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Decreases in Dietary Glycemic Index Are Related to Weight Loss among Individuals following Therapeutic Diets for Type 2 Diabetes[1–4]

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Abstract

This study assessed the effect of changes in glycemic index (GI) and load (GL) on weight loss and glycated hemoglobin (HbA1c) among individuals with type 2 diabetes beginning a vegan diet or diet following the 2003 American Diabetes Association (ADA) recommendations. The study was a 22-wk, randomized trial of 99 participants with type 2 diabetes who were counseled to follow 1 of 2 diet treatments. GI and GL changes were assessed based on 3-d dietary records. The relationships between GI/GL and changes in weight and HbA1C were calculated. In an intention-to-treat analysis ($n = 99$), the vegan group reduced GI to a greater extent than the ADA group ($P < 0.05$), but GL was reduced further in the ADA than the vegan group ($P < 0.001$). GI predicted changes in weight ($P = 0.001$), adjusting for changes in fiber, carbohydrate, fat, alcohol, energy intake, steps per day, group, and demographics, such that for every point decrease in GI, participants lost ~0.2 kg (0.44 lb). GI was not a predictor for changes in HbA1C after controlling for weight loss ($P = 0.33$). Weight loss was a predictor of changes in HbA1C ($P = 0.047$). GL was not related to weight loss or changes in HbA1C. A low-GI diet appears to be one of the determinants of success of a vegan or ADA diet in reducing body weight among people with type 2 diabetes. The reduction of body weight, in turn, was predictive of decreasing HbA1C. J. Nutr. 141: 1469–1474, 2011.

Introduction

Overweight and obesity are increasingly problematic in the US and other countries. Two-thirds of U.S. adults are overweight or obese (1) and the prevalence of type 2 diabetes among this population is 9.3% (2). The use of a low-fat, low-glycemic index (GI)[12] vegan diet may be a useful strategy in promoting weight loss and reducing risk of associated comorbidities. People following vegan diets have a lower BMI than nonvegetarians, as well as a lower prevalence of type 2 diabetes (3). Clinical trials using vegetarian and vegan diets have demonstrated significant improvements in body weight (4), glycemic control (5), and cardiovascular risk factors (6) compared with conventional therapeutic approaches.

Consumption of a diet with a high GI, a measure of blood glucose response after consumption of a carbohydrate-containing food (7), may be linked to an increased risk of type 2 diabetes, heart disease, obesity, and metabolic syndrome (8,9). Diets with a high GI and a high glycemic load (GL), which is the product of a food's GI and the amount of carbohydrate in that food, have been associated with increased insulin resistance (10) and more

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[3] This trial was registered at clinicaltrials.gov as NCT00276939.
[4] Supplemental Fig. 1 is available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at jn.nutrition.org.
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[12] Abbreviations used: ADA, individualized diets based on the 2003 American Diabetes Association group; GI, glycemic index; GL, glycemic load; HbA1c, glycated hemoglobin; vegan, low-fat, low-glycemic index vegan diet group; NDS-R, Nutrition Data System for Research.

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frequent episodes of hypoglycemia among people with type 2 diabetes who are treated with insulin (11). Several prospective and cross-sectional studies have examined the relationship between GI or GL and the risk of developing type 2 diabetes (10), but there have also been a number of randomized clinical trials of GI and diabetes management (9,12). In a study by Jenkins et al. (13), participants with type 2 diabetes were randomly assigned to a low-GI diet or a high-fiber diet. Participants in the low-GI group had greater reductions in glycated hemoglobin (HbA1c) and a greater increase in HDL cholesterol. The effect on body weight did not reach significance in the intent-to-treat analysis (P = 0.053) but was a major predictor of change in HbA1c. Studies suggest that a low-GI diet may be more effective at producing weight loss (9,11,12,14,15) and assisting with weight maintenance (16) than a high-GI diet. In view of the continuing debate over the utility of the GI and GL concepts in diet selection (17), the effect of changes in GI and GL on weight loss and changes in HbA1c were assessed among individuals with type 2 diabetes in the context of both a vegan and a conventional dietary approach to diabetes management.

