Original Article

Adding glycaemic index and glycaemic load functionality to DietPLUS, a Malaysian food composition database and diet intake calculator

Sangeetha Shyam MSc[1], Tony Ng Kock Wai PhD[2], Fatimah Arshad PhD[2]

[1]*School of Post-Graduate Studies and Research, International Medical University, Kuala Lumpur, Malaysia*
[2]*Department of Nutrition & Dietetics, School of Pharmacy & Health Sciences, International Medical University, Kuala Lumpur, Malaysia*

This paper outlines the methodology to add glycaemic index (GI) and glycaemic load (GL) functionality to food DietPLUS, a Microsoft Excel-based Malaysian food composition database and diet intake calculator. Locally de-termined GI values and published international GI databases were used as the source of GI values. Previously published methodology for GI value assignment was modified to add GI and GL calculators to the database. Two popular local low GI foods were added to the DietPLUS database, bringing up the total number of foods in the database to 838 foods. Overall, in relation to the 539 major carbohydrate foods in the Malaysian Food Composi-tion Database, 243 (45%) food items had local Malaysian values or were directly matched to International GI da-tabase and another 180 (33%) of the foods were linked to closely-related foods in the GI databases used. The mean ± SD dietary GI and GL of the dietary intake of 63 women with previous gestational diabetes mellitus, cal-culated using DietPLUS version3 were, 62 ± 6 and 142 ± 45, respectively. These values were comparable to those reported from other local studies. DietPLUS version3, a simple Microsoft Excel-based programme aids calcula-tion of diet GI and GL for Malaysian diets based on food records.

Key Words: glycaemic index, glycaemic load, diet, dietary carbohydrate, Malaysia

INTRODUCTION

Glycaemic index (GI) is a physiological ranking of car-bohydrates on a scale of 0 to 100 according to the extent to which they raise blood sugar levels.[1] GI is defined as the incremental area under the blood glucose response curve elicited by a 50 g available carbohydrate portion of a food expressed as a percentage of the response shown after 50 g anhydrous glucose taken by the same subject.[2] GI is therefore a reflection of the rate of conversion of carbohydrate into glucose.[3]

GI can be successfully used to predict glycaemic re-sponse to meals containing fat and protein,[4] demonstrat-ing its applicability to mixed meals.[5] It is even possible to calculate meal GI, by establishing the percentage of car-bohydrate contributed by each carbohydrate food in the meal and the GI assigned to each of these foods. 6 All GI studies using or comparing low-GI and high-GI meals and diets, are based on the meal GI calculation. [6] All GI studies using or comparing low-GI and high-GI meals and diets, are based on the meal GI calculation.[6] Extend-ing the concept, diet GI is obtained by calculating the GI for an entire day, as the mean GI of each meal consumed during the day.[6]

Glycaemic load (GL) of a typical serving of food is the product of the amount of available carbohydrate in that serving and the GI of the food and is more reflective of the postprandial glycaemic response of a portion of food.[7] Diet GL is calculated as the sum total of GL of foods

consumed in a day.[7,8] Higher GL elicits, greater elevation in postprandial glycaemic and insulinogenic effect of the food.[8]

It has been recognized that changes associated with re-sistance to insulin-mediated glucose uptake and hyperin-sulinaemia play an important role in the aetiology and clinical course of patients with the metabolic syndrome,[9] type 2 diabetes, high blood pressure, and coronary heart disease.[10,11] Hence, postprandial excursions in blood glu-cose and its determinant dietary GI and GL, have physio-logical and metabolic effects far beyond merely influenc-ing the glycaemic responses.[2] Low GI diets also reduce insulin levels and insulin resistance.[1] Epidemiological evidence suggests direct associations between GI, GL, and risk of diabetes,[7,9] CHD,[12] and obesity.[13] Evidence is also emerging of a possible link with cancers of the colon,[14] breast,[9] and Parkinson's disease.[15] Significant positive associations between GI or GL and relative risks for various chronic diseases after adjustment for potential confounders have been established.[16]

Corresponding Author: Sangeetha Shyam, School of Post Graduate Studies and Research, International Medical Univer-sity, No 126, Jalan 19/155B, Bukit Jalil, 57000 Kuala Lumpur, Malaysia
Tel: +603-8656 7228, +60123509243; Fax: +603-8656 7299
Email: sangeeshyam@gmail.com;
        Sangeetha_Shyam@imu.edu.my

Evidence therefore indicates that differences in the GI of the diet, irrespective of the amount of carbohydrate in the diet, influence a wide variety of physiological processes which are relevant not only to the prevention and treatment of diseases but also in the functioning and performance of healthy individuals.[2]

However, calculations of diet GI and GL require in-depth knowledge of carbohydrate intake.[2] Additionally, for detailed application of the GI, a value of the GI for every food in the diet or meal needs to have been assigned, and since not all foods have currently been analysed, the value may have to be carefully estimated. The available GI data on local Malaysian food products are limited to a few frequently consumed local foods, and a few rice and bread varieties.[17] In such a scenario, when expanding a food composition database to include GI values, the accuracy of GI calculation depends upon the accuracy of the GI values ascribed to foods,[18] the methods used to assign and calculate the GI/GL values,[19] and the source of data of the GI values.[20]

