ORIGINAL ARTICLE

Predictors of Good Glycemic Controls Among Type 2 Diabetes Mellitus Patients in Two Primary Health Clinics, Kuala Selangor

Nurul Ain Abdullah[1], Suriani Ismail[1] , Sazlina Shariff Ghazali[2], Muhamad Hanafiah Juni[1], Hayati Kadir Shahar[1], Noor Rafizah Aminah Aziz[3]

[1] Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[2] Department of Family Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
3 Kuala Selangor District Health Office, Jalan Semarak, 45000 Kuala Selangor Selangor, Malaysia

ABSTRACT

Introduction: The objective of this study was to determine the factors and predictors of good glycaemic control among patients with Type 2 Diabetes Mellitus (T2DM) in two rural government health clinics in Kuala Selangor. **Methods:** This cross-sectional study involved 200 patients selected through systematic random sampling from a list of T2DM patients in two government health clinics in Kuala Selangor. Data was collected using a self-administered questionnaire while glycosylated haemoglobin (HbA1c) results were obtained from the patients' blood results record at the clinic. HbA1c of 6.5 % and below was categorized as good glycaemic control. The factors studied were socio-demographic characteristics (age, gender, ethnicity, level of education, occupation and household income), T2DM medical history (T2DM duration and type of treatment), diabetes knowledge, health literacy, adherence to treatment, body mass index (BMI) and physical activity. Pearson's chi square test was used to test for associations and multiple logistic regressions were used to determine the predictors. **Results:** The response rate was 86.9%. The proportion of good glycaemic control was 34.0%. Level of glycaemic control was significantly associated with duration of being diagnosed with T2DM (p=0.006) and type of treatment (p=0.009). The probability of having good glycaemic control was 2.5 times more likely among respondents diagnosed with T2DM for less than 10 years (AOR=2.458, 95% of CI=1.504-14.282, p=0.037). **Conclusion:** Shorter duration of being diagnosed with T2DM has been found to be a predictor of good glycaemic control in this study population, thus warranting stricter monitoring among patients who have been diagnosed for a longer period.

Keywords: Glycaemic control, HbA1c, Rural health clinic

Corresponding Author:
Suriani Ismail, PhD
Email: si_suriani@upm.edu.my
Tel: +603-97692408

INTRODUCTION

In Malaysia there is currently an estimated 3.3 million people aged 18 years and older living with diabetes. The National Health and Morbidity Survey (NHMS) 2011 reported an increased prevalence from 11.6% in 2006 to 15.2% in 2011(1). The Diabetic Care Performance Report 2016 described the age-standardized prevalence of diabetes in Malaysia as being almost three times higher than that of the Organization for Economic Co-operation and Development (OECD-34) average, and noticeably higher than most countries in comparison (2).

The increased risks of diabetic retinopathy, chronic kidney disease and cardiovascular disease are associated with higher levels of glycosylated hemoglobin (HbA1c). To achieve optimal health impact, the targeted level of HbA1c should be attained. In Malaysia, it is recommended that adults with Type 2 Diabetes Mellitus (T2DM) achieve HbA1c levels of 6.5% and below to reduce the possibility of developing complications of diabetes (3). The Diabetic Care Performance Report 2016, also stated that the rate of diabetic complications such as retinopathy, nephropathy, myocardial infarction, diabetes foot ulcer and lower limb amputation has decreased by about 1% to 7%, but the rate of cerebrovascular complication has increased by 5% since 2011.

There are many factors associated with glycemic control such as age, gender, ethnic groups, type of treatment,

diabetes knowledge, body mass index (BMI), and physical activities. For example, a few local studies in Tampin (a district in Negeri Sembilan) and Hulu Selangor (a district in Selangor) have shown that age, duration of diabetes mellitus, type of treatment received, having co-morbidities, adherence to treatment are associated with poor glycemic control (4,5). Other factors that are often studied include BMI, physical activity, diabetic knowledge and health literacy.

Poor glycemic control caused 2.2 million deaths, as well as increasing the risk for cardiovascular and other diseases (6). The determination of factors associated with as well as predictors of good glycemic control could help in planning programs to minimise diabetes complications among T2DM patients, specifically among those attending health clinics in the rural area of Kuala Selangor, Selangor, Malaysia. Therefore, this study aims to determine the factors associated with glycaemic control among T2DM patients in two rural health clinics in Selangor, Malaysia.

