ORIGINAL ARTICLE

Levels of Knowledge about the Glycemic Index Concept among Women with Gestational Diabetes Mellitus

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ABSTRACT

Introduction: Low glycemic index (GI) diet is recommended as part of medical nutrition therapy for the management of gestational diabetes mellitus (GDM). While the clinical benefits are evident, data assessing knowledge of the GI concept among women with GDM are scarce. This was a needs assessment study to determine the level of knowledge about the GI concept among women with GDM. **Methods:** Using a cross-sectional design, we included 85 women with GDM (mean age: 30.6 ± 4.0, pre-pregnancy BMI: 24.8 ± 4.1 kg/m2, gestational age: 34.0 ± 4.0 weeks) from Hospital Serdang, Malaysia. Knowledge about the GI concept was assessed using a developed questionnaire. Additional questions on GDM were assessed using Gestational Diabetes Mellitus Knowledge Questionnaire (GDM-KQ). Subjects with less than 50%, 51-74%, and more than 75% total score were categorized as having poor, fair, and good knowledge levels, respectively. **Results:** The mean knowledge score obtained by the subjects was 12.8 ± 3.5. More subjects scored correctly for GDM-related knowledge (68.2%). More than half (58.8%) had heard about the GI concept previously and 55.3% understood the definition of GI. The average knowledge score about the GI concept was 55.6%; subjects scored highest on the influence of different carbohydrates (teh tarik versus milk) on blood glucose level (87.1%). However, the majority of the subjects had fair knowledge level (62.4%). **Conclusion:** Women with GDM had moderate knowledge about the GI concept. Results of the needs assessment served as preliminary data for the development of a GI-based nutrition education program in Malaysia.

Keywords: Nutrition knowledge, Gestational diabetes mellitus, Glycemic index, Pregnancy

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INTRODUCTION

Gestational diabetes mellitus (GDM), defined as any degree of glucose intolerance recognized during pregnancy (1) is a burgeoning public health problem worldwide. The prevalence of GDM in Malaysia ranged from 8-25% between 1993 and 2017 (2-6). Optimal management of GDM reduces the risk of potential adverse outcomes, including macrosomia (7) and future type 2 diabetes (8). Medical nutrition therapy (MNT) is a mainstay of GDM management. MNT is an individualized nutrition therapy aimed to improve lifestyle behaviour, including improving eating habits, increasing physical activity to at least 150 minutes in a week, and achieving and maintaining a 7-10% loss from initial body weight, if necessary (9). MNT has been proven effective in achieving optimal maternal glucose control and nutritional status (10). Nonetheless, it depends on the women's ability to understand the concept of nutrition. Although having good nutrition knowledge does not necessarily stimulate change, it acts as a tool to promote appropriate eating practices (11).

Various studies have identified the knowledge level among women with GDM (11-17). However, studies focusing specifically on nutrition knowledge among women with GDM are sparse. Additionally, no study had yet to determine the knowledge level on the glycemic index (GI) concept among women with GDM. The GI is a ranking of carbohydrates in different foods according to their effects on postprandial glucose response; high-GI foods elicit more significant fluctuations in blood glucose compared to foods with a lower GI (18).

Low-GI dietary interventions have been shown to reduce postprandial blood glucose among women with GDM, without restricting dietary carbohydrates (19-

22). A study on a low-GI diet intervention conducted in Asian women with GDM had produced similar benefits (23). A GI-based nutrition education program has been shown to reduce fasting blood glucose and HbA1c levels significantly; however, this study was conducted among Korean adults with type 2 diabetes, and the education was based on Korean foods (24). In a survey of 81 clinical dietitians in Malaysia who are currently counselling GDM patients, only 11% incorporated glycemic index education into their dietary intervention. The majority (82%) of the clinical dietitians instead opted to use the more conventional advice on carbohydrate exchanges and distribution (25). The Malaysian MNT guidelines outlined GI education as part of dietary counselling for patients with diabetes, but only after patients were familiar with the carbohydrate exchange concept. Additionally, no standardized GI-based nutritional education package is currently being used by clinical dietitians in Malaysia.

Therefore, our study aimed to assess the knowledge level of the GI concept among women with GDM. Results from this informational needs assessment would serve as a foundation for the development of a GI-based nutrition education program for women with GDM in Malaysia.

