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Patient-Reported Outcomes

Medication Adherence and Diabetes Self-Care Activities Among Patients With Type 2 Diabetes Mellitus

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ABSTRACT

Background: The prevalence of type 2 diabetes mellitus (T2DM) is increasing at an alarming rate in developing countries. The accompanying complications of T2DM can be reduced by maintaining a good adherence to medication and self-care activities. **Objectives:** To evaluate medication adherence and self-care behaviors among patients with T2DM. **Methods:** A total of 497 subjects with T2DM were recruited from three hospitals and a government clinic in the state of Selangor, Malaysia. Previously validated scales were used to measure medication adherence (Morisky Medication Adherence Scale) and diabetes self-care activities (Summary of Diabetes Self-Care Activities). Pearson correlation coefficient was used to investigate the relationship between the risk factors and medication adherence. Pearson χ^2 test of association was used to test significant association. **Results:** The mean age of the subjects was 55.5 years. The mean Morisky Medication Adherence Scale score was 5.65 ± 1.97, indicating a moderate adherence level to medication. Among the subjects who had low adherence level, 50.9% were Malays, followed by 34.2% Indians. The Pearson χ^2 test of association indicated a significant association ($P = 0.000$) between ethnicity and medication adherence. The subjects had better self-care behaviors in their general diet (mean 5.04 ± 1.88) and poor self-care behaviors in blood sugar testing (mean 2.13 ± 2.34). **Conclusions:** The Malaysians had a moderate medication adherence level, whereas they were nonadherent to blood glucose testing. Emphasis on self-care activities and medication adherence is relevant to improve outcomes in the management of T2DM.

Keywords: blood sugar testing, medication adherence, self-care activities, type 2 diabetes mellitus.

Introduction

Diabetes mellitus (DM) is a disease that has become an important public health concern. It has been estimated that the number of patients with DM will increase from 171 million to 366 million between the years 2000 and 2030. As reported by Wild et al. [1], the prevalence of DM has increased dramatically in most countries in the world. Malaysia being a multiethnic country is not shielded from the increase in the prevalence of DM. According to the National Health and Morbidity Survey, the prevalence of DM among Malaysian adults older than 30 years had increased from 6.3% in 1986 to 8.3% in 1996, to 14.9% in 2006, and finally to 15.2% in 2010 [2]. People with DM have reported increasing psychological distress due to complex regimens and self-care activities. Because of the day-to-day management demands, many people suffering from DM often feel challenged [3].

The real burden of the disease is mostly caused by its micro- and macrovascular complications, which lead to increased morbidity and mortality [4,5,6]. The risk of these complications can be reduced by maintaining a good glycemic control. Nonadherence to medication reduces the efficacy of the medication and in turn the glycemic control [7]. The prevalence of strokes among patients with type 2 diabetes mellitus (T2DM) has increased, and most of them had a poor glycemic control irrespective of their age and treatment [4,8]. Self-care is a key component in diabetes care procedure [9]. Diabetes self-care, which made up of 98% of self-care procedures, is demanding and multifaceted. Its application may also involve other family members [10]. This is especially true for patients withT2DM, who have a daily responsibility of managing and controlling the blood glucose level to prevent complications [11]. Self-care activities include blood glucose self-monitoring, low fat diet, daily exercise, and checking one's foot, and research has found that many of these self-care activities are independent of one another [12,14].

There is also a continuing need to assess the level of adherence to medication and self-care activities and the factors that are related to nonadherence to medication and self-care among subjects with T2DM in primary care settings. This would facilitate health care professionals to identify subjects with low medication adherence and thereby aid them in planning interventions to improve medication and self-care adherence. The objective of the

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present study was to assess medication adherence and self-care activities among patients with T2DM.

