Higher body mass index and lower intake of dairy products predict poor glycaemic control among Type 2 Diabetes patients in Malaysia

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Abstract

This cross-sectional study was designed to determine factors contributing to glycaemic control in order to provide better understanding of diabetes management among Type 2 Diabetes patients. A pre-tested structured questionnaire was used to obtain information on socio-demographic and medical history. As a proxy measure for glycaemic control, glycosylated haemoglobin (HbA1c) was obtained as secondary data from the medical reports. Perceived self-care barrier on diabetes management, diet knowledge and skills, and diet quality were assessed using pretested instruments. With a response rate of 80.3%, 155 subjects were recruited for the study. Mean HbA1c level of the subjects was 9.02 ± 2.25% with more than 70% not able to achieve acceptable level in accordance to WHO recommendation. Diet quality of the subjects was unsatisfactory especially for vegetables, fruits, fish and legumes as well as from the milk and dairy products group. Higher body mass index (BMI), poorer medication compliance, lower diet knowledge and skill scores and lower intake of milk and dairy products contributed significantly on poor glycaemic control. In conclusion, while perceived self-care barriers and diet quality failed to predict HbA1c, good knowledge and skill ability, together with appropriate BMI and adequate intake of dairy products should be emphasized to optimize glycaemic control among type 2 diabetes patients.

Introduction

Type 2 Diabetes (T2D) is one of the most common non-communicable diseases with growing incidence worldwide including Malaysia [1–4]. It is a well-established risk factor for cardiovascular diseases, with people with T2D having a higher cardiovascular morbidity and mortality [5]. The glycaemic control among T2D Malaysiane has been reported to be poor [6]. Achieving optimal glycaemic control requires a complex regimen of behaviours that must be followed consistently over a lifetime [7]. Insulin or medication administration and adjustment, self-monitoring of blood glucose (SMBG), and managing food intake represent significant behavioural demands [8]. Although the importance of lifestyle modification is highly emphasized to obtain optimal outcomes in diabetes, low compliance to lifestyle modification is frequently
reported with a significant proportion of patients’ diets remain poorly controlled [9–11]. Prospective studies have consistently shown poor adherence to the dietary recommendations for macronutrient intake, fruit and vegetable consumption in diabetic patients [12–14]. The persistent increasing trend in the total number of T2D patients warrants proper investigation into the determinants of poor glycaemic control among this population. Taking together this study aimed to identify whether perceived self-care barriers, diet knowledge and skills and diet quality contribute to HbA1c level among type 2 diabetics.

Materials and methods

Subjects and study location

This was a cross-sectional analytical study designed to identify factors associated with glycaemic control among individuals with T2D. All subjects were recruited from the Medical Specialist Out-Patient Department of Serdang Hospital, one of the tertiary hospitals in Malaysia. Inclusion criteria included, aged 18–65 years old and had received diabetes care treatment for at least a year prior to the study. Patients who were suffering from severe illnesses such as end stage kidney disease and advanced stages of cancer, which may change/interfere with the nutritional behaviours; pregnant and lactating mothers; patients with frequent hypoglycaemic attacks (at least one attack per week) and modification in type or dosage of medication over the past three months were excluded from the study. Random sampling was used to recruit the eligible subjects into the study. Ethics approvals were obtained from the Research Ethics Committee of the National Medical Research Registry (NMRR) Malaysia and Universiti Putra Malaysia. The study subjects were given both oral and written explanation via subject information sheet and written informed consent was obtained from each subject before enrollment.

Study instruments

All subjects were interviewed by the same researcher using a pre-tested structured questionnaire. Information obtained included socio-demographic background (sex, ethnicity, age, marital status, and household monthly income) while information on duration of diabetes, types of medication, presence of comorbid diseases as well as the latest glycosylated haemoglobin A1c (HbA1c) readings were obtained from individual medical reports as secondary data. Body weight of subject was measured using a TANITA electronic balance scale (TANITA-HD-302) to the nearest 0.1kg. The height of the subjects was measured by using a SECA body meter (SECA-206) to the nearest 0.1cm. Two measurements were taken for body weight and height and the average was recorded. Body Mass Index (BMI) was computed accordingly.

Diet knowledge and skill of subjects on their understanding on the importance of regular meal timing, skill on carbohydrate counting, and matching carbohydrate with physical activity were ascertained using a modified Personal Diabetes Questionnaire (PDQ) [15]. It is a clinically-focused and structured self-report measure that address the prescribed self-care regimen and current behaviour and future readiness to change [16–17]. Maximum possible score was 25 with higher score of diet knowledge and skill indicates better diet knowledge and skill. Perceived barriers to healthy eating, medication and self-monitoring blood glucose (SMBG) were assessed using a 24-item questionnaire, adopted and adapted from previous studies [18–19]. Examples of statements pertaining to diet, medication and SMBG barriers include, “Healthy foods are often not available when it is time for me to eat”, “I feel discouraged due to lack of results (e.g. no weight loss, high blood glucose)” and “feeling discouraged or dislike needles”, respectively. Participants were asked to rate from 1–5 (1 = 1 or more times per day; 2 = 4–6 times per week; 3 = 1–2 times per week; 4 = 1–3 times per month; 5 = never) the extent to how often a stated barrier has made it difficult for them to follow appropriate eating, medication or
SMBG in the past 3 months. Higher summary scores indicate more perceived barriers, with a maximum cumulative score of 120.

Dietary intake of subjects was determined using a 122 structured listing of individual food items semi-quantitative food-frequency questionnaire. For each item on the food list, the subjects were asked to estimate how frequent the food was consumed for the past one month. Number serving for food groups of the subjects was determined based on national dietary guidelines (MDG 2010) [20]. The dietary quality of the subjects was measured using the modified Healthy Eating Index (HEI 2005) [21] which assesses conformance to national dietary guidelines (MDG 2010). The overall HEI score is the sum of 10 dietary components (grains & cereal products, vegetables, fruits, milk & dairy products, fish, meats & legumes, total fat, saturated fat, cholesterol, sodium, variety), weighted equally. Each component of the index has a maximum score of 10 (full compliance) and a minimum score of zero (lack of compliance). The score was calculated proportionately for in between responses. For all components, higher scores reflect better diet quality because the moderation components are scored such that lower intakes receive higher scores. The scores of the 10 components are summed to yield a total score, which has a maximum value of 100. The dietary quality of the subjects was classified into three categories namely, good (score > 80), need improvement (score 51–80) and poor (score < 50) [21].