Methods

The study design and exclusion criteria have been described elsewhere (5). Briefly, participants with type 2 diabetes (fasting plasma glucose concentration >6.94 mmol/L on 2 occasions or a prior diagnosis of type 2 diabetes with the use of hypoglycemic medications for ≥6 mo) were recruited in 2 cohorts between 2003 and 2004. The protocol was approved by the George Washington University Institutional Review Board. All participants gave written informed consent.

Dietary intervention. Participants were randomly assigned to follow either a low-fat, low-GI vegan diet (vegan) or individualized diets based on the 2003 American Diabetes Association (ADA) dietary recommendations (17). The vegan diet (~10% of energy from fat, 15% protein, 75% carbohydrate) consisted of vegetables, fruits, grains, and legumes, and participants were not given an energy intake restriction (5). The ADA diet (15–20% protein, <7% saturated fat, 60–70% carbohydrate and monounsaturated fats; cholesterol ≤200 mg/d) was individualized based on body weight and plasma lipid concentrations (17). ADA participants with a BMI >25 kg/m^2 were prescribed energy intake deficits of 500–1000 kcal.[13] Both groups were instructed to limit alcoholic drinks to no more than 2 drinks/d for men and 1 drink/d for women. Participants met with their assigned group each week for 22 wk where they learned about food preparation and meal planning (5).

Outcome measures. Over the course of the 22-wk study, 3-d weighted food records, body weight, physical activity, and HbA1c were collected at 0, 11, and 22 wk and methods for collection have been described elsewhere (5). Physical activity was assessed over a 3-d period by using a pedometer (Omron HJ-112) and with the Bouchard 3-d Physical Activity Record (18). Dietary measure, including GI and GL (both using the bread reference), were collected using 3-d dietary records that were analyzed using Nutrition Data System for Research (NDS-R) software version 5.0, (Nutrition Coordinating Center, University of Minnesota, Food and Nutrient Database 35, released May 2004). All foods and beverages, including alcohol, were included in the GI and GL calculations. Results were totaled for each day and averaged for the 3 d of dietary recording. The GI and GL values of the diet were obtained from NDS-R calculations. For GI, the ingredient proportion of available carbohydrate was multiplied by the ingredient GI to get the proportional GI for each ingredient. For GL, ingredient available carbohydrate was multiplied by the ingredient GI and divided by 100 to obtain the ingredient GL. Selection of GI values for NDS-R's database has been discussed in more detail elsewhere (19).

Statistical analyses. Values presented are means ± SD unless otherwise noted. Race was dichotomized into white compared with nonwhite. Two sample t tests were conducted to determine whether outcomes were significantly different between groups and paired sample t tests were used to examine within-group differences. ANOVA was used to examine differences in changes in variables among the 3 tertiles of change in GI. The Tukey's test was used for post hoc analyses among the 3 groups. Intention-to-treat analysis was conducted by bringing baseline values forward in cases where participants did not complete 22-wk assessments. A linear regression model was analyzed with weight loss as the dependent variable and GI as an independent variable, adjusting for age, race, sex, group assignment, and changes in energy intake, fiber, carbohydrate, fat, and steps per day. An additional model using the same independent variables and controls was analyzed for changes in HbA1c. Weight loss was also included as a covariate in the model with HbA1c as the dependent variable to control for the effect of weight loss on HbA1c. Similar models with GL were run with HbA1c and weight loss as dependent variables. For the GL models, however, changes in carbohydrate were not included as a covariate, because carbohydrate is included in the calculation of GL. All models were run with and without inclusion of the main effect of diabetes medication changes and an interaction term for diabetes medication changes with changes in GI to assess the effect modification of diabetes medication adjustments, because change in diabetes medications can interact with changes in weight and HbA1c (5). SPSS (SPSS for Windows, 17.0.0 2008, SPSS) was used for analyses with a P-value of 0.05 used to indicate significant differences.