Methods

Study Design and Patients

The target population was adults with T2DM attending the endocrine outpatient clinics in local hospitals in Malaysia. They were recruited from three hospitals (Hospital Tuanku Ampuan Rahimah, Hospital Sungai Buloh, and Hospital Serdang) and a government clinic (Klinik Kesihatan Botanic). The three hospitals and the clinic were located in the state of Selangor, Malaysia. A convenience sample was recruited for this study. Patients who were older than 18 years, diagnosed with T2DM for at least 1 year, taking T2DM diabetes medications, and able to speak, read, and write either in English or Malay were included. Subjects who were diagnosed with gestational diabetes or mental disorders and who were not able to read in Malay or English were excluded from this study. The Medical Research Ethics Committee under the National Medical Research Register approved the study protocol (NMRR-13-640-15679). The sample size should be greater or equal to 10 times the number of indicators [13]. Because the total number of indicators was 66, the sample size should be at least 660. Nevertheless, the population size of the patients with T2DM was unavailable in Malaysia and the hospitals could not provide the list of patients because of a card registration system in use. Hence, a sample size of 750 patients (250 for each ethnicity: Malay, Chinese, and Indian) was targeted.

During the data collection, information regarding the study was provided and consent forms were signed by the participants. Before handing the questionnaires over to the patients, each patient would receive information about the study from the investigator through both formal and verbal explanations, including the purpose and procedure of the study. After the participants agreed to participate, the consent form was given to them and a formal signature was obtained. The patients volunteered to participate in this study, and they were informed that they were free to withdraw from this data collection process at any time without comment and penalty. The participants were also given the opportunity to clarify with the investigator anything they did not understand or any questions they wanted to ask. A total of 497 patients agreed to participate in this study.

Instrumentation

The Summary of Diabetes Self-Care Activities (SDSCA) measured the diabetes self-care behavior. It is a popular and well-known instrument that has been applied widely in diabetes management studies. The SDSCA is a valid and reliable instrument having moderate inter-item reliability ($r = 0.59–0.74$) [15]. It is a self-report measure consisting of 12 items: 10 items to measure four components of diabetes self-management, namely, diet, exercise, blood sugar testing, and foot care, and 2 items on tobacco use. The respondents are asked to rate how many days during the past 7 days they performed a specific self-care behavior. The scale ranges from 0 to 7, whereby higher scores correspond to higher diabetes management activities [16]. The two items on smoking were for the question "Have you smoked a cigarette—even one puff—during the past 7 days?" (0, No; 1, Yes [number of cigarettes]). A mean score is calculated for each of the five domains (diet, exercise, blood glucose testing, foot care, and smoking), whereby higher scores indicate better diabetes self-management. Adequate internal and test-retest reliability, validity, and sensitivity to change were demonstrated by normative data from seven studies [16]. For the purpose of this study, only 10 questions from the SDSCA were used excluding the question on smoking. The Malay version of the SDSCA was obtained from the study by Jalaludin et al. [17] whereby a thorough translation procedure consisting of forward and backward translations and pretesting of the instrument was used before the actual implementation. Cronbach α was reported to be 0.782, which showed good internal consistency reliability.

Morisky et al. [18] originally developed a four-item medication adherence scale. The four-item scale exhibits poor psychometric properties, but it is still widely used in self-reporting medication adherence. Recently, Morisky et al. [19] developed an eight-item scale known as the Morisky Medication Adherence Scale (MMAS). The questions were formulated in such a way that the respondents avoid a "yes-saying" bias. The response choices consist of yes/no for questions 1 to 7 and a five-point Likert scale for the last item. The scoring is such that each "no" response is rated as "1" and the "yes" response as "0" except for question 5 (Did you take your diabetic medicine yesterday?), which is the reverse; that is, "yes" is rated as 1 and "no" as 0. For item 8 (How many times do you have difficulty remembering to take all your medications?), if the patient responds "0 (Never/Rarely)," the score is "1," and if response "4 (All the time)" is chosen, the score is "0." The responses to questions 1, 2, and 3 are rated respectively as 0.25, 0.75, and 0.75 on the basis of the scoring method from the original developer. The total score for the MMAS-8 ranges from 0 to 8. The scores are then categorized as low (<6), medium (6–<8), and high (8) medication adherence.