Statistical analysis

Analyses were performed using the IBM Windows Version 22 (Chicago, IL). Explanatory Data Analysis was carried out to determine the normality and homogeneity of the data. Unless otherwise specified, continuous variables are presented as mean ± standard deviation while categorical variables are expressed as percentage for each item. Multivariate analysis was performed to identify factors that predict the glycaemic control, with HbA1c as the dependent variables. The level of probability, p<0.05 was used to show the level of significance for all the tests.

Results

A total of 155 T2D patients were recruited with a response rate of 80.3%. Respondents were made up of 46.5% males and 53.5% females (Table 1). The mean age of the subjects was 53.0 ± 9.4 years with the males having slightly higher (51.7 ± 9.9 years) mean age than the females (54.0 ± 8.9 years). Approximately one-third of the respondents were older adults. Majority of the subjects (86.5%) were married, with a comparable number of married females and males. Almost all subjects had attended at least some formal education at the primary school level but 2.6% had not received any formal education. The mean number of years of education was 10.5 ± 4.2 years with males having slightly more years than females (t = 5.217, p = 0.001). There were higher numbers of male subjects (44.4%) who had attended tertiary school compared to female subjects (15.7%). The mean duration of diabetes diagnosis was 10.4 ± 10.7 years. Most of the subjects (45.8% males and 38.6% females) had been diagnosed as diabetics for at least 1 to 5 years. A majority of the subjects have more than one comorbid diseases, with only 10.0% without any comorbid disease. The overall average medication compliance rate of the subjects was 94.1 ± 13.9% with majority of the subjects (72.3%) being compliant with the prescribed medication. There were 81.8%, 69.7% and 52.2% of subjects who complied with oral medication, oral medication plus insulin and insulin injection respectively.

Mean BMI of the subjects was 29.38 kg/m² with majority (60.0%) of the diabetic subjects being obese, 24.5% overweight and only 14.2% had normal BMI. Besides, mean HbA1c was
9.02 ± 2.25% indicating that subjects were at high risk of diabetes complications. Only 28.4% of the subjects were able to achieve normal target of HbA1c below 7.5%. Almost a third (32.9%) of the subjects had high levels of HbA1c while 38.7% had HbA1c > 9.5% which predisposed them to very high risk of diabetes complications.

Despite a mean total HEI score of 71.53 ± 10.16, the overall diet quality of the subjects was unsatisfactory, with a majority of them (76.8%) needing to improve their diet quality and only 1.9% had good diet quality. As shown in Fig 1, adequacy of intakes in several food groups namely fruits, milk and dairy products and vegetables were relatively low compared to other food groups. Given that a score of 10 is optimum intake, mean HEI scores on vegetable, fruit, meat, poultry, fish, and legumes as well as milk and dairy products were only 5.41, 4.18, 5.42 and 3.95, respectively. The mean diet knowledge and skill score of the subjects was a low of 9.74 ± 4.08. There were 26.5%, 36.8%, 24.5% of the subjects whose dietary knowledge and skill were very low, low or medium level, respectively. Assessment on perceived self-care barrier on the other hand showed that majority of the subjects (93.5%) have the barrier scores in the range of 91–120, indicating that subjects had severe constraints to good self-care.

As presented in Table 2, the predictors for poor HbA1c were BMI, medication compliance, diet knowledge and skill scores, poor intake of milk and dairy products and increased

### Table 1. Distribution of subjects according to selected characteristics (n = 155).

| Characteristics                        | Male (n = 72) | Female (n = 83) | Total (n = 155) |
|----------------------------------------|--------------|----------------|----------------|
| **Socio-demographic Factors**          |              |                |                |
| Age (Years)                            | 51.7 ± 9.9   | 54.0 ± 8.9     | 53.0 ± 9.4     |
| Marital Status                         |              |                |                |
| Single                                 | 5 (6.9)      | 2 (2.4)        | 7 (4.5)        |
| Married                                | 65 (90.3)    | 69 (83.1)      | 134 (86.5)     |
| Divorced                               | 1 (1.4)      | 0 (0.0)        | 1 (0.6)        |
| Widow/widower                          | 1 (1.4)      | 12 (14.5)      | 13 (8.4)       |
| **Education (years)**                  |              |                |                |
| None                                   | 0 (0.0)      | 4 (4.8)        | 4 (2.6)        |
| Primary                                | 7 (9.8)      | 24 (29.8)      | 31 (20.0)      |
| Secondary                              | 33 (45.8)    | 42 (50.6)      | 75 (48.4)      |
| Tertiary                               | 32 (44.4)    | 13 (15.7)      | 45 (29.0)      |
| **Body Mass Index (BMI) (kg/m2)**      |              |                |                |
|                                        | 29.70 ± 5.96 | 29.09 ± 6.39   | 29.38 ± 6.18   |
| Total HEI Score                        | 69.11 ±11.00 | 94.1 ± 14.9    | 71.53 ±10.16*  |
| **Diet knowledge and skill score**     |              |                |                |
|                                        | 9.63 ± 3.96  | 9.84 ± 4.21    | 9.74 ± 4.08    |
| Perceived self-care barrier score      | 105.54 ±12.98| 107.70 ± 9.40  | 106.69 ± 11.22 |
| HbA1c (%)                              | 9.12 ± 2.24  | 8.94 ± 2.26    | 9.02 ± 2.25    |
| **Medical related Information**        |              |                |                |
| Duration of diagnosis (years)          | 9.5 ± 8.0    | 11.2 ± 12.6    | 10.4 ± 10.7    |
| **Presence of comorbid diseases**      |              |                |                |
| None                                   | 8 (11.1)     | 7 (8.4)        | 15 (9.7)       |
| Hypertension                           | 12 (16.7)    | 14 (16.9)      | 26 (16.9)      |
| Hyperlipidemia                         | 10 (13.9)    | 14 (16.9)      | 24 (15.5)      |
| Multiple comorbid diseases             | 40 (55.5)    | 48 (57.8)      | 88 (56.6)      |

Data presented as mean ± SD or frequency (percentage)

* significant different between sex at p<0.01

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intake of vegetables which in total contributed significantly to HbA1c level with the final model explaining 20.0% of the variables (R = 0.517, Adjusted R² = 0.200, F = 3.953), with the estimated model: HbA1c = 12.41 + 0.063 BMI—0.026 medication compliance—0.125 diet knowledge and skill score—0.601 milk and dairy products intake + 0.286 vegetables intake. The remaining of 80.0% of the variance may be caused by factors such as physical activity, professional factors and others which were not studied in this study. Other factors such as self-care barriers or total HEI score (measures for diet quality) failed to predict HbA1c significantly.