MATERIALS AND METHODS

This study was conducted in two government health clinics located in Kuala Selangor, Malaysia. Kuala Selangor is one of the districts reported to have a high prevalence of T2DM cases in the state of Selangor (7). These clinics were classified as health clinics in a rural area. The two clinics can easily be accessed by the residents in the nearby villages. The clinics serve about 1400 patients in a month. Systematic random sampling was used to select the respondents for the study from a list of T2DM patients attending the clinics during data collection. The inclusion criteria were patients aged 18 and above, those diagnosed with T2DM in the period of at least 3 months prior to data collection, patients on at least one type of diabetic medication drug treatment, and are able to understand the Malay language. Diabetic patients with advanced diabetes complications, those with known psychiatric illnesses, and non-Malaysian citizens were excluded from this study. An estimated sample size requirement calculated for this study was 228 after considering the possibility of 20% non-responders. Data was collected from August 2017 until November 2017. Respondents were approached at the clinic and written consents were obtained from those who fulfil the selection criteria and were willing to participate in the study.

Data was collected using a structured self-administered questionnaire. The researcher assisted respondents who needed clarification on the items contained within the questionnaire. The questionnaires were collected immediately after the respondents have completed them. The questionnaire consisted of five sections. The first section contained questions on socio-demographic characteristics such as age, sex, marital status, ethnicity, level of education occupation and household income. The second section consisted of questions on the duration of being diagnosed with T2DM and the type of treatment. The third section consists of question on diabetes knowledge as measured by the Michigan Diabetes Knowledge Test (MDKT) in Malay language (8). Health literacy was assessed using Short Test of Functional Health Literacy in Adults (S-TOFHLA) in Malay language obtained from the Institute for Health Behavioural Research. Adherence to treatment was assessed using 3-items adapted from Medication Compliances Assessment Form (9). Physical activity was measured using 7-item International Physical Activity Questionnaire (IPAQ) (10). Cronbach's alpha of the MDKT, S-TOHFLA and IPAQ were 0.702, 0.942 and 0.556 respectively. BMI was calculated from the weight and height measurements obtained from the patients' current medical record. HbA1c result was taken as the latest blood test results done in the clinic from the respondent's medical record. Respondents with HbA1c $\leq 6.5\%$ were considered to have good glycaemic control.

Analysis was conducted using Statistical Package for the Social Sciences (IBM SPSS) Version 23.0 software for Windows operating system. Pearson's chi square test was used to test the associations between glycaemic control and its associated factors. Multiple logistic regressions were used to find the predictors of good glycaemic control in this study. Level for significance was set at alpha level of 0.05. For the predictors, variables that obtained p-value of less than 0.25 through simple logistic regression analysis were chosen to be included in the multiple logistic regression model using ENTER method.

Ethical approval was obtained from the Medical Research Ethics Committee (MREC), Ministry of Health Malaysia (NMRR-17-66-33858 (IRR)) and Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia (Reference no. UPM/TNCPI/RMC/1.4.18.2 (MREC-JKEUPM).

RESULTS

The response rate was 87.7% with a total of 200 respondents. Only 34.0% of the respondents had good glycemic control (HbA1c level 6.5% or less). Table I shows that the majority of respondents were aged between 41 and 64 years (59.5%). The youngest was 28 years old while the oldest was 90 years old. Majority of the respondents were women (59.0%), married (94.5%), of Malay ethnic group (88.0%), had secondary level of education (53.0%), housewives (33.0%) and their household income were below RM1000 (33.5%). Majority of the respondents have been diagnosed with T2DM for more than 10 years (82.5%) and were on oral medications (67.0%). Most had adequate health literacy (85.0%), but low knowledge on diabetes (73.5%). Majority reported that they were adherent to treatment (88.0%). Most were either overweight or obese (86%),

Table I: Characteristics of respondents (N=200)

