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Low- Glycaemic Index Diet to Improve Dietary Intake among Women with Gestational Diabetes Mellitus

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ABSTRACT

This study examines the effect of a low glycaemic index (LGI) intervention to improve dietary intake among women with Gestational Diabetes Mellitus (GDM). Women with GDM were randomised to receive either a low GI intervention (LGI; $n = 20$) or standard nutrition therapy (SNT; $n = 20$) for a 4-week period. Food Frequency Questionnaire (FFQ) and Three-Day Diet Record assessed the dietary intake and food choices. Dietary intake and food choices of the participants were comparable at baseline. At the end of the study, energy, protein, fat and carbohydrate were reduced in both groups ($p < 0.05$). In the LGI group, fibre and calcium intake was higher compared with SNT group. More participants in the LGI group consumed rice from the low GI varieties, the whole grain breads and the low GI biscuits ($p<0.05$) compared with participants in the SNT group. The diet GI reduced significantly in the LGI group (50 ± 9 units) compared with the SNT group (57 ± 6) ($p < 0.05$). Findings showed low GI dietary intervention improved the dietary intake of women with GDM.

Keywords: Carbohydrate, dietary intake, Gestational Diabetes Mellitus, low glycaemic index

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INTRODUCTION

Maternal diet is important to ensure optimum foetal growth, and this includes sufficient energy, protein, calcium, and iron intake. In general, dietary recommendations for women with gestational diabetes mellitus (GDM) is not very different from normal pregnancy. However, due to abnormality of blood glucose excursion in women with GDM, carbohydrate management has become the interest of dietary therapy. This is because dietary carbohydrate is a major determinant of maternal blood glucose excursion especially at the postprandial stage (American Diabetes Association, 2008).

An increase in maternal blood glucose during pregnancy can lead to greater incidence of adverse maternal and infant outcomes, including increased risk of developing type 2 diabetes after pregnancy and foetal macrosomia (American Diabetes Association, 2003). An intensive blood glucose management for GDM will reduce neonatal complications. Therefore, the primary goal of the medical nutrition therapy in GDM is to ensure adequate pregnancy weight gain and foetal growth while maintaining euglycemia and avoiding ketones (Mareno, Mauricio, & Hernandez, 2016)

Carbohydrates which have a low glycaemic index (LGI) have a strong influence on glycaemic responses (American Diabetes Association, 2008). In an acute study, the serum glucose spiked after the consumption of a high GI meal compared with a low GI meal, although the amount of CHO remained constant (Galgani, Aguirre, & Diaz, 2006). In a long-term trial, low GI dietary intervention showed improvement in 2-hPPG at lunch, pre-prandial and 2hr postprandial glucose at dinner towards the end of pregnancy (Perera et al., 2012).

The impact of LGI diet in women with GDM has been investigated in a few well-designed randomised controlled trial (RCT) (Louie et al., 2011; Moses, Barker, Winter, Petocz, & Brand-Miller, 2009), one each for Iran (Afaghi, Ghanei, & Ziaee, 2013), Canada (Grant, Wolever, O' Connor, Nisenbaum, & Josse, 2011) and Mexico (Parera et al., 2012). All of these studies suggested that LGI diet may become a new alternative strategy in reducing postprandial blood glucose in women with GDM without restriction of the dietary CHO (Louie et al., 2011; Afaghi, Ghanei. & Ziaee, 2013; Moses et al., 2009; Perera et al., 2012; Grant et al., 2011). However, only two studies compared the dietary intakes of participants at baseline and at the end of the study (Louie et al., 2011; Moses et al., 2009).

LGI dietary intervention may be compromised as it may limit food choices and varieties; some LGI foods are high in fat and sugar. A recent study has shown that LGI diet in Asia has its own limitations (Barakatun Nisak et al., 2014) due to the limited availability of LGI foods in the market. Additionally, prices of LGI foods are more expensive than HGI (high glycaemic meals) (Barakatun Nisak, Ruzita, Norimah, Gilbertson, & Kamaruddin, 2010).

Although the beneficial effects of a low GI diet have been noted, the findings may not be generalised to the Asian dietary context because of the cultural and food pattern differences between Western and Asian countries (Barakatun Nisak et al., 2014). For example, in Malaysia, white rice, an HGI food, is usually consumed twice daily. This study is conducted to determine the effect of a low GI diet on dietary intake and food choices among women with GDM. It is hypothesised that participants in LGI group achieves significantly improvement in dietary intake than standard nutrition therapy (SNT) group.