Table 2. Multiple linear regression for factors contributing to HbA1c.

| Predicted of Risk Factors          | Unstandardized Coefficients | T     | Sig.  |
|-----------------------------------|-----------------------------|-------|-------|
| Constant                          | 12.41                       | 5.408 | 0.000 |
| BMI                               | 0.063                       | 0.172 | 2.234 | 0.027 |
| Medication compliance             | -0.026                      | -0.226| -2.102| 0.037 |
| Diet knowledge and skill score    | -0.125                      | -0.163| -2.996| 0.003 |
| Milk and dairy products intake    | -0.601                      | -0.205| -2.680| 0.008 |
| Vegetables intake                 | 0.286                       | 0.197 | 2.453 | 0.015 |

R = 0.517, R² = 0.267, R² adjusted = 0.200, F = 3.953, Sig-F = 0.000

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Discussion

The mean age of the subjects in the current study was slightly lower than other local studies among diabetics [6, 22–24]. In the current study, subjects were knowledgeable and were able to seek appropriate treatment and management for their diabetes as majority of them had some formal education. The mean duration of the diabetes diagnosis was in line with other local studies [25]. The increasing duration of the diagnosis of diabetes is an alarming sign for proper investigation and diabetes management to prevent higher rates of diabetes-related complications and premature mortality. By using the non-compliance definition from other studies [26–27], the current study reported almost one third of the subjects failed to comply with the medication prescribed. This finding was in agreement with several studies which found that medication compliance ranged between 36–93% [28–29]. Majority of subjects were able to discipline themselves to comply with oral medication but not insulin. Approximately half of the subjects failed to comply with the daily insulin injections. With the increasing complexity of the medication, a declining trend of compliance has been observed in the current study. The possible reasons attributed to non-compliance in both oral medication plus insulin and insulin only groups were the fact that the subjects had difficulty in assessing accurately insulin levels or insulin injection [30–32] and subjects’ own perception or emotional phobia towards insulin [33–35]. Non-compliance to drug prescription is highly prevalent and had been linked to increase in morbidity, mortality, and medical treatment costs. Thus, strict supervision and proper guidance is highly needed to improve low compliance to insulin injection.

Majority of the subjects were either overweight or obese regardless of sex. Similar scenario was reported in other countries [36–37]. Given that obesity reduces insulin sensitivity [38] and predisposes individuals to abnormal cardio metabolic profiles such as increased waist circumference with increased visceral adiposity and inflammatory adipokines, insulin resistance, elevated triglycerides, decreased high-density lipoprotein cholesterol, and lead to hypertension [39], there is an urgent need for weight management intervention. Mean BMI of subjects was higher than that of the National Diabetes Registry Malaysia (2009) [40]. Such finding definitely warrants further investigation.

Studies had consistently reported low vegetable intakes among Malaysian adults [4, 41–42]. The current findings are in concordance with Federal Agriculture Marketing Authority of Malaysia who reported the reduction in the consumption of vegetables per capita for Malaysians from 2006 to 2013 [43]. The reason for the decline in the consumption of vegetables may be due to bitterness, pungency and astringency compounds in vegetables [44–45]. The HEI scoring for fruit group was low (4.18 out of 10), as 81.9% of the subjects were unable to achieve two servings of fruits per day. These findings however is on contrast to reported increase in per capita fruits consumption over time for Malaysian [43]. However, such findings were not unexpected as earlier study documented that diabetes patients will try to refrain from having fruits in their meal as fruits are considered “too sweet” for them [46]. Despite consumption of milk per capital for Malaysian was relatively higher than Thailand, China and the Republic of Korea [47–48], inadequate intakes of milk and dairy products was evident in the present study as a majority of subjects (83.9%) failed to fulfil their minimum daily recommendation. Our finding was in congruent with the national dietary survey where only 15% of the Malaysian consumed milk on daily basis [41]. Milk and dairy products are not habitual Malaysian food items unlike Western populations. The belief that dairy products are fattening [49] and hence can impaired good glycaemic control among diabetics can partly explain the low consumption of milk and dairy products among diabetics in this study. Earlier local studies also documented that dairy products were the least-frequently consumed foods among T2D patients [46]. With
regards to the protein group (meat, fish, poultry, eggs, legumes), a subgroup analysis showed that 76.1% of the subjects had adequate intakes of poultry, meats and egg. This is in-line with national surveillance studies that documented high prevalence of poultry and eggs product consumption among the adult population [41]. Consumption of fish and legumes however were inadequate where a total of 41.3% and 48.4% of the subjects failed to achieve recommended servings for fish and legumes, respectively (data not shown). The overall diet quality of the subjects was unsatisfactory especially in the consumption of vegetables, fruits, fish and legumes as well as milk and dairy products. Therefore in this study many subjects at the “need improvement” level of diet quality. Proper dietary guidance is needed to improve the subjects’ diet quality, to reduce their glycaemic levels [50–51].

Diet knowledge and skill level of the subjects in the present study was lower than other studies [52–53]. Subjects had inadequate diet knowledge and skill in determining appropriate food choices based on nutrients content. On the other hand, given that continuous motivation intervention is crucial for diabetics to choose healthy diets with actual food portion size, using foods exchange list and food calories in order to achieve better glycaemic outcome [54–55], health care providers especially dieticians should emphasize counselling approach which could help to increase diet knowledge and skill among diabetics.

The present study reveals high prevalence of study subjects who had “very high” perceived self-care barrier scores. The barrier score was relatively higher compared to the several studies [56–58]. This could be related to subjects’ depression, low socio-economic status, and lack of diabetes related knowledge. Long-term exposure to the disease can lead to the development of hopelessness, discouraged and disappointed if SMBG always gave an undesirable readings and uncontrolled blood glucose levels as reported by Lin et al. [59] and Ong, Chua and Ng [60]. Better self-care outcome mainly depends on the patient’s knowledge of self-care which also include knowledge of the disease, health-related and care-seeking behaviour [61–63] which are guided and determined by individually and culturally defined beliefs about health, illness and health-care [64].

Mean HbA1c of subjects was higher than other local studies [6, 65–66] putting them at high risk of diabetes complications. A high proportion of the subjects had HbA1c > 9.5% reflecting poor control of glycaemic level according to World Health Organization [67]. Only approximately 10% of the subjects achieved HbA1c of less than 6.5% and this percentage is relatively lower than other local studies [6, 65–66]. Given the overall high mean level of HbA1c and proportion of subjects with poor controlled glycaemic level as well as the low 10% of subjects achieving target HbA1c range, it is worth noting that the glycaemic control among the subjects is poor, despite the good compliance rate for medication. This highlights the urgency for the health care providers to review the treatment approach (e.g. dosage of medication, interval of follow-up, multi-disciplinary approach) for the diabetics.

