J.Natn.Sci.Foundation Sri Lanka 2018 46 (3): 443 - 451
DOI: http://dx.doi.org/10.4038/jnsfsr.v46i3.8496

RESEARCH ARTICLE

Diet related factors for good glycaemic control among patients with diabetes mellitus in the Teaching Hospital, Batticaloa, Sri Lanka

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Revised: 12 March 2018; Accepted: 27 April 2018

Abstract: Ideal dietary practices and diet patterns for the better self-management of diabetes mellitus (DM) remains to be determined. This study was aimed at determining the diet related factors for good glycaemic control among patients with DM attending the Teaching Hospital, Batticaloa, Sri Lanka. A study was conducted among 339 patients with DM in medical clinics. Patients (n = 77) with DM who had fasting blood sugar less than or equal to 110 $mgdL^{-1}$ (cases) and patients (n = 197) with DM who had fasting blood sugar more than or equal to 111 $mgdL^{-1}$ (controls) for at least 3 last consecutive occasions during 6 months were compared. A pre-tested and validated seven-day dietary diary was used. Not consuming at least one serving of fruits in a week (AOR 2.83, 95 % CI = 1.03 – 7.76); not consuming bitter gourd (*Momordica charantia*) at least one tablespoon in a week (AOR 2.23, 95 % CI =1.01 – 4.95); not consuming Kurinja leaves (*Gymnema sylvestre*) at least one tablespoon in a week (AOR 2.49, 95 % CI =1.01 – 6.17); and consuming any yam (AOR 4.75, 95 % CI =1.61 – 14.07); having a bad lunch (AOR 4.64, 95 % CI =1.93 – 11.14) and not following a normal diet pattern for ≥ 4 days/week (AOR 8.22, 95 % CI = 3.61 – 18.74) were found to be the diet related factors for having poor glycaemic control in the multivariate logistic regression model. Influencing dietary factors on good glycaemic control need to be taken into account for comprehensive management and better outcome of DM.

Keywords: Batticaloa, diabetes mellitus, dietary practice, good glycaemic control.

INTRODUCTION

The prevalence of diabetes mellitus (DM) has become more widespread in developing countries (WHO, 2016). In Sri Lanka, around 1.5 million adults suffer from DM and the numbers are expected to rise up to 2.1 million by the year 2030 (Somasundaram *et al*., 2013). The recent prevalence of DM for Sri Lankans was 10.3 % and the prevalence was high in urban than rural population (Katulanda *et al*., 2008). Premaratne *et al*. (2005) projected a rise of 36 % in the incidence of hospitalisations due to DM in 2010 compared to 2005 among Sri Lankan adults.

Glycaemic control becomes the major therapeutic objective in the prevention of organ damage and other complications among DM patients (Kamuhabwa & Charles, 2014). Understanding the significance of nutrition therapy, physical activity and regular medication is important for the effective management of blood sugar levels (Ministry of Health, 2014). At the same time, nutrition therapy is an integral part as well as the keystone of diabetes self-management (Folorunso & Oguntibeju, 2013) in preventing or at least slowing the rate of developing complications (ADA, 2008).

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Further, it is an essential component in the management of DM for reducing new complications (Medagama & Widanapathirana, 2015).

The adoption of proper dietary habits is essential in the control of DM for the prevention of acute and chronic complications (Queiroz *et al*., 2010). The diet for patients with DM need not be a separate one or completely different from the normal diet (Kisokanth *et al*., 2016). Better glycaemic control would be achieved among patients with DM by practicing healthy diet habits through obtaining assistance from a dietitian and/ or a diabetes educator. In addition, adopting healthy eating practices with recommended food for achieving good glycaemic control daily bring both acute and long term effects among DM patients (Jayawardena *et al*., 2012), and the American Diabetes Association has also recognised it (ADA, 2017). Further, each patient with DM should be actively involved with his or her healthcare provider to develop an individualised dietary plan (ADA, 2017). Physicians are frequently challenged with the task of motivating patients to follow healthy eating for improving the patients' diabetes control and to slow the occurrence of complications of the disease (Fowler, 2010).