MATERIALS AND METHODS

Study design and subject selection

This was a cross-sectional study conducted at the Obstetric and Gynecology (O&G) clinic at Hospital Serdang. Inclusion criteria were Malaysian women who were diagnosed with gestational diabetes mellitus (GDM) aged between 18 and 45 years old. They were excluded if they had one of the following criteria: were already diagnosed with type 1 or type 2 diabetes mellitus before pregnancy, had pre-eclampsia, had been seen by a dietitian during the current pregnancy, or had a hearing or vision impairment. GDM diagnosis was made following a 75-g oral glucose tolerance test (OGTT) using the diagnostic criteria based on Malaysian Clinical Practice Guidelines (26).

The study used a convenience sampling design. Eligible patients who met the study criteria were invited to participate in the study. They received an information sheet and provided their consent at enrolment. The Research and Ethics Committee of the Ministry of Health, Malaysia approved the study (NMRR-14-1479-20965).

Sample size

The sample size was calculated using a formula to estimate population mean (27):

$$n = \frac{Z_{1-\alpha/2}^2 \, SD^2}{d^2}$$

Where

$Z_{1-\alpha/2}$ = z-score for the level of significance in a two-sided test (1.96)

d = margin of error allowed (1.0)

SD = standard deviation based on a previous study (3.6)

The value of the estimated standard deviation (SD) was based on a previous interventional study that assessed the effects of low glycemic index (GI) nutrition education on dietary management and glycemic control of 48 T2DM patients in Korea (24). The parameter used for sample size calculation was the post-test BMI in the treatment group. In that study, the group receiving low GI nutrition education had significantly reduced their BMI (post-test BMI 24.5 ± 3.6 kg/m2) (24). Hence, a minimum of 50 women with GDM was required for the study to ensure a 90% confidence level with 80% power. An additional 20% is required to account for non-response or refusal to participate, leading to a sample size of at least 60 subjects for the study.

Measurements

Socio-demographic data included age, ethnicity, gestational week, occupation, education, and monthly household income were collected using questionnaires. Obstetric history and height were obtained from their medical records. Subjects provided self-reported pre-pregnancy weight, defined as their usual weight before pregnancy. Pre-pregnancy BMI was calculated as pre-pregnancy weight (kg) divided by height (m2) (28). Pre-pregnancy BMI was then categorized using the standard international adult BMI classification: underweight (<18.5 kg/m^2), normal weight (18.5 - 24.9 kg/m^2), overweight (25.0 - 29.9 kg/m^2), or obese (>30 kg/m^2) (28).

Subjects' knowledge level on the GI concept was assessed using questions adapted from a previous study among patients with type 2 diabetes mellitus (T2DM) (29). A total of 13 questions were asked on GI, including its concept and definition (5 questions), the impact of low- and high-GI foods on blood glucose (3 questions), and the relationship between carbohydrates and blood glucose control (5 questions). The questionnaire had been face validated and pilot tested on 10 patients with T2DM. The internal consistency was acceptable as shown by Cronbach's alpha value of 0.630 (29).

Additionally, a total of 9 questions on GDM were asked, comprising of basic knowledge of GDM (5 questions), complications (2 questions) and management (2 questions). We aimed to explore whether the subjects had a basic understanding of the pathophysiology of GDM, including how impairment of insulin function led to the development of GDM. We also assessed whether the subjects were aware of risk factors of GDM, including high pre-pregnancy weight. Subjects were also tested on whether they knew about the adverse outcomes of GDM, including the risk of macrosomia and pre-term delivery. We also assessed their knowledge on how to manage GDM, including increasing physical activity. These questions were adapted from the

Malaysian Gestational Diabetes Mellitus Knowledge Questionnaire (GDMKQ) (14). Both versions (Malay and English languages) had been validated in terms of its face and content validity by a panel of experts, including physicians and specialists from the O&G department, lecturers, registered pharmacists, and Ph.D. scholars from pharmacy practice division. The GDMKQ was a reliable tool in assessing knowledge on GDM as indicated by Cronbach's alpha value of 0.77 (14).

The questionnaire used in this study, as adapted from the two previous studies above (14, 29) had been validated in terms of face and content validity by a panel of experts, including lecturers from the Department of Nutrition and Dietetics, UPM (n = 3) and clinical dietitians (n = 2). The expert panel reviewed the list of questions for suitability for women with GDM. Additionally, the questionnaire was pre-tested among 5 women with GDM for face validity and acceptability. Comments included avoiding using medical jargon, for instance changing "hyperglycemia" to "high blood sugar level". The internal consistency reliability analysis, as shown by Cronbach's alpha value of 0.72, showed that the questionnaire was a reliable tool to assess the knowledge level.