MATERIALS AND METHODS

Study Design and Ethical Approval

This is a randomised controlled study to compare the effects of a low GI diet against SNT on dietary intake and food choices in women with GDM. The duration of the study is four weeks, and it was conducted at Universiti Kebangsaan Malaysia Medical Centre (UKMMC). Clinical research and Ethnics Committee of UKMMC approved the study protocol and all participants provided written consent prior enrolment into the study.

Subjects' Selection and Sample Size

The sample size for this study was 40 women with GDM. They were pregnant women aged 18 - 45 years with confirmed diagnosis of GDM between 18 and 23 weeks of gestation. They had a pre-pregnancy BMI of > 23 kg/m^2 (World Health Organization, 2000) and a haemoglobin level of ≥ 11g/dl (World Health Organization, International Obesity Task Force, & International Association for the Study of Obesity, 2011). Participants excluded from the study were those on insulin therapy and reported having chronic hyperemesis gravidarum, complicated pregnancy, food allergy, having gastrointestinal disease that interfered with bowel function and dietary intake (i.e., gastroparesis, diarrhoea due to chronic inflammatory bowel disease and galactosaemia).

The sample size required for the study was calculated based on the mean differences in glucose control by 0.5 mmol/L and variance of 1 mmol/L between the control and low GI intervention in women with GDM (Perera et al., 2012). This study used 95% confidence level and additional 20% for considering the drop-out rate

Dietary Intervention

The participants subscribed to either low GI or the SNT dietary intervention in which the outcomes were measured after a 4-week period. All participants received individualised counselling. Dietary intervention and recommendations were similarly structured and the only differences was in the type of carbohydrates consumed. Nutritional prescriptions are based on the MNT for GDM (REF- CPG and MNT diabetes). Macronutrient composition was set at 50-55% for carbohydrates, 15-20% for protein and 30% fat based on the previous survey on dietetics practices (Farhanah, Fatin Nasirah, Barakatun Nisak, Nor Azlin, & Zalilah, 2014). Energy requirement was calculated based on pre-pregnancy BMI (REF). Participants with pre-pregnancy BMI between 23 and 24.9 kg/m^2 were provided with 30 to 35 kcal/kg and pre-pregnancy BMI > 25 kg/m^2 were given 25 to 30 kcal/kg.

To maintain the same amount of carbohydrates, participants were instructed to eat according to carbohydrate exchange systems. In this exchange system, one exchange of carbohydrates is equal to 15 g of carbohydrates and they were allowed to exchange the carbohydrates within the same food groups (American Diabetes Association, 2003). In the LGI group, participants received education to substitute high GI to low GI foods. The list of low GI and high GI foods for one exchange of carbohydrates within the same food groups was provided. Participants needed to incorporate at least one low GI food in each meal and distribute low GI foods for each meal throughout the day in order to achieve the daily diet GI's goal (Barakatun Nisak, Ruzita, Norimah, Gilbertson, & Kamaruddin, 2010). In the SNT group, participants were instructed to eat a high fibre carbohydrate containing foods without referring to the GI concept.

All participants received advice on eating pattern for small frequent meals, distributed evenly throughout the day and portion size controlled by using a plate method (Farhanah et al., 2014.) They also received a set of meal plan based on their energy requirement and food baskets that contained recommended foods. In an LGI group, the food basket consisted of basmati rice, pasta, whole grain bread, barley, hi-calcium biscuits and low-fat milk. In the SNT, the food baskets consisted of white rice, whole grain bread, instant oats, meehoon, cream crackers and cornflakes.

Dietary Assessment

Participants provided information on their usual dietary intake for the past one month at baseline and during the 4-week study using the food frequency questionnaire (FFQ). The diet GI and GL (glycaemic load) were also calculated from the FFQ. The FFQ is adapted from Norimah and Kather (2003) and consisted of 137 food items which were listed under 14 food groups in order to identify specific sources of carbohydrate that contributed to the GI value of the study participants. These 14 food groups included rice, bread, noodle and pasta, kuih, dough, starchy vegetables, fruits, milk and dairy products, biscuits, beverages, breakfast cereals, miscellaneous, confectionery, legume, and sucrose.

