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10.4103/tjo.tjo\_30\_18

# Factors associated with retinal screening among patients with diabetes in Taiwan

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## Abstract:

**PURPOSE:** The purpose of this study is to explore the factors associated with having a diabetic retinopathy exam (DRE) during the past 2 years among patients with diabetes.

**METHODS:** Patients visiting the eye clinic at Shin-Kong Memorial Hospital in Taipei were enrolled in this study from January to June 2009. A total of 313 patients participated in this study. Excluding patients with missing responses for more than three questions (38) yielded a final sample of 275 participants. Chi-square and Mann–Whitney U-tests were used for bivariate analysis. Multivariable logistic regression examined factors associated with having a DRE controlling for demographic and health factors.

**RESULTS:** Although 83% of participants said that their physician suggested DRE, only 60% were screened during the past 2 years. In response to the question about why patients did not seek a DRE exam, 43.2% reported that they did not know having this exam was necessary. In adjusted results, receiving information about the relationship between diabetes and retinopathy from medical staff and believing that diabetes could damage the vision were associated with having a DRE in the past 2 years (both  $P < 0.05$ ).

**CONCLUSIONS:** Although most patients indicated that their physician suggested the need for eye care, a substantial percentage of patients with diabetes were not aware of the need for a regular DRE. Information about the relationship between diabetes and retinopathy and concerns about damage to vision were associated with greater likelihood of seeking a DRE. These factors should be considered to promote DR screening.

## Keywords:

Diabetes mellitus, diabetic retinopathy, dilated eye exam, patient education, physician communication

## Introduction

Diabetes is the fifth leading cause of death in Taiwan.<sup>[1]</sup> There is evidence that the prevalence of adults with Type 2 diabetes in Taiwan increased notably 1999–2004.<sup>[2]</sup> Diabetic retinopathy (DR), characterized by retinal hemorrhage and edema leading to blindness, is a potential disabling consequence of diabetes. In a population-based study in Taiwan in 1992, DR was present in 35% of patients with diabetes.<sup>[3]</sup> The annual incidence of DR among persons with diabetes was 6.6%

from 1999 to 2002.<sup>[4]</sup> Early detection and effective treatment of DR can reduce severe vision loss by up to 94%.<sup>[5]</sup> The International Council of Ophthalmology has established the guidelines for DR screening program.<sup>[6]</sup> Dilated eye examination is recommended at least annually among individuals with diabetes.<sup>[7]</sup>

A patient-centered diabetes shared care network was launched in Taiwan in 1996 to integrate diabetes care across among primary and specialty physicians, nutrition specialists, nurses, and healthcare educators.<sup>[8]</sup> This network encourages physicians to provide comprehensive care for patients with diabetes; it also offers

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**How to cite this article:** Peng PH, Laditka SB, Lin HS, Lin HC, Probst JC. Factors associated with retinal screening among patients with diabetes in Taiwan. Taiwan J Ophthalmol 2019;9:185-93.

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Submission: 19-03-2018

Accepted: 18-07-2018

incentives for patients (e.g., an annual free DR screening is scheduled) and physicians (e.g., reimbursement for DR examinations). For patients not enrolled in diabetes shared care network, annual screening rates for DR in Taiwan are low, in absolute terms and in comparison with rates in other countries. According to the latest report by the National Health Insurance of Taiwan, only 28.2% of patients with diabetes ever received an annual DR examination (DRE) in 2009<sup>[9]</sup> compared to annual screening rates ranging from 79% in the United Kingdom<sup>[10]</sup> and in the United States<sup>[11]</sup> to 87% in Australia.<sup>[12]</sup>

