Original Article

# Lack of Awareness amongst Community Patients with Diabetes and Diabetic Retinopathy: The Singapore Malay Eye Study

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## Abstract

**Introduction: We assessed awareness of diabetes and diabetic retinopathy in a Singaporean Malay population. We hypothesised that poor awareness is associated with poorer control of diabetic retinopathy risk factors (glycaemic and blood pressure levels) and suboptimal treatment with laser therapy. Materials and Methods: A population-based survey of 3280 (78.7% response rate) persons among Singaporean Malays aged between 40 and 80 years old. Diabetes was defined in persons with random glucose ≥11.1mmoL/L, use of diabetic medication, or a previous physician diagnosis. Diabetic retinopathy was graded from retinal photographs following the modified Airlie House classification. Patient awareness was assessed via structured interviews. Glycosylated haemoglobin was measured from venous blood. Results: Of the 3280 study participants, 768 had diabetes, of whom 13.2% (n = 101) were unaware of their diabetes status. Participants unaware of their diabetes status had significantly higher mean glycosylated haemoglobin (9.7% vs 8.2%, *P* <0.001), systolic blood pressure (160.0 mmHg vs 153.7 mmHg, *P* = 0.01) and diastolic blood pressure (83.5 mmHg vs 78.5 mmHg, *P* <0.001), compared to participants who were aware. Of the 272 (35.4%) participants detected to have diabetic retinopathy, 83.4% (n = 227) were unaware of having retinopathy. Of the 77 with vision-threatening retinopathy, laser treatment had been performed in only 55.6% of those unaware of having retinopathy. Conclusion: In a sample of Malays with diabetes, high proportions were unaware of their disease. Unawareness was associated with poorer control of diabetic retinopathy risk factors. Only half of persons who were unaware that they had vision-threatening diabetic retinopathy had received laser treatment. These data highlight room for improvement in diabetic retinopathy prevention through better patient education and screening.**

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**Key words: Asia, Epidemiology, Ophthalmology**

## Introduction

Diabetes is a major public health problem, and diabetic retinopathy is the leading cause of blindness in working-aged people.[1] Previous studies have documented poor attainment of guidelines of glycosylated haemoglobin ($HbA_{1c}$) and blood pressure control[2] and eye care utilisation[3-6] in the prevention of diabetic retinopathy. Studies have also documented poor knowledge of diabetes[7] and diabetic retinopathy.[8] One study of 1333 patients with Type 2 diabetes conducted in Tokyo's Women's Medical University in 2003 found that 32.0% did not know, and 16.5% were uncertain if they had diabetic retinopathy.[8] Furthermore, patients who were unaware that they had diabetic retinopathy were less likely to be compliant to regular ophthalmic screening.

A lack of patient awareness is considered a major contributing factor to poor compliance with guidelines,[9] and

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is an important issue to address given the escalating burden of diabetes, particularly in Asian countries.[10] To date, there remains a paucity of Asian population-based data about patients' awareness of their disease status. In this report, we assessed the awareness of diabetes and diabetic retinopathy in a population-based sample of Singaporean Malays with diabetes, and the associations between awareness and metabolic and blood pressure control.

## Materials and Methods

### *Study Population*

The Singapore Malay Eye Study (SiMES) was a population-based, cross-sectional study of 3280 participants (78.7% response) aged between 40 and 80 years old in Singapore, conducted between 2004 and 2006. Details of the study design, sampling plan, methodology and eligibility criteria have been reported.[11] For this analysis, we included 768 persons with diabetes mellitus, defined either as having a random glucose ≥11.1 mmol/L, use of diabetic medication or a previous physician diagnosis of diabetes.[12] The study was approved by the hospital institutional review board, and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

### *Questionnaire*

A standardised questionnaire was administered in English or Malay, depending on the participants' preferences, by trained interviewers. Awareness of diabetes, diabetic retinopathy and laser treatment was assessed using the following questions:

1. "Has a doctor advised you that you have diabetes (high blood sugar in the blood or urine)?"
2. "Have you ever been told by a doctor that you have eye disease or eye damage related to your diabetes (diabetic retinopathy)?"
3. "Have you ever had laser treatment for your diabetic eye disease?"