A revised "International Tables of Glycaemic Index" had brought together all internationally relevant GI data in a format, where the quality of the data can be verified on the basis of the experimental methods (ie, compliance to FAO/WHO Testing standards (1997).[18] In total, the revised table contains nearly 1300 individual entries, representing in excess of 750 different types of foods. The revised table published by Foster Powell et al in 2002 is available at the following URL: http://www.ajcn.org/cgi/content-nw/full/76/1/5/T1.[8] The tables provide the GI and GL values for each food with either glucose or white bread used as the reference food, the type and number of subjects tested, testing duration used, the country of origin, the country of origin, brand or manufacturer for applicable commercial products and the published source of the data. This additional information is intended to enhance the ability to match foods carried on a particular database to similar foods in the literature.[8,21] For many foods there are more than two published values. In such cases the tables also present the mean ± SEM GIs. Thus, the user is made aware of the variation for any one food, and, and is provided with the option of using the GI value appropriate for the food found in their country.

In 2006, Olendzki et al.[22] proposed a systematic method of adding the GI and GL values to the nutrient database of the 24-hour dietary recall, where the food items were matched to the International Table of Glycaemic Index and Glycaemic Load Values.[8] The GI values for foods not available in the table were estimated from similar foods using physical and chemical factors that determine GI as guidelines.[22] Mixed foods were separated into individual ingredients and accordingly analysed.[22] This method, they declared, could be used in both clinical and survey research settings.[23] However; Olendzki's method was highly sophisticated and relied on detailed food science data including amylose: amylopectin ratio and particle size.[22] Taking cognizance of the fact that food composition databases do not always provide these level of detail, Louie et al (2011) outlined a simplified methodology to allocate GI and GL values to the 24-h dietary recalls.[19]

GI concept is in its infancy in Malaysia. However, with the increasing incidence of obesity and related chronic diseases such as diabetes and cardio-vascular disease, endocrinologists, dieticians and nutritionists are looking at the concept in a more favourable light. This is by most part driven by increasing scientific evidence in the physiological benefits of the application of GI concept. While we are aware, at this juncture, of the development of systematic GI or GL calculators in United States of America,[20,22-24] Australia,[19] and Finland,[25] such a calculator is not available in Malaysia. Currently calculations of Dietary GI and GL are done after importing the carbohydrate data from other software or programs used for dietary intake calculations, thereby making the process convoluted, time-consuming and introducing scope for errors. Hence the need for a systematic dietary GI and GL calculator based on the Malaysian food composition database was identified. The objective of this project was to develop one such calculator that was both economical and easy to use for students and researchers working in this area.

MATERIALS AND METHODS

The project was approved by the Joint Research and Ethics Committee of the International Medical University (IMU), Kuala Lumpur, Malaysia, where DietPLUS was developed. The data collection using three day food records from 63 post-gestational diabetes mellitus (GDM) subjects was carried out at the National University of Malaysia Medical Centre (UKMMC) and was approved by the Research Ethics Committee of UKMMC. Informed consent was obtained from all the subjects and, patient confidentiality and privacy have been preserved.

DietPLUS: a Microsoft Excel-based Malaysian Food Composition Table and Dietary Intake Calculator

A teaching and research tool called 'DietPLUS', was originally developed in 2008 by one of the authors of this paper and published in 2010.[26] Version 2 of DietPLUS contained nutrient information of 836 food items in Microsoft Excel format. DietPLUS functions as a '2-in-1' food composition database and calculator of nutrient intakes. The macronutrients originally featured in the programme were energy, protein, fat, carbohydrates, dietary fibre, sugars (intrinsic and added), poly-unsaturated omega-6 fatty acids mainly linoleic acid and polyunsaturated omega-3 fatty acids (alpha-linolenic acid, EPA and DHA). The micronutrients in the programme are vitamin A as retinol equivalents (RE), vitamin C, thiamine, riboflavin, and niacin. Cholesterol content completed the list of food components tabled. Information on macronutrients and micronutrients of foods was obtained mainly from four sources: Nutrient Composition of Malaysian Foods (1997),[27] Food Composition Guide Singapore Health Promotion Board Singapore (2003),[28] Australian Food Composition Tables (NUTTAB, 2006),[29] and publications on Malaysian foods.[26] It must be noted that only values for total dietary fibre, total sugars and PUFA were obtained from non-Malaysian sources, since comprehensive data on these nutrients are currently unavailable for Malaysian foods.

The food items in DietPLUS are divided into the following food categories which resemble the format used in

the Malaysian Food Composition database:[27] 1) cereals and cereal products; 2) roots and tubers; 3) legumes; 4) nuts and seeds; 5) vegetables; 6) fruits; 7) meat and eggs; 8) fish and sea foods; 9) condiments pastes, dressings and sauces; 10) fats and oils; 11) milk and milk products; 12) beverages and syrups; 13) cakes, desserts, snacks; and 14) restaurant/hawker foods and fatty foods.