The most challenging part of the treatment plan among many DM individuals is determining what to eat and how to eat. There is no ideal conclusive eating pattern that is of benefit to all the individuals with DM (Wheeler *et al*., 2012). But, some foods need to be added or avoided with the proper food intake patterns for the maintenance of good glycaemic control among the patients with DM. A number of nutritional factors have been found to influence better management of DM (Evert *et al*., 2014). Better understanding of the dietary factors on the improvement in diabetes control is warranted to help health professionals for successful glycaemic control. Therefore, the study was aimed at determining the diet related factors for good glycaemic control among patients with DM in the Teaching Hospital, Batticaloa.

METHODOLOGY

Study design

This unmatched (1:2) case control study was conducted among patients with DM at the Medical Clinic, Teaching Hospital, Batticaloa. This study compared a group of patients with DM who have had good glycaemic control (cases) with a group of patients with DM who have had poor glycaemic control (controls) with respect to a number of diet related factors. A case in this study was defined as a patient with DM who had fasting blood sugar less than or equal to 110 $mgdL^{-1}$ in at least last 3 consecutive occasions during the last 6 months and control was defined as a patient with DM who had fasting blood sugar more than or equal to 111 $mgdL^{-1}$ in at least last 3 consecutive occasions during the last 6 months.

Fasting blood glucose of 110 $mgdL^{-1}$ or less was considered as better control of glycaemia among patients with DM (Ministry of Health Care and Nutrition, 2007). Further, the American Association of Clinical Endocrinologists (AACE) and the American College of Endocrinology (ACE) emphasised that fasting blood glucose should be targeted less than 110 $mgdL^{-1}$ (AACE/ ACE, 2015) and levels more than 110 $mgdL^{-1}$ were associated with substantial cardiovascular risk.

Study participants and size

The participants included in this study were patients who have lived at least for 2 years in the Batticaloa District with DM, diagnosed at least 2 years ago, treated with oral hypoglycaemic agents or insulin or both or diet alone, and age of above 30 years. Patients who refused to give consent for participating in the study, patients with gestational DM and patients having any physical discomfort or pain due to surgery or ulcers when attending the medical clinic were excluded from the study. The sample size was calculated for unequal case control ratio (Schlesselman & Schneiderman, 1982). Expose rate among controls was considered as 50 % and odds ratio was 2. Calculated sample size for case was 113 and the control was 226.

Study instrument and validation

A validated pre-tested seven-day dietary diary was used by the author for obtaining the information on each patient's dietary practices along with their sociodemographic details. Each patient was asked to fill the seven-day dietary diary with the food and beverages that would be consumed in 3 main meals and 2 snacks for the next 7 days.

The seven-day dietary diary was prepared in English initially. Then, it was translated to Tamil language by two independent language experts, where they were requested by the author to retain the original structure and content as much as possible. The translated seven-day dietary diary was compared by the two bilingual English - Tamil experts. The author discussed some variations with the two experts and consensual alterations were made. The agreed Tamil version of the seven-day dietary diary was

translated back to English by the two bilingual English - Tamil experts. The back-translated version was again checked with the original version of seven-day dietary diary by the author for consistency and accuracy of the information. However, only a few discrepancies were found and were corrected again after discussions with the expert translators. Judgemental validity was carried out to assess the validity of the Tamil version of the seven-day dietary diary. The Tamil version and the original English version of the seven-day dietary diary were sent to three nutritionists who were treating patients with DM. These nutritionists were fluent in reading, writing and speaking the Tamil and English Languages. All experts did some overall changes especially on the wording and the understanding in the local context. These changes were attended to by the author.

Pre-testing of study instrument

The seven-day dietary diary was pre-tested for acceptability, comprehension and to assess the clarity and suitability of the words used, at the Base Hospital, Kaluwanchikudy, Sri Lanka. Modifications were made based on the clarifications. After that, pilot testing was conducted at the same hospital to identify the potential problems in carrying out the study and to assess the time needed to carry out the study properly.

