

BMJ Open Prevalence of ocular fundus pathology with type 2 diabetes in a Chinese urban community as assessed by telescreening

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ABSTRACT

Objective: To describe the telescreening model and assess the prevalence of ocular fundus pathology in patients with type 2 diabetes within a Chinese urban community.

Design: Community-based cross-sectional study.

Setting: Healthcare centre of Fengyutan Community, Shenyang, China.

Participants: A total 528 patients (287 females) with type 2 diabetes mellitus (DM) were randomly recruited using health files from the healthcare centre of Fengyutan community between 8 October and 20 November 2012.

Main outcome measures: Signs of any diabetic retinopathy (DR), signs of glaucoma and signs of age-related macular degeneration (AMD).

Results: The main ocular fundus pathologies were DR (75 patients, 14.20%), 65 (86.67%) cases of which were newly detected, AMD (57 patients, 10.79%) and glaucoma (63 patients, 11.93%). The risk factors for fundus pathology were long duration of diabetes (OR 2.31, 95% CI 1.87 to 2.56), and higher fasting plasma glucose (OR 3.64, 95% CI 1.81 to 5.21) and glycated haemoglobin (HbA1c) levels (OR 3.83, 95% CI 1.87 to 6.35).

Conclusions: There was a high prevalence of fundus pathology among patients with type 2 diabetes, and in most of the cases, this was newly detected. Community screening for fundus pathology among patients with a long duration of type 2 diabetes and high fasting plasma glucose and HbA1c levels using a telescreening model will provide an effective strategy for the prevention and treatment of fundus pathology.

BACKGROUND

Diabetes mellitus (DM) is known to affect vascular autoregulation and cause microvascular damage, especially in the retina and optic nerve. Many fundus pathologies such as retinopathy, glaucoma and age-related macular degeneration (AMD) are associated with DM.^{1–3} Screening would be very important for many patients with DM and early fundus pathology, which may be almost asymptomatic.

Strengths and limitations of this study

- This study described the telescreening model and assessed the prevalence of ocular fundus pathology among patients with type 2 diabetes mellitus within a healthcare centre in a Chinese urban community.
- In all participants, diagnoses were systematically ascertained using checking, and fundus diseases were measured according to standardised protocol by telescreening.
- As a community-based study, some diagnostic examinations were not performed to facilitate diagnosis.
- Because this was a baseline study, the sensitivity and cost-effectiveness analyses for this screening model need further investigation.

A recommended approach to the early detection of pathology is annual examinations of the ocular fundus. However, general practitioners (GPs) in Chinese communities do not normally or routinely check their patients for ocular fundus diseases, the retinal manifestations of diabetic retinopathy (DR) and retinal changes produced by other disorders.

The telescreening model includes digital fundus photography in participants attending the primary healthcare centre, and subsequent electronic transmission of these photographs to a reading centre for evaluation by professionals. The telescreening model has been used for screening of DR, and was performed in conjunction with a visit to the primary care physician, without referral to an ophthalmologist or optometrist.⁴ Telescreening has been confirmed as having the potential to improve compliance with other DR screening methods.⁵

This study was performed to assess the prevalence and risk factors for fundus pathology among patients with type 2 DM using telescreening in a Chinese community.

METHODS

Ethics statement

This research was performed according to the principles of the Declaration of Helsinki, and written informed consent was obtained from the participants after explanation of the nature and possible consequences of the study.

Patient recruitment

The healthcare centre of Fengyutan community is a demonstration unit for the prevention and treatment model for diabetic eye disease at Liaoning Diabetic Eye Center. It provides health services for 80 000 people in Fengyutan community in the Shenhe district of Shenyang city. A cross-sectional study was carried out among patients attending the Fengyutan Health Service. There were more than 1000 patients with DM attending the Fengyutan community healthcare centre, who were diagnosed in hospital according to the WHO criteria. The health files of patients over 45 years of age, with DM documented in hospital records or diagnosed during community clinic visits, were retrieved. Excluding ineligible patients with DM who had died, moved out of the community and were hospitalised or institutionalised in nursing homes, a total of 800 (80%) patients were recruited by random sampling. Briefly, a total of 528 patients with type 2 DM (mean age 55.09±3.18 years, range 45–70) (response rate 66%) participated in this study.