Results

Of 1049 individuals screened by telephone, 99 met the participation criteria and were randomly assigned to either the vegan (n = 49) or ADA (n = 50) group (5). The reasons for exclusion can be found in **Supplemental Figure 1**. All participants completed laboratory assessments; however, 11 participants did not complete diet records at 22 wk (n = 3 vegan, n = 8 ADA). The mean percent of meetings participants attended in the vegan (75.8 ± 21.5%) or ADA groups (65.6 ± 32.3%) did not differ (P = 0.12). Baseline characteristics, measurements, or nutrient intakes also did not differ between diet groups (5). There were no differences in baseline demographic characteristics among those in tertile 1 of GI change (GI ≥0), tertile 2 (−0.001 to −6.46), and tertile 3 (≥−6.47) (**Table 1**). Changes in steps per day and self-reported energy expenditure revealed no significant differences among tertiles. Because weight was a calculation within the 3-d activity records, pedometer data were used in the analyses that required a control for changes in physical activity. Pedometer data were incomplete for 3 participants in the ADA group at baseline and were not included in the analyses.

There were significant differences among tertiles in changes in energy, percent energy from carbohydrate, total fat (grams and percent), fiber (total, soluble, and insoluble), and body weight (**Table 2**). Those in the tertile with the greatest decrease in dietary GI (tertile 3) had a greater increase in percent energy from carbohydrate (P = 0.02) and total fiber (P = 0.01), soluble fiber (P = 0.04), and insoluble fiber (P = 0.003) and a greater decrease in total fat (percent and grams; P = 0.003) and body weight (P = 0.004) than those in tertile 1 of change in GI.

Including all participants (n = 99) in an intention-to-treat analysis, the vegan diet group reduced their GI (−5.4 ± 8.2) to a greater extent than did the ADA group (−1.7 ± 8.6) (P = 0.03), whereas the reduction in GL was greater in the ADA group (−37.4 ± 52.9) than the vegan group (9.5 ± 56.2) ($P < 0.001$). Both groups decreased their energy intake, but there was no difference between groups (P = 0.43) (20). At 22 wk, percent energy from carbohydrates was higher in the vegan group

[13] 1 kcal = 4.184 kJ.

TABLE 1 Baseline demographic information of participants in a dietary intervention for type 2 diabetes by tertile of change in glycemic index (GI)

	Tertiles of change in GI			
	Tertile 1	Tertile 2	Tertile 3	P^1
n	40	27	32	
Age,[2] *y*	53.7 (35–75)	59.0 (40–82)	53.9 (26–82)	0.07
Sex[3]				0.87
Male	15 (37)	11 (41)	14 (44)	
Female	25 (63)	16 (59)	18 (56)	
Race, ethnicity[3]				0.36[4]
Black, non-Hispanic	19 (47)	8 (30)	17 (53)	
White, non-Hispanic	15 (38)	15 (55)	13 (41)	
White, Hispanic	4 (10)	1 (4)	1 (3)	
Asian, non-Hispanic	2 (5)	3 (11)	1 (3)	
Marital status[3]				0.07
Not married	11 (27)	3 (11)	12 (37)	
Married	29 (73)	24 (89)	20 (63)	
Education[3]				0.31
High school, partial or graduate	5 (14)	3 (14)	1 (4)	
College, partial or graduate	20 (56)	10 (45)	21 (72)	
Graduate degree	11 (30)	9 (41)	7 (24)	
Occupation[3]				0.55
Employed	8 (20)	8 (30)	6 (19)	
Retired or unemployed	32 (80)	19 (70)	26 (81)	
BMI,[5] *kg/m²*	34.8 ± 7.3	34.6 ± 9.1	35.1 ± 6.1	0.97

[1] *P*-values for continuous variables refer to *t* test for 2 comparisons and ANOVA for 3 comparisons. χ^2 was used for categorical variables.
[2] Data are mean (range).
[3] Data are *n* (%).
[4] *P*-value calculated for race distribution; for ethnicity (Hispanic vs. non-Hispanic) $P = 0.40$ for tertiles of change in GI.
[5] Data are mean ± SD.

(70.8 ± 10.6) than in the ADA group (47.8 ± 9.7) ($P < 0.001$), percent energy from total fat was lower in the vegan group (17.9 ± 7.0) than in the ADA group (32.8 ± 7.4) ($P < 0.001$), and percent energy from protein was lower in the vegan group (14.7 ± 4.9) than in the ADA group group (21.2 ± 4.0) ($P < 0.001$). Total fiber intake was also higher in the vegan group (35.4 ± 14.4 g/d) than in the ADA group (18.3 ± 7.7) ($P < 0.001$), as were soluble and insoluble fibers ($P < 0.001$) (20). Changes in GI were correlated with changes in fat intake ($r = 0.36$; $P < 0.001$) but not with carbohydrate or protein ($P > 0.05$). Changes in carbohydrate were correlated with GL ($r = 0.49$; $P < 0.001$) but not fat or protein ($P > 0.05$).