It is interesting to note that higher intake of milk and dairy products, diet knowledge and skill score and compliance to medication while lower BMI and vegetable intake were associated with lower HbA1c, hence better glycaemic control. Higher medication compliance rate may reduce or control the glycaemic level via several different biological mechanisms. Several research supported the finding of the present study that good adherence to medication were strongly associated with lower HbA1c levels [68–71]. Diet and knowledge score was inversely significantly correlated with HbA1c level. Individuals with better dietary knowledge and skill enabled them to follow the dietary recommendations and were more likely to make the correct food choices and refusing foods high in sugar, calories, and fat [53]. The findings of this study have implications for patient education and clinical practice in Malaysia. By providing the required resources, glycaemic outcome is expected to improve. Body Mass Index was positively associated with higher reading of HbA1c. This emphasizes the
importance of weight management in glycaemic control as majority of the subjects were overweight or obese.

While total diet quality did not contribute to HbA1c significantly, our findings was in congruence with a majority of the previous prospective studies [72–74], systematic review [75] or meta-analysis [76] which reported an inverse relationship between intakes of dairy product and risk of diabetes, but not in others [77–80]. There is an increasing interest in the potential role that dairy products play in diabetes etiology. Previous studies showed that milk proteins have insulinotropic properties and appear to induce rapid release of insulinotropic amino acids and incretin hormones [81–82], which may explain its benefit to glycaemic control. The discrepancies in findings with others [77–80] could be largely be attributed to the used of different types of dairy products in the different studies, with evidence generally favoring the low fat dairy and low fat fermented dairy product specifically yogurt, compared to whole milk [73, 83–85]. Fat content especially saturated fat in dairy products is generally being thought of as being able to offset the benefits of the potentially protective dairy components such as calcium, magnesium, vitamin D and whey proteins [75]. Nonetheless the present study did not study the influence of the types of dairy products on glycaemic control, because evidence favors the consumption of low fat dairy products compared to whole milk dairy products [79, 84–85]. Malaysian are in general non-habitual milk drinkers with milk consumption falling markedly among the children and adolescents. The present findings add to the evidence that low fat dairy products fit well into a healthy eating pattern and hence consumption should be promoted. As dairy products are diverse in structure, composition, and usage and are produced by a variety of methods, including fermentation, further research is warranted on the specific type of dairy products in relation to glycaemic control to elucidate its potential clinical role on optimal glycaemic control among diabetes patients. On the other hand, as there are studies showing that dairy fats may be more beneficial than other animal-derived fats in modulating risk of diabetes [86–87], suggesting food sources of fat instead of type of fats may be more imperative in determining risk of diabetes. Hence, more research that spans nutritional epidemiology and dietary public health that underpins the possible associations between dairy products consumption and glycaemic control are deemed necessary.

Intake of sufficient amounts of fruit and vegetables is recommended as a part of a healthy diet, in view of the presence of considerable protective constituents, including potassium, folate, vitamins, fiber, anti-oxidant content and phenolic compounds [88–89]. However, the mechanisms by which fruit and vegetables reduce the risk of type 2 diabetes have not been precisely elucidated. To date, many epidemiological studies have examined the association between fruit and vegetable intake with risk of diabetes or glycaemic control and the results are not entirely consistent. While some studies showed an inverse association with risk of diabetes or lower HbA1c with higher intakes of total fruit [90–92] and total vegetables [93–94], other studies did not [78, 95]. Our data suggest that fruit consumption is not associated with better glycaemic control in this population. Other studies have found similar results [94, 96–99]. The high fructose content of fruit may counteract the protective effect of antioxidants, fiber, and other antidiabetic compounds of fruit [98] as sugars containing fructose have been suggested to play a major role in the development of hypertension, obesity, diabetes and metabolic syndrome [100]. More research is needed to investigate the association between fructose content in fruit and health outcomes. On the other hand, our findings of a positive contribution of vegetables intake towards higher HbA1c was not seen in other studies [90, 93, 99, 101] and should be interpreted cautiously. We do not have a ready explanation for this finding but are speculating that the common cooking methods for vegetables in this population may partially explain this unexpected finding. Having vegetables consumed in a salad is not common in Malaysia as vegetables are often stir-fried or cooked with water or coconut milk. The high
total fat or saturated fat content of cooked-vegetables may offset the benefits of other components of vegetables such as lignans, phytates and polyphenols, which are known for their antioxidant properties. The present study reveals that it is insufficient to convey public health messages about overall vegetable intake, but that a more direct messages identifying the type of vegetables and how they should be prepared are required. We suggest that caution should be observed in the recommendation of vegetable intake in an effort to provide healthier options. Besides vegetable intakes, dietitians and nutritionists should highlight the importance of preparation of vegetables in favor of raw, less oily, and coconut milk free cooking methods. On the other hand, as only total vegetable intakes was assessed in this study without information on the consumption of green leafy vegetables, the actual correlation between vegetables intake and glycaemic control cannot be elucidated clearly. Protective role of vegetables on risk of diabetes depends on type of vegetables. While green vegetable have been found to reduce risk to diabetes [90–91, 95], total vegetable intakes, yellow and red vegetables were not found to be beneficial in several studies [90–91]. In this study there was no significant correlation between HbA1c with age, education, income, duration of diabetes diagnosis and self-care barrier score in the multivariate analysis. These findings failed to support earlier studies [102–106] where number years of education, income, duration of diabetes diagnosis or self-care barrier were correlated with glycaemic control.

This study was in agreement with Jansen et al. [107] who reported that variance of HbA1c predicted by patients’ characteristics was relatively low compared to genetics factors. On the other hand, despite the variance of HbA1c predicted in this current study being lower than that reported by Egan et al. [108], it was comparable with other studies which reported that the variance of HbA1c predicted only ranged from 12–22% [109–111]. The dissimilarities of the findings may be attributed by difference in the type of predictors included in the model. The variance in the contribution of HbA1c in the present study can be further improved with large-scale populations recruited.

**Conclusion**

Despite self-care barriers and diet quality failed to predict HbA1c, higher diet knowledge and skill score significantly contributed to better glycaemic control. On the other hand, factors that were found to predict poor glycaemic control are highly modifiable (BMI, medication compliance, diet knowledge and skill score, intakes of milk and dairy products). This study provides an insight on glycaemic control among diabetic patients, which can be a good reference for future studies. It is believed that through appropriate strategies, the glycaemic control among the type 2 diabetics can be greatly improved.

