenience sampling method. The inclusion criteria for this study were as follows: (1) participants were at least 18 years old and diagnosed with diabetes; (2) underwent DRS using a non-mydriatic ultra-widefield scanning laser ophthalmoscope (SLO) and optical coherence tomography (OCT) and (3) independently completed a self-reported questionnaire. Participants who had (1) severe cataracts and could not have thorough fundus exams, (2) diagnosed DR previously or (3) a history of other eye conditions that needed long-term ophthalmological follow-up, such as retinal artery/vein occlusion, age-related macular degeneration, glaucoma, was excluded. The sample size was determined to be 381 cases, with an estimated overall probability of P=31% and an acceptable error δ=0.15P, derived from a presurvey analysis. We increased the sample size to 572 to account for potential non-responses to the questionnaire. Finally, a total of 468 participants completed the investigation, resulting

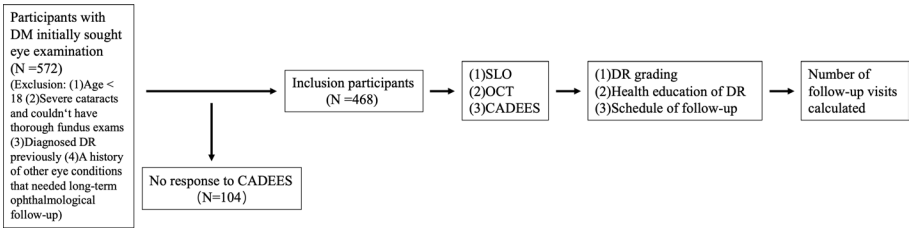

Figure 1 Diagram illustrating the inclusion and exclusion of study participants. CADEES, Compliance with Annual Diabetic Eye Exams Survey; DM, diabetes mellitus; DR, diabetes retinopathy; OCT, optical coherence tomography; SLO, scanning laser ophthalmoscope.

Table 1 The comparison of demographic data between participants exhibiting good versus poor compliance with annual DRS

Variates	n (%)	Good compliance to annual DRS (n=308)	Poor compliance to annual DRS (n=160)	P value
Gender, n (%)				0.843
Male	192 (41.0)	125 (40.6)	67 (41.9)	
Female	276 (59.0)	183 (59.4)	93 (58.1)	
Age, n (%)				0.068*
<50 years	27 (5.8)	19 (6.2)	8 (5.0)	
50~70 years	249 (53.2)	152 (49.4)	97 (60.6)	
>70 years	192 (41.0)	137 (44.5)	55 (34.4)	
Education, n (%)				0.186
Middle school and below	301 (64.3)	205 (66.6)	96 (60.0)	
High school and above	167 (35.7)	103 (33.4)	64 (40.0)	
Residential location, n (%)				0.007*
Urban	378 (80.8)	260 (84.4)	118 (73.8)	
Rural	90 (19.2)	48 (15.6)	42 (26.3)	
DR level, n (%)				0.027*
None	330 (70.5)	229 (74.4)	101 (63.1)	
NVTDR	50 (10.7)	31 (10.1)	19 (11.9)	
VTDR	88 (18.8)	48 (25.0)	40 (25.0)	
High pressure, n (%)				0.483
Yes	206 (44.0)	132 (42.9)	74 (46.3)	
No	262 (56.0)	176 (57.1)	86 (53.8)	
Hyperlipidaemia, n (%)				0.213
Yes	121 (42.3)	83 (45.1)	38 (37.3)	
No	165 (57.7)	101 (54.9)	64 (62.7)	
Abnormal renal function, n (%)				0.342
Yes	397 (84.8)	265 (86.0)	132 (82.5)	
No	71 (15.2)	43 (14.0)	28 (17.5)	
Duration of diabetes, n (%)				0.192
≤10 years	294 (62.8)	200 (64.9)	94 (58.8)	
>10 years	174 (37.2)	108 (35.1)	66 (41.3)	
HbA1c, n (%)				0.235
<7.0%	92 (32.2)	64 (34.8)	28 (27.5)	
≥7.0%	194 (67.8)	120 (65.2)	74 (72.5)	

*Variables of p<0.1.
DR, diabetic retinopathy; DRS, diabetic retinopathy screening; HBA1c, haemoglobin A1c; NVTDR, non-vision threatening diabetic retinopathy; VTDR, vision-threatening diabetic retinopathy.

in an effective response rate of 81.8% (figure 1). Written informed consents were obtained directly from all participants.