Data collection

The administration of the Tamil version of the seven-day dietary diary was carried out by the trained data collector after obtaining socio-demographic information. The data collection was carried out in Medical Clinics, Teaching Hospital, Batticaloa on clinic days from Monday to Friday. The nurse in-charge of the clinic recruited the cases and controls from clinic according to the inclusion and exclusion criteria of the study. These patients were sent to the data collector. The data collector was not aware whether the patient is a case or a control. Repetition was avoided by using the patient's clinic registration number and clarified with the patient while selecting. At the time of recruitment, written consent was obtained from each participant. An information sheet outlined the objectives as well as the maintenance of anonymity for research purposes. None of the patients refused to participate in the study. Each patient was given a seven-day dietary diary to fill the type of food and beverages they would consume for 3 main meals and 2 snacks every day during the following 7 days. This seven-day dietary diary was given along with a self-addressed stamped envelope of the author. Each patient was advised on how to fill the dietary diary and requested to post it on the 8th day.

Glycaemic index (GI) and portion size determination

The foods or combination of foods for breakfast and dinner from the seven-day dietary diary was assigned to one of the following three categories; low, medium and high glycaemic index, based on previous studies carried out in Sri Lanka (Pirasath *et al*., 2010; 2013; 2015a; 2015b; Ministry of Health, 2014). Portion size of fruit consumed by the participants was determined according to Jayawardena *et al*. (2012). A good lunch was defined as 1/4 plate of rice with 3 vegetable curries (1/2 plate) and 1 piece of fish or chicken or an egg (protein component 1/4 plate). A normal diet pattern per day was defined as 3 main meals plus 2 healthy snacks per day (Ministry of Health, 2014).

Statistical analysis

The analysis for identifying factors associated with good glycaemic control started with simple univariate analysis followed by multivariate logistic regression using statistical package for the social sciences (SPSS) software version 20.

Unadjusted odds ratio (OR) with 95 % confidence interval (CI) of the results was used to test the significance of the differences observed. Odds ratio is a better index of assessing the casual relationship between variables and diseases as it is the ratio of the odds among cases to the odds among the controls (Hennekens & Buring, 1987). A probability of < 0.05 was considered as statistically significant.

Multivariate analysis was used to control the independent and intervening variables upon one another (confounding). Covariates that were insignificant at the multivariate level were dropped consecutively from the model after careful assessment of confounding. The final model was selected on the basis of theoretical and statistical significance of factors associated with good glycaemic control. The type 1 error rate was set at 0.05. The model estimates are presented with the adjusted odds ratios (AOR) and 95 % CI.

Ethical clearance

Ethical approval (ERC No: 627/12) was obtained from the Ethics Review Committee, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka. Permission was obtained from the Director, Teaching Hospital, Batticaloa prior to the study. The study procedure was explained in detail and written informed consent was obtained from all the participants. Data obtained were kept under lock and key. Privacy and

confidentiality of the subjects were ensured throughout the study. The research findings were used for academic purposes only.

RESULTS AND DISCUSSION

Socio-demographic details of the participants

A total of 339 patients were included (113 good glycaemic control and 226 poor glycaemic control) in this study. The response rate was 80.8 % (n = 274). Among them, 77 (68.1 %) patients were in good glycaemic control while 197 (87.2 %) patients were in poor glycaemic control. Two hundred and seventy four (274) participants were interviewed, of which 197 (71.9 %) were females. Nearly 47 % of participants were in the age of ≥ 60 years. More than half of the participants in both groups had obtained school education up to GCE Ordinary Level (O/L). Most of the participants (72.6 %) were married. Further, 76.3 % of the participants were physically inactive/ had no employment. None of the sociodemographic factors showed a statistically significant difference between the two groups ($p > 0.05$) except place of residence ($p = 0.02$) (Table 1).