A better understanding of perceived patient barriers may help to improve screening rates. Studies have identified several characteristics that are associated with reduced adherence to retinopathy screening including lack of recognition of the need for periodic eye examinations,<sup>[13-15]</sup> economic or geographic barriers,<sup>[16,17]</sup> cultural beliefs,<sup>[18,19]</sup> and duration of diabetes.<sup>[20]</sup> To the best of our knowledge, no research has examined the factors associated with the acceptance of DR screening among patients with diabetes in Taiwan. The present study sought to identify beliefs, personal characteristics, and other factors influencing diabetic eye care among patients in an outpatient clinic in Shin-Kong Hospital, a teaching medical center, located in Taipei, the largest city in Taiwan. The objectives of this study were to: (1) determine the regular DR screening rate among patients in a metropolitan medical center in Taiwan; (2) examine the characteristics of patients with diabetes that are associated with the acceptance of DR screening; and (3) identify the ways to improve DR screening rates.

### Theoretical framework

The Health Belief Model (HBM) was used to guide this research, and conceptualize factors relevant to DRE acceptance in patients with diabetes.<sup>[21]</sup> The HBM suggests that an individual's adherence to advice from healthcare providers depends on her or his perceived susceptibility to illness. Cues to action, likelihood of benefits, and self-efficacy contribute to the likelihood of taking recommended preventive health actions. Modifying factors include demographic (age, gender, and race), social and psychological (personality, peer pressure), and structural (knowledge about disease) characteristics.

## Methods

### Patient recruitment

Patients with Type 1 and Type 2 diabetes who visited the outpatient eye clinic of Shin-Kong Wu Ho-Su Memorial Hospital were recruited to participate in the study. Shin-Kong Wu Ho-Su Memorial Hospital is a tertiary medical center in Taiwan, with 921 beds. A sample

size of about 300 patients was estimated to provide sufficient power for the analyses. Enrollment began in January 2009 and continued until June 2009 when 313 patients completed the questionnaires. Patients with diabetes were encouraged to participate in the diabetes shared care network by endocrinologists and general practitioners.<sup>[8]</sup> Patients indicated if they participated in the diabetes shared care network in one of the survey questions. Written informed consent was obtained from all participants.

### Survey instrument

The survey was designed by the authors. Each question was designed to represent one of the dimensions of the HBM or a demographic factor. We conducted a pilot test to assess the degree to which the questions were interpreted and understood, the relevance to intended topics, and the effectiveness in providing useful information. A total of 20 patients with diabetes at the eye clinic of Shin-Kong hospital participated in the pilot. We discussed the questionnaire items individually with each participant. We revised the questionnaire to improve the reliability and validity of our survey.<sup>[22]</sup>

Physicians invited patients enrolled in the study to complete the survey during their visit to the clinic. For patients with low literacy, a trained assistant read the questions and recorded responses. Several survey questions addressed the perceived susceptibility as follows: duration of diabetes in years; presence of diabetic complications; presence of any eye problems; general health; belief that diabetes would affect vision; presence of diabetes-related eye problems; recent eye symptoms; and concern about their eyes. A number of survey questions obtained information related to cues to action, if the patient had been told by medical staff that diabetes could affect vision; their physician had suggested an eye checkup; and the patient had joined the diabetes shared care network. Several questions addressed possible benefits and reasons for not receiving a DRE. Patient knowledge of diabetes management methods was assessed with an eight items checklist preceded by the question, "what methods do you think can help control your diabetes?" The number of correct answers was summed and ranged from 0 to 5. Knowledge about diabetes and DR was assessed with several questions including hearing about DR; understanding how often a DRE is needed; and having information about the treatments for DR. Knowledge of the risk factors for DR was assessed by asking respondents whether six listed factors were associated with increased risk. Respondents were given one point for each correct answer. The result was a 4-point score, coded from 0 to 4. Demographic variables included age, gender, education, living arrangements (living alone or living with others in household), income, and

employment status. The study was approved by the Institutional Review Boards of Shin-Kong Hospital and the University of South Carolina.