Demographic data and DR grading

Demographic information of participants, including age, gender, education, place of residence and duration of diabetes, was obtained. Furthermore, renal function, blood pressure, blood lipids and haemoglobin A1c (HbA1c) were assessed. All participants received retinal imaging, which included ultrawide-angle SLO (Optos 200Tx, Optos, Dunfermline, UK) and high-resolution spectral-domain OCT (Cirrus HD-OCT 5000, Zeiss, Dublin, California, USA). In such cases, raster OCT scans, along with horizontal and vertical B-scans through the fovea, are executed as a standard imaging protocol. The international clinical diabetic retinopathy and DME disease severity scale was employed to assess the severity of DR. VTDR was defined as the occurrence of PDR, severe non-PDR (NPDR) or DME in at least one eye. In statistical analysis, the worst eye of each patient was selected.

Table 2 The comparison of the scores of CADEES items between participants exhibiting good versus poor compliance with annual DRS

Item	Good compliance to annual DRS (n=308)	Poor compliance to annual DRS (n=160)	P value
1. My eyes are healthy.	2.26±0.628	2.22±0.806	0.661
2. Early diabetic eye disease usually causes changes in vision.	3.19±0.868	3.03±0.958	0.080*
3. Having an eye exam is not pleasant.	2.74±0.925	2.88±0.954	0.177
4. I am confident in my ability to make an appointment for an eye exam.	3.30±0.957	3.28±1.065	0.541
5. Having an eye exam once a year can help me prevent losing my eyesight.	3.56±0.726	3.45±0.699	0.552
6. I have trouble reading a book or newspaper, even if I use my glasses or contacts.	2.92±0.884	2.97±0.980	0.973
7. Over the past 4 weeks I have felt blue, downhearted, or depressed.	2.85±0.890	2.68±0.934	0.076*
8. I know someone who has lost some or all of his/her eyesight because of problems from diabetes.	2.88±0.913	2.81±1.246	0.006*
9. I know a lot about diabetes and the effect it can have on health.	3.80±0.528	3.96±0.597	0.922
10. Diabetes can result in a loss of visual function (eg, difficulty reading, driving).	3.62±0.728	3.64±0.900	0.310
11. I think I will lose some or all of my eyesight because of diabetes.	3.51±0.759	3.60±0.926	0.158
12. I am confident I can keep a scheduled appointment with an eye doctor.	3.49±0.875	3.32±0.871	0.050*
13. I do not want to know if I have an eye disease.	2.32±0.848	2.23±0.720	0.041*
14. People who have good control of their diabetes are unlikely to have eye problems.	3.15±0.869	3.04±1.021	0.018*
15. Diabetes can cause severe eye problems.	3.78±0.518	3.86±0.536	0.435
16. I would benefit from having an eye exam every year.	3.99±0.449	4.01±0.462	0.823
17. My medical provider (ie, doctor, nurse, nurse practitioner) talks to me about the importance of eye exams.	3.88±0.644	3.92±0.673	0.423
18. Eye exams cost too much.	3.24±0.925	3.29±1.085	0.289
19. There is no treatment for diabetic eye diseases.	2.84±0.703	2.99±0.663	0.002*
20. It is hard for me to travel to an eye doctor.	2.45±0.804	2.49±0.958	0.678
21. There are many things that make it hard to get an eye exam every year.	2.55±0.877	2.58±0.968	0.663
22. I do not like having my eyes dilated with eye drops that make my pupils large.	3.07±0.973	3.33±0.936	<0.001*
23. I think it is important to have an eye exam every year.	3.88±0.527	3.99±0.462	0.104
24. My overall general health is excellent.	3.14±0.769	3.17±0.863	0.912
25. Diabetic eye disease can be seen with an eye exam.	3.89±0.450	3.87±0.490	0.180
26. Diabetes can damage the blood vessels in the eye.	3.50±0.590	3.52±0.624	0.560
27. There are many eye doctors where I live.	2.90±0.900	2.79±0.991	0.112
28. My family members or friends help me make doctor appointments.	4.09±0.447	4.13±0.551	0.343
29. Eye exams can find many different kinds of eye problems.	3.98±0.419	3.94±0.322	0.308
30. I am confident I can control my blood sugar.	3.53±0.788	3.50±0.876	0.522
31. Having a yearly eye exam will help me to save the eyesight I have now.	3.65±0.636	3.46±0.643	0.933
32. People with diabetes are unlikely to get an eye disease.	2.28±0.748	2.10±0.665	0.009*
33. I cannot afford an eye exam.	2.64±0.792	2.75±0.883	0.367
34. My insurance covers most of the cost of an eye exam.	3.26±0.767	2.97±0.900	0.002*
35. There are things I can do to prevent losing my vision from diabetes.	3.80±0.674	3.84±0.734	0.577
36. Diabetic eye diseases often cause blindness.	3.07±0.814	3.21±0.934	0.751
37. I have medical problems from diabetes.	2.58±0.841	2.89±3.319	0.737
38. I want to get an eye exam every year.	3.69±0.646	3.65±0.762	0.141
39. I only seek eye care when I am having trouble with my vision.	3.59±0.848	3.99±0.876	0.101
40. Getting an eye exam every year is not one of my top priorities.	2.57±0.814	2.79±0.941	0.056*