Table 1: Socio-demographic characteristics of the participants

Socio-demographic characteristics	Poor glycaemic control (n = 197) n (%)	Good glycaemic control (n = 77) n (%)	Total (n = 274) N (%)	p value
Gender				0.06
Male	49 (24.9)	28 (36.4)	77 (28.1)	
Female	148 (75.1)	49 (63.6)	197 (71.9)	
Age (years)				0.77
30 – 39	7 (3.6)	3 (3.9)	10 (3.6)	
40 – 49	25 (12.7)	12 (15.6)	37 (13.5)	
50 – 59	74 (37.5)	24 (31.2)	98 (35.8)	
≥ 60	91 (46.2)	38 (49.1)	129 (47.1)	
Education level				0.73
No schooling	13 (4.6)	4 (5.2)	17 (6.2)	
Up to grade 5	46 (23.4)	15 (19.5)	61 (22.3)	
Up to O/L	117 (59.4)	45 (58.4)	162 (59.1)	
Up to A/L and above	21 (10.7)	13 (16.9)	34 (12.4)	
Monthly income (Rs)				0.12
Low (< 10,000)	152 (77.2)	55 (71.4)	207 (75.5)	
Middle and above (≥ 10,000)	45 (22.8)	22 (28.6)	67 (24.5)	
Marital status				0.59
Married	146 (74.1)	53 (68.8)	199 (72.6)	
Unmarried	10 (5.1)	5 (6.5)	15 (5.5)	
Living together	1 (0.5)	0 (0.0)	1 (0.4)	
Separated/ divorced	3 (1.5)	2 (2.6)	5 (1.8)	
Widowed	37 (18.8)	17 (22.1)	54 (19.7)	
Employment				0.20
Physically active	42 (21.3)	23 (29.9)	65 (23.7)	
Physically inactive	155 (78.7)	54 (70.1)	209 (76.3)	
Place of residence				0.01
Urban	129 (65.5)	37 (48.1)	166 (60.6)	
Rural	68 (34.5)	40 (51.9)	108 (39.4)	

Factors related to consumption of fruits and vegetables

The importance of adopting healthy eating habits has been identified as an essential measure for the prevention of acute and chronic complications in patients with DM (ADA, 2017). However, a few studies have evaluated the impact of eating habits in the metabolic control of patients with DM. In this study, multivariate logistic regression was applied to the control for confounding factors and to predict the variables for poor glycaemic control.

In the present study, patients who did not consume fruits (at least one serving in a week) were nearly at 3 times higher risk of getting poor glycaemic control than those who ate fruits except mango and jackfruit at least one serving in a week (AOR 2.83, 95 % CI = 1.03 – 7.76). This finding was supported by Thompson *et al.* (2012) that showed consumption of a high-fruit diet had a tendency towards improvement of glycosylate haemoglobin (HbA1c) in patients with DM. Also, avoiding high glycaemic index (GI) fruits especially, dates, jackfruit and mango would improve the glycaemic control among DM patients (Ministry of Health, 2014). Further, a Canadian study confirmed that low GI fruit consumption was significantly associated with lower HbA1c among DM patients (Jenkins *et al*., 2011). However, consumption of fruits in day-to-day life among the study participants was very minimal. It was supported by a Sri Lankan study carried out among DM patients that stated only one fourth of the participants consumed the recommended portion of fruits daily and 33 % did not consume fruits at all (Medagama & Widanapathirana, 2015).

In this study, patients who had consumed any yam, specially potato (*Solanum tuberosum*) and manioc (*Manihot esculenta*) were nearly at 5 times higher risk of getting poor glycaemic control than those who had not consumed potato and/or manioc at all (AOR 4.75, 95 % CI = 1.61 – 14.07) (Table 2). The habitual consumption of yams has adversely affected the glycaemic control of study participants. Those who had received advice from

Table 2: Fruits and vegetables related factors between poor and good glycaemic controls

