



Periodic Blood Glucose Test and Its Relationship with Diabetic Retinopathy among Patients with Diabetes in a Tertiary Ophthalmic Centre

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Authors' contributions

This work was carried out in collaboration between all authors. Author SS carried out the conceptualization, design, execution, and editing of the manuscript. Author YCC participated in the statistical analyses, data interpretation and writing of manuscript. Author SY performed statistical analyses and aided in the writing of results section. Author ELO participated in data collection. Author KGAE was involved in the editing of manuscript. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aim: To assess the awareness of periodic blood glucose test and its relationship with diabetic retinopathy among adult diabetic patients attending a tertiary ophthalmic centre.

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Study Design: Cross-sectional study.

Place and Duration of Study: Ophthalmology and Visual Sciences, Alexandra Hospital, between January and February 2007.

Methodology: An interviewer-administered survey was administered to 506 participants with diabetes mellitus, aged 23 to 88 years old (mean: 62.1 years).

Results: Only 296 (58.5%) participants were aware of the relationship between periodic blood glucose test and diabetic retinopathy. Participants who were Indians ($p=.01$) or had a highest education level of primary school ($p=.04$) were less aware. However, participants with higher education had higher awareness ($p=.01$). The age- and gender-adjusted odds ratio (OR) of having diabetic retinopathy was 0.54 (95% confidence interval (CI): 0.38-0.78, $p=.001$). On multivariate adjustment, results remained statistically significant (OR: 0.49, CI: 0.31-0.77, $p=.002$).

Conclusion: Periodic blood glucose test awareness is lower in Indians and those who were less educated. Participants who were aware of periodic blood glucose test were less likely to have diabetic retinopathy.

Keywords: Diabetic retinopathy; blood glucose test; awareness; Singapore.

1. INTRODUCTION

Diabetes mellitus (DM) results in considerable morbidity and mortality, affecting about 180 million people worldwide.[1] It is predicted that the prevalence will rise to an estimated 300 million cases by 2025 and this may be a cause for public concern.[2] Diabetic retinopathy (DR) represents a leading cause of blindness in adults <75 years.[3] This increase is compounded by a lack of awareness of DM and the risk factors and associated complications.[4] A study by Tham et al [5] found 25% of patients with DM were ignorant of some key aspects of DM such as the need for home glucose monitoring and regular ophthalmic reviews.

Wang et al [6] found that a lack of patient awareness of increased glycated haemoglobin (HbA1c) as a marker of poor DM control, is a major contributing factor to poor compliance with guidelines to keep HbA1c <7%. It is paramount to address this issue as the number of persons with DM is anticipated to increase, particularly in Asian countries.[7] In addition, HbA1c or periodic blood glucose test (3 monthly) provides an indication to physicians on the effectiveness of current diabetic management. [8] In the present study, we assessed the awareness of a periodic blood glucose test and DR in a hospital-based survey among Singapore residents with DM. Knowledge of the factors associated with less awareness between periodic blood glucose test and DR can help us to target this group of people, and hence, aim to improve awareness among them.

2. METHODOLOGIES

2.1 Study Population

A hospital-based, cross-sectional study of 506 participants aged between 23 and 88 years old in Singapore, was conducted between January and February 2007. The participants were existing eye patients or were referred to the eye clinic for DR screening. Participants were asked about awareness of periodic blood glucose test. The survey population consisted of ethnic Chinese, Malay, Indian and other racial groups. Our inclusion criteria

included participants who were unaware of the term HbA1c but were familiar with periodic blood glucose test (Relationship of awareness of HbA1c and DR had earlier been published [9]); participants who were willing to participate in the study and able to give consent. Exclusion criteria included participants who were unwilling to participate, unable to give consent, or when there was unavailability of a suitable interpreter of the spoken language.

Verbal consent was sought prior to the interview. An interpreter who was well versed with the questionnaire and could answer the participant queries was enlisted to facilitate the conversation when required. The questionnaire replies were elicited on an average of 10-15 minutes per participant.

2.2 Questionnaire

A trained interviewer administered standard questionnaire surveys to consecutive participants with diabetes attending a tertiary ophthalmic centre. Awareness of periodic blood glucose test and DR were assessed using the questions below.

1. What is your highest education level attained?
2. What is your occupation?
3. Are you aware that you have DR?
4. Have you done any laser treatment to the eye as a result of diabetic eye complications?
5. Who do you follow-up with for DM; a family physician or endocrinologist?
6. Are you aware that DM can cause blindness?
7. Are you aware that increased blood glucose can cause blindness?

Questions 1-2 were open-ended while for questions 3-7, participants answered 'yes', 'no' or 'don't know'. Survey answer 1, 2 and 4 were cross-checked by the clinician (Dr Sanjay Srinivasan) with the participant's record to ensure accuracy.