Continued

Table 2 Continued

Item	Good compliance to annual DRS (n=308)	Poor compliance to annual DRS (n=160)	P value
41. I have an eye doctor I can go to for diabetic eye exams.	0.98±0.235	0.93±0.287	0.006*
42. I receive a reminder from my eye doctor's office when it is time to schedule an exam.	3.23±0.935	2.82±1.007	<0.001*
43. I am happy with the care I get from my eye doctor.	3.85±0.520	3.99±0.331	0.123
44. Visiting the eye doctor takes too much time.	2.49±0.969	2.68±0.986	0.041*

*Variables of p<0.1.
CADEES, Compliance with Annual Diabetic Eye Exams Survey; DRS, diabetic retinopathy screening.

Participants were inquired about their completion of DRS in the preceding year. The absence of fundus examination in the previous year indicates non-adherence to DRS, whereas the completion of a fundus examination within the previous year signifies adherence to DRS. All participants would complete the questionnaire for the Chinese version of CADEES (online supplemental appendix S1). The CADEES questionnaire comprises 44 item stems, with responses evaluated on a 1–5 scale ranging from strongly disagree to strongly agree. Subsequently, every participant would receive instruction on DR-related topics, such as the definition, pathogenesis, symptoms, warning signs of complications, associated risk factors, insulin dosage, self-monitoring of blood glucose, diet and lifestyle, as well as the importance of DRS and effective follow-up time.

All participants were then informed of their follow-up plans based on their DR levels. A notification message would be dispatched prior to each future follow-up visit. Participants without DR or mild NPDR should have 12-month follow-up intervals, whereas those with moderate NPDR require follow-up every 6 months. Participants with severe NPDR were monitored at 3-month intervals, while those with PDR were assessed monthly. Participants should have follow-up intervals of 1 month for centre-involved DME (CI-DME) and 3 months for non-CI-DME. Completing all visits as per the doctor's instructions within the following year indicates good follow-up compliance, while omitting certain visits indicates poor follow-up compliance. The follow-up visits at other eye healthcare centres that participants reported would also be included.

Statistical analysis

Data analysis was conducted using SPSS V.27.0 (IBM), establishing a statistical power of 95% and an alpha level of 0.05. The mean and SD represent continuous values, while percentages represent categorical variables. A χ^2 test or independent sample t-test was employed to compare the demographic characteristics and scores from the CADESS questionnaire for each item were compared between participants with poor compliance to DRS and those with good compliance. In the comparative analysis of CADEES scores among participants with no DR, non-vision-VTDR (NVTDR) and VTDR, the responses of 'strongly disagree' and 'disagree' were categorised as 'disagree', while the responses of 'strongly agree' and 'agree' were categorised as 'agree'. Variables with p<0.1 were subsequently included in a multivariate binary logistic regression analysis to identify risk factors associated with poor compliance with DRS. Binary logistic regression analyses, both multivariate and univariate, were used to identify risk factors associated with poor follow-up compliance.

Patient and public involvement

None.

RESULTS

Patient characteristics

The mean age of all participants (n=468) was 67.42±10.66 years, with 62.8% having diabetes for more than 10 years. 98.9% of the participants received a diagnosis of type 2 DM. The participants' HbA1c levels varied between 4.3% and 14.0%, with 41.5% exhibiting levels of ≥7.0%.

