Mal J Nutr 17(3): 287 - 299, 2011

Dietary Compliance and its Association with Glycemic Control among Poorly Controlled Type 2 Diabetic Outpatients in Hospital Universiti Sains Malaysia

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ABSTRACT

Introduction: Compliance with medical nutrition therapy is important to improve patient outcomes. The purpose of this study was to determine dietary compliance and its association with glycemic control among outpatients with poorly controlled type 2 diabetes mellitus (T2DM) in Hospital Universiti Sains Malaysia (HUSM). **Methods:** In this cross-sectional study, patients who had a glycosylated hemoglobin (HbA1c) level of at least 6.5%, after attending a diet counseling session at the Outpatient Dietetic Clinic, HUSM, were enrolled. Out of 150 diabetic patients reviewed between 2006 and 2008, 61 adults (32 men and 29 women) agreed to participate in this study. A questionnaire-based interview was used to collect socio-demographic, clinical and diabetes self-care data. The patient's dietary compliance rate was determined by the Summary of Diabetes Self-Care Activities (SDSCA) measure. Anthropometric and biological measurements were also taken. **Results:** Only 16.4% of the respondents adhered to the dietary regimen provided by dietitians. Among the 7 dietary self-care behaviours, item number 6 (eat lots of food high in dietary fibre such as vegetable or oats) had the highest compliant rate (54.1%); whereas item number 3 (eat five or more servings of fruits and vegetables per day) had the lowest compliant rate (23.0%). There was a significant association between gender (p=0.037) and fasting blood sugar (FBS) (p=0.007) with the compliance status. **Conclusion:** Dietary non-compliance is still common among T2DM patients. Dietitians need to improve their skills and use more effective intervention approaches in providing dietary counseling to patients.

Keywords: Dietary compliance, diet counseling, type 2 diabetes mellitus

INTRODUCTION

Diabetes mellitus (DM) is one of the most common chronic diseases and its prevalence is on an upward trend globally due to population growth, aging, urbanisation, and increasing prevalence of obesity and physical inactivity (Zanariah *et al.*, 2008; Shaw, Sicree & Zimmet, 2010). The World Health Organization (WHO) estimates that more than 220 million people worldwide are having diabetes and Type 2 Diabetes Mellitus (T2DM) constitutes 90% of people with diabetes around the world (WHO, 2010).

In Malaysia, diabetes is a growing concern. According to the Third National Health Morbidity Survey (NHMS III), the

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overall prevalence of diabetes among adults above 30 years was 14.9% in 2006 compared to a rate of 8.3% found in the second NHMS in 1996, an increase of 80% over a decade, representing an average 8% rise per year (Zanariah *et al.*, 2008).

In the state of Kelantan in North-East Peninsular Malaysia, the overall prevalence of DM and impaired glucose tolerance (IGT) were 10.5% and 16.5% and they are associated with a high prevalence of obesity, hypertension and hypercholesterolemia (Mafauzy *et al.*, 1999). Suhaiza *et al.* (2004) show that 85.7% of the Kelantan diabetic population have poor glycemic control and these patients are at risk of developing diabetic complications. The total cases for diabetic outpatients in HUSM also showed a significance increase from 14,034 in 2005 to 17,862 in 2008 (Medical Record Department HUSM, 2009).

The four main diabetic management self-care practices include compliance to dietary intake, medication, physical activity and self-monitoring of blood sugar (Tan & Magarey, 2008). Optimal self-care practices and glycemic control can reduce the likelihood of developing complications like coronary artery disease, peripheral vascular disease, stroke, diabetic retinopathy, renal failure, amputation, blindness, premature mortality and loss of productivity (Morgan *et al.*, 2000).

Dietary compliance is one of the major factors in achieving glycemic control in T2DM patients. However, a few studies have shown poor compliance to dietary recommendations by diabetic patients, especially those with T2DM (Thanopoulou *et al.*, 2004). Rubin and Peyrot (2001) showed that dietary self-care activities, the most central element of the diabetic treatment regimen, are the most difficult treatment regimen to follow. Thus, the main objective of this study was to determine dietary compliance and its association with glycemic control among outpatients with T2DM in the Outpatient Dietetic Clinic, HUSM.