2.3 Statistical Analysis

Statistical tests were performed using the Statistical Package for the Social Sciences (v. 15.0 SPSS Inc., STATE, USA). The distributions of participant characteristics were analysed using univariate analysis (chi-square and ANOVA test). Logistic regression models were used to assess the awareness of periodic blood glucose test within each stratum and association between awareness of periodic blood glucose test and DR. Results were adjusted for the different models; model 1 comprised age and gender; model 2 comprised variables in model 1 and race, education, diabetes duration, and care by endocrinologist or family physician. Associations were presented as odds ratio (OR) with corresponding 95% confidence intervals (CI). A p-value of <0.05 was taken to be statistically significant.

3. RESULTS

Out of 623 patients invited to participate in the survey, 507 were recruited (81.2% response rate). One participant was excluded due to incomplete data, leaving only 506 sets of data. The majority of non-participants cited a lack of time or interest in the study. Details of the non-participants could not be obtained.

Table 1 shows the demographical data of our participants. There were 257 (50.8%) men and

249 (49.2%) women. The mean age of the participants was 62.1 years (range: 23 to 88 years). The education level of the participants ranged from no formal education to a postgraduate degree with 156 (30.8%) having completed at least secondary level. Of the participants, 272 (53.8%) had DR and 132 (26.1%) had previous laser treatment. There were 296 (58.5%) participants who were aware of the relationship between periodic blood glucose test and DR. There was significantly greater awareness among participants with lower HbA1c ($p < 0.001$) and had laser treatment ($p = .004$).

Table 1. Demographic of participants who were aware of periodic blood glucose test but unaware of HbA1c (n=216)

Characteristics of participants	Mean (SD) or n (%)			P-value
	All participants	Aware of periodic blood glucose test only (n=216)	Unaware of periodic blood glucose test (n=290)	
Age, years	62.1 (11.7)	63.2 (10.0)	61.4 (12.8)	0.086
Gender, % men	257 (50.8)	116 (53.7)	291 (57.4)	0.282
Race				0.097
Chinese	333 (65.8)	153 (70.8)	181 (62.2)	
Malay	98 (19.4)	31 (14.4)	67 (23.0)	
Indian	71 (14.0)	30 (13.9)	41 (14.1)	
Others	4 (0.8)	2 (0.9)	2 (0.7)	
Highest Educational Level Attained				0.061
No formal education	166 (32.8)	76 (35.2)	91 (31.3)	
Completed primary education	184 (36.4)	76 (35.2)	108 (37.1)	
Completed secondary education/Completed N/O levels	99 (19.6)	49 (22.7)	50 (17.2)	
Completed Pre university/Junior college/A levels	38 (7.5)	13 (6.0)	25 (8.6)	
Completed polytechnic/diploma	14 (2.8)	2 (0.9)	12 (4.1)	
Completed bachelors/university degree	3 (0.6)		3 (1.0)	
Completed post graduate degree	2 (0.4)	0 (0)	2 (0.7)	
Occupation				0.197
Self employed	14 (2.8)	9 (4.2)	5 (1.7)	
Employee	121 (23.9)	52 (24.1)	70 (24.1)	
Unemployed	47 (9.3)	18 (8.3)	29 (10.0)	
Full time student	4 (0.8)	0 (0)	4 (1.4)	
Retired	320 (63.2)	137 (63.4)	183 (62.9)	
HbA1c, %	7.68 (1.4)	3.23 (3.8)	5.52 (3.5)	<0.001

Diabetes Duration, years	10.2 (6.7)	10.1 (7.3)	10.3 (6.2)	0.710
DR, %	272 (53.8)	128 (59.3)	139 (47.8)	0.012
Laser Treatment	132 (26.1)	76 (35.2)	68 (23.4)	0.004
Care by Family Physician	307 (60.7)	125 (57.9)	182 (62.5)	0.371
Care by Endocrinologist	236 (46.6)	113 (52.3)	123 (42.3)	0.101
Aware that DM could cause Blindness	212 (41.9)	215 (99.5)	286 (98.6)	0.531
Aware of having Diabetic Retinopathy	220 (43.5)	103 (47.7)	117 (40.3)	0.252

SD = Standard deviation, HbA1c = Glycated haemoglobin, DR = Diabetic retinopathy, DM = Diabetes mellitus

Logistic regression analyses (Table 2) found that Indians (OR: 0.5, 95% CI: 0.3-0.9, $p=.01$) and participants with a highest education level of primary school (OR: 0.6, 95% CI: 0.4-1.0, $p=.04$) were less aware of periodic blood glucose test. However, participants who had completed pre-university/junior college/A levels had higher awareness (OR: 4.4, 95% CI: 1.4-13.7, $p=.01$).