The participants also recorded foods and beverages consumed over the last 24 hours for three days throughout the intervention period. They were asked to record intake for two week-days and one weekend day. The amount of foods consumed was based on the standard household measurement Suzana, Noor, Nik Shanita, Rafidah and Roslina (2009).

Nutrient analysis was done using the Dietary Plus Software developed by Ng (2010) for energy, protein, fat, carbohydrate, calcium, iron and cholesterol. Dietary GI and GL was also analysed using this software. A majority of the foods consumed by the participants were gleaned from the database. However, for certain cases where the food was not available in the database, the methods described previously (Barakatun Nisak et al., 2010) were used to estimate the GI of the foods. In general, the estimation of GI values was based on similar matched factors of the individual ingredients of the foods such as the type of fibre (soluble or insoluble), fat content, acidity, particle size, protein, and cooking and processing methods.

Statistical Analysis

Data was analysed using SPSS version 21 (SPSS Inc. Chicago, USA) and the significant level was set at $p < 0.05$. Results were expressed as mean ± SD, unless otherwise stated. Descriptive statistics were used to present the baseline socio-demographic, obstetric characteristic and dietary intake. Comparisons between two groups were analysed using the independent T-Test. The effect of dietary intervention on dietary intake was assessed using General Linear Model (GLM) over time, between time and treatment group, and time interaction with repeated measures on time.

RESULTS

We screened 480 participants but almost 92% of them (n = 440) were not eligible mainly because they exceeded 34 weeks of gestations (n = 396). A total of 40 participants signed the informed consent letter. They were randomised to LGI (n = 20) or SNT (n = 20). All participants completed the study (Figure 1).

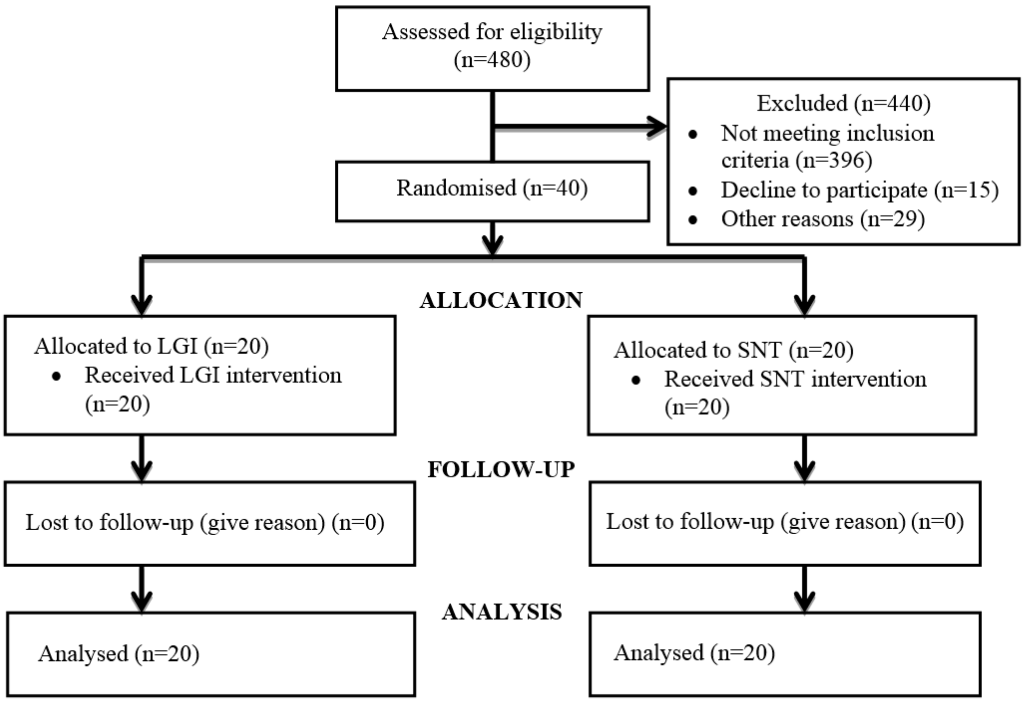

Figure 1. Participants enrolment and follow-up

At baseline, no significant differences were noted in the participant's characteristics between the LGI and control SNT groups. Participants on average had 32.5 ± 4 gestation weeks with majority of them having a history of GDM (75%) (Table 1).