Food items consumed are converted into gram quantities of edible portions and are entered in one column in the Microsoft Excel worksheet and DietPLUS instantaneously sums up the macronutrients and micronutrients consumed with each subsequent entry. Percentage calories from macronutrients protein, fat, carbohydrate and dietary fibre consumed as a percentage of the Recommended Nutrient Intakes for Malaysia (2005)[30] are presented. An approximate number of servings are also provided for vegetables, fruits, legumes, fish and meat, to aid meal planning and nutrition/dietetic counselling.

The modular nature of DietPLUS lends itself to updates when new nutrient information becomes available. Thus, DietPLUS was a natural choice to create a GI and GL calculator for Malaysian diets. Two recently available low GI foods; low-GI bread and Ponni Rice that were gaining popularity among the local public as health foods were added to DietPLUS database, thereby bringing the total number of foods in the database to 838.

GI Databases used in the compilation
Locally-determined Malaysian GI values and the values published internationally[1] were used in assigning the GI values to the foods in DietPLUS Version 3. Malaysian GI values published by independent Malaysian researchers,[17,][31-33] were the first choice in direct assignment of GI values to foods in the database. Other values were obtained from online GI database published by the University of Sydney, freely accessible from www.glycemicindex.com.[1] This online database is viewed as an updated version of the Foster-Powell et al's revised international tables of GI values published in 2002.[8]

Methodology used to assign GI values to foods in the database
While the information in international GI database provides for discretion while adding GI values to a food composition database, there is subjectivity involved in the estimation of appropriate matches and assignment of GI values.[20] Hence to improve the accuracy of GI assignment, systematic methods to assign GI values to DietPLUS were modified from the 5-step algorithm developed by Louie et al.[19] An earlier Malaysian GI intervention study by Yusof et al, identified foods that were major contributors to Malaysian dietary GI and GL and further assigned GI values to the 291 commonly consumed carbohydrate containing foods in the Malaysian diet after intensive review based on data collected from 264, three day food records.[17] These assigned GI values were regularly consulted while proceeding with the subsequent steps.

Five sequential steps were defined the algorithm outlined by Louie et al for GI assignment.[19] We adapted the same five steps to suit the requirement of assigning GI to Malaysian DietPLUS Version 3 database for GI assignment.

Step1: Each food item in the database was checked for available direct matches to Malaysian GI values or international database at glycemicindex.com.[1]

When matching foods directly at the first step, the GI values assigned by Yusof et al [17] were also consulted.

General Criteria for Selecting GI Values
Guideline criteria were outlined to help select appropriate GI values. These included:
1. Testing Protocol: While assigning GI values, attempts were made to select GI values obtained from standard testing protocol.[18] These include GI values determined using a minimum of 10 healthy human subjects, with the area under the curve determined for a period of 2 hours, with glucose as the reference food were.
2. Subject Criteria: Since GI values obtained from diabetic subjects have questionable applicability to the general population[2,19] these values were avoided if possible.
3. Geographical Proximity: GI values determined locally in Malaysia were the first choice for assignment. When such values were not available, the priority of selection was in the following order: SE Asia, Asia, Australia and the rest of the world
4. Exclusion of Outliers: When more than one GI value was available for a food, median value was chosen instead of mean, to exclude outliers. If there were two medians, a mean of the two medians are assigned.

Step 2: For the rest of the foods, defining criteria were created for the purpose of assigning GI values to the items in the list. *'Major carbohydrate foods in the Malaysian food database'* were described as those that contained more than 5g of carbohydrate per 100g of the food portion in the DietPLUS database. Foods containing less than this amount of carbohydrate do not excessively alter dietary GI/GL and can hence be assigned a GI value of 0.[19]

Step 3: Foods that could still not be directly assigned the GI value from the GI databases used, were assigned that of *"a closely related food item"* [19] based on the food item's ingredients, composition, properties and cooking method, as is the current practice. Previously published Malaysian research[17] that matched closely-related Malaysian foods to the international database was used as a basis in this operation.

Step 4: Foods left without a GI value after the previous step, were assigned the "median GI of subgroup" [19] that it corresponded to.

Step 5: Food items that remained without a GI value, after step 4, were checked for their contribution to the Malaysian dietary GI and GL. *'Top Diet GI/GL contributors'* was a term used to describe foods that contained more than 3.5 g of carbohydrate per serving;[34,35] and belonged to sub-food groups identified to be top contributors to Malaysian dietary GI and GL, as established in a previous study.[17] The contribution of various food groups to Malaysian Dietary GI and GL as identified by Yusof (2008)[17] is presented in Table 1. Those foods that could be categorized as "Top Diet GI/GL contributors" to Malaysian diet were either assigned the GI of the "closest possible match" [19] or a GI of 50, or 0 as was most appropriate. Food items not in the "Top diet GI/GL contribu-

Table 1. Percentage contribution of foods to Malaysian dietary GI and GL

Sub-Food Group	Percentage contribution to diet GI and GL (%)
White Rice	57
Bread	15
Noodles	11
Confectionary/sucrose added to drinks/jam/sushi	5
Fruits	4
Cakes (Kuih)	4
Milk	2
Starchy vegetables	2
Total	100%

Source: Yusof, 2008.[17]
GI- Glycaemic Index, GL- Glycaemic Load

tors" list were assigned a GI value of 0 as they by definition were not major determinants of Malaysian dietary GI.