Changes in GI predicted changes in weight ($P = 0.001$), adjusting for changes in fiber, carbohydrate, total fat, alcohol, energy intake, steps per day, and demographic characteristics and group assignment, such that for every point decrease in GI, participants lost ~0.2 kg (0.44 lb) (**Table 3**). Ethnicity was also a predictor of mean weight change (±SE) with whites (−6.3 ± 0.6 kg) losing more weight than nonwhites (−3.8 ± 0.6 kg) ($P = 0.01$). A model including main effects and an interaction term between changes in GI and changes in diabetes medications showed the interaction to be nonsignificant ($P = 0.42$) and was thus not included in the main model. Change in GI was not a predictor of HbA1c ($P = 0.08$) and remained nonsignificant after adjustment for weight loss ($P = 0.33$) (**Table 4**). Weight loss remained the only significant predictor ($P = 0.047$) of HbA1c changes such that each kilogram of body weight lost corresponded to a 0.06-point decrease in HbA1c. Weight loss remained significant after further adjustment for the interaction of change in GI with change in diabetes medications ($P = 0.03$).

Because changes in fat intake were not correlated with GL, dietary fat was not included in the models for GL. GL was not a predictor of weight loss ($P = 0.29$), adjusting for changes in fiber, alcohol, energy intake, steps per day, and group assignment and demographic characteristics. Only change in steps per day predicted change in weight ($P = 0.001$). A model including main effects and an interaction term between changes in GL and changes in diabetes medications showed the interaction were nonsignificant ($P = 0.50$) and thus were not included in the main model. A similar model with changes in HbA1c as the dependent variable approached significance ($P = 0.053$) but was significant after the addition of weight loss as a covariate ($P = 0.009$; model $R^2 = 0.24$). Weight loss was the only predictor of changes in HbA1c (B = 0.07; $P = 0.01$); GL was not (B = 0.001; $P = 0.70$). Weight loss remained the only predictor (B = 0.06; $P = 0.02$) of HbA1c changes after further adjustment for the interaction between diabetes medication changes and changes in GL such that every 1-kg decrease in weight resulted in a 0.06-point drop in HbA1c.

Discussion

Our objective in this study was to assess the effect of changes in GI and GL on weight loss and changes in HbA1c among individuals with type 2 diabetes in the context of a vegan diet and the 2003 ADA dietary recommendations while controlling for dietary and demographic variables. Vegan diets have been shown to be effective in the treatment of overweight (4) and type 2 diabetes (5). Low-GI and -GL diets have also demonstrated effectiveness in producing weight loss (9,14,15), assisting with weight maintenance (16), and improving glycemic control among individuals with type 2 diabetes (9,12,13). Both diet groups reduced their energy intake to equal levels. Of interest is that the ADA group was given an energy reduction prescription, whereas the vegan group was not required to restrict energy intake.

In this dietary intervention, individuals in the ADA diet group had greater reductions in GL than the vegan group, but the vegan diet group reduced the GI of their diets more than did the ADA group. The vegan diet group also increased intakes of both soluble and insoluble fiber more so than the ADA group (20). The overall reductions in GI in the present study were modest. One difficulty in assessing the effect of GI on health outcomes is that GI can be associated with fiber and carbohydrate intake. In the present study, independent of changes in carbohydrate and fiber, decreases in GI were associated with decreases in weight. Changes in GL were not associated with weight loss. These findings suggest that overweight individuals with type 2 diabetes may benefit not only from increased fiber but specifically from a reduction in the GI of their diets. GI was not a significant predictor of HbA1c after controlling for weight loss, which was the only significant variable. It is possible that small reductions in GI may be associated with weight loss, with HbA1c reductions as a secondary effect. Greater reductions in GI may be required to detect an independent effect on HbA1c (13). Changes in GL were not associated with improvements in HbA1c.