Table 1
Obstetrical characteristics of participants in the LGI and SNT group at baseline

Characteristics	LGI Group (n=20)	SNT Group (n=20)	p-value
	Means ± SD	Means ± SD	
Age#	33 ± 3.1	32 ± 4.9	0.4
Pre-pregnancy BMI (kg/m^2)#	29.7 ± 6.8	28.5 ± 6.4	0.5
Body weight (kg)#	70.4 ± 16.1	70.4 ± 17.6	0.9
Height (cm)#	154 ± 5.9	156 ± 5.1	0.2
Week of gestation#	27 ± 4.4	24.6 ± 3.4	0.06
History of GDM (%)*	45%	30%	0.3

Statistical Analysis: t-test#, descriptive*

Table 2 shows energy, protein, fat and carbohydrate over time were significantly reduced in the LGI and SNT group ($p<0.05$). Furthermore, percentage of fat and carbohydrate significantly reduced within 4 weeks of intervention in both groups over time ($p<0.05$). Nevertheless, no significant interaction (time*group) and group effect was noted in all nutrients as shown in Table 2.

Table 2
Comparison of daily nutrient intake data (Mean± SD) calculated from food frequency questionnaires of the participants in the LGI and SNT over 4 weeks period

Nutrient	Group						P		
	Low Glycaemic Index (n=20)		Δ	Standard Nutrition Therapy (n=20)		Δ	Time	Time* group Group	Group
	Baseline Mean ± SD	Week 4 Mean ± SD		Baseline Mean ± SD	Week 4 Mean ± SD				
Energy (kcal)	2599 ±1476	2234 ±1115	-365	2031 ±744	1842 ±708	-189	<0.05	ns	ns
Protein (g)	109 ±70	86 ±48	-22	83 ±43	76 ±44	-6	<0.05	Ns	ns
Protein (g/kg body weight)	1.5	1.2	-0.3	1.2	1.1	-0.1	ns	Ns	ns
Protein (%)	17 ±9	15 ±2	-1.7	15 ±7	16 ±4	1.1	<0.05	Ns	ns
Fat (g)	85 ±50	75 ±38	-10	60 ±26	59 ±27	-1	<0.05	Ns	ns
Fat (%)	28± 9	31 ±4	2.5	27 ±5	29 ±5	2.4	<0.05	Ns	ns
CHO (g)	363 ±201	290 ±154	-72	278 ±104	243± 85	-35	<0.05	Ns	ns
CHO (%)	55 ±6	52 ±5	-3.6	56 ±7	53 ±7	-2.3	<0.05	Ns	ns
Cholesterol (mg)	323± 239	302±236	-20	284±177	289±183	5	ns	Ns	ns

Statistical Analysis: General Linear Model (GLM)

Participants in the LGI group had higher dietary calcium compared with those in the SNT group ($p<0.05$ Table 3). The fibre intake of the participants in the LGI group seemed to be higher than the SNT group with no statistically significant difference but the differences in the means was moderate (eta squared = 0.08). Dietary GI in the LGI group seemed to be significantly lower than the SNT group with the difference of 7 units of GI ($p<0.05$) (Table 3).

Table 3
Daily nutrient intake data (Mean± SD) calculated from 3-day food records of the participants in the LGI and SNT over 4 weeks

Nutrient	Low Glycaemic Index (n=20) Mean ± SD	Standard Nutrition Therapy (n=20) Mean ± SD	p-value
Energy (kcal)	1456± 358	1431 ±374	0.8
kcal/ kg body weight	19.85 ±7.6	18.79 ±6.9	0.6
Protein (g)	70 ±16	64 ±13	0.2
g/1000kcal	49 ± 7.5	46 ±6.8	0.1
% Protein	19 ±3	17± 3	0.09
Fat (g)	45 ±21	42 ±14	0.5
g/1000kcal	30.4 8.8	30 7.1	0.8
Dietary fibre (g)	17± 16	11 ±5	0.09
g/1000kcal	12.2 ±10	7.5 ±2.6	0.05
Ca (mg)	702 ±309	500 ±278	<0.05
Fe (mg)	30± 75	16 ±14	0.3
Cholesterol (mg)	255 ±120	253 ±120	0.9
Dietary GI	50± 9	57 ±6	<0.05
Dietary GL	24 ±7	26± 5	0.4

Statistical analysis: t-test

Table 4 compares the carbohydrate sources between LGI and SNT groups based on a 3-day food records throughout the intervention. It has been documented that the main source of carbohydrate between both groups were from rice. However, in the LGI group, it has been reported that 22% of rice consumed were from the low GI rice varieties such as basmati and parboiled ($p<0.05$).