Participants unaware of having diabetes and were not on diabetic treatment were deemed to be undiagnosed cases. Self-reported histories of other eye conditions (vision deterioration, eye irritation, cataracts, myopia, macular degeneration, glaucoma, eye trauma) were also taken. Other demographic data included the participants' education level, income and housing status. A low socioeconomic status was defined as meeting all 3 criteria of having a primary or lower education, an individual monthly income <SGD2000 and living in a 1 or 2 room government-subsidised Housing Development Board flat.

### *Retinal Photography and Diabetic Retinopathy Assessment*

Diabetic retinopathy was assessed through standardised dilated retinal photography,[11,13] using a digital retinal camera (Canon CR-DGi with 10D SLR back, Japan). Two retinal photographs, centred at the optic disc and macula, were taken from both eyes of each participant. The degree of retinopathy was graded based on the modified Airlie House classification system, using the Blue Mountains Eye Study protocol.[14]

Retinopathy was considered present if characteristic lesions as defined by the Early Treatment Diabetic Retinopathy Study[13] were found on retinal photographs. Disease severity was based on the worse of both eyes, and categorised as minimal non-proliferative diabetic retinopathy (NPDR), mild NPDR, moderate NPDR, severe NPDR and proliferative retinopathy. Vision-threatening retinopathy was defined as the presence of severe NPDR, proliferative retinopathy or clinically significant macular oedema (CSME), using the Eye Diseases Prevalence Research Group definition.[12] Macular oedema was defined as exudates in the presence of microaneurysms and blot haemorrhages within one disk diameter of the foveal centre, or the presence of focal photocoagulation scars in the macular area. CSME was considered present when the macular oedema was within 500 μm of the foveal centre, or if focal photocoagulation scars were present in the macular area. Participants were deemed to have undergone laser treatment if laser photocoagulation scars were present.

### *Assessment of $HbA_{1c}$ and Blood Pressure*

Non-fasting venous blood samples (3 mL) were drawn and analysed for $HbA_{1c}$ levels at the National University Hospital Reference Laboratory on the same day. The $HbA_{1c}$ assay was carried out using high performance liquid chromatography cation exchange chromatography system implemented on a Biorad variant II analyser. The assay was accredited by the National Glycoprotein Standardisation programme with controls traceable to the Diabetes Control and Complications Trial. Blood pressure was measured according to the protocol used in the Multi-Ethnic Study of Atherosclerosis.[13]

### *Statistical Analysis*

We compared the characteristics of 3 mutually exclusive subgroups of participants: (i) Participants with diabetes but no retinopathy, (ii) Participants with diabetic retinopathy but no prior laser therapy, (iii) Participants with prior laser therapy, with participants without diabetes using frequency tables. Frequency tables were also used to determine the proportions aware of their diabetes and laser treatment. In participants with diabetic retinopathy, retinopathy severity and awareness of having retinopathy were cross-tabulated to elucidate the respective frequencies.

Characteristics of participants who were aware of their diabetes and diabetic retinopathy were then compared with

those who were unaware. Pearson's chi-square ($\chi^2$) test was used to compare proportions of categorical variables (e.g., gender), while independent-samples Student's *t*-test was used to compare the means and standard deviations of continuous variables (e.g., $HbA_{1c}$), after checking variances using Levene's Test for Equality of Variances. The significance level was set to be <0.05. Age-gender and multivariable-adjusted odds ratios were calculated using binary logistic regression models. All analyses were performed in SPSS version 15 (SPSS Inc, Chicago, Ill).

## Results

Of the 768 participants with diabetes, 764 (99.5%) had retinal photographs taken, of which 761 (99.6%) were gradable. Of the 761 with gradable retinal photographs, 272 (35.7%) had retinopathy, including 59 (7.8%) participants with prior laser photocoagulation. The characteristics of the 3 subgroups (those with diabetes but without retinopathy, those with retinopathy but without prior laser photocoagulation, and those with prior laser photocoagulation) were compared to participants without diabetes (n = 2512) in Table 1. Across the 3 subgroups, there were increasing proportions of female participants and persons with low education and low socioeconomic status. In particular, 39.3%, 43.4% and 50.0%, respectively had never completed any formal academic education, and 4.5%, 7.1% and 11.9%, respectively had low socioeconomic status. Participants with diabetes had a lower education and socioeconomic status than participants without diabetes.