METHODOLOGY

This cross-sectional study utilised a purposive sampling method. The inclusion criteria included (1) T2DM patients with glycosylated hemoglobin (HbA1c) level of at least 6.5%; (2) consulted dietitian at Outpatient Dietetic Clinic HUSM; (3) aged between 30 to 55 years; (4) did not use insulin; and (5) had neither serious ongoing illnesses nor cognitive disorder. Exclusion criteria were any condition that would prevent participation and / or completion of the study protocols. Ethical approval was obtained from the Human Ethics Committee of USM in April 2009.

Data collection

All eligible respondents were sent an invitation letter introducing the study and were contacted by phone to ask if they would like to participate in the study. Those patients who expressed interest were invited to USM Kubang Kerian, Kelantan for data collection in June 2009. At that time, patients were given further details of the study and written informed consent was obtained from those who agreed to participate. Respondents were then interviewed by trained interviewers to assess their socio-demographic characteristics, health related behaviours, clinical, dietary and diabetes self-care data using a structured questionnaire. Medical records were referenced in order to obtain other related information (i.e. comorbidities, frequency of dietitian consultation, previous dietary regimen provided etc.).

Data on diabetes self-care behaviours were obtained utilising the Summary of Diabetes Self-Care Activities (SDSCA) measure. It is a brief self-reported questionnaire of diabetes self-management that includes items assessing the following aspects of a diabetes regimen: general diet, specific diet, exercise, blood glucose test, foot care, and smoking (Toobert, Hampson &

Glasgow, 2000). The SDSCA measure was adapted and modified in this study to assess the level of self-care and compliance to a prescribed dietary regimen. This modified SDSCA measure consists of 7 items which focus on dietary components only. The translation (from English to Malay language) and internal consistency reliability test of this modified Malay SDSCA version was previously done by Kow (2009) in a group of 136 T2DM patients at Diabetes Centre, HUSM in February 2009. Kow (2009) showed that the modified Malay version SDSCA has good internal consistency reliability with a Cronbach's alpha reading of 0.76.

The SDSCA measure asked the respondents the number of days per week they had practised the diabetic dietary self-care activities: '0' would indicate no performance at all; while '7' indicated a daily performance. For purposes of this study, good compliance with each of the dietary self-care activities was considered as $\geq$ 5 days per week; and low compliance considered as < 5 days per week, with the exception of one item (Item 4 – eat high fat foods such as red meat or full fat dairy products) which had a reversal score. The overall dietary compliance of respondents was defined based on the mean days per week for these 7 items ($\geq$5 days considered good compliance; and < 5 days considered low compliance).

The body weight and height of the respondents were measured by trained personnel using the SECA 769 Digital Medical Scales (SECA Corporation, Hamburg, Germany). All the respondents were weighed in light clothing, without accessories and shoes. Weight and height were taken twice for the average value, to the nearest 0.5 kg and 0.1 cm, respectively. Body mass index (BMI) was defined as the weight in kilograms divided by the square of the height in meters (kg / m^2). The WHO classification of BMI was used to classified the respondents as underweight (BMI < 18.5 kg / m^2); normal range (BMI 18.5 – 24.9 kg / m^2); overweight (BMI 25.0 – 29.9 kg / m^2); and obese (BMI $\geq$ 30 kg / m^2) (WHO, 1995).

The percentage of body fat was predicted using the Omron HBF-306C body fat monitor (hand-held impedance analyser) (Omron Healthcare Co., Ltd., Kyoto, Japan). After the personal particulars (weight, height, age and gender) were keyed into the device, the respondent had to stand with correct posture (straight with both feet slightly apart) while holding the grip electrodes of the device with both arms straightened out at a 90 degree angle of the body. The device sent an extremely weak electric current of about 50 KHz to 500 μA between both hands and subsequently calculated the body fat percentage based on the entered personal particulars and impedance value. The formula employed is not known. This measurement was repeated twice for average value.