The Louie et al[19] algorithm for GI assignment, as modified to suit Malaysian DIETPLUS database requirements is detailed in Figure 1.

Glycaemic load and dietary glycaemic index calculation
GL was calculated as the product of a food's GI as percentage and the amount of carbohydrate in grams (as provided in Malaysian Food Composition database) from a serving of that food ie GL = GI value of food×amount of carbohydrate/100.[17] Dietary GL was calculated as sum total of GL of foods consumed in the day i.e. diet GL=ΣGL of all foods consumed in a day. Thereafter, dietary GI was calculated using the formula Dietary GI= Diet GL×100/amount of carbohydrate in the diet.[7]

The Excel programme tools were appropriately manipulated in additional columns introduced into the Diet-PLUS version 2, to calculate, GL of individual foods, diet GL and consequently diet GI. This new version with added GI and GL calculators was called DietPLUS version 3.

Available carbohydrates are needed to calculate GL. However, total carbohydrate values on DietPLUS version 2 are primarily obtained from standard Malaysian food composition database and provide total carbohydrate minus crude fibre values. As a result, in DietPLUS version 3, GL was calculated per serving as the product of GI and total carbohydrate as mentioned in Malaysian food composition database.[17]

Earlier versions of DietPLUS have been scrutinised by the nutritionists and dieticians of the Department of Nutrition and Dietetics, IMU.[26] DietPLUS has been extensively used in undergraduate and postgraduate research at
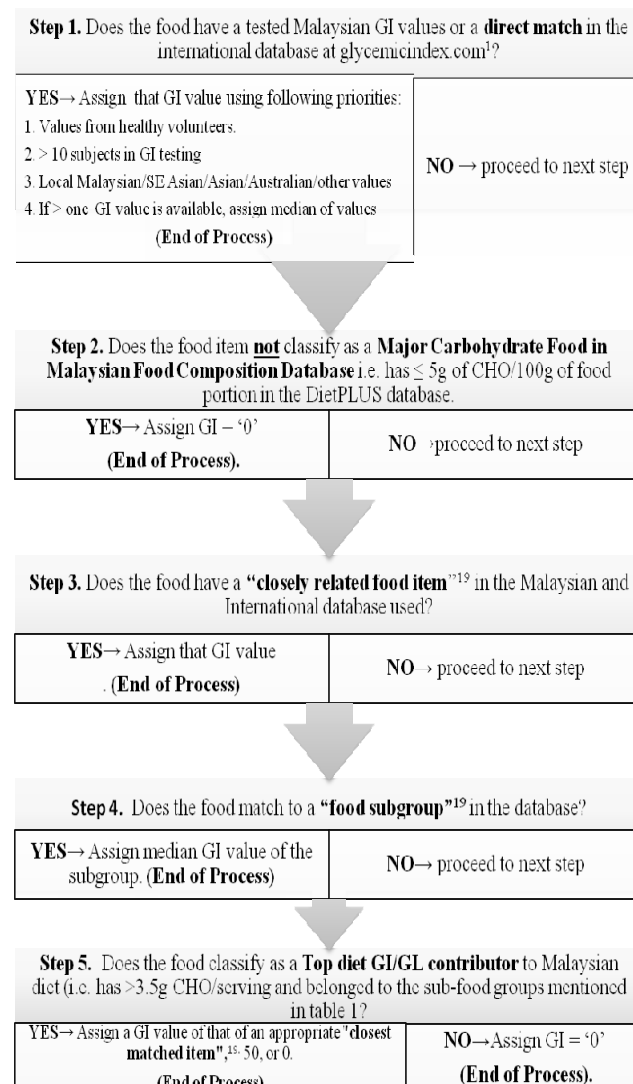

Step 1. Does the food have a tested Malaysian GI values or a **direct match** in the international database at glycemicindex.com[1]?

YES→ Assign that GI value using following priorities:
1. Values from healthy volunteers.
2. > 10 subjects in GI testing
3. Local Malaysian/SE Asian/Asian/Australian/other values
4. If > one GI value is available, assign median of values
(End of Process)

NO → proceed to next step

Step 2. Does the food item **not** classify as a **Major Carbohydrate Food in Malaysian Food Composition Database** i.e. has ≤ 5g of CHO/100g of food portion in the DietPLUS database.

YES→ Assign GI – '0'
(End of Process).

NO →proceed to next step

Step 3. Does the food have a **"closely related food item"**[19] in the Malaysian and International database used?

YES→ Assign that GI value
(End of Process)

NO → proceed to next step

Step 4. Does the food match to a **"food subgroup"**[19] in the database?