### Statistical analysis

Statistical analyses were conducted using SPSS (version 15.0; SPSS Inc., Chicago, IL). Descriptive analysis examined the associations between demographic and socioeconomic characteristics of participants, and the reasons why patients did not have a DRE in the past 2 years. In bivariate analysis, the Chi-square statistic was used to examine the categorical variables; Mann–Whitney U-tests were used for continuous variables. Logistic regression was used for multivariable analysis, with the receipt of a DRE in the past 2 years (coded 1 if the patient received an examination in the past 2 years) as the dependent variable. To determine statistical significance, a  $P < 0.05$  was used.

We used the Durbin–Watson (D) value to examine the collinearity among all of the variables in the model. There was no evidence of notable collinearity. Variables were assessed for multicollinearity with the variance inflation factor. There was no evidence of notable multicollinearity.<sup>[22]</sup>

## Results

### Characteristics of patients

A total of 313 patients were recruited to participate in this study. Excluding those with no response for more than three questions eliminated 38 patients, resulting in an analytical sample of 275. Descriptive characteristics are shown in Table 1. About 44% (120) of the patients were men. The mean age was  $63.8 \pm 13.2$  years. About 55% of participants were over age 60. Two-thirds of the patients had less than a high school education. Most patients lived in households earning <2500 US\$ per month. About 45% of patients reported having diabetes <5 years, 27% between 5 and 10 years, and 25% more than 10 years; the remaining 3% did not report the duration of their diabetes. Hypertension was the most common comorbid disease (47.6%, results not shown). About half of the participants did not know whether they were diagnosed with Type 1 or Type 2 diabetes.

### Knowledge about diabetes

Table 2 reports the findings regarding health beliefs related to diabetes. In cues to action, nearly 80% of patients reported that medical staff had told them that diabetes might threaten their vision; about 83% said their physician had suggested an eye examination.

In responses related to perceptions of threat, about 80% of patients believed that diabetes could threaten

**Table 1: Demographic and socioeconomic characteristics and comorbidities among 275 patients with diabetes in Taiwan, 2009**

	Total number (%)
Sociodemographic characteristics	
Age	
18-39	13 (4.7)
40-59	111 (40.4)
Over 60	151 (54.9)
Gender	
Male	120 (43.6)
Highest education level	
Elementary and junior high school	183 (66.5)
Senior high school (or professional school)	59 (21.5)
College and graduate diploma	12 (4.4)
Live with family	
Yes	247 (89.8)
Household income per month (\$)	
<900	100 (36.4)
900-2500	99 (36.0)
>2500	38 (13.8)
Working status	
Full time	65 (23.6)
Part time	24 (8.7)
Homemaker	88 (32.0)
Retired	87 (31.6)
Diabetes and comorbidities	
Duration of diabetes (years)	
<5	124 (45.1)
5-10	78 (27.2)
>10	69 (25.1)
Presence of other systemic diseases	
None	99 (36.0)
1	97 (35.2)
2	49 (17.8)
3	16 (5.8)
4 or more	14 (5.1)
Presence of any eye problems <sup>a</sup>	118 (42.9)
Yes	118 (42.9)
General health	
Excellent	16 (5.8)
Good	60 (21.8)
Fair	166 (60.4)
Bad	27 (9.8)
Knowledge of diabetic status (type I or type II)	
Yes	132 (48.0)
DM control	
By medication	241 (87.6)
By insulin injection	45 (16.4)

<sup>a</sup>Responses for types of eye problems (frequency): cataract (22); blurred vision (10); glaucoma (10); allergy (6); diabetic retinopathy (5); near-sighted (5); presbyopia (4); dry eye (3); floater (2); double vision (1); red eye (1); nystagmus (1); trauma (1); fatigue (1). DM=Diabetes mellitus

vision. Nearly two-thirds (64%) of the patients reported recent eye symptoms, including impaired vision (mostly due to cataract), allergic eye problems, and dry eye (results for specific symptoms not shown).