Variables	Mean ± SD	Frequency (n)	Percentage (%)
Age	60.7± 9.4 years		
<40 years old		3	1.5
41-64 years old		119	59.5
≥ 65 years old		78	39.0
Gender			
Men		82	41.0
Women		118	59.0
Marital Status			
Single		1	0.5
Married		189	94.5
Others		10	5.0
Ethnic			
Malay		176	88.0
Chinese		19	9.5
Indian		5	2.5
Level of education			
Primary school		59	29.5
Secondary school		106	53.0
Diploma		24	12.0
Degree		6	3.0
Postgraduate		5	2.5
Occupation			
Government sector		25	12.5
Private sector		8	4.0
Self employed		50	25.0
Retired		41	20.5
Housewife		66	33.0
Unemployed		10	5.0
Income			
<RM1000		67	33.5
RM 1,000-1,999		63	31.5
RM 2,000-2,999		43	21.5
RM 3,000-3,999		11	5.5
≥RM 4,000		16	8.0
Duration diagnosed of T2DM	6.8 ± 4.8 years		
<10 years		165	82.5
≥ 10 years		35	17.5
Type of treatment obtained			
Oral medication		134	67.0
Insulin		21	10.5
Both		45	22.5
Level of diabetes knowledge	6.1 ± 2.1		
Low		147	73.5
Acceptable		48	24
Good		5	2.5
Level of health literacy	29.1 ± 7.8		
Inadequate		19	9.5
Marginal		11	5.5
Adequate		170	85.0
Level of adherence to treatment	1.68 ± 0.5		
Adherent		176	88.0
Non-adherent		24	12.0
Body mass index	28.6 ± 5.6		
Underweight		3	1.5
Normal		25	12.5
Overweight		64	32.0
Obese		108	54
Physical activities	3796.50 ± 4188.0 MET/min		
Low		17	8.5
Moderate		32	16.0
High		151	75.5
HbA1C	7.6 ± 1.9%		
≤ 6.5 % (good control)		68	34.0
> 6.5 % (poor control)		132	66.0

HbA1c: Glycosylated haemoglobin. MET/min: metabolic equivalent of task per minute

but were physically active (75.5%).

Table II summarizes the associations between good glycaemic control and its associated factors. There was no significant association between good glycaemic control and any of the socio-demographic factors (age, gender, marital status, ethnicity, level of education, occupation and household income). However, good glycaemic control was significantly associated with the duration of being diagnosed with T2DM and the type of treatment prescribed. The proportion of good glycaemic control was higher among those who have

Table II: Association between glycemic control and respondent's characteristics (N=200)

Characteristics	Glycaemic control		*p*-value
	Good n (%)	Poor n (%)	
Age			0.283
<40 years	0(0.0)	3(100.0)	
41-64 years	42(35.3)	77(64.7)	
≥65 years	22(28.2)	56(71.8)	
Gender			0.431
Men	28(34.1)	54(65.9)	
Women	40(32.2)	78(66.1)	
Marital Status			0.816
Single	0(0.0)	1(100.0)	
Married	60(31.7)	129(68.3)	
Others	4(40.0)	6(60.0)	
Ethnic			0.201
Malay	63(35.8)	113(64.2)	
Chinese	3(15.8)	16(84.2)	
Indian	2(40.0)	3(60.0)	
Level of education			0.675
Primary school	18(30.5)	41(69.5)	
Secondary school	40(37.7)	66(62.3)	
Tertiary school	10(28.6)	25(71.4)	
Occupation			0.370
Self employed	18(36.0)	32(64.0)	
Retired	11(26.8)	30(73.2)	
Housewife	27(40.9)	39(59.1)	
Others	12(27.9)	31(72.1)	
Income			0.861
<RM1000	25(37.3)	42(62.7)	
RM 1,000-1,999	20(31.7)	43(68.3)	
≥RM 2,000-2,999	23(32.9)	47(67.1)	
Duration diagnosed with T2DM			0.006 *
<10 years	63(38.2)	102(61.8)	
≥11 years	5(14.3)	30(85.7)	
Type of treatment prescribed			0.009*
Oral medication	55(41.0)	79(59.0)	
Insulin	3(14.3)	18(85.7)	
Both	10(22.2)	35(77.8)	
Level of diabetes knowledge			0.989
Poor	47(32.0)	100(68.0)	
Good	17(32.1)	36(67.9)	
Level of health literacy			0.308
Inadequate	12(40.0)	18(60.0)	
Adequate	52(30.6)	118(69.4)	
Level of adherence to treatment			1.000
Adherent	56 (31.8)	120(68.2)	
Non-adherent	8 (33.3)	16 (68.2)	
Body mass index			0.184
Normal	12 (42.9)	16(57.1)	
Overweight	52 (30.2)	120(69.8)	
Physical activities			0.873
Low	5 (29.4)	12 (70.6)	
Moderate	12 (37.5)	20 (62.5)	
High	51 (33.8)	100 (66.2)	