The format of the question was a true-or-false, with only one correct answer. The answer option provided were yes, no and unsure. Each correct answer was given 1 point and an incorrect answer or unsure was allocated 0 point. The possible total score for knowledge was 22 (100%). The level of knowledge was then categorized into 3 scoring categories (Table I). The categorization of the knowledge level was based on a previous study, prepared by members of a Technical Working Group on Research (30).

Table I: Knowledge scoring category

Scoring Category	Score
Poor	<50%
Fair	51-74%
Good	> 75%

Subjects were given the knowledge assessment questionnaire during their waiting period at the clinic. They were either asked via a one-to-one interview or self-answered with the guidance of the researcher depending on the subject's preference. The subjects took about 15 minutes to complete the questionnaires. All questionnaires were checked for completeness before collected.

Statistical analysis

Data were analysed using SPSS version 22.0 (SPSS Inc, Chicago, IL, USA). All the variables in this study were normally distributed and did not significantly deviate from a normal distribution, based on $p > 0.05$ shown by the Shapiro-Wilk test (31). Descriptive statistics were shown as means and standard deviations (SD) or proportions (%). Factors affecting nutrition knowledge score were determined using multiple linear regression. Knowledge score was the independent variable, whereas the following predictors were entered into the model: age, ethnicity, years of education, occupation, monthly household income, gestational age, history of GDM, family history of diabetes, gravidity and parity. All statistical tests are set at a significance level $p < 0.05$.

RESULTS

A total of 85 women with GDM attending the antenatal clinic were interviewed. On average, women in this study were in their early thirties (mean 30.6 ± 4.0 years old), predominantly Malays (71.8%), were multiparous (67%), and were working women (68.2%). Almost half of them had tertiary education (48.2%), whereas 36.5% and 44% of the subjects had a family history of diabetes mellitus and a history of GDM, respectively. The majority of the subjects were in their third trimester of pregnancy (86%; mean gestational age of 34.0 ± 4.0 weeks). The mean pre-pregnancy weight was 61.4 ± 14.6 kg; on average, the subjects had normal pre-pregnancy BMI (mean 24.8 ± 4.1 kg/m2). The mean knowledge score obtained by the subjects was 12.8 ± 3.5. 62% of the subjects had fair knowledge, whereas about one-third (25.9%) of the subjects had a poor knowledge level regarding GDM and GI (Table II).

Responses to GDM and GI knowledge questionnaire are presented in Table 3. About half of the subjects had heard about the GI concept previously (58.8%) (Q2), and 55.3% of them understood the definition of GI (Q3). The lowest number of patients (55.6%) scored correctly for the GI concept applications, referring to Q9, Q10, Q11 and Q12, whose scores were 31.8%, 42.4%, 32.9% and 31.8%, respectively. However, 71.8% of the subjects were able to respond correctly to the categories of GI (Q4), and 80% of the subjects understood that an excessive amount of carbohydrates would increase blood gsugar level (Q1). About 87.1% were then able to apply this concept correctly in Q8 (how teh tarik would increase blood sugar level in comparison to milk) (Table III).

The highest score of 73.2% was noted on basic knowledge about GDM category. Almost all of the subjects knew about GDM (96.5%), and the majority of them were aware of the risk of developing GDM (88.2%). About 58.9% of the subjects knew the consequences of GDM, and 66.5% of the subjects knew the benefits of managing GDM well (Table III).

A further test of the independence of relevant factors was shown in Table IV. These factors might affect the knowledge level of women with GDM and hence were included in the regression model. Results were considered significant if the probability was less than 5% or p-value was less than 0.05. Consequently, we

Table II: Characteristics and knowledge score of women with GDM (n = 85)

Characteristics	n	%	Mean ± SD
Socio-demographic			
Age (years)			30.6 ± 4.0
Ethnicity			
Malay	61	71.8	
Chinese	12	14.1	
Indian	9	10.6	
Others	3	3.5	
Education (years)			13.2 ± 2.8
Primary or below	7	8.2	
Secondary	37	43.5	
Tertiary	41	48.2	
Occupation			
Not working/housewife	27	31.8	
Self-employed	9	10.6	
Employed	49	57.6	
Monthly household income (RM) [a]			
< RM1500	14	16.5	
RM1501 – RM3500	53	62.4	
RM3501 – RM5500	11	12.9	
RM5501 – RM7500	5	5.9	
> RM7501	2	2.4	
Obstetrical information			
Family history of diabetes mellitus	31	36.5	
History of gestational diabetes mellitus	37	43.5	
Gravidity			
≤ 3 Pregnancy	64	75.0	
> 4 Pregnancy	21	25.0	
Parity			
Nulliparous	28	33.0	
Multiparous	57	67.0	34.0 ± 4.0
Current gestational age (weeks)			
Trimester			
First (1-12 weeks)	0	0	
Second (13-27 weeks)	12	14.0	
Third (28-40 weeks)	73	86.0	
Anthropometry measurements			
Height (cm)			157.0 ± 5.1
Pre-pregnancy weight (kg)			61.4 ± 14.6
Pre-pregnancy body mass index (kg/m^2)			24.8 ± 4.1
Knowledge level score			12.8 ± 3.5
Poor (≤50%)	22	25.9	
Fair (51 – 74%)	53	62.4	
Good (≥75%)	10	11.8	