The validity of this HBF-306C body fat monitor measurements was good as shown by a study done among Singaporean Chinese, Malay and Indians participants (Deurenberg & Deurenberg-Yap, 2002). The correlation between body fat percentage measured by the reference method (a chemical four-compartment model consisting of fat, water, protein and mineral) and the body fat percentage measured by the HBF-306C was 0.87 (P < 0.001) and the standard error of estimate (SEE) of the regression between these two parameters was 4.5%. These values indicate a good overall validity of body fat percentage as measured by HBF-306C.

Fasting blood samples (at least 8 hours of fasting) were collected from respondents by a trained nurse. The blood glucose levels were measured by fasting blood sugar (FBS) and HbAlc level. The FBS level showed the ongoing diabetes control whereas HbA1c test provided a measure of average plasma glucose control for the previous 3 months. These two metabolic control indicators were classified into two categories (good control / normal and poor control / impaired) according to WHO criteria for diagnosis of

DM (HbA1c level of < 6.5% was considered as good control; and FBS level of < 6.1mmol / L was considered as normal) (WHO, 2006).

A dietary history questionnaire (DHQ) with a food frequency list of sweetened foods and drinks was used to assess respondents' usual dietary habits (Suzana, Earland & Suriah, 2000). Common household measures including bowls, spoons, and cups were used to help estimate the quantities and portion size of food intake during the interview. The information collected was compared with respondents' previous dietary recall data in medical records in order to know if dietary changes and modifications had been made since their previous visit to the dietitian. The DHQ with food frequency list was also used to check with the items in the SDSCA measures. The interviewer would clarify with the respondents if any inconsistency appeared.

Statistical analysis

All data was entered and analysed using the Statistical Package for Social Sciences (SPSS) version 17.0. Descriptive statistics were used to characterise the study respondents. Mean and standard deviation (SD) were calculated for the normally distributed continuous variables, and median and interquartile range (IQR) for the skewed variables. Frequency and percentage (%) were calculated for the categorical variables. Independent *t*-test and Mann-Whitney test were used to compare the mean / median differences; Pearson Chi-square test or Fisher's Exact test was used to determine the association between two categorical variables. Significance level was set at 0.05.

RESULTS

Out of 150 diabetic patients reviewed for the period of 2006 to 2008, 61 adults (32 men and 29 women) met the inclusion criteria and had agreed to participate in this study with written consent. Table 1 shows the general characteristics of the respondents. Their age ranged from 31 to 55 years old

Table 1. General characteristics of the respondents (n=61)

Variables	*Frequency (%)*	*Mean (SD)*	*Median (IQR)*
Gender			
Male	32 (52.5)		
Female	29 (47.5)		
Ethnicity			
Malay	55 (90.2)		
Others	6 (9.8)		
Age (year)			48.00 (8.00)[a]
Marital status			
Married	59 (96.7)		
Widowed	2 (3.3)		
Education level			
No formal education	1 (1.6)		
Primary	2 (3.3)		
Secondary	44 (72.1)		
College / University	14 (23.0)		
Occupation			
Government / Private	33 (54.1)		
Self-employed	18 (29.5)		
Unemployed	10 (16.4)		

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Smoking status			
Non-smoker / ex-smoker	54 (88.5)		
Current smoker	7 (11.5)		
Family history of diabetes			
Yes	41 (67.2)		
No	20 (32.8)		
Duration of diabetes			
≤ 5 years	51 (83.6)		
> 5 years	10 (16.4)		
Co-morbidities			
Yes	155 (90.6)		
No	16 (9.4)		
Type of treatment			
Diet therapy	8 (13.1)		
Diet and oral hypoglycemia agents	53 (86.9)		
Frequency of dietitian consultation			
Once	31 (50.8)		
More than once	30 (49.2)		
Physical activity			
Active	31 (50.8)		
Inactive	30 (49.2)		
BMI		28.47 (3.92)	
Normal (18.5 – 24.9 kg / m^2)	10 (16.4)		
Overweight (25.0 – 29.9 kg / m^2)	30 (49.2)		
Obese (≥30.0 kg / m^2)	21 (34.4)		
HbA1c			7.40 (3.60)[b]
Good control (< 6.5%)	20 (32.8)		
Poor control (≥ 6.5%)	41 (67.2)		
FBS			8.00 (4.90)[b]
Normal (< 6.1mmol / L)	10 (16.4)		
Impaired (≥ 6.1mmol / L)	51 (83.6)		
Body fat percentage (%)		33.57 (6.26)	

Abbreviations: BMI- Body Mass Index; FBS- fasting blood sugar; HbA1c - glycosylated hemoglobin; IQR- Interquartile range; SD- standard deviation.