YES→ Assign median GI value of the subgroup. **(End of Process)**

NO→ proceed to next step

Step 5. Does the food classify as a **Top diet GI/GL contributor** to Malaysian diet (i.e. has >3.5g CHO/serving and belonged to the sub-food groups mentioned in table 1?

YES→ Assign a GI value of that of an appropriate "closest matched item",[15] 50, or 0.
(End of Process)

NO→Assign GI = '0'
(End of Process).

Figure 1. Algorithm for GI assignment for Malaysia modified from Louie et al. 2011 [19] (CHO: carbohydrate, GI: Glycaemic Index, GL: Glycaemic Load)
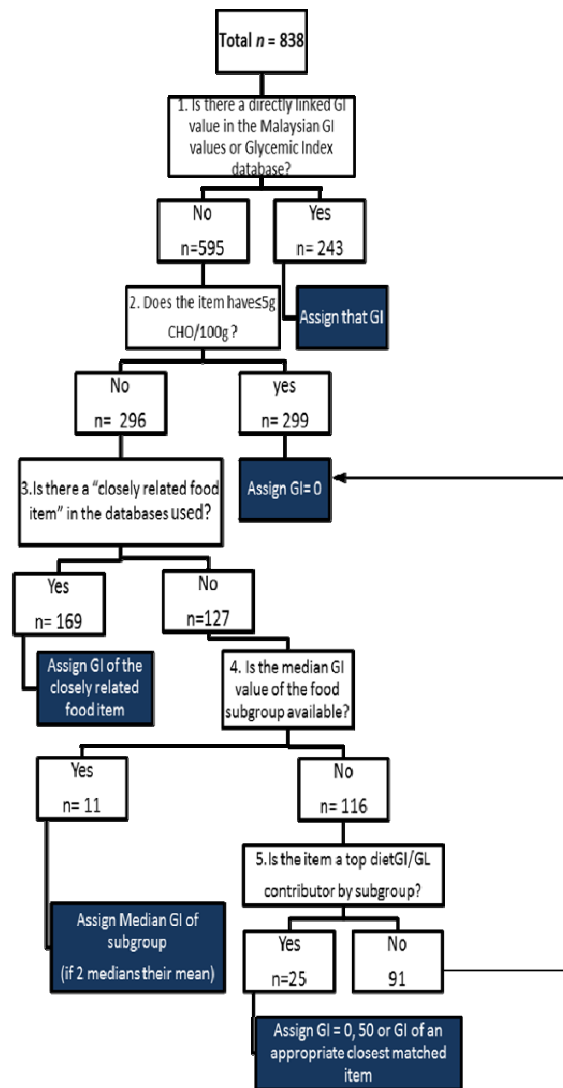
Figure 2. Process Outcome for GI value assignment on using the algorithm. Shaded boxes indicate decision end points (GI- Glycaemic Index, GL- Glycaemic Load). Our results presented in a figure modified from Louie et al, 2011. [19]

the university. DietPLUS Version 3 was used to analyse the 3 day food record collected from 63 post-gestational diabetes mellitus (GDM) women at a University Medical Centre (UKMMC), KL; Malaysia.

RESULTS

All 838 foods in the DietPLUS database were subjected to the five step process described above. Figure 2 presents the results of GI assignment for the database. The percentages of foods that were assigned at each stage are presented in the Table 2. Among 539 carbohydrate-rich items in the Malaysian DietPLUS database, 243 (45%) food items had local Malaysian values or were directly matched to International GI database and another 180 (33%) of the foods were linked to closely-related foods in the GI databases used.

The results of the dietary analysis using DietPLUS Version3 and its comparison to those reported in other Malaysian and regional studies are presented in Table 3. Using the database ensured that the same GI value was ascribed to a particular food every time it appeared in the calculations and reduced errors that could arise due to differential assignment of GI values to the same foods.

Table 2. Process outcome of GI Assignment to Diet-PLUS Version 3

Step	Process Outcome	Food assigned GI, n (%)
1	Direct Match	243 (29 %)
2	Excluded for ≤5 g/100g portion (ie, assigned GI=0)	299 (35.7%)
3	Assigned GI of "closely related" food item"	169 (20.2%)
4	Assigned median GI of food sub-group	11 (1.3%)
5	Excluded for not classifying as a Malaysian "Top Diet GI/GL contributor"	91(10.9%)
Re-mainder	Estimated assignment of appropriate closest matched item, 0 or 50	25 (3.02%)
	Total	838 (100%)

DISCUSSION

This paper describes the method used to expand the Diet-PLUS, a Microsoft Excel based Malaysian food composition database and diet intake calculator, to include values for GI using data from available references thereby adding diet GI and GL calculation functionality. To our knowledge this is the first such an attempt in Malaysia. Published Malaysian and international GI values were

Table 3. Comparison of baseline dietary intakes of subjects with subjects of other studies in Malaysia