[a]Based on (21)

Table III: Correct responses (%) for the questions related to the glycemic index concept and gestational diabetes mellitus

Questions	Correct responses n (%)
A. The Glycemic Index (GI) Concept	**47 (55.6)**
Q1 About amount of carbohydrate and blood sugar levels	68 (80.0)
Q2 About heard of the GI concept	50 (58.8)
Q3 About what GI is	47 (55.3)
Q4 About GI category	61 (71.8)
Q5 About GI category and impact on blood sugar level	54 (63.5)
Q6 About white rice versus parboiled rice	50 (58.8)
Q7 About banana versus apple	43 (50.6)
Q8 About *teh tarik* versus milk	74 (87.1)
Q9 About 1 cup of white rice containing similar amount of carbohydrates with noodles	27 (31.8)
Q10 About bean curd as a vegetable	36 (42.4)
Q11 About fruit intake (green apple) and GDM	28 (32.9)
Q12 About fruit and carbohydrate content	27 (31.8)
Q13 About egg as carbohydrate	49 (57.6)
B. About Gestational Diabetes Mellitus (GDM)	**58 (68.2)**
i) Basic knowledge of GDM	62 (73.2)
Q1 About definition of GDM	82 (96.5)
Q2 About impairment of insulin function	55 (64.7)
Q3 About risk of getting GDM	75 (88.2)
Q4 About pre-pregnancy weight increasing the risk of GDM	51 (60.0)
Q5 About GDM disappearing after delivering the baby	48 (56.5)
ii) Consequences of GDM	50 (58.9)
Q6 About risk of having premature infant	52 (61.2)
Q7 About risk of having macrosomic infant	48 (56.5)
iii) Management of GDM	57 (66.5)
Q8 About controlling GDM will reduce risk of type 2 diabetes mellitus	59 (69.4)
Q9 About exercise helping to control blood sugar	54 (63.5)

Legend: Q = question

Table IV: Factors affecting nutrition knowledge level among women with GDM

Factor	Value	df	p-value
Age	41.682	34	0.171
Ethnicity	4.669	6	0.587
Years of education	21.646	20	0.360
Occupation	60.652	64	0.596
Monthly household income	65.519	70	0.494
Gestational age	26.035	30	0.673
History of GDM	51.689	2	0.430
Family history of diabetes	0.693	2	0.707
Gravidity	8.986	10	0.533
Parity	13.941	14	0.454

found that there were no factors that were significantly associated with the subjects' knowledge level, including age, educational level, years of education, occupation, monthly household income, gestational age, history of GDM, gravidity and parity (Table IV).

DISCUSSION

This study described the socio-demographic characteristics, nutritional status and the knowledge level of the GI concept of women with GDM. Understanding the nutritional characteristics and the knowledge level would assist in the development of an appropriate GI-based nutrition education program for women with GDM. One of the major findings was the lack of knowledge regarding GI and GDM among women with GDM. Only 11.8% of the respondents had a good level of knowledge regarding GDM and the concept of GI. A quarter of the women with GDM in this study (25.9%) had poor nutrition knowledge level and the majority of them (62.4%) had a fair nutrition knowledge level. The mean knowledge score was 12.8 ± 3.5, or 58% of the total scores; hence, the overall knowledge level was moderate among women in our study.

Our results were comparable to a cross-sectional study conducted among 166 women newly diagnosed with GDM in Penang, Malaysia (14). The subjects had fair knowledge level on GDM and its risk factors, management and complications. However, contrary to our study, they scored highest on diet and food values. This was most probably due to the majority of their study participants (87.3%) being on diet control therapy. Women in our study had never been seen by a dietitian during current pregnancy. Thus, a lower knowledge level of the GI concept was expected.