Table 2. Stratified analysis on participant characteristics on awareness of periodic blood glucose test

	OR (95% CI)	P-value
Age	1.0 (1.0 – 1.0)	0.105
Gender		
Female	1.0	
Male	1.1 (0.7-1.6)	0.731
Race		0.041
Chinese	1.0	
Malay	1.0 (0.6-1.8)	0.990
Indian	0.5 (0.3-0.9)	0.013
Others*	-	-
Highest educational level attained		
No formal education	1.0	
Completed primary education	0.6 (0.4-1.0)	0.042
Completed secondary education/Completed N/O levels	1.3 (0.7-2.3)	0.405
Completed Pre university/Junior college/A levels	4.4 (1.4-13.7)	0.012
Completed polytechnic/diploma	3.3 (0.7-16.1)	0.133
Completed bachelors/university degree*	-	-
Completed post graduate degree*	-	-
Diabetes Duration, years	1.0 (1.0-1.0)	0.601
Care by Family Physician	1.0 (0.9-1.2)	0.627
Care by Endocrinologist	1.0 (0.8-1.2)	0.992

*There were less than 5 participants in this group

Table 3 shows the adjusted OR together with 95% CI for DR with respect to the different models. For DR, the age- and gender-adjusted OR for having DR per SD increase in awareness is 0.54 (95% CI: 0.38-0.78, $p=.001$). After adjusting additionally for race, education, occupation, diabetes duration, care by family physician, care by endocrinologist

and being aware that diabetes causes blindness, results remained statistically significant (OR: 0.49, 95% CI: 0.31-0.77, p=.002).

Table 3. Relationship of awareness of periodic blood glucose test with diabetic retinopathy

	OR (95% CI)	P-value
DR		
Model 1	0.54 (0.38-0.78)	0.001
Model 2	0.49 (0.31-0.77)	0.002

OR = Odds Ratio, CI = Confidence Interval, DR = Diabetic retinopathy

Model 1: Age-, gender- adjusted

Model 2: Model 1, race, education, occupation, diabetes duration, care by family physician, care by endocrinologist, aware that diabetes causes blindness

4. DISCUSSION

In order to reduce the incidence of DR, patient awareness is of utmost importance. However, our study shows that knowledge of the periodic blood glucose test and its relationship with DR is relatively low (n=296, 58.5%) amongst patients attending a tertiary ophthalmic centre.

Our study showed that a high education level (tertiary and above) is associated with greater awareness of the link between higher blood glucose and DR (OR 4.4, 95% CI 1.4-13.7, p=.01). Similarly, in a study by Muecke et al [10], compared with tertiary-educated patients with DM, those who had never attended school were less likely to see an endocrinologist (OR 0.24; 95% CI 0.09-0.66). Hence, they were less awareness of the association between higher blood glucose and DR.

In a study by Huang et al [11] among the Singaporean Malay population on the awareness of DM, high proportions of patients with DM (83.4%) were unaware that they had DR. Also, the lack of awareness was linked to poorer control of DR risk factors. [11] Similarly, Zgibor and Simmons [12] demonstrated that a better grading on the Diabetes Knowledge Test is associated with lower blood glucose and HbA1c levels. However, in our study, we found that participants who were aware of periodic blood glucose test had higher HbA1c (7.8% vs 7.4%), but this was not statistically significant (p=.104). Huang et al [11] also found that a mere half of the study population among Malays who were unaware that they had DR had received laser treatment.[13] We found that a significant proportion of participants who were unaware of periodic blood glucose test had laser treatment (16.7% vs 32.8%, p=.001). This could be due to more participants who were aware of blood glucose test, having DR (59.7% vs 45.2%, p=.002).

Self-monitoring of blood glucose levels is an essential part of the intensive management required to optimize glucose control,[13] and thus, diabetes education may play a vital role in preventing DR.[14] Also, patients with DM should be educated on the need for regular ophthalmic examinations to effectively prevent DR. In order to increase participation rates in annual eye examination among diabetics, Brechner et al [15] showed that attending a diabetes education class helps increase participation rate.

Several limitations of our study need to be discussed. Firstly, this is a cross-sectional design which does not allow us to investigate whether participants who were aware of periodic blood glucose test were less likely to have diabetic retinopathy or vice versa. Secondly, we

were unable to obtain information about non-participants for comparison. Thirdly, a high percentage of our participants (90%) had a highest education level of 'O' levels (10 years of formal education) or less, this limits our analysis of participants with education levels higher than O levels. The strength of this study is a high response rate (81.2%).

During the course of this study, we encountered some difficulties in explaining what a periodic blood glucose test was to participants who were unaware of HbA1c and in explaining that periodic blood glucose test is not the routine blood glucose test done daily. The use of flow charts, bar diagrams or pamphlets would have been a good aid in answering our research question. Alternative methods to explain the role of periodic glucose monitoring, optimal control, the prevention of end-organ complications such as DR to patients to prevent its progression are being considered. Further studies could be done after interventions using results from this survey to determine the effectiveness of intervention.

5. CONCLUSION

In conclusion, the awareness between periodic blood glucose test and DR is lower in Indians and the less educated. Participants who were aware of periodic blood glucose test were less likely to have DR. Improvement to awareness levels needs to be done through continuous education and reassessment to improve the awareness in those who are not aware.

CONSENT

All authors declare that verbal informed consent was obtained from the patient at recruitment.

ETHICAL APPROVAL

All authors hereby declare that this study was approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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