The response rates for the questionnaire were 99.7% (n = 766), 98.9% (n = 269) and 96.6% (n = 57) for participants with diabetes, diabetic retinopathy, or laser treatment, respectively. Amongst those who responded to the questionnaire on diabetes and diabetic retinopathy, HbA1c was measured in 745 (97.3%) and 262 (97.4%) participants, and blood pressure measured in 764 (99.7%) and 268 (99.6%) participants, respectively.

Table 1. Comparison of Characteristics among Sub-groups of Study Participants in the Singapore Malay Eye Study (SiMES)

| | **Participants without diabetes n = 2512** | **Participants with diabetes but no diabetic retinopathy n = 489** | **Participants with diabetic retinopathy but no prior laser photocoagulation n = 213** | **Participants with prior laser photocoagulation n = 59** |
|---|---|---|---|---|
| Age (y) | | | | |
| 40-49 | 29.4 | 9.8 | 10.3 | 6.8 |
| 50-59 | 29.4 | 29.7 | 29.6 | 16.9 |
| 60-69 | 21.0 | 28.6 | 37.1 | 54.2 |
| 70-80 | 20.2 | 31.9 | 23.0 | 22.0 |
| Gender | | | | |
| Male | 49.5 | 46.0 | 39.9 | 35.6 |
| Female | 50.5 | 54.0 | 60.1 | 64.4 |
| Marital status | | | | |
| Single | 4.8 | 2.9 | 1.9 | 3.4 |
| Married | 75.0 | 70.1 | 79.6 | 65.5 |
| Separated/Divorced | 6.2 | 3.5 | 0.9 | 6.8 |
| Widowed | 14.0 | 23.4 | 17.5 | 23.7 |
| Education | | | | |
| No formal education | 26.7 | 39.3 | 43.4 | 50.0 |
| Primary education | 45.3 | 44.7 | 44.8 | 41.4 |
| Secondary education | 20.6 | 12.3 | 8.5 | 6.9 |
| Post-Secondary education | 7.4 | 3.7 | 3.3 | 1.7 |
| Low socioeconomic status | | | | |
| Yes | 3.8 | 4.5 | 7.1 | 11.9 |
| No | 96.2 | 95.5 | 92.9 | 88.1 |

Numbers presented in cells are in percentages.
Data presented include all participants (n = 3280), irrespective of whether they responded to the questionnaire.

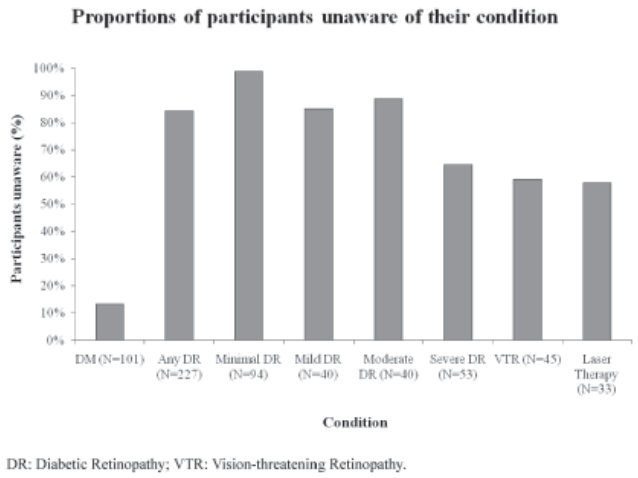


Fig. 1. Awareness of their condition in the population.

Figure 1 shows the proportions of participants unaware of their disease and laser treatment. There were 13.2% (n = 101) participants unaware of their diabetes, of whom 5.9% (n = 6) were receiving diabetic medication and 94.1% (n = 95) were undiagnosed cases. In participants with diabetic retinopathy, an overall 84.4% (n = 227) were unaware of having retinopathy, with proportions ranging from 98.9% to 64.6% across the spectrum of retinopathy severity, from the least to the most severe. In participants with vision-threatening retinopathy, 59.2% (n = 45) were unaware of their retinopathy status, of whom 55.6% (n = 25) had received laser therapy. Amongst the 41.8% (n = 32) who were aware of their vision-threatening retinopathy, 90.3% (n = 28) had received laser therapy. Amongst all participants with prior laser therapy (n = 59), 50.9% (n = 29) were unaware of their retinopathy and 57.9% (n = 33) were unaware of having had laser therapy.