There were 330 (70.5%) participants without DR signs. VTDR was observed in 88 (18.8%) of the participants, including 13 patients with CI-DME, 11 patients with PDR and 17 patients who had both PDR and CI-DME. Non-VTDR was observed in 50 (10.7%) of the participants. A total of 308 (65.8%) participants had DRS in the previous year, and 160 (34.2%) respondents did not (table 1).

Risk factors associated with poor DRS compliance

The compliance of urban inhabitants was notably greater than that of rural inhabitants (84.4% vs 73.8%, p=0.007). The adherence to routine DRS was significantly different among patients with VTDR (54.5%), non-VTDR (62.0%) and those without DR (69.4%) (p=0.027) (table 1).

As shown in table 2, there were statistical differences in the scores of 10 CADEES items between the participants who followed routine DRS and those who did not. The multivariate logistic regression analysis indicated that non-adherence to routine DRS was associated with rural residents (OR 1.704, 95% CI 1.019 to 2.850, p=0.042), VTDR (OR 1.948, 95% CI 1.145 to 3.313, p=0.014), item 7 (over the past 4 weeks I have

Table 3 Multivariate binary logistic regression analysis for risk factors associated with poor adherence to annual DRS

Variates	Coefficient	SE	Wald	P value	OR (95% CI)
Age					
<50 years				–	1.00
50–70 years	0.471	0.490	0.924	0.336	1.602 (0.613 to 4.189)
>70 years	0.078	0.497	0.024	0.876	1.081 (0.408 to 2.866)
Residential location					
Urban				–	1.00
Rural	0.533	0.262	4.130	0.042	1.704 (1.019 to 2.850)
DR level					
none				–	1.00
NVTDR	0.340	0.342	0.988	0.320	1.406 (0.718 to 2.750)
VTDR	0.667	0.271	6.050	0.014	1.948 (1.145 to 3.313)
CADEES Items					
Item 2	−0.006	0.261	0.001	0.980	0.994 (0.596 to 1.656)
Item 7	−0.472	0.226	4.366	0.037	0.624 (0.401 to 0.971)
Item 8	−0.311	0.216	2.062	0.151	0.733 (0.479 to 1.120)
Item 12	0.208	0.269	0.599	0.439	1.231 (0.727 to 2.085)
Item 13	−0.245	0.295	0.690	0.406	0.782 (0.438 to 1.396)
Item 14	−0.362	0.244	2.200	0.138	0.696 (0.432 to 1.123)
Item 19	0.279	0.275	1.031	0.310	1.322 (0.771 to 2.264)
Item 22	0.489	0.294	2.758	0.097	1.630 (0.916 to 2.902)
Item 32	−0.481	0.303	2.529	0.112	0.618 (0.341 to 1.118)
Item 34	−0.452	0.259	3.048	0.081	0.636 (0.383 to 1.057)
Item 40	0.319	0.244	1.718	0.190	1.376 (0.854 to 2.219)
Item 41	0.615	0.500	1.513	0.219	1.849 (0.694 to 4.924)
Item 42	−0.480	0.239	4.031	0.045	0.618 (0.387 to 0.989)
Item 44	0.345	0.239	2.077	0.150	1.411 (0.883 to 2.255)

CADEES, Compliance with Annual Diabetic Eye Exams Survey; DR, diabetic retinopathy; NVTDR, non-vision-threatening diabetic retinopathy; VTDR, vision-threatening diabetic retinopathy.

felt blue, downhearted, or depressed) (OR 0.624, 95% CI 0.401 to 0.971, p=0.037) and item 42 (I receive a reminder from my eye doctor's office when it is time to schedule an exam) (OR 0.618, 95% CI 0.387 to 0.989, p=0.045) (table 3).

CADEES scores among no DR, NVTDR and VTDR participants

In item 30, a higher proportion of participants with VTDR (22.7%) believed they could not effectively manage their blood sugar compared with those without DR (9.4%) and those with NVDR (14.0%) (p=0.004) (table 4).

Factors to non-compliance with scheduled follow-ups

A total of 356 participants (76.1%) completed all of the scheduled follow-up visits in the subsequent year, while 112 participants (23.9%) did not (table 5). For the second year, 275 of the 340 (80.9%) participants without DR or with mild NPDR completed their annual DRS. VTDR (OR 3.063, 95% CI 1.852 to 5.066, p<0.01) was identified as a risk factor for non-compliance with scheduled follow-up in the multivariate logistic regression analysis (table 6).