**Table 2: Diabetes-related health beliefs among 275 patients with diabetes in Taiwan, 2009**

Health belief concepts	Variables	Number	Percentage responding "yes"
Cues to action	Medical staff informed patient that diabetes can affect eyes	218	79.3
	Doctor ever suggested eye checkup	229	83.3
Individual perception of threat (perceived susceptibility)	Believe that diabetes could affect the eyes	219	79.6
	Presence of diabetes-related eye problems	93	33.8
	Presence of eye symptoms recently	176	64.0
Likelihood of action (perceived benefits)	Worry about eyes	235	85.5
	Responses to "what methods do you think can help control your diabetes" (check all that apply)		
	Home monitoring of blood glucose (correct)	177	64.4
	Proper diet (correct)	128	46.5
	Drink a lot of water (incorrect)	94	34.2
	Reduce salt intake (incorrect)	87	31.6
	Exercise (correct)	80	29.1
	Follow doctors' instructions (correct)	66	24.0
	Reduce stress (incorrect)	31	11.3
	Control body weight (correct)	12	4.4
Modifying factors	Ever heard of diabetic retinopathy	174	63.3
	Know that diabetic retinopathy can be treated with laser or surgery	83	30.2
	Correct answer to "how often should you have an eye checkup to detect diabetic retinopathy"	81	29.5
	Which of the items below might cause diabetic retinopathy? (Check all that apply)		
	Having diabetes more than 5 years (correct)	43	15.6
	Type I diabetes (correct)	15	5.5
	Type II diabetes (correct)	17	6.2
	High blood sugar (correct)	110	40.0
	High blood lipid level (incorrect)	22	8.0
	Overweight (incorrect)	27	9.8
Self-efficacy	Not sure (incorrect)	126	45.8
	Believe regular physician checkup can keep one healthier	248	90.2
	Know recent blood sugar level	187	68.0
	Joined Diabetic Care Network	107	38.9
	Number of diabetes-related doctor visits per year		
	<5	95	34.5
	5-10	83	30.2
	>10	80	29.1
Other reasons for no eye checkup in the past 2 years	I did not know it was necessary	67	43.2
	I feel it is unnecessary	37	23.9
	My eyes are healthy	28	18.1
	I am too busy	24	15.5
	No family to accompany me	12	7.8
	Making an appointment is troublesome	10	6.4
	I cannot afford medical expense	10	6.4
	Lack of transportation	9	5.8
	No eye doctors nearby	9	5.8
I have other health problems to take care of	8	5.2	

Regarding likelihood of action, in response to questions about the methods that can help to control diabetes, participants indicated as follows: monitoring blood glucose (64.4%), adopting a proper diet (46.5%), exercise (29.1%), and following their doctor's instructions (24%).

As for modifying factors, 60% of the participants had heard the term, "DR." However, only about one-third of the patients knew that retinopathy can be treated.

Only about 30% of the patients knew the frequency with which they should receive a DRE to detect eye problems in a timely manner. When asked to indicate risk factors for developing retinopathy, 40% of the participants recognized that high blood sugar was a risk. Only 15.6% of the patients correctly indicated that having diabetes more than 5 years was a risk factor for DR. Nearly half (45.8%) of the patients indicated that they were unsure of DR risk factors.

In responses to the self-efficacy questions, about 90% of patients had a positive attitude toward medical care and believed that regular checkups could help their health. More than two-thirds of the patients indicated that they were aware of their blood sugar level. When asked how many diabetes visits they made annually, 34.5% of patients reported 5 or fewer visits per year, 30.2% reported 5–10 visits, and 29.1% reported more than 10 visits.

### Patients' reasons for lack of diabetic retinopathy screening in the past two years

The last set of results in Table 2 shows other reasons patients reported for not seeking DR screening in the past 2 years. About 43% indicated that they did not realize the need for screening. Nearly one-quarter of the patients indicated they felt it was not necessary to have a regular eye checkup. The third most common reason provided was that they believed their eyes were in excellent condition (18.1%). Other reasons provided by smaller percentages of patients included: being too busy (15.5%), having no family to accompany them to an appointment (7.8%), and difficulty obtaining an appointment (6.4%).