The associations of participants' lack of awareness with their characteristics are shown in Table 2 (crude data), Tables 3 and 4 (multivariable-adjusted data). Participants unaware of their diabetes were significantly younger ($P$ = 0.02), and had higher mean $HbA_{1c}$ levels ($P$ <0.001) and diastolic blood pressure ($P$ = 0.01), compared to those who were aware in multivariable-adjusted analyses (Table 3).

The lack of awareness of diabetic retinopathy was significantly associated with a higher mean $HbA_{1c}$ after adjusting for age and gender ($P$ = 0.04), but not with blood pressure ($P$ = 0.40). Older participants aged between 70 and 80 years old were more likely to be unaware of their retinopathy status ($P$ = 0.04) compared to those aged between 40 and 49 years old. Participants with a shorter duration of diabetes ($P$ = 0.04) were also more likely to be unaware in

Table 2. Characteristics of Participants with Diabetes and Diabetic Retinopathy in the Singapore Malay Eye Study (SiMES)

| Characteristic | Participants with diabetes | | | Participants with diabetic retinopathy | | |
|---|---|---|---|---|---|---|
| | Awareness of diabetes (n = 766) | | P* | Awareness of diabetic retinopathy (n = 269) | | P* |
| | Yes (n = 665) | No (n = 101) | | Yes (n = 42) | No (n = 227) | |
| Age (y) | 63.0 (9.1) | 59.7 (10.6) | 0.004 | 60.5 (8.6) | 62.2 (8.6) | 0.25 |
| Gender: Male | 286 (43.0) | 46 (45.5) | 0.63 | 13 (31.0) | 91 (40.1) | 0.30 |
| Education | | | 0.24 | | | 0.49 |
| Primary or less | 574 (86.6) | 83 (82.2) | | 36 (85.7) | 202 (89.4) | |
| Secondary or more | 89 (13.4) | 18 (17.8) | | 6 (14.3) | 24 (10.6) | |
| Previous eye history | 381 (57.6) | 39 (39.0) | 0.001 | 23 (57.5) | 109 (48.0) | 0.30 |
| Serum glucose (mmol/L) | 10.3 (5.1) | 15.6 (4.4) | <0.001 | 11.8 (5.9) | 12.1 (6.2) | 0.76 |
| $HbA_{1c}$ (%) | 8.2 (1.9) | 9.7 (2.1) | <0.001 | 8.3 (1.8) | 9.0 (2.0) | 0.05 |
| Systolic blood pressure (mmHg) | 153.7 (23.2) | 160.0 (26.4) | 0.01 | 160.7 (24.9) | 159.0 (24.5) | 0.69 |
| Diastolic blood pressure (mmHg) | 78.5 (10.6) | 83.5 (12.3) | <0.001 | 77.0 (11.1) | 79.7 (12.0) | 0.18 |
| BMI ($kg/m^2$) | 27.5 (4.7) | 26.8 (5.2) | 0.17 | 26.7 (4.3) | 27.1 (4.5) | 0.63 |
| Oral diabetes medication | 442 (66.5) | 6 (5.9) | <0.001 | 39 (97.5) | 193 (97.5) | 1.00 |
| Insulin treatment | – | – | – | 12 (31.6) | 41 (24.1) | 0.41 |
| Diabetes duration (y) | – | – | – | 16.6 (9.3) | 14.4 (9.4) | 0.17 |

Data presented are means [standard deviations (SD)] or number (%), as appropriate for variable.
Data presented include only participants who responded to the questionnaire.
* $P$ value for the difference in characteristics by awareness status, based on chi-square test or $t$-test as appropriate.

Table 3. Associations of Lack of Awareness of Diabetes with Participant Characteristics, the Singapore Malay Eye Study (SiMES)