About 40% of the rice that were consumed by the participants in the SNT group came from HGI rice varieties such as white rice, fragrance rice and instant rice which was significantly higher than the LGI group ($p<0.05$). During the intervention, whole grain bread and LGI biscuits were highly preferable in the LGI group as compared with participants in the SNT group ($p<0.05$).

Table 4
Comparison of carbohydrate sources between LGI and SNT groups based on 3-day food records

Cho Sources	Low Glycaemic Index (mean±SD)	Standard Nutrition Therapy (mean±SD)	Total
Total rice (%)	40 ± 12	44 ± 18	ns
Low GI varieties (%)	22 ± 15	3.5 ± 9	<0.05
High GI varieties (%)	18 ± 15	40.5 ± 23	<0.05
Total bread (%)	9.5 ± 5.5	6.6 ± 9.2	ns
Whole grain (%)	6.6 ± 6.3	1.4 ± 4.2	<0.05
Whole meal (%)	0.5 ± 1.4	0.6 ± 2.6	ns
White bread (%)	2.4 ± 5.1	4.4 ± 7.6	ns
Total noodle and pasta (%)	7.4 ± 8.2	11 ± 9.7	ns
Noodle wheat based (%)	0.4 ± 2.2	0.7 ± 3.3	ns
Noodle rise base (%)	5.7 ±6.5	10 ± 10	ns
Pasta (%)	1.3 ± 5.8	0.3 ± 1.3	ns
Total Kuih (%)	7.2 ± 11	7.7 ± 9	ns
Kuih-wheat based (%)	4.6 ± 8.4	6.5 ± 8.7	ns
Kuih rice based (%)	2.6 ± 8.9	1.2 ± 4.3	ns
Total dough (%)	3.2 ± 4.9	6.7 ± 9.2	ns
Low GI varieties (%)	0.7 ± 2.4	0.6 ± 2.6	ns
Other varieties (%)	2.5 ± 4.7	5.9 ± 8.8	ns
Starch vegetables (%)	0.6 ± 0.9	1.0 ± 3.0	ns
Low GI varieties (%)	0 ± 0	0 ± 0	ns
Other varieties (%)	0.6 ± 0.9	1.0 ± 3.0	ns
Total Fruits (%)	7.6 ± 10	4.8 ± 5.2	ns
Low GI varieties (%)	3.9 ± 6.2	2.3 ± 4.8	ns
Other varieties (%)	3.7 ± 6.9	2.5 ± 3.6	ns
Milk and dairy products (%)	9.8 ± 8.5	4.9 ± 6.8	ns
Biscuits (%)	5.4 ± 6.3	5.2 ± 6.0	ns
Low GI varieties (%)	4.4 ± 5.9	1.0 ± 4.4	<0.05
Other varieties (%)	1.0 ± 2.2	4.2 ± 4.9	ns
Beverages (%)	4.3 ± 6.3	1.5 ± 2.1	ns
Low GI varieties (%)	2.9 ± 5.6	0.4 ± 1.2	ns
Other varieties (%)	1.4 ± 2.4	1.1 ± 2.0	ns
Breakfast cereals (%)	1.0 ± 3.4	0.9 ± 2.3	ns
Low GI varieties (%)	0.6 ± 2.4	0.2 ± 1.1	ns
Other varieties (%)	0.4 ± 1.3	0.7 ± 2.1	ns
Miscellaneous (%)	0 ± 0	0.1 ± 0.2	ns
Confectionery (%)	0 ± 0	1.5 ± 3.6	ns
Legume (%)	2.1 ± 4.8	0.1 ± 0.2	ns
Sucrose added (%)	1.9 ± 2.2	4.0 ± 6.1	ns
Total	100	100	

Statistical Analysis: t-test

DISCUSSION

This study examined the effects of low GI diet on the metabolic response of women with GDM in Malaysia. The energy, protein, fat, CHO and dietary fibre intake of the participants in the LGI and SNT group were similar. Furthermore, there was no significant difference in the dietary of GI and GL between both groups. Nevertheless, it showed that the percentage of CHO was higher among Malaysian women with GDM compared with women with GDM from Western countries (Moses et al., 2009; Perera et al., 2012). This may be due to the fact Asian staple food consist of polished rice and refined wheat with HGI and GL values (Ludwig, 2002).

