Glycemic Index–Based Nutritional Education Improves Blood Glucose Control in Japanese Adults

A randomized controlled trial

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A low–glycemic index (GI) diet is effective in lowering A1C in diabetic patients (1–3). However, most research is from Western countries, where potato and wheat are the main sources of carbohydrates. A GI-based nutrition education program, designed for people who consume white rice (a high-GI food) as the staple, has not yet been studied. We developed a low-GI dietary regimen based on Japanese foods. This study aimed to evaluate whether GI-based nutrition education improves blood glucose control more than a conventional nutrition education in participants with type 2 diabetes or impaired fasting glucose.

RESEARCH DESIGN AND METHODS — We conducted a 3-month, randomized, controlled, parallel-group trial. Participant inclusion criteria were as follows: *1*) fasting plasma glucose (FPG) between 110 and 160 mg/dl or A1C between 5.8 and 8.0% (4) and *2*) nonusage of any hypoglycemic drugs.

All participants attended one group session on conventional nutritional education at baseline. Each participant was then randomly assigned to either GI-based or conventional nutrition education; four individual sessions followed (2nd week and 1st, 2nd, and 3rd month).

Conventional nutritional education was based on the Japan Diabetes Society guidelines (4) and focused on lowering total energy intake, mainly by reducing fat intake or eliminating snacking. The GI-based nutrition education aimed to train participants to consume one-half or more of their daily carbohydrate intake from low-GI foods (1,5–7). Because the main determinant of dietary GI is the staple food (5,8), education focused on the selection of low-GI staple foods. Participants were instructed to combine the high-GI staple foods with vinegar (7,9–12), dairy products (7,13,14), or fermented foods such as yogurt and pickles (7,15) to reduce postprandial blood glucose spikes.

After a 12-h fasting, blood samples were collected and immediately refrigerated and transported for analyses to the Health Science Research Institute. Under the same condition, height, weight, and fat were assessed by stadiometer (YG200; Yagami) or bioelectric impedance (BF-616; Tanita) without shoes. Dietary intake was assessed with a 3-day dietary record. Dietary GI was calculated by a method we described previously (5). All analyses were performed using SAS (version 9.1; SAS Institute, Cary, NC). Baseline differences between groups were assessed by an unpaired *t* test. Changes in outcomes were assessed by repeated-measures two-way ANOVA. The statistical significance standard was 5%.

RESULTS — Of the 40 participants, 19 and 21 were placed in the GI and conventional groups, respectively. One from the conventional group withdrew in the first month. All of the 39 remaining participants attended all sessions, took all required measurements, and submitted all of their dietary records.

A1C improved more in the GI group than in the conventional group (Table 1). The average changes in A1C were −0.46 ± 0.33% in the GI group and −0.21 ± 0.43% in the conventional group, and the effect size due to intervention was −0.25 (95% CI −0.50 to −0.004).

FPG, total and LDL cholesterol, and body weight and fat decreased significantly in both groups. Carbohydrate from low-GI foods and combination of high-GI staple foods with vinegar or other foods increased more in the GI group than in the conventional group. In both groups, dietary GI, total energy, and cholesterol intake significantly decreased and dietary fiber intake significantly increased.

CONCLUSIONS — According to a Cochrane meta-analysis, dietary advice plus exercise is associated with a mean 0.9% decrease in A1C at 6 months among type 2 diabetic patients (16). For the general population, a 0.3% decrease in A1C may well have significant health benefits (17). Our findings showed a posteducation difference of 0.25% in reduced A1C between the groups, despite a solely nutritional education–based strategy and a short duration of the intervention. Participants in the GI group may have shown further reduction in A1C over a longer period.

This is the first study to develop a GI-based nutritional education program for individuals whose staple food is white rice. Although replacing white rice with low-GI staple foods can increase fat intake (5), the GI group decreased energy intake without increasing fat intake. Furthermore, dietary indexes related to GI significantly improved

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Abbreviations: FPG, fasting plasma glucose; GI, glycemic index.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Metabolic parameters and dietary data over the 3-month period for the GI-based conventional nutritional education groups*