Data collection and telescreening

Name, age, smoking history, alcohol consumption and other health-related information of each participant were collected using a standardised questionnaire. Following an interview by a community worker, all participants were asked to fast overnight (>8 h) before a physical examination. All participants had their intraocular pressure (IOP) measured using a non-contact tonometer (NT-2000, NIDEK, Aichi, Japan). For all participants, two fundus photographs of each eye (the first focused on the macular fovea and the second focused on the optic centre) were taken by a well-trained general physician, using a 45° non-mydratic fundus camera (CR-DGi, Canon, Tokyo, Japan). The photographs were identified using questionnaire information and stored on a computer, and the general physician transmitted the photographs and participant information to the reading centre (Liaoning Diabetic Eye Center, Shenyang, China) by email. The photographs were used for diagnosis and grading, respectively, by two ophthalmologists. If there were differences, a third ophthalmologist was invited to read the photographs in order to ensure that the diagnosis was correct. After the photographs had been read, reports that included the results of the retinal assessment of the fundus photographs were sent to the GPs at the Fengyutan HealthCare Center and patients. The patients who needed treatment were referred to an ophthalmologist.

Laboratory methods

Blood was drawn from an antecubital vein in the morning after at least 8 h of fasting, for determination of total cholesterol, triglyceride and fasting plasma glucose levels and concentrations of glycated haemoglobin (HbA1c). All measurements were performed at the Endocrinology Laboratory, China Medical University, Shenyang, China, using commercially available assays.

Information from the questionnaire, physical examination, laboratory measurements and fundus pathology assessments was stored in a database.

Definitions of DR, glaucoma, AMD and other factors

DR was defined as the presence of any microaneurysms, haemorrhages, hard exudates, cotton-wool spots, intraretinal microvascular abnormalities and any neovascularisation or macular oedema. Sign of glaucoma was defined as an IOP >21 mm Hg, a cup-disc ratio (CDR) greater than 0.60, disc asymmetry with a CDR greater than 0.20 or known glaucoma. Sign of AMD was defined as large drusen and retinal pigment epithelial changes.

Smoking status was classified as not smoking (smoked <100 cigarettes in a patient's lifetime and currently not a smoker) and smoking (smoked ≥100 cigarettes in a patient's lifetime regardless of whether the patient is currently a smoker). Alcohol consumption was defined as self-reported consumption of an average of more than 12 g of alcohol per day during the year before the examination among men and an average of more than 6 g/day among women. Hypertension was defined as an adult systolic blood pressure of 140 mm Hg or greater or a diastolic blood pressure of 90 mm Hg or greater. The length of time from the first diagnosis of DM was defined as duration of DM.

Statistical analyses

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) V.16.0 for Windows. χ^2 Tests were used to compare the distributions of categorical variables and t tests for unequal variances were used to compare continuous variables. Multivariate logistic regression models were used to estimate the ORs for fundus pathology. Potential confounders, including age and sex, were adjusted for, and the OR for fundus pathology was calculated. A p value <0.05 was considered statistically significant.

RESULTS

As shown in table 1, there were 223 (42.23%) patients with fundus pathology among the 528 patients with type 2 DM. There were 75 patients with DR, 63 with glaucoma, 57 with AMD and 28 with other pathologies. In most of these patients, except those with other pathologies, the fundus pathology was newly detected. The prevalence of DR (14.20%) was somewhat higher than that of any of the other pathologies.

Table 1 Categorisation of the different types of fundus pathology identified in 223 of the 528 patients with type 2 diabetes mellitus*

Fundus pathology	Number of patients (%)	Number of patients with newly detected pathology (%)
Signs of DR	75 (14.20)	65 (86.67)
Signs of glaucoma	63 (11.93)	53 (84.13)
Signs of AMD	57 (10.79)	48 (84.21)
Sign of DR and glaucoma	9 (1.70)	6 (66.67)
Sign of DR and AMD	6 (1.13)	6 (100)
Sign of glaucoma and AMD	2 (0.38)	2 (100)
Sign of DR, glaucoma and AMD	1 (0.19)	1 (100)
Other pathology (including pathological myopia, retinal vessel occlusion, optic nerve atrophy, macular hole, etc)	28 (5.30)	9 (32.14)

*Some patients may have had more than one fundus pathology. AMD, age-related macular degeneration; DR, diabetic retinopathy.

As shown in table 2, most of the patients with fundus pathology had DM for 6–15 years, and they also had higher total cholesterol and HbA1c levels ($p < 0.01$). Most of the patients with DR were aged 55–64 years, and had hypertension and higher HbA1c levels ($p < 0.01$).

Among the patients with glaucoma, 65.79% were women, and most of these patients were aged 55–64 years and also had higher IOPs ($p < 0.01$). More than half of the patients with AMD were older than 65 years, and were smokers with a long duration of DM ($p < 0.01$).