**Limitation of the study**

This was a cross-sectional analytical study and the cause and effect relationship cannot be determined. Another limitation of this study was the use of non-probability sampling method in the selection of study location. It may not be a representative study that could be generalized for the whole population of T2D patients. Besides, this study only involved a small-scale population which could be too small to represent the whole population of the type 2 diabetes mellitus patients. Dietary recall bias where subjects could not remember clearly the frequency or type of foods that they have consumed in the past one month could have been a shortcoming in this study. However steps like the use of a validated food frequency questionnaire was used to overcome some of the limitations.
Supporting information
S1 Dataset. Data sps.
(XLSX)

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References
1. Institute of Public Health. National Health Morbidity Survey (NHMSII), Institute of Public Health, Ministry of Health, Malaysia. 1996.
2. Institute of Public Health. National Health Morbidity Survey (NHMSIII). Institute of Public Health, Ministry of Health, Malaysia. 2006.
3. Institute of Public Health. National Health Morbidity Survey (NHMS). Institute of Public Health, Ministry of Health, Malaysia. 2011.
4. Institute for Public Health. National Health and Morbidity Survey 2015 (NHMS 2015). Vol. II: Non-Communicable Diseases, Risk Factors & Other Health Problems. 2015.
5. Gu K, Cowie CC, Harris MI. Diabetes and decline in heart disease mortality in US adults. JAMA. 1999; 281:1291–7. PMID: 10208144
6. Mastura I, Chew BH, Lee PY, Cheong AT, Sazlina SG, Jamaiyah H, et al. Control and treatment profiles of 70,889 adult type 2 diabetes mellitus patients in Malaysia: A cross sectional survey in 2009. Int J Collaborative Res Intern Med Public Health, 2011; 3(1):98–113.
7. Lane JD, Mccaskill CC, Williams PG, Parekh P, Feinglos MN, Surwit RS. Personality correlates of glycaemic control in type 2 diabetes. Diab Care. 2000; 23(9):1321 –5.
8. Vallis M, Russiero L, Rossi JS, Greene G, Jones H, Zinman B, et al. Stages of Change for healthy eating in diabetes- Relation to demographic, eating-related, health care utilization, and psychosocial factors. Diab Care. 2003; 26(6):1468–74.
9. Harris M I. Frequency of blood glucose monitoring in relation to glycaemic control in patients with type 2 diabetes. Diab Care. 2001; 24(6):979–82.
10. Maizlish NA, Shaw B, Hendry K. Glycaemic control in diabetic patients served by community health centres. Am J Med Quality. 2004; 19(4):172–9.

11. Monnier L, Grimaldi A, Charbonnel B, Iannascalci F, Lery T, Garofano A, et al. Management of French patients with type 2 diabetes mellitus in medical general practice: Report of the Mediab observatory. Diab Metab. 2004; 30(1):35–42.

12. Nelson KM, Reiber G, Boyko EJ. Diet and exercise among adults with type 2 diabetes: Findings from the third national health and nutrition examination survey (NHANES III). Diab Care. 2002; 25(10):1722–8.

13. Thanopoulou A, Karamanos B, Angelico F, Assaad-Khalil S, Barbato A, Del Ben M, et al. Nutritional habits of subjects with type 2 diabetes mellitus in the Mediterranean Basin: Comparison with the non-diabetic population and the dietary recommendations. Multi-Centre Study of the Mediterranean Group for the Study of Diabetes (MGSD). Diabetologia. 2004; 47(3):367–76. doi: 10.1007/s00125-003-1316-0 PMID: 14730377

14. Virtanen SM, Feskens EJ, Rasanen L, Fidanza F, Tuomilehto J, Giampaoli S, et al. Comparison of diets of diabetic and non-diabetic elderly men in Finland, The Netherlands and Italy. Eur J Clin Nutr. 2000; 54(3):181–6. PMID: 10713738

15. Stetson B, Schlundt D, Rothschild C, Floyd JE, Rogers W, Mokshagundam SP. Development and validation of The Personal Diabetes Questionnaire (PDQ): A measure of diabetes self-care behaviours, perceptions and barriers. Diabetes Res Clin Pract. 2011; 91(3):321–32. doi: 10.1016/j.diabres.2010.12.002 PMID: 21215487

16. Colagiuri R, Eigenmann CA. A national consensus on outcomes and indicators for diabetes patient education. Diab Med, 2009; 26(4):442–6.

17. Funnel M, Brown TL, Childs BP, Haas LB, Hosey GM, Jensen B, et al. National standards for diabetes self-management education. Diab Care. 2010; 33(Suppl. 1):S89–S96.

18. Schlundt D, Pichert JW, Rea MR, Puryear W, Penha MLI, Kline S. Situational obstacles to adherence for adolescents with diabetes. Diabetes Educ. 1994; 20:207–11. doi: 10.1177/014572179402000305 PMID: 7851234

19. Schlundt D, Rea MR, Kline SS, Pichert JW. Situational obstacles to dietary adherence for adults with diabetes. J Am Diet Assoc. 1994; 94:874–6. PMID: 8046181

20. Ministry of Health, Malaysia (MOH). Malaysian Dietary Guideline (MDG). National Coordinating Committee on Food and Nutrition, Ministry of Health, Putrajaya, Malaysia; 2010.

21. Guenther PM, Reedy J, Krebs-Smith SM, Reeve BB, Basioitis PP. Development and Evaluation of the Healthy Eating Index-2005: Technical Report. Center for Nutrition Policy and Promotion, U.S. Department of Agriculture. 2007.

22. Mafaouzy M. Diabetes control and complications in public hospitals in Malaysia. Med J Mal. 2006; 61 (4):477–83.

23. Mafaouzy M, Hussein Z, Chan SP. The status of diabetes control in Malaysia: Results of DiabCare 2008. Med J Mal. 2011; 66(3):175–81.

24. Mastura I, Mimi O, Piterman L, Teng CL, Wijesinha S. Self-monitoring of blood glucose among diabetes patients attending government health clinics. Med J Mal. 2007; 62(2):147–51.

25. Abougalambou SSI, Mafaouzy M, Sulaiman SSS, Abougalambou AS, Hassali MA. Current clinical status and complications among type 2 diabetic patients in Hospital Universiti Sains Malaysia. Int J Diab Mellit. 2010; 2(3):184–8.

26. Baubeng KO, Matowe L, Plange-Rhule J. Unaffordable drug prices: the major cause of non-compliance with hypertension medication in Ghana. J Pharm Pharm Sci. 2004; 7(3), 350–2. PMID: 15576016

27. Holdebarin R, Campbell RJ, Jin YP, Buys YM. Multicentre study of compliance and drop administration in glaucoma. Can J of Ophthal. 2008; 43(4):454–61.