| | | | Lack of awareness of diabetes | | | |
|---|---|---|---|---|---|---|
| **Characteristics** | **No. at risk** | **n (%)** | **Age-gender adjusted OR (95% CI)** | ***P*** | **Multivariable-adjusted* OR (95% CI)** | ***P*** |
| Age (y) | | | | | | |
| 40-49 | 72 | 19 (26.4) | 1.00 (ref) | – | 1.00 | – |
| 50-59 | 219 | 31 (14.2) | 0.46 (0.24, 0.89) | 0.02 | 0.45 (0.22, 0.90) | 0.02 |
| 60-69 | 253 | 28 (11.1) | 0.35 (0.18, 0.67) | 0.002 | 10.45 (0.22, 0.91) | 0.03 |
| 70-80 | 222 | 23 (10.4) | 0.32 (0.16, 0.63) | 0.001 | 0.51 (0.24, 1.05) | 0.07 |
| Gender | | | | | | |
| Female | 434 | 55 (12.7) | 1.00 (ref) | – | 1.00 (ref) | – |
| Male | 332 | 46 (13.9) | 1.18 (0.77, 1.81) | 0.44 | 1.18 (0.75, 1.85) | 0.47 |
| $HbA_{1c}$ | | | | | | |
| 1st Quartile | 201 | 13 (6.5) | 1.00 (ref) | – | 1.00 (ref) | — |
| 2nd Quartile | 179 | 9 (5.0) | 0.73 (0.30, 1.76) | 0.48 | 0.71 (0.29, 1.71) | 0.44 |
| 3rd Quartile | 188 | 28 (14.9) | 2.36 (1.18, 4.73) | 0.02 | 2.18 (1.07, 4.40) | 0.03 |
| 4th Quartile | 177 | 49 (27.7) | 5.10 (2.63, 9.91) | <0.001 | 4.91 (2.51, 9.62) | <0.001 |
| Diastolic blood pressure (BP) | | | | | | |
| 1st Quartile | 215 | 19 (8.8) | 1.00 (ref) | – | 1.00 (ref) | – |
| 2nd Quartile | 175 | 19 (10.9) | 1.21 (0.61, 2.36) | 0.59 | 1.11 (0.55, 2.23) | 0.77 |
| 3rd Quartile | 189 | 27 (14.3) | 1.59 (0.84, 3.00) | 0.15 | 1.25 (0.65, 2.41) | 0.51 |
| 4th Quartile | 185 | 36 (19.5) | 2.28 (1.25, 4.17) | 0.01 | 2.19 (1.18, 4.07) | 0.01 |
| Systolic BP | | | | | | |
| 1st Quartile | 201 | 24 (11.9) | 1.00 (ref) | – | | |
| 2nd Quartile | 185 | 15 (8.1) | 0.70 (0.36, 1.40) | 0.32 | – | – |
| 3rd Quartile | 188 | 34 (18.1) | 1.87 (1.05, 3.32) | 0.03 | | |
| 4th Quartile | 190 | 28 (14.7) | 1.70 (0.92, 3.15) | 0.09 | | |
| Education level | | | | | | |
| Primary or more | 107 | 18 (16.8) | 1.00 (ref) | – | – | – |
| Primary or less | 657 | 83 (12.6) | 1. 04 (0.57, 1.91) | 0.90 | | |
| Low SES | | | | | | |
| No | 721 | 94 (13.0) | 1.00 (ref) | 0.32 | – | – |
| Yes | 45 | 7 (15.6) | 1.55 (0.66, 3.65) | | | |

95% CI: 95% confidence interval; OR: odds ratio

Data presented include only participants with diabetes who responded to the questionnaire (n = 766).

* Adjusted for age, gender, $HbA_{1c}$, diastolic blood pressure.

multivariable-adjusted analyses. There was no association ($P = 0.47$) between having any previous eye disease history with being aware of having retinopathy (Table 4).

In participants with previous laser therapy, those who were unaware of having undergone the procedure had a lower mean diastolic blood pressure (73.5 ± 7.1 mmHg vs 80.3 ± 11.2 mmHg, $P = 0.01$), but had non-significantly higher mean $HbA_{1c}$ levels (9.0 ± 2.0% vs 8.4 ± 1.6%, $P = 0.32$), compared to those who were aware of having laser therapy.

## Discussion

The extent of patient awareness and its relationship to diabetic retinopathy care may be keys to further improvements to diabetic retinopathy management and prevention. Our study provides population-based data showing that high proportions of Singaporean Malays in the community are unaware of their diabetes/diabetic retinopathy status, and such a lack of awareness is associated with poor control of $HbA_{1c}$ and blood pressure levels. In