[a] Data skewed to the left.

[b] Data skewed to the right.

(median age 48.00 years, IQR 8.00 years). The majority of the respondents were Malay (90.2%), married (96.7%), had completed secondary school education (72.1%), and were employed as government servants or in the private sector (54.1%). Of these respondents, 88.5% were non-smoker, 67.2% had a family history of DM, 57.4% had co-morbidities, 83.6% had diagnosed T2DM for less than 5 years, 86.9% were on diet therapy and oral hypoglycemia agents to control their DM condition, and 50.2% had consulted a dietitian only once. With regard to BMI, 49.2% of the respondents were overweight (BMI 25.0 – 29.9 kg / m^2) and 34.4% were obese (BMI ≥ 30 kg / m^2).

Of the total 61 respondents, 32.8% had good control (<6.5%) level of HbA1c, while 16.4% had normal (<6.1mmol / L) FBS level. Both the median HbA1c (7.40%, IQR 3.60%) and FBS (8.00mmol / L, IQR 4.90mmol / L) levels were considered as poor control / impaired.

Table 2 shows the overall dietary compliance rate, mean days per week and frequency of dietary compliance for each SDSCA item response. Generally, only 16.4% of the respondents adhered to their dietary regimens according to the definition of good dietary compliance (≥5 days per week) applied in this study. The mean days per week showed considerable consistency across different measured items in which respondents typically reported low compliance to the dietary self-care behaviours (mean days – 3.20 to 4.44 days per week). Among these 7 dietary self-care behaviours, item number 6 (eat lots of food high in dietary fibre such as vegetables or oats) had the highest compliant rate (54.1%); whereas item number 3 (eat five or more servings of fruits and vegetables per day) had the lowest compliant rate (23.0%).

The association of dietary compliance with several characteristics of respondents is shown in Table 3. Clearly, gender (p=0.037) and FBS level (p=0.007) were significantly associated with dietary compliance. The mean percentage of fat was significantly higher in the good compliance group (p=0.006). Other variables did not attain statistical significance.

Table 4 shows the assessment of glycemic control using FBS and HbA1c level and its association with dietary self-care activities in SDSCA and several other characteristics of respondents. Glycemic control as measured by FBS showed significant association with 2 dietary self-care activities – "followed a healthful eating plan" (p<0.001) and "followed your eating plan" (p=0.007). None of the tested variables attained statistical significance with glycemic control as measured by HbA1c level.

DISCUSSION

This is one of the few studies in Malaysia focusing on dietary compliance rate among T2DM patients after they had consulted the dietitians. The study showed that the dietary compliance rate among poorly controlled T2DM outpatients was low (16.4%). This indicates that the patients did not adhere to their dietary regimen provided by the dietitians. The result was similar to the study

Table 2. Performance of dietary self-care behaviors by respondents (n=61) using Summary of Diabetes Self-Care Activities (SDSCA) measure

Items	*Mean (SD)*	*Good compliance**	*Low compliance**
		Frequency (%)	
1. Followed a healthful eating plan	3.36 (2.57)	22 (36.1)	39 (63.9)
2. Followed your eating plan	3.20 (2.47)	19 (31.1)	42 (68.9)
3. Eat five or more servings of fruits and vegetables	3.23 (2.16)	14 (23.0)	47 (77.0)
4. Eat high fat foods such as red meat or full-fat dairy products**	3.33 (2.54)	29 (47.5)	32 (52.5)
5. Eat fewer sweets	4.10 (2.48)	32 (52.5)	29 (47.5)
6. Eat lots of food high in dietary fibre such as vegetable or oat	4.44 (2.54)	33 (54.1)	28 (45.9)
7. Reduce the number of calories you eat to lose weight	3.93 (2.50)	30 (49.2)	31 (50.8)
Overall compliance rate	3.70 (1.59)	10 (16.4)	51 (83.6)

* Good compliance: ≥ 5 days per week; Low compliance: < 5 days per week.
** Question with reversal scoring scale.