Statistical Analysis

Statistical analyses were done using the Statistical Package for Social Sciences, version 21.0 Armonk, NY: IBM Corp. On the basis of the scores obtained on the MMAS, they were classified as high, medium, and low adherence. Descriptive statistics such as percentages were used to describe the sample. The means and SDs of the risk factors such as age, diabetes duration, glycated hemoglobin (HbA_{1c}), and body mass index (BMI) were also calculated on the basis of the three levels of adherence. The normality conditions were checked before any statistical analysis. The skewness and kurtosis values were checked accordingly. The statistical significance of the association between ethnicity and medication adherence was determined by using the Pearson χ^2 test of association, and a P value of less than 0.05 was considered statistically significant. Moreover, correlation coefficient was also computed between risk factors and medication adherence.

Results

Descriptive Results

Overall, the sample comprised 53.7% males and 46.3% females. The mean age was 55.5 ± 10.9 years, ranging from 25 to 85 years. The mean duration of diabetes was 9.97 ± 7.74 years, ranging from 1 to 37 years. The mean BMI was 28.56 ± 6.51 kg/m^2, ranging from 14.84 to 72.62 kg/m^2. The mean duration of oral medication intake was 9.25 ± 7.75 years to control their diabetes. In addition, the mean duration of insulin injection was 4.09 ± 4.53 years. In the sample, 47.7% were Malays (n = 237), 34.8% were Indians (Punjabis) (n = 173), and 17.5% (n = 87) were Chinese. Most of the respondents were married (83.9%) and attended secondary school (54.3%). For those who were working, the most frequently reported income was less than RM1000 (42.9%). Most participants were living with their spouse and children (59.6%) or with only their spouse (16.3%), and only 2.8% were living alone.

Medication Adherence

Results demonstrated that the MMAS scores had a slightly negatively skewed distribution, with a skewness of −0.790 and a

Table 1 – Descriptive statistics of MMAS.

Item	Questions	Yes (%)	No (%)
1	Do you sometimes forget to take your diabetic pills?	43.7	56.3
2	People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past 2 wk, were there any days when you did not take your diabetic medicine?	25.2	74.8
3	Have you ever cut back or stopped taking your medication without telling your doctor, because you felt worse when you took it?	19.7	80.3
4	When you travel or leave home, do you sometimes forget to bring along your diabetic medication?	33.4	66.6
5	Did you take your diabetic medicine yesterday?	24.3	75.7
6	When you feel like your diabetes is under control, do you sometimes stop taking your medicine?	25.8	74.2
7	Taking medication every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your diabetes treatment plan?	29.6	70.4

MMAS, Morisky Medication Adherence Scale.

Table 2 – Level of medication adherence of patients.

Characteristic	High adherence, mean ± SD	Medium adherence, mean ± SD	Low adherence, mean ± SD
Age (y)	57.3 ± 9.18	57.1 ± 10.2	53.4 ± 11.9
Duration of diabetes	11.1 ± 8.12	10.8 ± 8.45	8.8 ± 6.79
HbA_{1c}	7.95 ± 2.43	8.17 ± 2.93	8.57 ± 2.97
BMI	27.9 ± 6.01	28.1 ± 6.27	29.2 ± 6.86

BMI, body mass index; HbA_{1c}, glycated hemoglobin.

kurtosis of −0.071. The total score of the MMAS ranged from 0 to 8, with a mean of 5.65 ± 1.97. The results indicated that the patients with T2DM had a moderate level of medication adherence. It was observed that most of the patients neither had forgotten to take their medications nor had cut down on their medication without informing their doctor (see Table 1). Table 2 presents the characteristics of patients according to groups of adherence. Of the 497 patients with T2DM, 88 (17.7%), 187 (37.6%), and 222 (44.7%) patients were in high, medium, and low adherence levels, respectively. The patients who had low medication adherence level had a longer diabetes duration of 8.8 years compared with those in the other levels. It was also observed that patients with low adherence had a larger BMI (29.2) on average. Among the patients who had low adherence level, 50.9% were Malays, 34.2% Indians, and 12.6% Chinese. Findings also reported that among these three ethnic groups, the Indians (38.6%) had higher medication adherence compared with the Malays (36.4%) and the Chinese (23.9%) (see Table 3). The Malay patients were found to have a lower medication adherence (n = 113) in comparison with the Chinese patients (n = 28). Nevertheless, the Indian patients were more compliant in comparison with the other two ethnic groups.