	GI group (n = 19)			Conventional (n = 20)			P for main effect*		P for group × time*
	0 month†	2 months	3 months	0 month†	2 months	3 months	Group	Time	
Metabolic parameters									
A1C (%)	6.51 ± 0.82	6.20 ± 0.80	6.05 ± 0.70	6.29 ± 0.57	6.06 ± 0.44	6.08 ± 0.44	0.631	<0.001	0.046
FPG (mg/dl)	131.3 ± 14.3	122.0 ± 15.3	124.3 ± 17.3	133.1 ± 17.2	125.3 ± 18.0	122.8 ± 13.2	0.803	<0.001	0.404
IRI (μU/ml)	7.75 ± 4.13	8.11 ± 5.72	7.49 ± 5.08	9.82 ± 6.97	7.88 ± 4.34	6.88 ± 3.66	0.782	0.054	0.098
Cholesterol (mg/dl)									
Total	215.0 ± 39.3	208.1 ± 36.6	207.7 ± 34.4	213.1 ± 34.5	195.3 ± 23.1	198.5 ± 29.0	0.429	<0.001	0.215
LDL	139.4 ± 30.9	133.1 ± 28.1	134.7 ± 30.6	131.7 ± 32.7	117.5 ± 23.6	119.8 ± 28.8	0.153	0.001	0.323
HDL	59.6 ± 10.2	58.6 ± 9.6	59.3 ± 9.8	61.5 ± 13.7	60.1 ± 14.4	60.0 ± 15.3	0.730	0.362	0.826
Triglyceride (mg/dl)	112.6 ± 88.3	107.8 ± 90.5	95.3 ± 67.2	146.5 ± 80.5	130.9 ± 66.2	134.6 ± 89.1	0.193	0.185	0.593
Weight (kg)	62.5 ± 14.2	60.9 ± 13.9	60.3 ± 13.5	60.3 ± 8.4	59.0 ± 7.7	58.6 ± 7.5	0.592	<0.001	0.611
Body fat (%)	29.6 ± 7.5	28.2 ± 7.4	27.8 ± 6.4	28.7 ± 6.7	28.0 ± 7.7	27.6 ± 7.7	0.859	<0.001	0.538
BMI (kg/m^2)	24.7 ± 4.1	24.1 ± 3.7	23.8 ± 3.5	24.2 ± 2.0	23.6 ± 1.8	23.5 ± 1.8	0.645	<0.001	0.467
Dietary GI‡	68.5 ± 5.2	64.7 ± 5.3	61.8 ± 5.6	70.2 ± 5.2	68.9 ± 6.0	68.1 ± 5.2	0.001	<0.001	0.066
Values related to GI									
Carbohydrate from low GI foods (%)§	31.3 ± 12.9	41.8 ± 15.5	50.0 ± 14.2	29.1 ± 12.3	32.0 ± 16.0	35.1 ± 12.6	0.005	<0.001	0.032
Combination of high GI staple foods with vinegar or other foods (%)§¶	43.9 ± 20.1	63.9 ± 25.8	65.5 ± 23.7	47.8 ± 24.2	49.2 ± 24.2	46.4 ± 21.3	0.112	0.065	0.035
Nutritional intake									
Total energy (kcal)	1,892.2 ± 256.4	1,834.7 ± 375.8	1,777.6 ± 329.7	1,905.3 ± 413.9	1,792.1 ± 335.4	1,714.1 ± 303.5	0.883	0.001	0.549
Protein (% of calories)	17.0 ± 2.4	16.8 ± 2.4	16.9 ± 2.1	14.6 ± 2.1	15.8 ± 1.7	15.8 ± 3.0	0.012	0.208	0.261
Total fat (% of calories)	25.0 ± 5.0	23.7 ± 4.6	23.4 ± 4.6	25.0 ± 6.1	24.6 ± 5.4	23.0 ± 4.8	0.953	0.149	0.760
Carbohydrate (% of calories)	58.0 ± 5.8	59.5 ± 4.3	59.7 ± 4.5	60.4 ± 6.5	59.6 ± 6.0	61.3 ± 6.1	0.303	0.476	0.630
Dietary fiber (g/1,000 kcal)	9.3 ± 2.5	11.7 ± 3.0	11.1 ± 2.6	8.4 ± 2.2	9.8 ± 3.9	10.3 ± 3.2	0.082	<0.001	0.236
Cholesterol (mg)	370.1 ± 131.3	287.7 ± 128.9	281.8 ± 108.3	353.5 ± 130.7	321.8 ± 116.5	294.2 ± 90.5	0.478	0.002	0.414

Data are means ± SD unless otherwise indicated. *Repeated-measures two-way ANOVA. †No significant differences were observed in the participants' baseline characteristics between the GI and the conventional groups. ‡Glucose-based values. §Foods with a white rice–based GI ≤70 (glucose-based GI 56) were considered low-GI foods, while foods with a white rice–based GI of ≥85 (glucose-based GI 68) were considered high-GI foods. ¶Proportion of combining high-GI staple foods with vinegar or other foods that decrease postprandial glycemia (times of combination/times of having high GI foods as the staple food). IRI, immunoreactive insulin.

in the GI group, suggesting good adherence to the program.

Our findings did not show a significant difference in the change over time in FPG, insulin, lipid metabolism, or body weight between the groups. Many studies have shown that low-GI diets are associated with changes in glucose metabolism (5,18–20), lipid metabolism (5,20–23), and body weight or fat (24–28). However, the conclusions of these associations are controversial (2,3,29,30). Further research to elucidate these relationships is needed.

The major limitation of our study was its small sample size. This may explain the nonsignificant differences between the two groups in baseline values. To generalize the study findings, a larger sample is needed.

In conclusion, GI-based nutrition education is effective in improving blood glucose control in participants with type 2 diabetes or impaired fasting glucose. The GI-based nutritional education yielded good adherence and could be considered a useful tool.

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