Table 3. Dietary compliancy and its association with characteristics of respondents

Variables	*Good compliance*	*Low compliance*	*p value*[a]
	Frequency (%)		
Gender			0.037
Male	2 (6.3)	30 (93.8)	
Female	8 (27.6)	21 (72.4)	
Family history of diabetes			>0.950
Yes	7 (17.1)	34 (82.9)	
No	3 (15.0)	17 (85.0)	
Duration of diabetes			0.663
≤ 5 years	8 (15.7)	43 (84.3)	
> 5 years	2 (20.0)	8 (80.0)	
Co-morbidities			0.300
Yes	4 (11.4)	31 (88.6)	
No	6 (23.1)	20 (76.9)	
Type of treatment			0.607
Diet therapy	2 (25.0)	6 (75.0)	
Diet & oral hypoglycemia agents	8 (15.1)	45 (84.9)	
Frequency of dietitian consultation			0.508
Once	4 (12.9)	27 (87.1)	
More than once	6 (20.0)	24 (80.0)	
Physical activity			0.731
Active	6 (19.4)	25 (80.6)	
Inactive	4 (13.3)	26 (86.7)	
FBS (mmol/L)			0.007
Normal (< 6.1)	5 (50.0)	5 (50.0)	
Impaired (≥ 6.1)	5 (9.8)	46 (90.2)	
HbA1c (%)			0.716
Good control (< 6.5)	4 (20.0)	16 (80.0)	
Poor control (≥ 6.5)	6 (14.6)	35 (85.4)	
Weight (kg)[b]	69.47 (6.79)	73.51 (11.82)	0.301
BMI (kg/m^2)[b]	29.01 (2.68)	28.37 (4.14)	0.642
Body fat percentage (%)[b]	37.10 (3.37)	32.87 (6.48)	0.006
Age (year)[c]	50.00 (8.00)	47.00 (7.00)	0.151[d]

Abbreviations: BMI, Body Mass Index; FBS, fasting blood sugar; HbA1c, glycosylated hemoglobin.
[a] Independent *t*-test for weight, BMI and body fat percentage; Fisher's Exact test for all others, α was set at 0.05.
[b] Mean (standard deviation) value provided for continuous variables.
[c] Median (interquartile range) value provided for skewed data.
[d] Mann-Whitney test for age, α was set at 0.05.

by Abduelkarem and Sackville (2009), who reported that the patients had poor diet behaviour as measured by SDSCA (dietary subscale). These results also suggest the need for improvement in ongoing patient education in relation to dietary self-care behaviours essential for diabetes management.

The dietitian who is involved directly in nutrition therapy plays a pivotal role in counseling patients on diet modification and in designing a diet for patients based on their preferences and health status (Tien *et al.*, 2008). In order to facilitate dietary compliance, patients' readiness and willingness to adopt changes is important

Table 4. Assessment of glycemic control using FBS and HbA1c level and its association with dietary self-care behaviours (SDSCA) and other variables