Test of Association and Correlation Results of SDSCA and MMAS

From the Pearson χ^2 test of association, results indicated a $\chi^2(4)$ of 10.660 and a P value of 0.031, showing a statistically significant

Table 3 – Level of adherence (demographic variables).

Characteristic	High adherence (n = 88), frequency (%)	Medium adherence (n = 187), frequency (%)	Low adherence (n = 222), frequency (%)
Sex			
Male	50 (56.8)	95 (50.8)	122 (55.0)
Female	38 (43.2)	92 (49.2)	100 (45.0)
Ethnicity			
Malay	32 (36.4)	92 (49.2)	113 (50.9)
Indian	34 (38.6)	56 (29.9)	76 (34.2)
Chinese	21 (23.9)	38 (20.3)	28 (12.6)
Education			
No school	4 (4.5)	8 (4.3)	9 (4.1)
Primary	15 (17.0)	37 (19.8)	40 (18.1)
Secondary	50 (56.8)	105 (56.1)	115 (51.8)
University	16 (18.2)	30 (16.0)	53 (23.9)
Others	2 (2.3)	7 (3.7)	4 (1.8)
Medical conditions			
Yes	73 (83.0)	141 (75.4)	174 (78.4)
No	15 (17.0)	46 (24.6)	48 (21.6)

Note. Total % is not equal to 100 in some cases because of missing values.

Table 4 – SDSCA results (n = 497).

Variable	Item	Questions	Median	Mean ± SD
General diet	1	How many of the last *7 d* have you followed a healthful eating plan?	5	5.05 ± 1.97
General diet	2	On average, over the past month, how many *days per week* have you followed your eating plan?	5	5.02 ± 1.92
Specific diet	3	On how many of the last *7 d* did you eat five or more servings of fruits and vegetables?	5	4.82 ± 2.01
Specific diet	4	On how many of the last *7 d* did you eat high-fat foods such as red meat or full-fat dairy products?	5	4.35 ± 2.05
Exercise	5	On how many of the last *7 d* did you participate in at least 30 min of physical activity (total minutes of continuous activity, including walking)?	3	3.01 ± 2.38
Exercise	6	On how many of the last *7 d* did you participate in a specific exercise session (such as swimming, walking, and biking) other than what you do around the house or as part of your work?	2	2.40 ± 2.39
Sugar testing	7	On how many of the last *7 d* did you test your blood sugar?	1	2.19 ± 2.49
Sugar testing	8	On how many of the last *7 d* did you test your blood sugar the number of times recommended by your health care provider?	1	2.05 ± 2.45
Foot care	9	On how many of the last *7 d* did you check your feet?	6	4.45 ± 2.82
Foot care	10	On how many of the last *7 d* did you inspect the inside of your shoes?	1	2.67 ± 2.96

SDSCA, Summary of Diabetes Self-Care Activities.

Table 5 – Descriptive statistics for SDSCA (ethnicity).

Variable	Malay, mean	Chinese, mean	Indian, mean
General diet	5.06	4.96	5.05
Specific diet	3.84	3.63	3.65
Exercise	2.58	2.45	3.01
Blood sugar testing	1.96	2.21	2.32
Foot care	3.49	3.77	3.58

SDSCA, Summary of Diabetes Self-Care Activities.

association between ethnicity and medication adherence. The strength of association between the variables was weak ($\phi = 0.146$; Cramer $V = 0.104$). Considering the correlation of MMAS with the risk factors, the correlation coefficient between age and MMAS total score was 0.165 ($P < 0.05$). The duration of diabetes had also a positive significant correlation with the MMAS score ($r = 0.114$; $P < 0.05$). The cumulative HbA_{1c} had a negative significant correlation with the MMAS score.