	Current study	Chew et al., 2011[36]	Song et al., 2011[37]	Yusof, 2008[17]
Subjects	Post-GDM subjects	Post-GDM subjects	Type 2 DM	Type 2 DM
Energy, Kcal	1734± 449	1806± 480	NA	1648±354
Dietary fibre, g	13±6	10±9	NA	11±5
Dietary GI	62±6	NA	63±6	63±5
Dietary GL	142±45	NA	102±40	146±36
Energy from fat, %	30±7	32±7	NA	28±4
Energy from Protein, %	16±3	15±3	NA	17±3
Energy from CHO, %	53±9	53±7	NA	56±4

NA- Not Available; Type 2 DM – Type 2 diabetes mellitus, GDM- Gestational Diabetes Mellitus, GI- Glycaemic Index, GL- Glycaemic Load

used for this purpose. The majority of the carbohydrate rich foods common in the Malaysian diet were assigned values in agreement with a previous reported study.[17] To further enhance, the quality of GI estimation the procedure was a collaborative process among the authors. The following limitations are also acknowledged. The validity of measuring GI from food records depends on the accuracy of reported food intake. However, this limitation is not restricted to calculating dietary GI alone, but also to accurately measure energy and all nutrient intakes from food records.[2]

Although most common carbohydrate rich Malaysian foods on the DietPLUS were linked to previously published-GI values, estimation was still involved for a large number of foods. This was a necessity as few published GI values were available for local foods and rarely for local mixed foods. Hence, the accuracy of calculated diet GI or GL values from DietPLUS ver 3 are subject to improvement as more GI of local foods become available. However it is pertinent to point out that all previous diet GI and GL calculators,[19,20,22,24,25] have used international tables of GI and GL values [8] as their primary GI data resource. And, all of the original data included in the international tables were generated from studies measuring GI under standardized conditions.

Additionally, when assigning GI values for local foods from the international GI database, [8] the potential for variability in food samples (e.g. variations in ingredients, processing, botanical species etc.) poses difficulties.[20] The food composition table's food description and nutrient data to an extent helps matching foods in the international GI table to DietPLUS database. While developing DietPLUS Version 3, in order to minimize the differences in GI values of foods arising from geographical differences, preference was given to assigning GI values from studies conducted within Malaysia, South-East Asia and Asia necessarily in that order based on the rationale[20] that foods from these areas would more closely resemble the ingredients and nutritional content of foods listed on the DietPLUS. If there were no such data from within this region, we assigned the median of the GI values of non-Asian origin conducted using standardized testing methods. Variables such as cooking time, the degree of ripeness of fruit etc. influence GI,[8,21] however, most instruments to measure dietary intake are not designed to or do not precisely capture such minute details.

Dietary GL values calculated using DietPLUS version 3 were probably slightly higher since the Malaysian food

composition database provides total carbohydrate (total carbohydrate-crude fibre) rather than available carbohydrate, and this was used in the GL calculations. However it is of interest to point out that previous studies have showed very little difference in the Food Frequency Questionnaire GL values for those estimated using available carbohydrate vs. total carbohydrate.[24] It is believed that GI of a food is generally related to soluble fibre (that delays gastric emptying and intestinal absorption, attenuating postprandial blood glucose response and thereby lowering GI) and not its insoluble fibre content.[2] Nevertheless, it has been suggested that further considerations systematically examine whether it is indeed necessary to restrict calculation to available carbohydrate.[24]

It is also acknowledged that the majority of values for total dietary fibre, total sugars and PUFA were obtained from non-Malaysian sources, since comprehensive data on these nutrients are currently unavailable for Malaysian foods. However, once work on these nutrients are completed for the Malaysian foods; the same could be updated in future versions of DietPLUS. Until then the DietPLUS could be only thought of to estimate these nutrients based on information from data obtained from geographically close regions.

The above limitations notwithstanding, there are several strengths to this work. With the association of GI with chronic disease risk,[16] being increasingly accepted by the scientific community, DietPLUS Version 3 described in this report will assist investigators using food records in Malaysian intervention and observational studies. And since it is based on the Malaysian food composition tables, it is more geographically appropriate to be applied in this region. The estimated energy, macronutrient distributions of GI and GL in the sample of Post-GDM study participants compare favourably to those from other Malaysian studies. Furthermore, this addition of dietary GI and GL calculators to DietPLUS is in true harmony with its original ideals of providing a dietary intake calculator that is flexible enough to be updated to suit the needs of time. More importantly DietPLUS is an economical alternative that makes it highly accessible to research students in Malaysia. This model can be used for development of GI and GL calculators in other parts of the developing world.

Conclusion
This paper details the method of adding GI and GL calculators to DietPLUS Version 2, a Microsoft Excel-based

Malaysian food database and nutrient intake calculator. This was achieved by assigning GI values to all the foods in the DietPLUS Version 2 database and computing for diet GI and GL using the Excel programme's functionality. While addition of GI and GL values to the food composition database is not free from limitations, it facilitates innovative local diet-carbohydrate research Using of the Microsoft Excel-based food composition database with included GI and GL calculators ensures that the same GI value is ascribed for the food every time the particular food appears in the calculation. When more local values for GI become available the DietPLUS can be regularly updated to improve its precision.