Variables	*FBS (mmol/L)*			*HbA1c (%)*		
	Normal (<6.1)	*Impaired (≥6.1)*	*p value*[a]	*Good (< 6.5)*	*Poor (≥ 6.5)*	*p value*[a]
	Frequency (%)			*Frequency (%)*		
SDSCA – Followed a healthful eating plan			< 0.001			0.113
Good compliance	9 (40.9)	13 (59.1)		10 (45.5)	12 (54.5)	
Low compliance	1 (2.6)	38 (97.4)		10 (25.6)	29 (74.4)	
SDSCA – Followed your eating plan			0.007			0.103
Good compliance	7 (36.8)	12 (63.2)		9 (47.4)	10 (52.6)	
Low compliance	3 (7.1)	39 (92.9)		11 (26.2)	31 (73.8)	
SDSCA – Eat five or more servings of fruits and vegetables			0.217			> 0.950
Good compliance	4 (28.6)	10 (71.4)		4 (28.6)	10 (71.4)	
Low compliance	6 (12.8)	41 (87.2)		16 (34.0)	31 (66.0)	
SDSCA – Eat high fat foods such as red meat or full-fat dairy products			0.729			0.796
Good compliance	7 (18.4)	31 (81.6)		12 (31.6)	26 (68.4)	
Low compliance	3 (13.0)	20 (87.0)		8 (34.8)	15 (65.2)	
SDSCA – Eat fewer sweets			0.307			0.410
Good compliance	7 (21.9)	25 (78.1)		12 (37.5)	20 (62.5)	
Low compliance	3 (10.3)	26 (89.7)		8 (27.6)	21 (72.4)	
SDSCA – Eat lots of food high in dietary fibre such as vegetable or oat			0.319			0.233
Good compliance	7 (21.2)	26 (78.8)		13 (39.4)	20 (60.6)	
Low compliance	3 (10.7)	25 (89.3)		7 (25.0)	21 (75.0)	
SDSCA – Reduce the			0.508			0.525

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number of calories you eat to lose weight						
Good compliance	6 (20.0)	24 (80.0)		11 (36.7)	19 (63.3)	
Low compliance	4 (12.9)	27 (87.1)		9 (29.0)	22 (71.0)	
Gender			0.170			0.057
Male	3 (9.4)	29 (90.6)		7 (21.9)	25 (78.1)	
Female	7 (24.1)	22 (75.9)		13 (44.8)	16 (55.2)	
Family history of diabetes			0.144			0.137
Yes	9 (22.0)	32 (78.0)		16 (39.0)	25 (61.0)	
No	1 (5.0)	19 (95.0)		4 (20.0)	16 (80.0)	
Duration of diabetes			>0.950			0.474
≤ 5 years	9 (17.6)	42 (82.4)		18 (35.3)	33 (64.7)	
> 5 years	1 (10.0)	9 (90.0)		2 (20.0)	8 (80.0)	
Comorbidities			>0.950			0.052
Yes	6 (17.1)	29 (82.9)		15 (42.9)	20 (57.1)	
No	4 (15.4)	22 (84.6)		5 (19.2)	21 (80.8)	
Type of treatment			0.115			> 0.950
Diet therapy	3 (37.5)	5 (62.5)		3 (37.5)	5 (62.5)	
Diet & oral hypoglycemia agents	7 (13.2)	46 (86.8)		17 (32.1)	36 (67.9)	
Frequency of dietitian consultation			0.731			0.316
Once	6 (19.4)	25 (80.6)		12 (38.7)	19 (61.3)	
More than once	4 (13.3)	26 (86.7)		8 (26.7)	22 (73.3)	
Physical activity			0.508			0.648
Active	4 (12.9)	27 (87.1)		11 (35.5)	20 (64.5)	
Inactive	6 (20.0)	24 (80.0)		9 (30.0)	21 (70.0)	
Weight (kg)[b]	71.14 (8.33)	73.19 (11.73)	0.602	72.03 (7.90)	73.25 (12.58)	0.693
BMI (kg/m^2)[b]	28.80 (3.19)	28.41 (4.08)	0.776	28.29 (2.88)	28.51 (4.38)	0.912
Body fat percentage (%)[b]	35.24 (5.12)	33.24 (6.45)	0.359	34.52 (6.38)	33.10 (6.23)	0.413
Age (year)[c]	47.50 (6.00)	48.00 (8.00)	0.396[d]	48.00 (8.00)	48.00 (8.00)	0.758[d]

Abbreviations: BMI- Body Mass Index; FBS - fasting blood sugar; HbA1c - glycosylated hemoglobin; SDSCA - Summary of Diabetes Self-Care Activities

[a] Independent *t*-test for weight, BMI and body fat percentage; Chi-Square test or Fisher's Exact test for all others, α was set at 0.05

[b] Mean (standard deviation) value provided for continuous variables.

[c] Median (interquartile range) value provided for skewed data.