Results demonstrated that the highest mean score among the subscales was for "general diet" (5.04 ± 1.88), and the lowest mean score was found to be for "blood sugar testing" (2.13 ± 2.34). The results suggested that patients with T2DM had better self-care behaviors in their general diet and poor self-care behaviors in blood sugar testing (see Table 4). Over the last 7 days, the patients with T2DM on average had a specific diet, exercise, and foot care activities for 4, 3, and 4 days, respectively. The subscales of the SDSCA—general diet, specific diet, exercise, blood sugar testing, and foot care—were normally distributed, with skewness within the range of −1 to +1.

Table 6 – Descriptive statistics for SDSCA (sex).

Variable	Male, mean	Female, mean
General diet	4.90	5.20
Specific diet	3.70	3.78
Exercise	2.77	2.64
Blood sugar testing	2.05	2.21
Foot care	3.57	3.57

SDSCA, Summary of Diabetes Self-Care Activities.

From Table 5, it can be observed that the patients with T2DM of the three ethnic groups, on average, followed their general diet for 5 days over the past 7 days. Nevertheless, adhering to a specific diet, such as eating red meat and full-fat dairy products, the patients had an average of 4 days. All three ethnicities recorded between 2 and 3 days for exercise, 2 days for blood sugar testing, and 4 days for foot care. Similar results were obtained in terms of sex (Table 6) whereby both males and females had the highest mean (5 days) for general diet, about 4 days for specific diet and foot care, and 3 days for exercise. The lowest mean (2 days) was for blood sugar testing.

The correlation results presented in Table 7 show that age was significantly negatively associated with BMI ($r = -0.152$; $P < 0.05$), indicating that people who were older had a lower BMI score. Duration of diabetes had a significant positive correlation with age ($r = 0.341$; $P < 0.05$). Age had also a positive significant association with the medication adherence scores (MMAS) ($r = 0.165$; $P < 0.05$) and general diet ($r = 0.177$; $P < 0.05$). Older patients had a tendency to adhere more to their diabetes medication and had better general diet. BMI was significantly associated with blood sugar testing in the SDSCA scale ($r = -0.113$; $P < 0.05$), indicating that those patients with higher BMI had a lower frequency of checking their blood glucose. A weak positive correlation existed between duration of diabetes and MMAS ($r = 0.114$; $P < 0.05$), showing that patients with a longer duration of diabetes adhered more to medication.

HbA_{1c} was found to be significantly negatively associated with MMAS ($r = -0.10$; $P < 0.05$). Thus, results showed that patients who had better medication adherence had lower HbA_{1c} values. MMAS was found to be related to specific diet in the SDSCA scale ($r = 0.159$; $P < 0.05$), indicating that patients who had higher medication adherence had a better specific diet. Furthermore, general diet was found to be significantly associated with specific diet

Table 7 – Correlation of risk factors with MMAS and SDSCA.

Variable	1	2	3	4	5	6	7	8	9	10
Age	1.00									
BMI	−0.152*	1.00								
Duration of diabetes	0.341*	−0.084	1.00							
HbA_{1c}	−0.121*	0.058	0.063	1.00						
MMAS	0.165*	−0.068	0.114*	−0.10*	1.00					
General diet	0.177*	0.002	0.012	−0.096	−0.011	1.00				
Specific diet	0.002	0.053	0.007	−0.028	−0.159*	0.282*	1.00			
Exercise	0.027	0.044	0.031	0.005	0.020	0.163*	0.196*	1.00		
Blood sugar testing	0.000	−0.113*	0.061	0.017	−0.028	0.043	0.021	0.066	1.00	
Foot care	0.005	−0.044	0.066	0.048	−0.002	1.00	0.149*	0.184*	0.314*	1.00

BMI, body mass index; HbA_{1c}, glycated hemoglobin; MMAS, Morisky Medication Adherence Scale; SDSCA, Summary of Diabetes Self-Care Activities.
*Significant at 0.05 level.

($r = 0.282$; $P < 0.05$) and exercise ($r = 0.163$; $P < 0.05$), denoting that respondents who had a higher frequency in general diet also had a higher frequency in specific diet and exercise (see Table 7).