DISCUSSION

The adherence to DRS on a global scale is notably inadequate.[18–21] In the USA, among the 298 383 insured patients with type 2 diabetes and no diagnosed DR, almost half had no eye exam visits over the 5-year period and only 15.3% met the ADA recommendations for annual or biennial eye exams.[24] The non-adherence rates of 36.6% and 21.3% for this national estimate in the USA did not change from 2005 to 2016.[25] The NHMRC in Australia has established guidelines that recommend annual DRS and visual acuity assessments for Indigenous Australians and biennial assessments for non-Indigenous Australians with diabetes who do not have significant risk factors for retinopathy. In the past 12 months, 52.9% of Indigenous diabetics underwent

Table 4 CADEES scores among no DR, NVTDR and VTDR participants

CADEES items	No DR	NVTDR	VTDR	P value
Item 1 (disagree/agree)	257/34	38/5	77/5	0.329
Item 2 (disagree/agree)	108/147	13/24	21/36	0.597
Item 3 (disagree/agree)	161/94	26/14	38/25	0.881
Item 4 (disagree/agree)	93/188	12/31	30/52	0.622
Item 5 (disagree/agree)	27/185	4/30	6/46	0.966
Item 6 (disagree/agree)	132/95	18/11	25/30	0.194
Item 7 (disagree/agree)	152/92	31/8	36/20	0.114
Item 8 (disagree/agree)	151/97	23/18	36/29	0.675
Item 9 (disagree/agree)	14/273	0/41	3/79	0.380
Item 10 (disagree/agree)	45/227	5/37	9/65	0.536
Item 11 (disagree/agree)	47/194	4/31	9/64	0.238
Item 12 (disagree/agree)	74/202	8/36	21/51	0.534
Item 13 (disagree/agree)	244/46	35/10	76/7	0.095
Item 14 (disagree/agree)	105/135	13/20	24/39	0.680
Item 15 (disagree/agree)	8/257	1/39	0/72	0.285
Item 16 (disagree/agree)	5/302	0/47	0/81	0.368
Item 17 (disagree/agree)	17/287	2/46	7/74	0.539
Item 18 (disagree/agree)	82/150	19/18	25/38	0.165
Item 19 (disagree/agree)	98/63	11/11	27/11	0.268
Item 20 (disagree/agree)	212/54	34/9	63/14	0.921
Item 21 (disagree/agree)	203/72	30/15	59/19	0.529
Item 22 (disagree/agree)	88/136	13/24	26/36	0.806
Item 23 (disagree/agree)	7/283	0/48	3/75	0.466
Item 24 (disagree/agree)	67/127	8/19	26/28	0.135
Item 25 (disagree/agree)	4/283	0/44	2/72	0.573
Item 26 (disagree/agree)	15/175	0/32	3/41	0.286
Item 27 (disagree/agree)	145/117	16/17	52/23	0.052
Item 28 (disagree/agree)	3/319	2/47	3/85	0.106
Item 29 (disagree/agree)	2/303	0/46	0/80	0.660
Item 30 (disagree/agree)	31/215	7/24	20/48	0.004
Item 31 (disagree/agree)	16/189	2/37	3/52	0.741
Item 32 (disagree/agree)	249/24	34/7	71/4	0.108
Item 33 (disagree/agree)	160/56	26/10	44/16	0.979
Item 34 (disagree/agree)	73/133	7/22	20/30	0.373
Item 35 (disagree/agree)	26/276	8/38	8/76	0.181
Item 36 (disagree/agree)	94/122	11/20	28/31	0.545
Item 37 (disagree/agree)	192/62	28/15	57/16	0.261
Item 38 (disagree/agree)	28/246	3/42	11/62	0.331
Item 39 (disagree/agree)	51/238	5/40	11/68	0.453
Item 40 (disagree/agree)	176/68	29/10	49/22	0.822
Item 41 (disagree/agree)	317/11	47/3	81/7	0.150
Item 42 (disagree/agree)	103/161	18/16	32/38	0.219
Item 43 (disagree/agree)	6/284	0/48	2/76	0.744
Item 44 (disagree/agree)	211/79	25/19	46/25	0.063