Variables	Poor glycaemic control (n = 197) n %	Good glycaemic control (n = 77) n %	Unadjusted odds ratio (95 % CI)	Adjusted odds ratio (95 % CI)
Consumed at least one serving of fruit/week				
No	80 (40.6)	14 (18.2)	3.08 (1.61 – 5.87)	2.83 (1.03 – 7.76)
Yes	117 (59.4)	63 (81.8)		
Included adequate vegetables in lunch for ≥ 4 days/ week	117 (59.4)	15 (19.5)	6.05 (3.21 – 11.37)	1.31 (0.52 – 3.28)
No	80 (40.6)	62 (80.5)		
Yes				
Consumed bitter gourd at least once/week				
No	150 (76.1)	37 (48.1)	3.45 (1.98 – 6.01)	2.23 (1.01 – 4.95)
Yes	47 (23.9)	40 (51.9)		
Consumed Kurinja leaves at least once/week				
No	166 (84.3)	54 (70.1)	2.28 (1.23 – 4.24)	2.49 (1.01 – 6.17)
Yes	31 (15.7)	23 (29.9)		
Consumed potato and manioc (any yams)				
Yes	78 (39.6)	7 (9.1)	6.56 (2.87 – 15.00)	4.75 (1.61 – 14.07)
No	119 (60.4)	70 (90.9)		

the healthcare provider at the clinic had not consumed any root vegetables at all, especially manioc and potato and obtained good glycaemic control. This is mainly due to the reason that manioc and potato have higher glycaemic index (> 75 %), which would increase the blood glucose level (Ministry of Health, 2014; Pirasath *et al*., 2015b).

Further, those who had not added bitter gourd (*Momordica charantia*) in their meal at least once in a week were nearly at 2 times higher risk of getting poor glycaemic control than those who had added bitter gourd in their meals once in a week (at least 1 tablespoon) (AOR 2.23, 95 % CI = 1.01 – 4.95). Similarly, patients who had not included Kurinja leaves (*Gymnema sylvestre*) in their meals at least once in a week were at 2.5 times higher risk of getting poor glycaemic control than those who had added Kurinja leaves in their meals at least once in a week (at least 1 tablespoon) (AOR 2.49, 95 % CI = 1.01 – 6.17). The consumption of bitter gourd was found to be effective in obtaining good glycaemic control in this study. Similarly, several animal studies proved that bitter gourd has a significant effect on the reduction of blood glucose level and increased plasma insulin concentration (Ahmad *et al*., 1999; Vikrant *et al*., 2001; Kar *et al*., 2003). Another study carried out in Sri Lanka among diabetic adults stated that most participants came up with a list of 'special' food items that had helped them to control blood sugar in addition to their medications such as fenugreek seeds ('Uluhal'), bitter gourd and curry leaves (Ranasinghe *et al*., 2015). Further, it was mentioned in a study conducted in Pakistan among patients with diabetes that majority of the participants believed that not consuming root vegetables while

Table 3: Diet pattern related factors between good and poor glycaemic controls

Variables	Poor glycaemic control (n = 197) n (%)	Good glycaemic control (n = 77) n (%)	Unadjusted odds ratio (OR) (95 % CI)	Adjusted odds ratio (AOR) (95 % CI)
Type of rice use for ≥ 4 days/week				
White	89 (45.2)	14 (18.2)	3.71 (1.95 – 7.06)	1.93 (0.82 – 4.57)
Red	108 (54.8)	63 (81.8)		
Type of food consumed for breakfast for ≥ 4 days/week				
Medium GI food	60 (30.5)	10 (13.0)	2.93 (1.41 – 6.09)	2.46 (0.93 – 6.51)
Low GI food	137 (69.5)	67 (87.0)		
Type of lunch used for ≥ 4 days/week				
Bad	159 (80.7)	27 (35.1)	7.75 (4.31– 13.93)	4.64 (1.93 –11.14)
Good	38 (19.3)	50 (64.9)		
Type of food used for dinner for ≥ 4 days/week				
Medium GI food	79 (40.1)	15 (19.5)	2.77 (1.47 – 5.21)	1.31 (0.56 – 3.07)
Low GI food	118 (59.9)	62 (80.5)		
Normal diet pattern for ≥ 4 days/week				
No	168 (8.3)	26 (33.8)	11.36 (6.14– 21.02)	8.22 (3.61 – 18.74)
Yes	29 (14.7)	51 (66.2)		
Consumption of sugar				
Yes	136 (69.0)	31 (40.3)	3.31(1.92 – 5.71)	0.96 (0.43 – 2.16)
No (Never)	61 (31.0)	46 (59.7)		

regular use of bitter gourd could manage diabetes well (Rafique *et al*., 2006). Furthermore, another Sri Lankan study found that bitter gourd was the most frequently consumed herbal remedy (65.8 %) for better glycaemic control among DM patients (Medagama *et al*., 2014).