*significant at *p* value <0.05

been diagnosed for less than 10 years (38.2%) compared to those who were diagnosed for 10 years or more (14.3%) (p=0.006). The proportion of patients having good glycaemic control is also higher among those on oral medication (41.0%) compared to those on insulin (14.3%) or both (22.2%) (p=0.009). There were no significant association between glycaemic control and low diabetes knowledge, health literacy, adherence to treatment, BMI or physical activities.

Table III shows that the significant predictor for good glycaemic control among this study population is the duration of being diagnosed with T2DM. The probability of having good glycaemic control among those diagnosed with T2DM for less than 10 years was 2.5 times more compared to those diagnosed for more than 10 years (AOR=2.458, 95% CI=1.504-14.282, p=0.037).

Table III: Predictors of glycaemic control (N=200)

Variables	Multiple logistic regression			
	AOR	95% CI		*p*-value
		Lower	Upper	
Ethnicity				
Indian	[Ref]			
Malay	0.768	0.095	6.240	0.805
Chinese	3.116	0.808	12.016	0.099
Occupation				
Retired	[Ref]			
Self-employed	0.509	0.189	1.373	0.182
Housewives	0.729	0.245	2.169	0.570
Others	0.336	0.131	0.866	0.024*
T2DM duration				
≥10 years	[Ref]			
<10 years	2.458	1.504	14.282	0.037*
Type of treatment				
Both (0ral and insulin)	[Ref]			
Oral medication	1.764	0.778	3.999	0.174
Insulin	0.353	0.068	1.838	0.216
Level of health literacy				
Marginal	[Ref]			
Inadequate	0.227	0.076	0.680	0.348
Adequate	0.585	0.133	2.577	0.478
Body mass index				
Underweight	[Ref]			
Normal	0.201	0.016	2.476	0.210
Overweight	0.614	0.229	1.649	0.333
Obese	0.519	0.250	1.078	0.079

AOR=adjusted odds ratio; CI= confidence interval; Ref: reference group for comparison in multiple logistic analysis; *statistically significant at *p* value <0.05

DISCUSSION

The proportion of respondents having good glycaemic control (achieving HbA1c treatment target of <6.5%) was found to be low at 34%. However, this proportion is higher compared to the national and Selangor state figures in 2012 which were 23.8% and 23.0% respectively (2). The proportion of good glycaemic control among this population was also higher compared to figures from two local studies among T2DM patients in a clinic in Hulu Langat, Selangor in 2014 which was reported at 22.5% (5) and 15.6% reported by another study in Klang Valley (11). Nevertheless, the proportion of individuals with good glycaemic control in this study is similar to the results of a study in Tampin, Negeri Sembilan which reported it as 33.6% (4). The differences in the proportion could be due to different socio demographic characteristics such as being in either urban or rural locality or the level of education. For example, the percentage of respondents with secondary school education and above was quite high in this study population (70%) as compared to the study population in Hulu Langat (54%) (5).

A shorter duration of being diagnosed with T2DM was found to be a significant factor associated with good glycaemic control among this study population. Duration of diagnosis with T2DM was also found to be a significant predictor for good glycaemic control. Respondents diagnosed with T2DM for less than 10 years were two times less likely to have good glycaemic control. These findings are consistent with other studies. A study in Tanzania among T2DM patients at a diabetes clinic (12) and a study in Hulu Langat, Malaysia (5) found that an increased duration of being diagnosed with T2DM was associated with disease progression which includes poor glycaemic control. This could be due to the decline in beta-cell function as the disease progresses causing poor glycaemic control. The decline in beta-cell function starts years even before the diagnosis of T2DM thus the disease progression contributes to uncontrolled glycaemic level (13). This is supported by another study among T2DM patient in a tertiary health care centre in Palestine which reported that people with long diabetes duration were less likely to have good glycaemic control (14). This could also be due to the fact that those diagnosed with diabetes for less than 10 years have had more recent information given to them as compared to those diagnosed much earlier, thus leading to better practices which results in better glycaemic control.