CADEES, Compliance with Annual Diabetic Eye Exams Survey; DR, diabetic retinopathy; NVTDR, non-vision-threatening diabetic retinopathy; VTDR, vision-threatening diabetic retinopathy.

a diabetic eye examination, while 77.7% of non-Indigenous diabetics underwent eye examinations in the previous 2 years.[7] Over one-fifth of diabetics in Saudi Arabia never underwent DR screening.[26] Denmark has a national tax-funded screening programme for DR. Approximately 53% of diabetics could attend DRS on time, and the rate of timely attendance was 54% for diabetics without VTDR.[9] In the present study, 34.2% of diabetics did not complete the annual examination for DR, aligning with prior research findings.

Table 5 The follow-up visits of all participants in 1 year

Real follow-up visits	0 (n=82)	1 (n=296)	2 (n=37)	3 (n=4)	4 (n=27)	12 (n=24)
Recommended follow-up visits						
1 (n=340)	65 (19.1)	275 (80.9)	–	–	–	–
2 (n=40)	7 (17.5)	3 (7.5)	30 (75.0)	–	–	–
4 (n=47)	5 (10.6)	10 (21.3)	4 (8.5)	1 (2)	27 (57.4)	–
12 (n=41)	3 (7.3)	8 (19.5)	3 (7.3)	3 (7.3)	–	24 (58.5)

The reasons for poor compliance with the annual DRS may vary among countries due to different national conditions. In the USA, the predictive value of insurance status was found to be the highest among associated factors, as 76% of Americans with a combination of private and public insurance were adherent, compared with only 36% of those who were uninsured.[25] In Australia, the adherence rate among non-indigenous participants is higher than that among indigenous participants, at 77.5% compared with 52.7%.[7] In the UK, social deprivation is strongly associated with poor attendance at retinal screening events.[8 27 28] The current study found that rural residents were significantly more likely to forgo the annual eye examination, with their risk of non-participation about double that of urban patients. Rural residents in China may experience a deficiency in ophthalmological medical resources, as general healthcare centres in these areas typically lack specialised ophthalmology departments. Additionally, using an artificial intelligence remote screening system may improve the DRS participation.[29]

VTDR was another risk factor associated with non-compliance with DRS. Thykjær *et al*[9] had reported delayed attendance was vastly increasing according to more severe DR levels at baseline compared with patients with no DR, with relative risk ratios of 1.68, 2.27, 3.14, 2.44 for mild, moderate, severe NPDR and PDR, respectively. Data analysis from the Behavioural Risk Factor Surveillance System indicates that a higher proportion of diabetic patients with vision impairment did not visit an eye care provider in the preceding 12 months compared with those without vision impairment (29% vs 22%).[19] In contrast to patients without DR, delayed DRS was found to have a significant increase in correlation with more severe levels of DR at baseline. Interestingly, patients who needed timely screenings were less likely to use them. This may contribute to an understanding of why their DR was at a more severe level. It should be noted that the groups of patients diagnosed with VTDR made up a small percentage of the cohort as a whole, and therefore, there might be a larger statistical uncertainty in the results for these patients. Several studies investigating the incentives and barriers to DRS found that understanding the potential consequences of missing a screening, such as vision impairment and worsening of the disease, significantly increases the likelihood of screening attendance.[30–32] In a survey regarding awareness of DR in Turkey, 31.8% of patients indicated unfamiliarity with it, while 41.9% reported that annual DRS was unnecessary.[33] In Saudi Arabia, as many as 51% of diabetics remain oblivious to DR.[26] In Australia, the major reason for non-adherence reported by both Indigenous (72.6%) and non-Indigenous participants (74.3%) was that they were unaware of the need for regular eye examinations.[7] In the present study, 30.34% of participants were unaware that diabetes could impact visual acuity, and 45.73% of participants questioned the necessity of periodic DR examinations. All the aforementioned indicate that improving health education for diabetics is essential.