## Associations between patient characteristics and receipt of diabetic retinopathy exam

### Unadjusted results

Of the demographic factors, only general health was associated with receipt of a DRE in the past 2 years in unadjusted bivariate analysis ( $P = 0.023$ ; results not shown). Table 3 shows the results for associations between patient beliefs and reported receipt of DRE. Regarding cues to action, compared with patients who did not report that they received DRE screening, those who said that they received DRE were more likely to report that the medical staff discussed the risk of having diabetes for their vision and that their physician advised them to get an eye checkup ( $P < 0.05$ ).

Among modifying factors, knowledge about DR was significantly associated with receipt of DR exam. Knowing that DR can be treated, knowing the risks of DR, and knowing the appropriate frequency to have an eye checkup for early detection of DR were significantly associated with receipt of a DR in the past 2 years (all  $P < 0.05$ ).

Among the self-efficacy items, none differed significantly between patients who reported receipt of a DRE within 2 years and those who had not.

**Table 3: Association between patient beliefs and reported receipt of diabetic retinopathy exam among 275 patients with diabetes in Taiwan, 2009**

Concepts	Variables	With screen (n=165), n (%)	Without screen (n=110), n (%)	OR	LB	UB	P
Cues to action	Doctor or nurse mentioned relationship between diabetes and DR (yes answer)	<b>144 (87.3)</b>	<b>74 (67.3)</b>	<b>3.777</b>	<b>1.974</b>	<b>7.227</b>	<b>&lt;0.001</b>
	Doctor recommended an eye checkup (yes answer)	<b>148 (89.7)</b>	<b>81 (73.6)</b>	<b>2.952</b>	<b>1.404</b>	<b>6.204</b>	<b>0.006</b>
Individual perception of threat (perceived susceptibility)	Belief that diabetes could affect the eyes (yes answer)	134 (81.2)	85 (77.3)	1.408	0.769	2.575	0.339
	Presence of diabetes-related eye problems	58 (35.2)	35 (31.8)	1.174	0.701	1.967	0.631
	Presence of recent eye symptoms recently	99 (60.0)	77 (70.0)	0.654	0.384	1.112	0.150
Likelihood of action (perceived benefits)	Worry about eyes						
	Yes	136 (82.4)	99 (90.0)	0.458	0.206	1.017	0.076
Modifying factors	Correct responses to "what methods do you think can help control your diabetes", mean scale value (SD)*	2.24 (0.98)	2.21 (1.1)	1.732	0.863	3.475	0.824
	Ever heard of DR (yes answer)	104 (63.0)	70 (63.6)	0.964	0.577	1.611	0.994
Self-efficacy	Knowing that DR can be treated, (yes answer)	<b>63 (38.2)</b>	<b>20 (18.2)</b>	<b>2.768</b>	<b>1.499</b>	<b>4.783</b>	<b>0.001</b>
	Correct response for risks of DR? <sup>b</sup>	<b>94 (57.0)</b>	<b>40 (36.4)</b>	<b>2.317</b>	<b>1.411</b>	<b>3.804</b>	<b>0.003</b>
	Knowing "how often should you have an eye checkup to detect DR"	<b>59 (35.8)</b>	<b>22 (20.0)</b>	<b>2.140</b>	<b>1.212</b>	<b>3.778</b>	<b>0.012</b>
Self-efficacy	Believe regular doctor visit can maintain health	149 (90.3)	99 (90.0)	1.183	0.516	2.711	0.855
	Know recent blood sugar level	119 (72.1)	68 (61.8)	1.750	1.015	3.016	0.059
	Joined Diabetic Care Network	66 (40.0)	41 (37.3)	1.155	0.699	1.908	0.664
	How often respondent sees a physician for diabetes care annually						
	<5	53 (32.1)	42 (38.2)	1.660	0.945	2.917	0.151
5-10	51 (30.9)	32 (29.1)					
>10	56 (33.9)	24 (21.8)					