[d] Mann-Whitney test for age, α was set at 0.05.

as well. The dietitian should provide dietary intervention tailored to patient's readiness to change, based on the Transtheoretical Model of Behaviour Change (Prochaska, DiClemente & Norcross, 1992). This model suggests that behavioral change is a process which involves progression through five stages including precontemplation, contemplation, preparation, action, and maintenance. Tailoring dietary intervention strategies to patients' stage of change (different advices and strategies at different stages), rather than expecting all patients to be ready for action-oriented strategies, not only can enhance patient progression but allow for effective use of therapeutic resources (Berg-Smith *et al*., 1999). Julien, Senecal & Guay (2009) showed that T2DM patients who maintain or improve their dietary compliance over time are those who follow their diet because it represents a personal choice for them. They feel that this activity is worthwhile or important for effectively managing their disease, even if this behaviour is not always pleasurable.

Optimal outcomes for diabetes control require daily self-management, including diet, exercise, and regular self-monitoring of blood glucose. Lifestyle modification has been found to improve and optimise glycemic control (Norris, Engelgau & Narayan, 2001). Our results showed a significant association between dietary compliance and the FBS level (p=0.007). However, the HbA1c did not show any significant difference. FBS is a glycemic index which reflect momentary situation of the glucose concentration, and is influenced by the short term fluctuations of blood glucose (Bouma *et al*., 1999); whereas HbA1c is an index of long term glycemic control which reflects the cumulative glycemic history of the preceding 2 to 3 months (Khan, Sobki & Khan, 2007). The discrepancy results between FBS and HbA1c may indicate that our respondents did not comply with their regimen on a long term basis and were thus unable to achieve an optimal glycemic control over time.

A number of studies report that poor glycemic control has contributions from other components of a diabetic regimen (i.e. type of treatment, physical activity) besides dietary management (Khattab *et al*., 2010; Jorge *et al*., 2011). However, the findings of our study are not consistent with that reported by other studies. There is no statistical significance attained with both the FBS and HbA1c level.

Both groups of good compliance (mean BMI 29.01 ± 2.68) and low compliance (mean BMI 28.37 ± 4.14) had BMI level above the normal range (>24.9 kg / m^2), but the difference was not significant. A meta-analysis done by Abdullah *et al*. (2010) reported that overweight and obesity are associated with a three-fold and 7 times higher risk of diabetes compared to those with normal weight respectively. Obesity not only leads to insulin resistance but has also been shown to be associated with other risk factors such as high blood pressure, hence complicating the control and management of diabetes (Steinberger & Daniels, 2003). Therefore weight management is important in overweight and obese T2DM patients.

Some limitations of our study have been recognised. First, the high proportion of poor glycemic control respondents (67.2% with HbA1c ≥ 6.5%; 83.6% with FBS ≥ 6.1mmol / L) in our study is not unexpected as our inclusion criteria had limited the participation of respondents with HbA1c of at least 6.5% (poorly controlled DM). Second, our study had a relatively small sample size (n=61) which might not allow for sufficient scope in detecting potential relationships. Several test variables that did not attain statistical significance in our study deserves further in-depth investigation, preferably using a larger sample size. Thirdly, we could not conclude that the dietary non-compliance behaviour is an independent factor that leads to poor glycemic control because of its cross-sectional nature. Future research is needed to understand the direction of association by using a

longitudinal study design. Intervention programs that facilitate long term behavioral changes are necessary in order to improve patient outcomes. Factors influencing dietary compliance should also be identified in order to formulate new strategies for countering the low compliance rate.

In conclusion, the results from this study demonstrated that dietary compliance rates among T2DM patients after consulting dietitians was low. Dietary compliance in isolation is not a strong factor that may contribute to poor glycemic control as lack of dietary compliance is significantly associated with short term glycemic control (i.e. FBS) only. Nevertheless, it is an important area of research as increased compliance and persistence with therapy are likely to improve patient outcomes.

ACKNOWLEDGEMENTS

We would like to express our gratitude and appreciation to all the health care providers and outpatients with T2DM in Outpatient Dietetic Clinic, HUSM for their contribution to this research. This study was financially supported by the grant from the National Institute of Health, Ministry of Health, Malaysia [304/PPSK/6150095/NI08].

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