28. Cramer J. A systematic review of adherence with medication for diabetes. Diab Care. 2004; 27 (5):1218–24.

29. Rubin RR. Adherence to pharmacologic therapy in patients with type 2 diabetes mellitus. Am J Med, 2005; 118(5A):27S–34S.

30. Bocuzzi S, Wogen J, Fox J, Sung J, Shah A, Kim J. Utilization of oral hypoglycaemic agents in a drug-insured US population. Diab Care. 2001; 24(8):1411–15.

31. Cramer J, Pugh M. The influence of insulin use on glycaemic control: How well do adults follow prescription for insulin? Diab Care. 2005; 28(1):78–83.

32. Donnan P, MacDonald T, Morris A. Adherence to prescribed oral hypoglycaemic medication in population of patients with type 2 diabetes: A retrospective cohort study. Diab Med. 2002; 19:279–84.
33. Blackburn DF, Swidrovich J, Lemstra M. Non-adherence in type 2 diabetes: Practical considerations for interpreting the literature. Patient Prefer Adher. 2013; 7:183–9.

34. Hassan HA, Tohid H, Amin RM, Long Bidin MB, Muthupalaniappen L, Omar K. Factors influencing insulin acceptance among type 2 diabetes mellitus patients in a primary care clinic: A qualitative exploration. BMC Family Medicine Practice, 2013; 14(164):1–10.

35. Latifah D, Ahmad SY, Reza NK, Azhan NM, Che Ghani CS. Barriers in initiating insulin therapy among patients with type 2 diabetes mellitus at primary health clinic in Kelantan, Ministry of Health, Malaysia. 2010.

36. Siram AT, Yanagisawa R, Skamagas M. Weight management in type 2 diabetes mellitus. Mt Sinai J Med. 2010; 77:533–48. doi: 10.1002/msj.20208 PMID: 20960555

37. Daousi C, Casson IF, Gill GV, MacFarlane IA, Wilding JPH, Pinkney JH. Prevalence of obesity in type 2 diabetes in secondary care: Association with cardiovascular risk factors. Postgrad Med J. 2006; 82(966):280–4. doi: 10.1136/pmj.2005.039032 PMID: 16597817

38. Bassuk SS, Manson JE. Lifestyle and risk of cardiovascular disease and type 2 diabetes in women: A review of the epidemiologic evidence. Am J Lifestyle Med, 2008, 2(3):191–213.

39. Alberti KG, Zimmet P, Shaw J. The metabolic syndrome: A new worldwide definition. Lancet. 2005; 366:1059–62. doi: 10.1016/S0140-6736(05 )67402-8 PMID: 16182882

40. Ministry of Health Malaysia. National Diabetes Registry: Volume 1, 2009–2012. Non-Communicable Disease Section, Disease Control Division, Ministry of Health Malaysia; 2013.

41. Norimah AK, Safiah M, Jamal K, Siti H, Zuhaida H, Fatimah S, et al. Food consumption patterns: Findings from the Malaysian Adult Nutrition Survey (MANS). Malays J Nutr. 2008; 14(1):25–39. PMID: 22691762

42. Nurul Izzah A, Aminah A, Md Pauzi A, Lee YH, Wan Rozita WM, Siti Fatimah D. Patterns of fruits and vegetable consumption among adults of different ethnicities in Selangor, Malaysia. Int Food Res J. 2012; 19(3):1095–107.

43. Ministry of Agriculture, and Agro-Based Industry Malaysia. Agro Food Statistic 2013. Information Management and Statistics Unit, Strategic Planning and International Division, Putrajaya, Malaysia. 2014.

44. Dinehart ME, Hayes JE, Bartoshuk LM, Lanier SL, Duffy VB. Bitter taste markers explain variability in vegetable sweetness, bitterness and intake. Physiol and Behav. 2006; 87:304–13.

45. Drewnowski A, Gomez-Carneros C. Bitter taste, phytonutrients and the consumer: a review. Am J Clin Nutr, 2000; 2(6): 1424–35.

46. Tiew KF, Chan YM, Lye MS, Loke SC. Factors associated with dietary diversity score among individuals with type 2 diabetes mellitus. J Health Popul Nutr. 2014; 32(4):665–76. PMID: 25895200

47. Beghin J. Evolving dairy markets in Asia: Recent findings and implications. Food Policy. 2006; 31:195–200.

48. Warr S, Rodriguez G, Penn J. Changing food consumption and imports in Malaysia: Opportunities for Australian agricultural exports. In, ABARE research report o.86. Canberra: Department of Agriculture, Fisheries and Forestry, Australia. 2008.

49. Elwood PC, Pickering JE, Givens DI, Gallacher JE. The consumption of milk and dairy foods and the incidence of vascular disease and diabetes: An overview of the evidence. Lipid. 2010; 45:925–39.

50. American Diabetes Association (ADA). Improving diet quality reduces risk for type 2 diabetes, Alexandria, American. 2014.

51. Nisak MYB, Ruzita AT, Norimah AK, Gilbertson H, Kamaruddin NA. Improvement of dietary quality with the aid of a low glycaemic index diet in Asian patients with type 2 diabetes mellitus. J Am Coll Nutr. 2010; 29(3):161–70. PMID: 20833988

52. Abioye-Kuteyi EA, Ojoefitimi EO, Ijadunola KT, Fasanu AO. Assessment of dietary knowledge, practices and control in type 2 diabetes in a Nigerian teaching hospital. Niger J Med. 2005; 14(1):58–64. PMID: 15832645

53. Persell SD, Keating NL, Landrum MB, Landon BE, Ayanian JZ, Borbas C, et al. Relationship of diabetes-specific knowledge to self-management activities, ambulatory preventive care, and metabolic outcomes. Prev Med. 2004; 39:746–52. doi: 10.1016/j.ypmed.2004.02.045 PMID: 15351541

54. Lanling LC, Joung IM, Vogel I, Bootsmah AH, Lamberts SW, Mackenbach JP. Ethnic differences in outcomes of diabetes care and the role of self-management behavior. Patient Educ Couns. 2008; 72 (1):146–54. doi: 10.1016/j.pec.2008.03.008 PMID: 18455354

55. Sovattanangoon N, Kotchabhaikdi N, Petrie KL. The influence of Thai culture on diabetes perceptions and management. Diabetes Res Clin Pract. 2009; 84:245–51. doi: 10.1016/j.diabres.2009.02.011 PMID: 19285741
56. Murata GH, Shah JH, Duckworth WC, Wendel CS, Mohler MJ, Hoffman RM. Food frequency questionnaire results correlate with metabolic control in insulin-treated veterans with type 2 diabetes: The diabetes outcomes in Veterans study. J Am Diet Assoc. 2004; 12:1816–26.