<sup>a</sup>\*Bold values indicate results that are significant at  $P < 0.05$ , <sup>b</sup>Nonparametric Mann–Whitney U-test, and Chi-square test was used for other items. SD=Standard deviation, CI=Confidence interval, LB=Lower bound of the 95% CI, UB=Upper bound of the same interval, DR=Diabetic retinopathy, OR=Odds ratio

### Adjusted results

The results of multivariable logistic regression are shown in Table 4. Factors significantly associated with reported receipt of a DRE within the past 2 years included: The doctor or nurse mentioned the relationship between diabetes and DR (cue to action); belief that diabetes could affect the eyes (perceived susceptibility); being a housewife, and reported having excellent health status (demographic characteristics); worry about eyes was associated with lower odds of receiving a DRE within the past 2 years (all  $P < 0.05$ ).

## Discussion

Sixty percent of patients in our study reported that they received a dilated eye examination in the past 2 years. Their belief that diabetes could harm their eyesight was significantly associated with reported receipt of a DR exam. These results suggest that the perceived susceptibility to illness is an important determinant of taking a health-protective action. Reasons patients provided for not receiving a DRE at recommended intervals were consistent with a lack of perception of severity of illness. Although nearly 80% of patients with diabetes said medical staff had informed them that diabetes could lead to eye complications, about two-thirds of patients without a recent DRE indicated the reason was they do not know (or think) it is necessary. The latter finding indicates that information provided in routine communication with health providers was not sufficient to prompt preventive actions.

Regarding the result that “worry about eyes” was associated with lower odds of receiving a DRE, we note that “belief that diabetes could affect the eyes” and “worry about eyes” ask about distinct concepts. The first question suggests that eyes could be damaged by diabetes. Responding to this question, patients may be concerned about the suggested medical threat, a concern that may cause them to envision seeking health care to avoid eye damage. The second question asks if patients are concerned about their eyes. Patients who worry about health problems may avoid screening to avoid unpleasant news, or discomfort (or perceived discomfort) associated with eye procedures.<sup>[23]</sup> The latter reasons may account for the results for “worry about eyes.”

In findings related to cues to action, whether a physician mentioned the relationship between diabetes and DR was significantly associated with receiving a periodic eye exam, whereas providing advice about having an eye checkup was not. Studies have shown the importance of receiving advice from health care professionals in developing structured educational programs.<sup>[24,25]</sup> Thus, physicians should emphasize the importance of DR screening to prevent

irreversible visual loss. In addition to education, health professionals should inquire about the status of a recent DR examination, and recommend patients for appropriate medical care.

Revisiting the conceptual framework that guided our study, five dimensions comprise the perception of illness: Identify, cause, timeline, consequences, cure or control; these factors provide a framework for patients to make sense of the symptoms, assess health risk, direct action, and cope.<sup>[26]</sup> Our findings indicate that perceived susceptibility is associated with the acceptance of DR screening. On the other hand, patients recently diagnosed with diabetes mellitus who did not experience eye problems may not be aware of the need to have eye examination; this finding is consistent with previous studies.<sup>[27-29]</sup>

Consistent with previous studies, our findings confirmed that knowledge is not a significant predictor for receiving regular eye examinations. Knowledge is the basis for health seeking,<sup>[30]</sup> but is not sufficient to prompt changes in health behaviors.<sup>[31,32]</sup> The level of knowledge about DR in our participants was low.

Taiwan implemented a universal health insurance system in 1995. Thus, for many, financial barriers for eye exams were minimized for patients who participated in this study. Regarding demographic and social characteristics, we found that patients who had a DR screening considered themselves to be in better health than those did not. The result is consistent with earlier studies in that individuals who prioritize their health may also be more aware of the importance of eye examinations to avoid loss of vision.<sup>[33]</sup>

Time spent for DRE has been recognized as a barrier.<sup>[13]</sup> We included working status in the multivariable model to capture information about time required for DRE. Women who reported that they were housewives were more likely than participants working in a stable job to report receiving DRE. About 32% of participants were retired. As retired women in Taiwan seldom work again, some of the women who were retired may have responded that they were housewives. However, receiving DRE was not significant for those who were retired. It is not clear why retired participants were also not significantly more likely to report receiving DRE.