Table 2 Demographic and clinical characteristics of the 528 patients with type 2 DM

	All participants	All patients with fundus pathology	Patients with signs of DR	Patients with signs of glaucoma	Patients with signs of AMD
Age (years), n (%)	528	223 (42.23)	75 (14.20)	63 (11.93)	57 (10.79)
45–54	186 (35.23)	71 (31.84)	32 (33.33)	19 (30.16)	11 (19.30)
55–64	224 (42.42)	89 (39.91)	36 (57.33)	32 (50.79)	14 (24.56)
>65	118 (22.35)	63 (28.25)	7 (9.33)	12 (19.05)	32 (56.14)
Sex, n (%)					
Females	287 (54.36)	118 (52.91)	44 (58.67)	41 (65.79)	25 (43.86)
Males	241 (45.64)	105 (47.09)	31 (41.33)	22 (34.21)	32 (56.14)
Smoking, n (%)					
Yes	309 (58.52)	128 (57.34)	42 (56)	31 (49.21)	37 (64.91)
No	219 (41.48)	95 (42.66)	33 (44)	32 (50.79)	20 (35.09)
Alcohol consumption, n (%)					
Yes	359 (67.99)	119 (53.36)	36 (48)	29 (46.03)	26 (45.61)
No	169 (32.01)	104 (46.64)	39 (52)	34 (53.97)	31 (54.39)
Duration of DM (years), n (%)					
<5	184 (34.85)	59 (26.46)	19 (25.33)	17 (26.98)	16 (28.07)
6–15	220 (41.67)	91 (40.81)	24 (32)	21 (33.33)	17 (29.82)
>16	118 (22.35)	73 (32.73)	32 (42.67)	25 (39.69)	24 (42.11)
Hypertension, n (%)					
Present	365 (69.13)	112 (50.22)	49 (65.33)	28 (44.44)	29 (50.88)
Absent	163 (30.87)	111 (49.78)	26 (34.67)	35 (55.56)	28 (49.12)
DM controlled, n (%)					
Yes	315 (59.66)	132 (59.19)	41 (54.67)	38 (60.32)	31 (54.39)
No	213 (40.34)	91 (40.81)	34 (45.33)	25 (39.68)	26 (45.61)
IOP, mm Hg, mean±SD	18.87±5.78	19.76±3.54	18.15±2.94	25.33±3.19	16.91±2.15
FPG, mmol/L, mean±SD	8.96±2.34	9.92±4.33	11.03±3.37	8.02±2.43	8.45±1.18
TG, mmol/L, mean±SD	1.89±0.65	1.94±0.56	1.98±0.54	1.66±0.44	1.81±0.32
TC, mmol/L, mean±SD	5.27±1.78	6.02±1.34	5.89±1.21	5.09±1.01	4.99±1.44
HbA1c (%)	7.99	11.92	12.21	6.01	5.98

Statistical methods: independent samples t test or χ^2 test.

DM controlled was defined as insulin injection therapy or antidiabetic drug to be taken orally.

AMD, age-related macular degeneration; DM, diabetes mellitus; DR, diabetic retinopathy; FPG, fasting plasma glucose; HbA1c, concentration of glycated haemoglobin; IOP, intraocular pressure; TG, triglycerides; TC, total cholesterol.

Table 3 Risk factors for fundus pathology in patients with type 2 DM as assessed by logistic regression analysis