57. Simmons D, Lillis S, Swan J, Haar J. Discordance in perceptions of barriers to diabetes care between patients and primary care and secondary care. Diab Care, 2007; 30(3):490–5.

58. Vijay S, Stuart N, Fitzgerald J, Ronis D, Hayward R, Slater S. Barriers to following dietary recommendation in type 2 diabetes. Diabetic Med, 2004; 22:32–8.

59. Lin Y, Guo H, Deng Z. Evaluating dietary quality of type 2 diabetics in Macao by Healthy Eating Index. Wei Sheng Yan Jiu, 2004; 33:737–40. PMID: 15727192

60. Ong WM, Chua SS, Ng CJ. Barriers and facilitators to self-monitoring of blood glucose in people with type 2 diabetes using insulin: A qualitative study. Patient Prefer Adher. 2014; 8:237–46.

61. Adibe MO, Aguwa CN, Ukwe CV, Okonta JM, Udegamanya OP. Diabetes self-care knowledge among Type 2 diabetic outpatients in South-eastern Nigeria. Int J Drug Dev Res. 2009; 1(1):95–104.

62. Hjelm K, Bard K, Nyberg P, Apelqvist J. Beliefs about health and illness in men with diabetes of different origin living in Sweden. J Adv Nurs. 2005; 50(1):47–59. doi: 10.1111/j.1365-2648.2004.03348.x PMID: 15789065

63. Hjelm K, Mufunda E. Zimbabwean Diabetics' beliefs about health and illness: An interview study. BMC Int Health Hum Rights. 2010; 10(7):1–10.

64. Ismail H, Hanafiah M, Saadiah S, Salmiah MS, Tahir A, Huda Z, et al. Control of glycosylated haemoglobin (HbA1c) among type 2 diabetes mellitus patients attending an urban health clinics in Malaysia. MHSJ. 2011; 9:58–65.

65. Tan MC, Ng OC, Wong TW, Joseph A, Chan YM, Hejar AR. Prevalence of metabolic syndrome in type 2 diabetic patients: A comparative study using WHO, NCEP ATP III, IDF and Harmonised definitions. Health, 2013; 5(10):1689–96.

66. World Health Organization (2011). Use of glycated hemoglobin (HbA1c) in the diagnosis of diabetes mellitus: Report of a WHO Consultation. World Health Organization, Geneva, Switzerland.

67. Lee KL, Yoon EH, Lee HM, Hwang HS, Park HK. Relationship between Food-frequency and Glycated Hemoglobin in Korean Diabetics: Using Data from the 4th Korea National Health and Nutrition Examination Survey. PLOS ONE | DOI:10.1371/journal.pone.0172231 February 24, 2017

68. O'Connor LM, Lentjes MA, Luben RN, Khaw KT, Wareham NJ, Forouhi NG. Dietary dairy product intake and incident type 2 diabetes: A prospective study using dietary data from a 7-day food diary. Diabetologia. 2014; 57(5):909–17. doi: 10.1007/s00125-014-3176-1 PMID: 24510203

69. Aune D, Norat T, Romundstad P, Vatten LJ. Dairy products and the risk of type 2 diabetes: A systematic review and dose-response meta-analysis of cohort studies. Am J Clin Nutr. 2013; 98(4):1066–83.

70. Deloor J, Ding EL, Malik VS, de Goede J, Geleijnse JM, Soedamah-Muthu SS. Consumption of dairy foods and diabetes incidence: a dose-response meta-analysis of observational studies. Am J Clin Nutr. 2016; 103(4):1111–24.
79. Chen M, Sun Q, Giovannucci E, Mozaffarian D, Manson JE, Willett WC, et al. Dairy consumption and risk of type 2 diabetes: 3 cohorts of US adults and an updated meta-analysis. BMC Med. 2014; 12:215. doi: 10.1186/s12916-014-0215-1 PMID: 25420418

80. Lang VB, Marković BB, Vrdoljak D. The association of lifestyle and stress with poor glycaemic control in patients with diabetes mellitus type 2: A Croatian nationwide primary care cross sectional study. Croat Med J. 2015; 56(4):357–65. doi: 10.3325/cmj.2015.56.357 PMID: 26321029

81. Pereira MA, Jacobs DR Jr, Van Horn L, Slattery ML, Kartashov AI, Ludwig DS. Dairy consumption, obesity, and the insulin resistance syndrome in young adults: the CARDIA Study. JAMA. 2002; 287(16):2081–9. PMID: 11966382

82. King JC. The milk debate. Arch Intern Med. 2005; 165:975–976. doi: 10.1001/archinte.165.9.975 PMID: 15883235

83. Tong X, Dong JY, Wu ZW, Li W, Qin LQ. Dairy consumption and risk of type 2 diabetes mellitus: A meta-analysis of cohort studies. Eur J Clin Nutr. 2011; 65:1027–103. doi: 10.1038/ejcn.2011.62 PMID: 21559046

84. Slujs I, Forouhi NG, Beulens JW, van der Schouw YT, Agnoli C, Arriola L, et al. The amount and type of dairy product intake and incident type 2 diabetes: results from the EPIC-InterAct Study. Am J Clin Nutr. 2012; 96:382–90. doi: 10.3945/ajcn.111.021907 PMID: 22760573

85. Gao DF, Ning N, Wang CX, Wang YH, Li Q, Meng Z, et al. Dairy Products Consumption and Risk of Type 2 Diabetes: Systematic Review and Dose-Response Meta-Analysis. PLoS One. 2013; 8(9):e73965. doi: 10.1371/journal.pone.0073965 PMID: 24086304

86. Malik VS, Sun Q, van Dam RM, Rimm EB, Willett WC, Rosner B, et al. Adolescent dairy product consumption and risk of type 2 diabetes in middle-aged women. Am J Clin Nutr. 2011; 94:854–61. doi: 10.3945/ajcn.110.009621 PMID: 21753066

87. Ericson U, Hellstrand S, Brunkwall L, Schulz CA, Sonestedt E, Wallström P, et al. Food sources of fat may clarify the inconsistent role of dietary fat intake for incidence of type 2 diabetes. Am J Clin Nutr. 2015; 101(5):1065–80. doi: 10.3945/ajcn.114.103010 PMID: 25832335