With advances in technology, nondilated digital retinal photography combined with remote evaluation of the resulting images has been applied to DR screening in a number of regions.<sup>[34-36]</sup> Retinal photography has acceptable sensitivity and specificity to detect DR.<sup>[37]</sup> Compared with traditional DRE, using nondilated digital photography is fast, cost-effective; this procedure

**Table 4: Multivariable logistic regression for possible factors associated with reported receipt of diabetic retinopathy exam in the past two years, among 275 patients with diabetes in Taiwan, 2009**

	OR	LB	UB	P
<b>Cues to action</b>				
Doctor or nurse mentioned relationship between diabetes and DR (yes answer)	<b>3.476</b>	<b>1.083</b>	<b>11.156</b>	<b>0.036</b>
Doctor recommended an eye checkup (yes answer)	1.077	0.281	4.134	0.913
<b>Individual perception of threat (perceived susceptibility)</b>				
Belief that diabetes could affect the eyes	<b>5.747</b>	<b>1.449</b>	<b>22.799</b>	<b>0.013</b>
Presence of diabetes-related eye problems	0.805	0.223	2.912	0.741
Presence of recent eye symptoms	2.230	0.726	6.849	0.161
Worry about eyes	<b>0.115</b>	<b>0.021</b>	<b>0.613</b>	<b>0.011</b>
<b>Likelihood of action (perceived benefits)</b>				
Correct answers to diabetes control questions (1 point change in score)	0.823	0.501	1.353	0.443
<b>Modifying factors</b>				
Ever heard of DR	0.473	0.167	1.339	0.159
Know risks for DR (1 point change in score)	1.371	0.683	2.754	0.375
Know that DR can be treated	2.854	0.957	8.508	0.060
Know the frequency for eye checkups for early detection of DR	1.173	0.399	3.452	0.772
<b>Self-efficacy</b>				
Believe regular physician checkups can keep one healthier	0.636	0.148	2.733	0.543
Presence of diabetes-related eye problems	0.805	0.223	2.912	0.741
Joined Diabetic Care Network	1.267	0.405	3.963	0.684
Know recent blood sugar level	1.638	0.604	4.442	0.332
Frequency of diabetes-related doctor visits (reference group: <5)				
5-10	0.806	0.260	2.500	0.709
>10	1.766	0.503	6.205	0.375
<b>Demographic factors</b>				
Age (reference group: 18-39 years)				
40-59	0.522	0.058	4.680	0.561
Over 60	0.658	0.051	8.499	0.748
Gender	0.751	0.209	2.694	0.660
Highest education level (reference group: elementary and junior high)				
Senior high school (or professional school)	0.654	0.162	2.633	0.550
College and graduate diploma	0.631	0.084	4.730	0.654
Live with family (yes)	0.511	0.075	3.506	0.495
Household income per month (reference group: <900 \$)				
900-2500 \$	1.180	0.356	3.908	0.786
>2500 \$	0.873	0.217	3.516	0.849
Working status (reference group: Stable job)				
Part time job	1.223	0.168	8.877	0.842
Housewife	<b>6.189</b>	<b>1.078</b>	<b>35.515</b>	<b>0.041</b>
Retired	2.189	0.522	9.169	0.284
General health (reference group: Bad)				
Fair	2.093	0.400	10.965	0.382
Good	1.580	0.240	10.405	0.634
Excellent	<b>14.347</b>	<b>1.163</b>	<b>177.002</b>	<b>0.038</b>
<b>Diabetes and comorbidities</b>				
Duration of diabetes (reference group: <5 years)				
5-10 years	2.323	0.749	7.205	0.144
>10 years	1.935	0.583	6.419	0.281
Presence of other systemic diseases	0.920	0.562	1.413	0.625
Presence of any eye problems	0.616	0.199	1.909	0.401
DM control by meds or injection	1.196	0.307	4.662	0.797
Knowledge of diabetic status (Type I vs. Type II)	2.631	0.900	7.688	0.077