	All patients with fundus pathology OR (95% CI)	p Value	Patients with signs of DR OR (95% CI)	p Value	Patients with signs of glaucoma OR (95% CI)	p Value	Patients with signs of AMD OR (95% CI)	p Value
Age (years)	–	–						
45–54	1.00		1.00		1.00		1.00	
55–64	0.79 (0.51 to 1.12)	0.06	0.52 (0.21 to 0.78)	0.01	1.08 (0.35 to 1.71)	0.06	0.79 (0.63 to 0.86)	<0.001
>65	1.21 (0.91 to 1.98)	0.07	0.48 (0.32 to 0.52)	0.02	1.52 (0.71 to 2.78)	0.07	1.29 (1.11 to 1.32)	<0.001
Sex								
Females	1.00		1.00		1.00		1.00	
Males	0.68 (0.53 to 0.73)	0.01	0.78 (0.62 to 0.84)	0.01	0.53 (0.42 to 0.61)	<0.001	0.61 (0.54 to 0.71)	0.01
Smoking								
No	1.00		1.00		1.00		1.00	
Yes	0.89 (0.82 to 1.02)	0.06	2.88 (1.79 to 3.91)	<0.001	1.88 (0.62 to 2.31)	0.10	1.18 (0.87 to 1.38)	0.07
Alcohol consumption								
No	1.00		1.00		1.00		1.00	
Yes	1.12 (0.86 to 1.31)	0.06	1.98 (1.49 to 2.96)	<0.001	0.97 (0.62 to 1.34)	0.06	2.08 (0.97 to 3.93)	0.01
Duration of DM (years)								
<5	1.00		1.00		1.00		1.00	
6–15	1.98 (1.29 to 2.97)	<0.001	1.93 (1.39 to 2.87)	<0.001	1.28 (1.09 to 1.47)	0.003	1.19 (1.02 to 1.37)	<0.001
>16	2.31 (1.87 to 2.56)	<0.01	2.45 (1.65 to 3.16)	<0.01	0.99 (0.87 to 1.16)	0.07	2.31 (1.87 to 2.56)	0.01
Hypertension								
No	1.00		1.00		1.00		1.00	
Yes	1.18 (0.97 to 1.54)	0.06	1.32 (1.29 to 1.66)	0.001	2.18 (1.39 to 2.94)	0.03	0.81 (0.49 to 1.34)	0.10
DM controlled								
No	1.00		1.00		1.00		1.00	
Yes	1.84 (0.88 to 2.35)	0.21	1.12 (0.38 to 2.15)	0.12	1.14 (0.58 to 2.23)	0.14	0.92 (0.55 to 1.55)	0.09
IOP >21 mm Hg								
No	1.00		1.00		1.00		1.00	
Yes	1.85 (0.38 to 3.15)	0.21	1.21 (0.56 to 1.75)	0.11	3.84 (2.85 to 4.66)	0.01	0.89 (0.81 to 1.25)	0.23
FPG >7 mmol/L								
No	1.00		1.00		1.00		1.00	
Yes	3.64 (1.81 to 5.21)	<0.001	2.55 (1.85 to 4.15)	0.03	1.81 (0.82 to 3.15)	0.22	2.82 (0.58 to 4.54)	0.28
TG >1.7 mmol/L								
No	1.00		1.00		1.00		1.00	
Yes	0.83 (0.55 to 1.38)	0.08	1.54 (0.78 to 2.33)	0.07	1.31 (0.96 to 1.67)	0.09	3.83 (0.25 to 6.15)	0.26
TC >5.5 mmol/L								
No	1.00		1.00		1.00		1.00	
Yes	2.24 (0.75 to 3.15)	0.11	1.11 (0.55 to 2.44)	0.18	0.89 (0.51 to 2.42)	0.27	1.14 (0.66 to 2.37)	0.21
HbA1c >7%								
No	1.00		1.00		1.00		1.00	
Yes	3.83 (1.87 to 6.35)	<0.001	3.12 (1.18 to 7.15)	0.001	1.12 (1.08 to 1.75)	0.01	1.22 (1.01 to 1.73)	0.02

Statistical method: logistic regression analysis.

AMD, age-related macular degeneration; DM, diabetes mellitus; DR, diabetic retinopathy; FPG, fasting plasma glucose; HbA1c, concentration of glycated haemoglobin; IOP, intraocular pressure; TG, triglycerides; TC, total cholesterol.

DM controlled was defined as insulin injection therapy or antidiabetic drug to be taken orally.

Table 4 Studies that have investigated the prevalence of fundus pathology in patients with type 2 DM in urban or community settings

Study (country)	Number of patients with DM	Study design	Type of DM	Prevalence	Risk factors
Any DR					
Shanghai Diabetic Complications Study (China) ⁶	3736	Cross-sectional, community based	NA	9.4%	Hyperglycaemia
The Beijing Communities Diabetes Study (China) ⁷	2007	Cross-sectional study	Type 2	24.7±1.0%	Long duration of diabetes; high-HbA1c levels; high-systolic blood pressure; elevated blood urea concentration; microalbuminuria
Epidemiological study of DR in Hong Kong (Hong Kong) ⁸	4423	Retrospective community-based study	Type 2	28.4%	Glycated haemoglobin level
Prevalence and determinants of DR (Qatar) ⁹	540	Community-based survey	Type 2	23.5%	Long duration of DM; poor glycaemic control
Prevalence of DR in Lampang (Thailand) ¹⁰	3049	Cross-sectional study	NA	BDR or NPDR was 18.9% and PDR was 3%	Long duration of DM
Glaucoma					
The Los Angeles Latino Eye Study (USA) ¹¹	1157	Cross-sectional study	Type 2		Long duration of DM
Singapore Malay Eye Study (Singapore) ²	764	Population-based study	NA	4.7%	Not associated
AMD					
DR and AMD study (Korea) ¹	315	Cross-sectional study	NA	5.4%	NA
The EUREYE study (Greece) ¹²	616	Cross-sectional study	NA	13.1%	NA

AMD, age-related macular degeneration; BDR, background diabetic retinopathy; DM, diabetes mellitus; DR, diabetic retinopathy; NPDR, non-proliferative diabetic retinopathy; NA, not applicable PDR, proliferative diabetic retinopathy;.