In a qualitative study conducted among women with GDM in Europe (32), they found that women with GDM had a good understanding of GDM, but not about lifestyle components. Many of them were able to answer correctly on GDM and its severity and adverse

implications. Hence, women with GDM acknowledged the needs to have tailored dietary advice and physical activity advice. The results were comparable to this present study, in which almost all of the subjects knew what GDM was (96.5%) and its risk factors (88.2%). The majority of the subjects (87%) in this study understood that sweetened beverages, for instance teh tarik would increase blood sugar level higher than milk does. However, they were unable to identify the concept of carbohydrate exchanges and food group categorisation.

Several studies had employed questionnaires to assess knowledge level regarding GDM (11-17), but questions incorporating diet/nutrition aspect are scarce. A study had compared the nutrition knowledge level between multi-ethnic women with and without GDM in the United Arab Emirates (33). About 22% of women with GDM had never received dietary counselling by a dietitian, whereas 65% stated only visiting a dietitian once or twice throughout their pregnancy. Hence, no significant difference in mean knowledge on diet and carbohydrates was found between women and without GDM. Women with GDM scored lowest on the three food items that could potentially elevate blood glucose levels (unsweetened fruit juice, low-fat milk, and whole wheat bread). Yet, significantly more women with GDM correctly identified two staple foods as being able to increase blood glucose levels compared with women without GDM: rice (86.2% vs. 73.0%, respectively, p=0.027) and white bread (90.4% vs. 70.8%, respectively, p=0.001). Nevertheless, no questions on GI were asked in this study (33).

To our knowledge, no study had assessed knowledge on GI among women with GDM in Malaysia. More than half (55.3%) of women with GDM in our study recognized the concept and definition of GI. Subjects also understood the GI concept better than food groups and carbohydrate exchanges, which would seem to address the needs to have an appropriate GI-based nutrition education program for women with GDM. Nonetheless, women with GDM should be advised on standard MNT therapy using carbohydrate exchanges before providing additional education on the GI concept.

The GI concept has generated tremendous interest in the last 25 years (34). This is because a plethora of nutrition information, including the GI concept, can be quickly gained from the Internet. Health organizations are increasingly using the internet to provide information and recommendations about health across the population (35). Information on GI is then possibly disseminated via social networking sites, since they are burgeoning with health and nutrition information (36). This was corroborated by a previous study in Malaysia, which found that education level was the most significant predictor of GDM knowledge (14). Those with higher education level might have greater access to literature and Internet sources related to health. However, our study did not find any factors that predicted knowledge level among women with GDM.

This study had some limitations. The study was conducted in a single centre, so the results of this study may not be generalized. We also did not collect data on the current treatment of women with GDM (diet control, on oral hypoglycaemic agents, or on insulin); and whether those with recurrent GDM had previous knowledge exposure. Hence, the variables could not be included in the analysis.

This was the first study that assessed nutrition knowledge on women with GDM in Malaysia that incorporated the GI concept. Knowledge score of the GI concept is needed as the baseline for the next phase of the study: the development and evaluation of a GI-based nutrition education package. Women with GDM in our study had a moderate knowledge level about GDM and the GI concept. In particular, they had a low level of knowledge or understanding regarding carbohydrate intake and GI application, as shown by the least number of respondents answering questions Q9, Q10, Q11, and Q12 correctly. The GI-based nutrition education package is aimed at both women newly diagnosed with GDM or those with recurrent GDM. Currently, there is no standardized GI-based nutrition education package utilized by clinical dietitians in Malaysia. Thus, the GI-based nutrition education package is a complete education program that would address basic knowledge of GDM (definition, pathophysiology, complications, risk factors, and management), and the GI concept (definition, benefits of low GI diet, high versus low GI foods, and menu planning). The GI-based educational tool can aid dietitians to incorporate the concept of GI in managing GDM, and is an alternative to current dietetics practice to enable more effective care for women with GDM in the clinical setting in Malaysia.

CONCLUSION

Women with GDM had an average level of knowledge of the GI concept. They also only scored moderately on knowledge about GDM. It is crucial to have a proper education program to increase GDM awareness and management skills in women with GDM. Nutrition education played a significant role in improving the knowledge level among women with GDM. Low GI diet is recommended as part of MNT for the management of GDM as it is reported to lower blood glucose levels. In general, the results from the informational needs assessment explained the current level of knowledge among women with GDM. The questionnaire used in this study was a reliable instrument designed to assess knowledge of GI among women with GDM. Findings from this study suggested the need to develop a GI-based nutrition education program to improve the knowledge level of women with GDM in Malaysia. A good level of nutrition knowledge among women with GDM helps to

improve their nutritional status, and subsequently leads to better GDM management and optimal pregnancy outcomes.

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