\*Bold values indicate results that are significant at  $P < 0.05$ . DR=Diabetic retinopathy, DM=Diabetes mellitus, CI=Confidence interval, LB=Lower bound of the 95% CI, UB=Upper bound of the same interval, OR=Odds ratio

eliminates temporary blurry vision associated with pupil dilation; the instrument can be readily installed. However, images can be unreadable due to media opacity and smaller pupils, which commonly occur among older adults.<sup>[34]</sup> To-date, ophthalmologists do not recommend that nondilated digital retinal photography replace traditional DRE.<sup>[37]</sup> In the present study none of the patients had nondilated photography as part of their retinopathy screening.

Approximately 40% of patients in our study participated in the nation-wide diabetes shared care network. Among these patients, only about 62% stated that they had a dilated eye checkup within the previous 2 years. There was no difference in the screening rate for eye exams among patients who were in the diabetes shared care network or who were not. Care networks have been reported to improve the process and outcome of diabetic care: For example, the prevalence of fundus examination increased from 2.4% to 31.6% after implementation of the national-wide diabetic care program in Kuwait.<sup>[38]</sup> Effectiveness of implementing diabetes shared care network in Taiwan warrants further study.

We acknowledge additional limitations. First, our participants had a variety of eye symptoms or diseases. Patients with greater knowledge about diabetes care may have been more likely to respond to the survey. Thus, the prevalence of having a recent DR examination may be higher among patients in our sample. We note that national estimates in Taiwan for annual DR exams in 2009 were about 28.2%, substantially lower than the results in our study. The sample size in our study was relatively small. The economic and educational levels of our sample were lower than the average levels in Taiwan. In 2008, among people age 25–64 in Taiwan, 36% of had at least collage degree; the analogous percentage in Taipei was 57.2%.<sup>[39]</sup> Average household income per month in Taiwan was about 2500 US\$ in 2005.<sup>[40]</sup> Thus, findings may not generalize to patients in Taiwan; however, our results may help to describe DRE use by individuals with characteristics that are similar to those of our sample, people who on average have greater risks for complications of diabetes than the population of Taiwan. The survey was conducted by self-administered questionnaires. We improved the validity and reliability of the survey with an extensive pilot test of the questionnaire.<sup>[22]</sup> Nonetheless, we acknowledge that the results may have been affected by difficulty recalling information or lack of accurate reporting by participants. The data were collected in 2009. However, to the best of our knowledge, this is the first study to address this topic. Further, there have been no notable changes in ophthalmology policy or practice since this study was conducted. In addition, we are not aware of any change in the relationship of

screening with ophthalmic outcomes since the time when we conducted this study, and we have no reason to believe that patient beliefs or behaviors regarding DR screening have changed since we conducted the study. Thus, the results of this study may help to inform practice and research.

Management of diabetic care is a complex process. A multifaceted approach to promote the management of diabetes is needed. Our findings highlight that the perception of threat was an important determinant in promoting diabetic eye care among patients in Taiwan.

## Conclusions

Sixty percent of patients reported that they received a DRE in the past two years. Their belief that diabetes could harm their eyesight was significantly associated with reported receipt of a DRE. These results suggest that the perceived susceptibility to illness is an important determinant of taking a health-protective action and may be an important determinant in promoting diabetic eye care among patients in Taiwan.

## Financial support and sponsorship

This study was financially supported by a research grant from Shin-Kong Memorial Hospital.

## Conflicts of interest

The authors declare that there are no conflicts of interests of this paper.

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