It is interesting to note that, participants who were in the LGI group has significantly lower dietary GI intake compared with the SNT group ($p < 0.05$). The dietary data of the participants were obtained from the 3-day food records and FFQ.

The incorporation of GI concept in the LGI group has significantly affected the dietary GI of the participants. Dietary assessment based on a 3-day food records from this study showed significant differences in dietary GI between LGI and SNT group which was 7 units ($p<0.05$). This may be due to an increase in consumption of basmati rice, whole grain bread, pasta, milk, and dairy products, barley biscuits and legumes, which are mostly from the low GI varieties.

The pattern of food intake in this study was similar to that observed in the previous study among participant with T2DM, whereby, the participants in the LGI group were more likely to consume food with low GI value such as parboiled and Basmati rice, whole grain bread, pasta, temperate-climate fruits and biscuits from LGI varieties (Barakatun Nisak, Ruzita, Norimah, Gilbertson, & Kamaruddin, 2010). Meanwhile, in study that involved women with previous history of GDM, fibre intake was significantly higher among participant in LGI group ($p<0.001$) compared with those who were allocated to the control group (Shyam et al., 2013).

Perera et al. (2012) and Moses et al. (2009) also found that participants in the LGI group have achieved and maintained significantly lower dietary GI than the control group. Dietary GI was reduced as much as 8 units in Moses et al. (2009) while 4 units reduction was reported by Perera et al. (2012) at the end of the study among participants in the LGI group.

Rice is a staple of over half of the world's population and provides 20% of the world's energy supply (Food & Agriculture Organization, 2004). Most of the white rice varieties are a GI food (Sugiyama, Tang, Wakaki, & Koyama, 2003). This was supported by a study done by Barakatun Nisak, Talib and Karim (2005) who studied the GI of eight types of commercial rice in Malaysia, reported that the GI value of Malaysian rice was categorised as medium to high GI food with the range of 60 to 87. Almost 97% of Malaysian consumed white rice twice daily (Norimah & Kather, 2003). This is also in accordance with our earlier observation, which showed that the largest proportion of carbohydrate sources was from rice, with the percentage of 40 and 44 in the LGI and SNT group respectively. However, more than half (22%) of the rice from the LGI group was in from low GI category ($p<0.05$).

Participants in the GI group were advised to substitute white rice with parboiled and Basmati rice to reduce the dietary GI throughout the study (Barakatun Nisak et al., 2011). The participants in this study were also given a food basket of cereals, pasta, milk and biscuits from the low GI food categories. This may be one of the factors that improved the dietary GI of LGI group in this study. This was in line with Grant et al. (2011) and Louie et al. (2011) who provided food samples, list of foods and menu planning based on participant's assignment to increase adherence to the diet prescribed.

Brand-Miller, Petocz, Hayne and Colagiuri (2003) found that a reduction of 10 units of dietary GI is considered clinically significant with a positive effect on the glycaemic outcomes. In this study, the dietary GI of LGI group was 7 units lower than SNT group.

Reported intake of energy, protein, fat and carbohydrate reduced significantly throughout time ($p<0.05$). The participants in both the LGI and SNT group have achieved the carbohydrate recommendation target, with the range of 50% to 55% of total energy intake. It is encouraging to compare the result with the previous study of women with GDM who discovered reduction in carbohydrate percentage in both the GI group as well as control group (Moses et al., 2009; Perera et al., 2012).