Discussion

Most health care providers and researchers have suggested that diabetes is a self-care management disease for which patients should be responsible for taking care of themselves [20]. One of the most important aspects of diabetes treatment often involves medication regimen and self-care behaviors, and often adherence is difficult for patients in these areas [21]. Past studies reported that high medication adherence reduced HbA_{1c} in patients with T2DM [22–24]. The finding of the present study conformed to past studies whereby patients with low medication adherence on the MMAS had a higher mean HbA_{1c}. Thus, medication adherence is a clear obvious requirement of good clinical care. As a matter of fact, this may also have a positive impact on the patients' lives in terms of both economic and quality-of-life outcomes.

Age also had a positive and significant association with medication adherence. This finding conformed to a retrospective cohort study whereby older patients in the age groups 44 to 64 years and older than 65 years had significantly higher medication adherence [25]. Studies in countries such as Malaysia and France found that the adherence to medication improved with age [26,27]. Medication adherence was also associated with duration of diabetes; patients having a longer duration of diabetes adhered more to medication. Blood sugar control measured by HbA_{1c} was significantly associated with medication adherence. This finding was consistent with that of Grant et al. [28] whereby patients in the highest quartile of medication adherence had lower HbA_{1c} values compared with those who were less adherent. In Malaysia, Al-Qazaz et al. [29] had a similar finding. Patients with higher adherence to medication have more awareness about diabetes control and management and they are also concerned that poor adherence may worsen their clinical condition. Hence, blood sugar control is an essential indicator to reflect physiological outcomes in people living with diabetes.

This result was consistent with previous findings reporting that older individuals were associated with better self-care behaviors in general diet [30,31]. Patients having low adherence to medication were significantly associated with specific diet, which means that these patients had a control on their weekly food intake with respect to full-fat foodstuff. Thus, they felt that this would compensate for the medication adherence. The specific diet was also significantly related to exercise and foot care. Patients who had a daily control of red meat or full-fat dairy products adhere more to regular exercise and daily foot care. Blood sugar testing frequency was also significantly associated with foot care, meaning that patients who had a good management of their blood glucose also had good foot care.

A prevalence of low medication adherence (44.7%) was noted from the present study, which was in line with past local studies [26,32,33] whereby the level of medication adherence was 40% to 50%. The fact that patients with T2DM of Indian ethnicity were more adherent (38.6%) to their medication compared with the Malay (36.4%) and Chinese (23.9%) patients was unexpected. Similar results were also reported by Ahmad et al. [26] whereby the Chinese patients had the least adherence level compared with the other two ethnic groups. Usually, Chinese patients are more adherent to different health recommendations such as exercise and they are often more health conscious [34]. The Chinese are also often thought to be more adherent to their medications as prescribed by their physicians. Another potential reason was that the Malays have tried traditional therapies to manage their T2DM [35] in comparison with Chinese patients who are more inclined toward medical opinions.

According to a recent study by Polonsky and Henry [22], it is worth noting that 45% of patients with T2DM fail to achieve an adequate HbA_{1c} (<7%) because of poor medication adherence. Poor medication adherence is linked to key nonpatient factors and patient demographic factors. Nevertheless, an educational 30-minute session on diabetes and medication adherence would have a statistically significant change in the adherence levels in adults with T2DM [23]. The findings support the idea of expecting and empowering patients to play a centrally active role in caring and planning their own health [36]. Letting patients know that they must take a leading role in their treatment has been strongly emphasized over the past decade. Psychosocial factors such as empowerment should be addressed to increase diabetes management.

One limitation of this study that is worth mentioning is that it was conducted at some selected hospitals in the state of Selangor, and hence the findings are not representative of the whole of Malaysia in different states. There are several confounding factors, such as duration of disease, comorbidities, and severity of illness, that need to be assessed in future studies.

Conclusions

Results of this study indicated that low medication adherence was related to a larger BMI and a poorer HbA_{1c}. Patients had the highest mean score for general diet on the SDSCA. It was also revealed that the patients had better self-care behavior in general

diet in comparison with blood glucose testing. Primary health care providers should provide adequate counseling for adults with T2DM.

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