Table 4. Associations of Lack of Awareness of Diabetic Retinopathy with Participant Characteristics, the Singapore Malay Eye Study (SiMES)

| | | | Lack of awareness of diabetic retinopathy | | | |
|---|---|---|---|---|---|---|
| **Characteristic** | **No. at risk** | **n (%)** | **Age-gender adjusted OR (95% CI)** | ***P*** | **Multivariable-adjusted* OR (95% CI)** | ***P*** |
| Age (y) | | | | | | |
| 40-49 | 25 | 19 (76.0) | 1.00 (ref) | – | 1.00 (ref) | – |
| 50-5 | 73 | 63 (86.3) | 1.91 (0.61, 5.98) | 0.26 | 2.45 (0.68, 8.86) | 0.17 |
| 60-69 | 110 | 91 (82.7) | 1.42 (0.50, 4.07) | 0.51 | 2.36 (0.67, 8.09) | 0.18 |
| 70-80 | 61 | 54 (88.5) | 2.20 (0.64, 7.51) | 0.21 | 4.63 (1.08, 19.93) | 0.04 |
| Gender | | | | | | |
| Female | 165 | 136 (82.4) | 1.00 (ref) | – | 1.00 | – |
| Male | 104 | 91 (87.5) | 1.40 (0.68, 2.87) | 0.36 | 1.97 (0.89, 4.34) | 0.10 |
| Duration of diabetes | – | – | 0.97 (0.93, 1.00) | 0.08 | 0.96 (0.93, 1.00) | 0.04 |
| $HbA_{1c}$ | | | | | | |
| 1st Quartile | 67 | 53 (79.1) | 1.00 (ref) | – | 1.00 (ref) | – |
| 2nd Quartile | 65 | 55 (84.6) | 1.68 (0.67, 4.22) | 0.27 | 1.73 (0.66, 4.51) | 0.26 |
| 3rd Quartile | 66 | 57 (86.4) | 2.02 (0.78, 5.26) | 0.15 | 1.70 (0.62, 4.65) | 0.30 |
| 4th Quartile | 64 | 57 (89.1) | 3.14 (1.09, 9.11) | 0.04 | 2.79 (0.93, 8.34) | 0.07 |
| Any eye history | | | | | | |
| No | – | – | 1.00 (ref) | – | 1.00 (ref) | – |
| Yes | | | 0.61 (0.30, 1.23) | 0.17 | 0.75 (0.35, 1.61) | 0.47 |
| Diastolic blood pressure | 70 | 57 (81.4) | 1.00 (ref) | – | | |
| | 68 | 59 (86.8) | 1.55 (0.61, 3.93) | 0.36 | | |
| | 64 | 54 (84.4) | 1.19 (0.48, 3.00) | 0.71 | – | – |
| | 66 | 57 (86.4) | 1.50 (0.59, 3.81) | 0.40 | | |
| Low SES | | | | | | |
| No | 247 | 210 (85.0) | 1.00 (ref) | – | – | – |
| Yes | 22 | 17 (77.3) | 0.59 (0.20, 1.74) | 0.34 | | |
| Insulin treatment | | | | | | |
| No | – | – | 1.00 (ref) | – | – | |
| Yes | | | 0.67 (0.31, 1.46) | 0.31 | | |

95% CI: 95% confidence interval; OR: odds ratio

Data presented include only participants with diabetic retinopathy who responded to the questionnaire (n = 269).

* Adjusted for age, gender, duration of diabetes, $HbA_{1c}$, diastolic blood pressure, eye history.

addition, nearly half of those unaware of their vision-threatening retinopathy had never had laser therapy. These represent significant public health issues in view of the anticipated rise in the prevalence of diabetes and diabetic retinopathy in Asia.[15]

The association of the lack of awareness of diabetes with $HbA_{1c}$ and blood pressure control is presumably because the majority of participants who were unaware were undiagnosed cases who were not receiving appropriate treatment or diabetes education.[4] The approximately 1:7 ratio (12.4%) of undiagnosed to diagnosed diabetic cases in our sample is substantially lower than Western counterparts[16] – 1:1 in the Australian Diabetes and Lifestyle Study, and 1:5-6 in the North West Adelaide Health Study. However, we may have underestimated[17] the proportion of undiagnosed persons, since we defined diabetes based on random blood glucose levels and other criteria, instead of fasting glucose or oral glucose tolerance tests.