REFERENCES
1. The Official Website of the Glycemic Index and GI Database. University Of Sydney; Available from: http://www.glycemicindex.com/.
2. Wolever TMS. The glycaemic index: a physiological classification of dietary carbohydrate. Oxfordshire, UK: CABI Publishing; 2006.
3. Burani J. Gushers and Tricklers: Practical use of the glycemic index [Powerpoint Presentation] Marco Island, Florida: University of Sydney; 2006 [cited 20103/11]; Available from: http://www.glycemicindex.com/glycemic. index.ppt.
4. Wolever TM, Yang M, Zeng XY, Atkinson F, Brand-Miller JC. Food glycemic index, as given in Glycemic Index tables, is a significant determinant of glycemic responses elicited by composite breakfast meals. Am J Clin Nutr. 2006;83: 1306-12.
5. Chew I, Brand J, Thorburn A, Truswell A. Application of glycemic index to mixed meals. Am J Clin Nutr. 1988;47: 53-6.
6. Kalergis M. The Role of the glycemic index in the prevention and management of diabetes: A review and discussion. Can J Diabetes. 2005;29:27-38.
7. Salmeron J, Ascherio A, Rimm EB, Colditz GA, Spiegelman D, Jenkins DJ, Stampfer MJ, Wing AL, Willett WC. Dietary fiber, glycemic load, and risk of NIDDM in men. Diabetes Care. 1997;20:545-50.
8. Foster-Powell K, Holt SH, Brand-Miller JC. International table of glycemic index and glycemic load values: 2002. Am J Clin Nutr.2002;76:5-56.
9. Augustin LS FS, Jenkins DJ, Kendall CW, La Vecchia C. Glycemic index in chronic disease: a review. Eur J Clin Nutr. 2001;56:1049-71.
10. Reaven GM. Role of insulin resistance in human disease syndrome X: an expanded definition. Ann Rev Med. 1993; 44:121-31.
11. Despres J-P, Lamarche B, Mauriege P, Cantin B, Dagenais GR, Moorjani S, Lupien Paul-J. Hyperinsulinemia as an independent risk factor for ischemic heart disease. New Engl J Med. 1996;334:952-8.
12. Liu S, Willett WC, Stampfer MJ, Hu FB, Franz M, Sampson L, Hennekens CH, Manson JE. A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women. Am J Clin Nutr. 2000; 71:1455-61.
13. Ludwig DS, Majzoub JA, Al-Zahrani A, Dallal GE, Blanco I, Roberts SB. High glycemic index foods, overeating, and obesity. Pediatrics. 1999;103:e26.
14. Franceschi S, Masco LD, Augustin L, Negri E, Parpinel M, Boyle P, et al. Dietary glycemic load and colorectal cancer risk. Ann Oncol. 2001;12:173-8.
15. Murakami K, Miyake Y, Sasaki S, Tanaka K, Fukushima W, Kiyohara C et al. Dietary glycemic index is inversely associated with the risk of Parkinson's disease: A case-control study in Japan. Nutrition. 2010; 26:515-21.
16. Barclay AW, Petocz P, McMillan-Price J, Flood VM, Prvan T, Mitchell P, Brand-Miller JC. Glycemic index, glycemic load, and chronic disease risk - a meta-analysis of observational studies. Am J Clin Nutr. 2008;87:627-37.
17. Yusof BNM. A Randomized Control Trial of Low Glycemic Index against Conventional Carbohydrate Exchange Diet on Glycemic Control and Metabolic Parameters in Type 2 Diabetes. [PhD Thesis] Kuala Lumpur: Universiti Kebangsaan Malaysia; 2008.
18. FAO/WHO. Carbohydrates in Human Nutrition: Report of a Joint FAO/WHO Expert Consultation. In: FAO/WHO, editor. Rome14-18 April 1997.
19. Louie JCY, Flood V, Turner N, Everingham C, Gwynn J. Methodology for adding glycemic index values to 24-hour recalls. Nutrition. 2011;27:59-64.
20. Martin CL, Murphy SP, Au DLM. Compiling glycemic index and glycemic load values for addition to a food composition database. J Food Compost Anal. 2008;21:469-73.
21. Hojas R, Villegas A, Ropero P, Valverde F, Nogales A, Gonzalez FA, Jose C, Villar L, Garcia C. Two new mutations in cis on Ggamma chain of fetal hemoglobin: Hb F-Madrid [G gamma 50D1Ser-->Cys] and [G gamma 75E19Ile-->Thr]. Ann Hematol. 2003;823:181-3.
22. Olendzki BC, Ma Y, Culver AL, Ockene IS, Griffith JA, Hafner AR, Herbert JR. Methodology for adding glycemic index and glycemic load values to 24-hour dietary recall database. Nutrition. 2006;22:1087-95.
23. Flood A, Subar AF, Hull SG, Zimmerman TP, Jenkins DJA, Schatzkin A. Methodology for adding glycemic load values to the National Cancer Institute Diet History Questionnaire Database. J Am Diet Assoc. 2006;106:393-402.
24. Neuhouser ML, Tinker LF, Thomson C, Caan B, Horn LV, Snetselaar L, Parker LM, Patterson RE, Robinson-O'Brien R, Beresford SAA. Development of a glycemic index database for food frequency questionnaires used in epidemiologic studies. J Nutr. 2006;136:1604-9.
25. Kaartinen NE, Simila ME, Pakkala H, Korhonen T, Mannisto S, Valsta LM. Glycaemic index values in the Finnish food composition database: an approach to standardised value documentation. Eur J Clin Nutr. 2010;64: S68-S72.
26. Ng TKW. DietPLUS- a User-friendly '2 in 1' Food Composition Database and Calculator of Nutrient Intakes. Mal J Nutr. 2010;16:125-30.
27. Siong TE, Noor MI, Azudin MN, Idris K. Nutrient Composition of Malaysian Foods. Kuala Lumpur: Institute for Medical Research; 1997.
28. Health Promotion Board Singapore. Food Composition Guide Singapore, HPB, 2003.
29. Food Standards Australia New Zealand. NUTTAB 2006. Online Database of the Nutritional Composition of Australian Foods.Canberra: FSANZ, 2006.