The CADEES questionnaire was developed based on the theoretical framework of HBM. The HBM, which elucidates and forecasts various health behaviours, bases these actions on six constructs: perceived severity, perceived susceptibility, perceived benefits, perceived barriers, cues to action and self-efficacy.[22] The current study discovered a substantial correlation between prompt reminders from medical institutions and increased participation in annual DRS. Researchers reported using quality improvement strategies to increase the participation rate in annual DRS by 5%–12%.[34] Patient-centred interventions include (1) educational programmes designed to increase awareness of DR and promote self-management and (2) the use of prompts and reminders. Provider-centred interventions consist of (1) clinician education and (2) audit and performance evaluation. System interventions encompass (1) alterations in team composition; (2) implementation of computerised registration and recall systems and (3) utilisation of telemedicine.[34] Following health education and reminder follow-ups, 80.9% of patients without DR or with mild DR completed their annual DRS for the second consecutive year. Moreover, sadness frequently co-occurs with other chronic illnesses. This study, in line with Zhu *et al*'s research, found a correlation between diabetics' propensity for depression and their increased participation in annual DRS. This suggests that patients' subjective health beliefs are more effective predictors of engagement in these examinations than objective visual function.[20] This study identified VTDR as a risk

factor for non-compliance with scheduled follow-up appointments. We advised patients undergoing VTDR treatment to complete 12 follow-up appointments per year. However, the high frequency of these appointments may cause some patients to struggle to maintain consistent follow-up.

This study has some limitations. The study's sample size is limited, as all participants are from a single centre, and the inclusion of only patients who sought eye examinations may introduce selection bias. The population in this study is predominantly type 2 diabetes and seems to be relatively older; young age was noted as a possible risk factor for non-attendance for screening in previous studies,[8 19 27 28] so the data in the current study may only represent a regional population of diabetics. Second, patients self-report participation in DRS, which may result in some individuals falsely claiming involvement, leading to erroneous

Table 6 The univariate and multivariate logistic regression analysis for risk factors associated with poor follow-up compliance

Variates	N	Good follow-up compliance (n=355)	Poor follow-up compliance (n=113)	Univariate		Multivariate	
				OR (95%CI)	P value	OR (95%CI)	P value
Gender, n (%)							
Male	192	141	51				
Female	276	214	62	0.801 (0.523 to 1.228)	0.309	–	–
Age, n (%)							
<50 years	27	17	10				
50–70 years	249	193	56	0.493 (0.214 to 1.138)	0.097*	0.525 (0.222 to 1.241)	0.142
>70 years	192	145	47	0.551 (0.236 to 1.286)	0.168	–	–
Education, n (%()							
Middle school and below	301	225	76				
High school and above	167	130	37	0.843 (0.538 to 1.319)	0.454	–	–
Residential location, n (%)							
Urban	378	285	93				
Rural	90	70	20	0.876 (0.506 to 1.517)	0.635	–	
DR level, n (%)							
none	330	265	65				
NVTDR	50	40	10	1.019 (0.484 to 2.145)	0.960	–	–
VTDR	88	50	38	3.098 (1.876 to 5.116)	<0.001*	3.063 (1.852 to 5.066)	<0.001†
High pressure, n (%)							
Yes	206	161	45				
No	262	194	68	1.254 (0.815 to 1.929)	0.303	–	–
Hyperlipidaemia, n (%)							
Yes	121	86	35				
No	165	127	38	0.735 (0.431 to 1.255)	0.259	–	–
Abnormal renal function, n (%)							
Yes	397	303	94				
No	71	52	19	1.178 (0.663 to 2.091)	0.576	–	–
Duration of DM, n (%)							
≤10 years	294	220	74				
>10 years	174	135	39	0.859 (0.551 to 1.338)	0.501	–	–
HbA1c, n (%)							
<7.0%	92	69	23				
≥7.0%	194	144	50	0.845 (0.469 to 1.522)	0.575	–	–

*Variables of p<0.1.
†Variables of p<0.05.
DM, diabetic mellitus; DR, diabetic retinopathy; HBA1c, haemoglobin A1c; NVTDR, non-vision-threatening diabetic retinopathy; VTDR, vision-threatening diabetic retinopathy.

outcomes. While not ideal, numerous prior investigations have used this pragmatic strategy of engaging patients in self-expression.[7 22] Third, as urban integration progresses throughout China, the distinction between urban and rural areas is increasingly ambiguous, potentially compromising the veracity of this study's results.

CONCLUSIONS

In summary, approximately one-third of patients with diabetes did not complete their annual DRS. However, after implementing health education and reminders for follow-up, this rate decreased to one-fifth. VTDR bears a significant responsibility for the low annual DRS and follow-up compliance rates.

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