Fibre intake, which could be a confounding variable in determining the potential advantages of a LGI diet, was similar with no significant difference between both groups. However, the intakes of dietary fibre in the LGI group were higher (12.2 g/1000 kcal/day) than those women in the SNT group (7.5 g/1000 kcal/day). This is due to fibre-rich foods which are LGI foods (Riccardi, Rivellese, & Giacco, 2008). Furthermore, the higher the viscous or soluble fibre is, the lower its GI (Kirpitch & Maryniuk, 2011). This increases the viscosity of the intestinal content, which slows down the interaction between starch and digestive enzymes resulting in lower and lower glycaemic excursions (Kirpitch & Maryniuk, 2011).

The calcium intake of participants in the LGI group appeared to be higher than the SNT group ($p<0.05$). This may be due to higher intake of milk and dairy products among participants in LGI groups. Overall, the implementation of the LGI diet has improved dietary quality in women with GDM as well as patients with T2DM in Malaysia (Barakatun Nisak, Ruzita, Norimah, Gilbertson, & Kamaruddin, 2010).

A recent study has stated that subscribing the low GI diet in Asia has its own limitations as the availability of low GI foods in the market is not as high GI foods (Barakatun Nisak et al., 2014). Besides, the prices of low GI foods are higher than high GI meals (Barakatun Nisak et al., 2010). Though the availability of low GI local Malaysian foods is limited, the few GI studies that have been done in Malaysia have proven that incorporation of GI concept dietetic management is feasible and has shown an improvement glycaemic control and dietary quality of patient with type 2 diabetes and women with history of GDM (Barakatun Nisak, Ruzita, Norimah, Azmi, & Fatimah, 2009; Shyam et al., 2013).

CONCLUSION

In conclusion, the incorporation of the LGI dietary strategy in dietetic management of GDM did not lead to poor quality of food consumed by the participants in LGI group. On the contrary, participants in the LGI group had greater intake of fibre and calcium than participants in SNT group. The reduction in dietary GI in LGI group has provided another dietary management option for managing GDM in Malaysia. Future trial is required to add more data on GI of Malaysian food. This would assist the feasibility of women with GDM to maintain low GI dietary intake in a traditional Asian diet.

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REFERENCES

Afaghi, A., Ghanei, & Ziaee, A. (2013). Effect of low glycaemic load diet with and without wheat bran on glucose control in Gestational Diabetes Mellitus: A randomized trial. *Indian Journal of Endocrinology and Metabolism, 17*(4), 689-692.

American Diabetes Association. (2007). Medical nutrition therapy and lifestyle intervention. *Diabetes Care, 30* (Suppl. 2), s188-s193.

American Diabetes Association. (2008). Nutrition recommendation and interventions for diabetes: A position statement of the American Diabetes Association. *Diabetes Care, 31*, s61-78.

American Diabetes Association. (2003). Gestational Diabetes Mellitus. *Diabetes Care, 26*(1), S103-S105.

Barakatun Nisak, M. Y., Ruzita, A. T., Norimah, K., Gilbertson, H., & Kamaruddin, N. A. (2010). Improvement of dietary quality with the aid of low glycaemic index diet in Asian patients with type 2 diabetes mellitus. *Journal of American College of Nutrition, 29*(3), 161-170.

Barakatun Nisak, M. Y., Talib, R. A. & Karim, N. A. (2005). Glycemic Index of eight types of commercial rice in Malaysia. *Malaysian Journal Of Nutrition, 11*, 151-163.

Barakatun Nisak, M. Y., Ruzita, A. T., Norimah, A. K., Azmi, N. K., & Fatimah, A. (2009). Acute effect of low and high glycaemic index meals on post-prandial glycemia and insulin responses in patients with type 2 diabetes mellitus. *Malaysian Journal of Medicine and Health Sciences, 5*(1), 11-20.

Barakatun Nisak, M. Y., Firouzi, S., Shariff, Z. M., Mustafa, N., Ismail, N. A. M., & Kamaruddin, N. A. (2014). Weighing the evidence of low glycaemic index dietary intervention for the management of gestational diabetes mellitus: An Asian perspective. *International Journal of Food Sciences and Nutrition, 65*(2), 144-150.

Brand-Miller, J., Petocz, P., Hayne, S., & Colagiuri, S. (2003). Low glycaemic index diets in the management of diabetes, a meta-analysis of randomized control trials. *Diabetes Care, 26*,2261-2267.

Farhanah, A. S., Fatin Nasirah, M. D., Barakatun Nisak, M. Y., Nor Azlin, M. I., & Zalilah, M. S. (2014). Current dietetic practices in the management of gestational diabetes mellitus: A survey of Malaysian dietitians. *Asian Journal of Clinical Nutrition, 6*(3), 67-74.