88. Van Duyn MA, Pivonka E. Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature. J Am Diet Assoc. 2000; 100: 1511–21. doi: 10.1016/S0002-8223(00)00420-X PMID: 11138444

89. Hofe CR, Feng L, Zephyr D, Stromberg AJ, Hennig B, Gaetke LM. Fruit and vegetable intake, as reflected by serum carotenoid concentrations, predicts reduced probability of polychlorinated biphenyl-associated risk for type 2 diabetes: National Health and Nutrition Examination Survey 2003–2004. Nutr Res. 2014; 34:285–93. doi: 10.1016/j.nutres.2014.02.001 PMID: 24774064

90. Montonen J, Knekt P, Harkonen T, Jarvinen R, Heliovaara M, Aromaa A, et al. Dietary patterns and the incidence of type 2 diabetes. Am J Epidemiol. 2005; 161(3):219–27. doi: 10.1093/aje/kwi039 PMID: 15671254

91. Bazzano LA, Li TY, Joshipura KJ, Hu FB. Intake of fruit, vegetables, and fruit juices and risk of diabetes in woman. Diab Care. 2008; 31(7):1311–17.

92. Wedick NM, Pan A, Cassidy A, Rimm EB, Sampson L, Rosner B, et al. Dietary flavonoid intakes and risk of type 2 diabetes in US men and women. Am J Clin Nutr. 2012; 95(4):925–33. doi: 10.3945/ajcn.111.028894 PMID: 22357723

93. Takahashi K, Kamada C, Yoshimura H, Okumura R, Iimuro S, Ohashi Y, et al. Effects of total and green vegetable intakes on glycated hemoglobin A1c and triglycerides in elderly patients with type 2 diabetes mellitus: the Japanese Elderly Intervention Trial. Geriatr Gerontol Int. 2012; 12(Suppl1):50–8.

94. Cooper AJ, Sharp SJ, Lentjes MA, Luben RN, Khaw KT, Wareham NJ, et al. A prospective study of the association between quantity and variety of fruit and vegetable intake and incident type 2 diabetes. Diab Care. 2012; 35:1293–300.

95. Carter P, Gray LJ, Troughton J, Khunti K, Davies MJ. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: Systematic review and meta-analysis. Brit Med J. 2010; 341:c4229. doi: 10.1136/bmj.c4229 PMID: 20724400

96. Williams DEM, Wareham NJ, Cox BD, Byrne CD, Hales CN, Day NE. Frequent Salad Vegetable Consumption Is Associated With A Reduction in the Risk of Diabetes Mellitus. J Clin Epidemiol. 1999; 52(4):329–35. PMID: 10235173

97. Liu S, Serdula M, Janket SJ, Cook NR, Secco HD, Willett WC, et al. A prospective study of fruit and vegetable intake and the risk of type 2 diabetes in women. Diab Care. 2004; 27:2993–6.
98. Villegas R, Shu XO, Gao Y-T, Yang G, Elasy T, Li H, Zheng W. Vegetable but not fruit consumption reduces the risk of type 2 diabetes in Chinese women. J Nutr. 2008; 138(3):574–80. PMID: 18287369

99. Tabesh M, Hariri M, Askari G, Ghasvand R, Tabesh M, Heydari A, et al. The relationship between vegetables and fruits intake and glycosylated hemoglobin values, lipids profiles and nitrogen status in type II inactive diabetic patients. Int J Prev Med. 2013; 4(Suppl 1):S63–7. PMID: 23717773

100. Johnson RJ, Segal MS, Sautin Y, Nakagawa T, Feig DI, Kang DH, et al. Potential role of sugar (fructose) in the epidemic of hypertension, obesity and the metabolic syndrome, diabetes, kidney disease, and cardiovascular disease. Am J Clin Nutr. 2007; 86(4):899–906. PMID: 17921363

101. Mursu J, Virtanen JK, Tuomainen TP, Nurmi T, Voutilainen S. Intake of fruit, berries, and vegetables and risk of type 2 diabetes in Finnish men: The Kuopio Ischaemic Heart Disease Risk Factor Study. Am J Clin Nutr. 2014; 99(2):328–33. doi: 10.3945/ajcn.113.069641 PMID: 24257723

102. Azim W, Omair M, Khan MQA, Shaheen N, Azim S. Correlation between glycated haemoglobin and random plasma glucose levels for the screening of diabetes mellitus. Int J Pathol. 2010; 8(2):59–62.

103. Bowlner C, Erde R, De P. An evaluation of knowledge and understanding of HbA1c in diabetes patients in a secondary care setting. Endocrine Abstracts. 2014; 34:221.

104. Ramona G, Ioan C, Simona T, Luminita P, Simona G, Lavinia M. Relationship between glycosylated haemoglobin and lipid metabolism in patients with type 2 diabetes. Studia Universitatis “Vasile Goldiș”, Seria Ştiinţele Vieţii, 2011; 21(2):313–18.

105. Schillinger D, Barton LR, Karter AJ, Wang F, Adler N. Does literacy mediate the relationship between education and health outcomes? A study of a low-income population with diabetes. Public Health Rep. 2006; 121: 245–54. doi: 10.1177/003335490612100305 PMID: 16640146

106. Abraham AM, Sudhir PM, Philip M, Bantwal G. Illness perceptions and perceived barriers to self-care in patients with type 2 diabetes mellitus: an exploratory study from India. Int J Diabetes Dev Countries. 2015; 35: 137.

107. Jansen H, Stolk RP, Nolte IM, Kema IP, Wolffenbuttel BH, Snieder H. Determinants of HbA1c in non-diabetic Dutch adults: Genetic loci and clinical and lifestyle parameters, and their interactions in the lifelines cohort study. J Int Med. 2013; 273:283–93.

108. Egan BM, Shaftman SR, Wagner CS, Bandyopadhyay D, Szymanski KA. Demographic differences in the treatment and control of glucose in type 2 diabetic patients: Implications for health care practice. Ethn Dis. 2012; 22:29–37. PMID: 22774306

109. Choi S, Rankin S. Glucose Control in Korean Immigrants with Type 2 Diabetes. Western J Nur Res. 2009; 31(3):347–63.

110. Goudswaard AN, Stolk RP, Zulthoff P, Rutten GE. Patient characteristics do not predict poor glycaemic control in type 2 diabetes patients treated in primary care. Eur J Epidemiol. 2004; 19(6),541–5. PMID: 15330126

111. O’Connor PJ, Rush WA, Davidson G, Louis TA, Solberg Li, Crain AL, et al. Variation in quality of diabetes care at the levels of patient, physician, and clinic. Prev Chronic Dis. 2008; 5(1):1–9.