Another significant association was found between the type of treatment received by the respondents and glycaemic control. The percentage of good glycaemic control is higher among respondents on only oral medication. This contradicts the results of a study in Yogyakarta, Indonesia which found that the use of combination of both insulin and oral medications achieved significantly greater reduction in HbA1c, fasting blood sugar and postprandial plasma glucose compared to those who consumed only oral medication (15). This could be because most of the respondents in this study are elderly (39 % aged more than 65 years

old while 59.5 % aged between 41-64 years old). A randomized control study among elderly patients with T2DM in long term care facilities in United States of America revealed similar glycemic control for oral antidiabetic drugs as compared to insulin (16).

Even though the majority of the respondents in the present study reported they adhered to treatment, there was no significant association found with the level of glycaemic control. This is similar to a study done among newly diagnosed diabetes patients in Singapore which found that there was no significant association between adherence to treatment with HbA1c changes (17). This could be due to the influence of other factors such as dietary intake, physical exercise and stress. For example a study among Native American reported that higher total fat and protein; as well as lower carbohydrate and fiber intakes were connected with poor glycemic control (18) while a study among T2DM patients in Korea showed that physical activity is expected to improve glycemic control (19) and a randomized trial among T2DM patients attending Duke University outpatient clinic reported that group stress management programs can clinically improve glycemic control (20).

There was no significant association found between the levels of glycaemic control and diabetes knowledge. Similarly, there was no significant association between knowledge and glycaemic control done in a study carried out among diagnosed cases of DM receiving treatment for at least 6 months prior to enrolment in a diabetic clinic in King Saud Medical City, Riyadh (21) and another study done among 515 T2DM patients in Dhaka Hospital, Bangladesh (22). The study in Bangladesh mentioned that it could be due to the fact that most of the respondents in their study had high level of education, while knowledge in diabetic helped improve glycemic control more among those in the low education level group. Similarly, this could explain the probable cause in this study, as 70 % of respondents in this study had secondary school level education and above, which is quite high.

There was also no significant association between levels of glycaemic control with health literacy. This result was similar to another study done among T2DM patients in University Internal Medicine Clinic at the Medical University of South Carolina (23), which found that there was no direct relationship observed between levels of HbA1c with health literacy However, the literacy level in that study was assessed using Rapid Estimate of Adult Literacy in Medicine, Revised (REALM-R) while in the present study we used S-TOFHLA. Nevertheless, the explanation could be similar to that of the study in Bangladesh mentioned in the earlier section discussing the association with diabetic knowledge. Since a high percentage of respondents in this study had high level of education, health literacy level didn't help much in improving practices and thus glycaemic control was more affected among those with low level of education (22).

Majority of the respondents in this study were obese. However, there was no significant association found between levels of glycemic control with BMI. Similarly, another study done in Spain also showed that BMI and waist circumference do not show association with HbA1c level (24). This could be because majority (67%) of this study population was only on oral medication. A study among newly diagnosed T2DM patients from 20 hospitals in China reported that baseline BMI had no impact on the efficacy of only oral medication such as metformin as monotherapy in Chinese patients (25).

There was also no significant association between HbA1c readings with physical activity. Similarly, a study in Indonesia found that there was no association between physical activities with blood glucose level (26). The study instrument used to measure physical activity in this study was the 7-item International Physical Activity Questionnaire (IPAQ). Data was self-reported and is thus subject to biases. Furthermore it includes leisure time physical activity, which might be in fact associated with poor glycemic control among women, as reported by the Finnish Diabetic Nephropathy Study (27).
This present study is not without limitations. The first limitation of the study is due to the cross-sectional study design of which the causal and effect relationship could not be determined. Furthermore, the questionnaire was self-reported, for which recall bias is possible.

CONCLUSION

The proportion of poor glycaemic control is high among T2DM patients even in a rural area. The diabetes knowledge was low, but the health literacy level was found to be adequate among the respondents. The predictor of good glycaemic control was having been diagnosed with T2DM for less than 10 years. Therefore, this finding is hoped to be able to raise awareness among healthcare providers on the need for closer monitoring of glycaemic control and optimising the care of T2DM patients who have had longer duration of T2DM. Programs aimed at retraining could help T2DM patients who were diagnosed for more than 10 years to increase their knowledge and improve their practices thus contributing to better glycaemic control.

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