Longer duration of DM (OR 2.31, 95% CI 1.87 to 2.56) and higher fasting plasma glucose (OR 3.64, 95% CI 1.81 to 5.21) and HbA1c levels (OR 3.83, 95% CI 1.87 to 6.35) were risk factors for fundus pathology after adjustment for age and sex, as shown in table 3. Smoking (OR, 1.12; 95% CI 0.86 to 1.31) and alcohol consumption (OR, 0.89; 95% CI 0.82 to 1.02) were no longer the significant risk factors for fundus pathology in all patients. However, the risk factors were smoking, alcohol consumption, long duration of DM and high fasting plasma glucose and HbA1c levels for patients with only signs of DR. The likelihood of developing glaucoma was increased in type 2 DM patients with hypertension and high IOPs or HbA1c levels. The risk factors for AMD were age, long duration of DM and high HbA1c levels.

DISCUSSION

In this cross-sectional study, we used a new telescreening model to identify fundus pathology among patients attending a community healthcare centre. The study showed that among 528 patients with type 2 DM, 223 (42.23%) had fundus pathology, and the risk factors for fundus pathology were long duration of DM and high fasting plasma glucose and HbA1c levels. Attention should be focused on long duration of DM and high HbA1c levels, which were the risk factors for all three fundus pathologies in this study. The results showed that the prevalence of fundus pathology was high, and that the risk factors, especially HbA1c levels, should be controlled. Table 4 shows the results of selected studies on the prevalence of fundus pathologies among patients with type 2 DM in urban or community settings. In the present study, 75 (14.20%) patients among the 528 with type 2 DM showed signs of DR, which was lower than the prevalence in a Beijing study⁷; this difference may be explained by the younger age of participants in the present study.

Glaucoma was the second most frequent fundus pathology identified in this study, with 63 (11.93%) patients being affected. Previous study reported that genetic factors such as the endothelial NO synthase (Glu298Asp) polymorphism might play a role in diabetic patients with glaucoma.¹³ However, we also need further research to investigate the relationship between glaucoma and DM.

AMD, which is an age-related fundus disease, was observed in 57 patients (10.79%) with type 2 DM. This phenomenon may be the result of both oxidation and a decline in pool size.¹⁴

Because most of the fundus pathologies were newly detected, early screening would appear to be very important, and patients with DM should be screened for fundus pathology regularly. Early screening has the potential to significantly improve final visual outcomes in patients who develop subfoveal choroidal neovascularisation associated with AMD.¹⁵ Apart from its clinical

significance, the economic impact of early screening could also be very significant.¹⁶ For early screening, there must be an effective and easily implementable screening model that is appropriate for conditions in China. Recently, Peng *et al*¹⁷ established a telescreening system for detecting DR in the Shanghai Beixinjing community. In this study, we identified patients and used email to transmit the data for reading, in order to ensure secure and timely communication. At the same time, we analysed the risk factors for fundus pathology associated with DM and established a database of all screened patients for prospective research.

Limitations of the study

Despite the conclusive results that were obtained from this study, there were some shortcomings that should be noted. First, this was a community-based study of patients attending a community healthcare centre; therefore fundus fluorescein angiography or visual field and optical coherence tomography were not performed to facilitate diagnosis. Second, only few participants were enrolled because a new screening model was used. Third, because this was a baseline study, the sensitivity and cost-effectiveness analyses for this screening model are still in progress. Fourth, we cited a number of studies in table 4. The number of fundus photographs taken, assessment method, diagnostic criteria and grading classification used for DR, glaucoma and AMD in this study may not be directly comparable to those used in the various cited studies. This could result in over-estimation or under-estimation of the true prevalence of DR, glaucoma and AMD in this study versus that of other studies. In addition, the κ statistic for two ophthalmologists diagnosis is not worked out; this should be studied in further research.

We believe this study is helpful for better understanding of the prevalence and risk factors for fundus pathology in patients with type 2 DM.

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Competing interests None.

Patient consent Obtained.

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