Diet pattern related factors

In the present study, patients who consumed a bad lunch for 4 or more days per week were nearly at 5 times higher risk of getting poor glycaemic control than those who had consumed a good lunch for 4 or more days per week (AOR 4.64, 95 % CI = 1.93 – 11.14). In addition, patients who had not followed a normal diet pattern for 4 or more days were at 8 times higher risk of getting poor glycaemic control than those who had a normal diet pattern for 4 or more days per week (AOR 8.22, 95 % CI = 3.61 – 18.74) (Table 3).

In the present study, a good glycaemic control was observed among those who consumed adequate vegetables for their lunch (good lunch) for most of the days in a week when compared to their counterparts. Similarly, it was emphasised by Medagama and Widanapathirana (2015), that adding both fruits and vegetables to a rice meal have shown beneficial effects on glycaemic control among type 2 diabetes mellitus (T2DM) patients. Further, a study by Kameyama *et al.* (2014) proved that postprandial glucose has been reduced by adding vegetables to rice-based meals among healthy Japanese men. It could be explained that the daily intake of green leafy vegetables and the quantity consumed were inadequate to obtain beneficial effects among Sri Lankan DM patients (Senadheera *et al*., 2016). Further, patients who had consumed low glycaemic index (GI) food for their breakfast and dinner for most of the days per week had the chance of having good glycaemic control among the study participants. A meta-analysis study emphasised that there was a significant reduction in HbA1c levels among those who had received low GI diets compared to high GI diets (Thomas & Elliott, 2010), and a Sri Lankan study concluded lower GI diets as better choices for better glycaemic control (Pirasath *et al*., 2015a). It could be explained that low GI foods supply glucose gradually into the bloodstream, which thus contributes to improve the glycaemic control (Jenkin *et al*., 1981). At the same time, low GI diets increase insulin sensitivity by minimising fluctuations in blood glucose levels and reducing the secretion of insulin over the day (Crapo *et al*., 1977). Thus, adding a low GI diet appears to be an effective method to improve glycaemic control among DM patients and would be considered as a part of management.

In addition, patients who followed the normal diet pattern also achieved good glycaemic control. This was evident in a study where adequate glycaemic control was achieved among diabetes patients who had the habit of eating breakfast and dinner regularly (Orbey *et al*., 2007). Also, eating at regular intervals with 3 main meals and 2 healthy snacks helps to prevent high blood glucose among patients with diabetes (Ministry of Health, 2014).

In addition, more effective self-management of DM would result from the mindfulness training of the patients on what they should or should not eat (Sowattanangoon *et al*., 2009). Although there is no ideal recommended eating pattern for successful glycaemic control, there are a few foods and dietary practices to be followed. When recommending foods and dietary practices, the culture, knowledge, health beliefs and availability and affordability of the foods should be considered.

CONCLUSION

A good glycaemic control is possible among DM patients by practicing the recommended dietary patterns. Consuming at least one serving of recommended fruits in a week, consuming bitter gourd at least one tablespoon in a week, consuming Kurinja leaves at least one tablespoon in a week, and not consuming any yams at all, were found to be significant dietary related factors for having good glycaemic control. Further, having a good lunch and a normal diet pattern for $\geq$ 4 days/week were also found to be significant dietary related factors for having good glycaemic control. At present, the compliance to recommended dietary practices is poor. Adherence to the acceptable dietary practices contributes to better self-management among diabetic patients through enabling healthcare workers.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this study

Acknowledgement

The authors thank all the patients participated in this study, and the Director, Consultant Physicians and Nurse in-Charge of the Medical Clinic, Teaching Hospital, Batticaloa.

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