Food & Agriculture Organization. (2004). Rice is life. Retrieved on 1 August 2015 from http://www.fao.org/newsroom/en/focus/2004 6887/

Galgani, J., Aguirre, C., & Diaz, E. (2006). Acute effect of meal glycaemic index and glycaemic load on blood glucose and insulin responses in humans. *Nutrition Journal, 5*(22), 1-7.

Grant, S. M., Wolever, T. M. S., O' Connor, D. L., Nisenbaum, R., & Josse, R. G. (2011). Effect of a low glycaemic index diet on blood glucose in women with gestational hyperglycaemia. *Diabetes Research and Clinical Practice, 91*, 15-22.

Kirpitch, A. R., & Maryniuk, M. D. (2011). The 3R's of glycaemic index: Recommendations, research, and the real world. *Clinical Diabetes, 29*(4), 155-159.

Louie, J. C., Markovic, T. P., Perera, N., Foote, D., Ross, G. P., & Brand-Miller, J. C. (2011). A randomized controlled trial investigating the effects of a low glycaemic index diet on pregnancy outcomes in gestational diabetes mellitus. *Diabetes Care, 34*(11), 2341-2346.

Ludwig D. S. (2002). The glycaemic index. Physiological mechanisms relating to obesity, diabetes, and cardiovascular disease. *The Journal of the American Medical Association, 287*, 2414–23.

Mareno C. C., Mauricio, D., & Hernandez, M. (2016). Role of medical nutrition therapy in the management of gestational diabetes mellitus. *Current Diabetes Report, 16*(4).

Moses, R. G., Barker, M., Winter, M., Petocz, P., & Brand-Miller, J. C. (2009). Can a low-glycaemic index diet reduce the need for insulin in gestational diabetes mellitus? *Diabetes Care, 32*(6), 996-1000.

Ng, T. N. K. W. (2010). DietPLUS- a user-friendly ‘ 2 in 1’ food composition database and calculator of nutrient intakes. *Malaysian Journal of Nutrition, 16*(1), 125-130.

Norimah, A. K., & Kather, H. M. M. (2003). Nutritional status and food habits of middle- aged adults in selected areas of Selangor. *Malaysian Journal of Nutrition, 9*(2), 125-136.

Perera, O. P., Nakash, M. B., Rodriguez-Cano, A., Legorreta, J. L., Parra-Covarrubias, A., & Vadillo-Ortega, F. (2012). Low glycaemic index carbohydrates versus all types of carbohydrates for treating diabetes in pregnancy: A randomised clinical trial to evaluate the effect of glycaemic control. *International Journal of Endocrinology*, 1-10.

Riccardi, G., Rivellese, A., & Giacco, R. (2008). Role of glycaemic index and glycaemic load in the healthy state, in prediabetes, and in diabetes. *American Society for Clinical Nutrition, 87*(1), 269S-274S.

Shyam, S., Arshad, F., Ghani, R. A., Wahab, N. A., Safii, N. S., Nisak, M. Y. B., ... & Kamaruddin, N. A. (2013). Low glycaemic index diets improve glucose tolerance and body weight in women with previous history of gestational diabetes: A six months randomized trial. *Nutrition Journal, 12*(68), 1-12.

Sugiyama, M., Tang, A. C., Wakaki, Y., & Koyama, W. (2003). Glycaemic index of single and mixed meal foods among common Japanese foods with white rice as a reference food. *European Journal of Clinical Nutrition, 57*, 743-752.

Suzana, S., Noor, A. M. Y., Nik Shanita, S., Rafidah, G., & Roslina, A. (2009). *Atlas of food exchange*s and portion sizes (2nd ed). Kuala Lumpur: MDC Publishers.

World Health Organization. (2011). Hemoglobin concentration for the diagnosis of anemia and assessment of severity. Vitamin and mineral nutrition information system. Retrieved on 16 June 2014 from http://www.who.int/vmnis/indicators/haemoglobin pdf

World Health Organization, International Obesity Task Force, & International Association for the Study of Obesity. (2000). The Asia-Pacific perspective: Redefining Obesity and its Treatment. Hong Kong.