The majority of SiMES participants with diabetic retinopathy were unaware of their retinopathy status, reasons for which may be manyfold. The high proportion of persons with undiagnosed diabetes in this group may have

contributed to their retinopathy going undetected, since previous studies showed that persons who did not report a diagnosis of diabetes were less likely to use ophthalmic services.[18,19] Our study also showed a trend of increasing awareness with increasing retinopathy severity, supporting previous studies demonstrating that a lack of utilisation of ophthalmic services is largely due to the disease being asymptomatic.[20] An older age and shorter duration of diabetes were also associated with unawareness after multivariable-adjusted analyses in our study. The former is surprising since previous studies demonstrate that older persons are more likely to have visited an ophthalmologist[3] or had a dilated eye examination,[4,6] compared to younger persons. This highlights the importance of better patient communication and education for older persons. The latter association of diabetes duration supports previous studies showing that a shorter duration of diabetes is associated with non-adherence to regular eye examinations.[4] However, as the prevalence of diabetic retinopathy is high even in persons with newly diagnosed diabetes,[12] the need for regular eye examinations should be accordingly emphasised in this group of patients.

The role of ophthalmic professionals and regular screening[21] is paramount for prevention of visual loss via early detection of retinopathy, since reductions in blindness can be achieved in up to 98% with the full range of therapeutic options.[22] Numerous studies[3-6] have reported low utilisation of ophthalmic services in persons with diabetes, with no improvement over the last 10 years.[5] Our study now demonstrates in a population-based sample of Singaporean Malays, a high proportion is unaware of their diabetic retinopathy, reflecting a consequence of poor compliance with eye care utilisation guidelines.[22]

Detection of early macular oedema or neovascularisation may call for laser photocoagulation treatment.[23] Consequently, the large proportion (59.2%) unaware of their vision-threatening retinopathy in our study is of concern. This finding is consistent with a study conducted in minority populations of low socioeconomic status in the United States which documented high proportions with advanced stages of ocular disease at initial presentation.[24] We further showed that an alarmingly high proportion (44.4%) of participants with vision-threatening retinopathy who were unaware of their status had never received laser treatment.

The lack of awareness in participants with a previous diagnosis of diabetes should also be highlighted. In those who were treated with diabetic medication, 6.1% were unaware of their diabetes status; in those treated with laser photocoagulation, 58% were unaware of having undergone laser treatment. This could be due to the lack of understanding of the questionnaire, since participants with diabetes had a relatively lower educational level compared to those without diabetes in our sample. Other reasons may include patient apathy, patient denial or poor patient-doctor communication. Previous studies[9,25] of white populations have also demonstrated that patients are largely unaware or apathetic of their diabetic care. For instance, more than half of patients who had undergone $HbA_{1c}$ testing were unaware of what $HbA_{1c}$ is,[9] and up to 91% of patients who had undergone ophthalmic screening were unaware of its purpose.[25]

Interestingly, our study showed no significant difference in proportions of participants with previous eye disease history in those who were aware of having retinopathy, compared to those who were unaware. This suggests that participants previously diagnosed with other eye conditions may not have been concomitantly assessed for diabetic retinopathy, or did not have retinopathy when previously assessed. This underscores the importance of regular ophthalmic screening for persons with diabetes. The strengths of our study include its population-based sample, masked external grading of retinal photographs from both eyes and masked external assessment of $HbA_{1c}$, with high frequencies of gradable photographs and $HbA_{1c}$ values. Thus, we were able to correlate participants' awareness with their retinopathy, $HbA_{1c}$ and blood pressure. A major limitation was the definition of diabetes used, due to fasting blood glucose not measured in our study. This could have resulted in an underestimation[17] of the true proportion of persons with diabetes. Another limitation was that we did not interview primary care physicians of participants, and hence were unable to assess if the lack of awareness was attributable to patient factors such as denial or apathy, or poor patient-doctor communication.

In summary, we documented poor awareness of diabetes and diabetic retinopathy in a population-based sample of Singaporean Malays with diabetes. Our data show that nearly 1 in 8 were unaware of their diabetes, and more than three-quarters unaware of their retinopathy. The lack of patient awareness and patient apathy in our study is in keeping with studies of Whites, regardless of population-based[16] or tertiary clinic settings.[9,24,25] The lack of patient awareness that was associated with poor control of diabetic retinopathy risk factors and missing laser photocoagulation highlights the importance of patient education in diabetes management. Early detection of diabetes and diabetic retinopathy can only be possible if regular screening is implemented. To these ends, patient education and their initiatives may be the keys to optimal management of diabetes and diabetic retinopathy.

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