30. National Coordinating Committee on Food and Nutrition Malaysia (NCCFNM). Recommended Nutrient Intakes of Malaysia, Ministry of Health Malaysia, Putrajaya. 2005

31. Robert SD, Ismail AA, Winn T, Wolever TM.. Glycemic index of common Malaysian fruits. Asia Pac J Clin Nutr. 2008;17:35-9.

32. Nik Shanita S. Development and determination of glycemic index and types of carbohydrate in endurance athletes' food choices. Kuala Lumpur: Universiti Kebangsaan Malaysia; 2004.

33. Robert SD, Ismail AA. Two varieties of honey that are available in Malaysia gave intermediate glycemic index values when tested among healthy individuals. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2009;1532: 145-7.

34. Ma Y, Olendzki B, Chiriboga D, Hebert JR, Li Y, Li W, Campbell M, Gendreau K, Ockene IS. Association between Dietary Carbohydrates and Body Weight. Am J Epidemiol. 2005;1614:359-67.

35. Murakami K, Sasaki S, Takahashi Y, Okubo H, Hosoi Y, Horiguchi H, Oguma E, Kayama F. Dietary glycemic index and load in relation to metabolic risk factors in Japanese female farmers with traditional dietary habits. Am J Clin Nutr. 2006;835:1161-9.

36. Chew WF, Chee WSS, Rokiah P, Lee LF, Hawa MT, Hazslin H, Chan YM, Chan SP. Nutritional status of women with previous history of gestational diabetes mellitus. [Abstract] 26th Scientific Conference & Annual General Meeting of the Nutrition society Of Malaysia; 2011; Kuala Lumpur, Malaysia p.128.

37. Song Y, Barakatun Nisak M, Nor Mazni I, Nor Azmi K. Assessment of nutritional status and calculated dietary glycemic index/glycemic load of patients with type 2 diabetes mellitus in UKM Medical Centre. [Abstract] 26th Scientific Conference & Annual General Meeting of the Nutrition society Of Malaysia; 24-25 March 2011; Kuala Lumpur, Malaysia. p. 133.

Original Article

Adding glycaemic index and glycaemic load functionality to DietPLUS, a Malaysian food composition database and diet intake calculator

Sangeetha Shyam MSc[1], Tony Ng Kock Wai PhD[2], Fatimah Arshad PhD[2]

[1]*School of Post-Graduate Studies and Research, International Medical University, Kuala Lumpur, Malaysia*
[2]*Department of Nutrition & Dietetics, School of Pharmacy & Health Sciences, International Medical University, Kuala Lumpur, Malaysia*

新增升糖指數和升糖負荷功能到DietPLUS-馬來西亞的食物成份資料庫和飲食攝取計算器

本文描述增加升糖指數(GI)和升糖負荷(GL)功能到DietPLUS的方法。DietPLUS是利用excel建立的馬來西亞食物營養成分資料庫和飲食攝取計算器。升糖指數資料來自當地已確認的升糖指數值及國際升糖指數資料庫。以文獻發表過的方法加以修改,來新增升糖指數值和升糖負荷計算器到資料庫中。增加兩項當地流行的低升糖指數食物到DietPLUS 資料庫,使得食物項目總數增加到838。整體來說,馬來西亞食物成份資料庫的539項主要的含醣食物中,有243項(45%)食物有當地或國際GI資料庫的數據,另外有180項(33%)食物可與GI資料庫中的相近似食物連結。利用DietPLUS 第3版,計算63名曾患妊娠糖尿病的婦女之飲食中的升糖指數和升糖負荷,所得到的平均數±標準差分別為62 ± 6 和142 ± 45。此數值與當地的其他研究結果相近。DietPLUS第3版是一個簡單的,利用excel設計的軟體,可根據飲食記錄,計算馬來西亞飲食的升糖指數和升糖負荷值。

關鍵字:升糖指數、升糖負荷、飲食、膳食醣類、馬來西亞