The utility of the GI in a clinical setting has been controversial (17). In a study examining type 2 diabetes incidence among men and women, high-GI diets were associated with an increased risk of diabetes (10), a finding confirmed even after adjusting for potential confounders such as BMI and family history (21). In a study of older adults, however, which relied on a single follow-up FFQ, researchers did not find a higher

TABLE 2 Changes in daily energy and macronutrient intakes, glycemic index (GI), glycemic load (GL), hemoglobin HbA1c, body weight, and physical activity among the 3 tertiles of change in GI among vegan and American Diabetes Association (ADA) diet group participants

Change in outcomes from baseline to 22 wk[1]	Tertiles of change in GI			
	Tertile 1, $n = 40$[2]	Tertile 2, $n = 27$[2]	Tertile 3, $n = 32$[2]	P[3]
Energy,[4] *kcal*	−213 ± 485	−425 ± 381	−458 ± 449	0.046
Carbohydrate, *g*	2.7 ± 81.6	−12.2 ± 78.2	7.9 ± 75.3	0.60
Carbohydrate, *%*	7.1 ± 15.2	10.7 ± 15.4	17.4 ± 15.9[a]	0.02
Protein, *g*	−13.1 ± 23.2	−19.5 ± 19.6	−21.8 ± 30.2	0.31
Protein, *%*	−1.1 ± 2.9	−0.2 ± 5.0	−0.3 ± 6.2	0.69
Total fat, *g*	−17.2 ± 29.5	−30.5 ± 32.1	−41.9 ± 31.1[a]	0.01
Total fat, *%*	−4.9 ± 12.5	−8.7 ± 12.8	−15.0 ± 12.0[a]	0.01
Saturated fat, *g*	8.3 ± 8.2	10.6 ± 6.6	8.0 ± 6.1	0.33
Alcohol, *g*	−0.7 ± 3.7	−1.9 ± 7.2	−0.1 ± 5.1	0.42
Total fiber, *g*	3.5 ± 12.4	8.2 ± 11.5	13.2 ± 13.9[a]	0.01
Soluble fiber, *g*	0.9 ± 3.1	2.1 ± 3.0	2.8 ± 3.7[a]	0.046
Insoluble fiber, *g*	2.6 ± 9.4	6.3 ± 8.9	10.3 ± 10.6[a]	0.01
GI	4.0 ± 4.9	−3.3 ± 2.0	−13.2 ± 5.3[a]	<0.001
GL	4.5 ± 60.8	−24.1 ± 55.8	−29.1 ± 55.2[a]	0.03
bA1c, *%*	−0.5 ± 1.3	−0.8 ± 0.8	−1.0 ± 1.2	0.22
Weight, *kg*	−3.7 ± 3.8	−4.8 ± 4.4	−7.0 ± 4.7[a]	0.01
Pedometer readings,[2] *steps/d*	5547 ± 2724	2339 ± 3332	6962 ± 4394	0.15

[1] Data are means ± SD. [a]Different from tertile 1, $P < 0.05$.
[2] The 22 wk data included all individuals with data at baseline, $n = 49$ (vegan group) and 50 (ADA group), with the exception of pedometer data [3 missing at baseline from ADA group, so $n = 37$ (tertile 1), 27 (tertile 2), and 32 (tertile 3)].
[3] Listed P-values are for ANOVA of comparisons among the three tertiles of change in GI (baseline to 22 wk).
[4] Dietary data were reported from 3-d food records. 1 kcal = 4.184 kJ.

incidence of type 2 diabetes among people in the highest quintiles of dietary GI (22).

In this 22-wk intervention, GI, but not GL, was predictive of weight loss. As previously reported, body weight was reduced to a greater extent in the low-GI vegan group among diabetes medication-stable participants compared with those in the ADA group (5). The participants in the vegan diet group decreased their dietary GI more so than those in the ADA group. High-GI diets may be less satiating and more palatable and possibly favor body fat storage compared with low-GI diets, which may be why a decrease in GI in the present study was associated with decreases in weight (12). Studies examining low-GI diets for weight loss have tended to show benefits in terms of body weight or body fat reduction or both (11). Other studies have found no differences in weight loss between participants consuming a low- or high-GI diet (23), whereas others have found health benefits other than weight loss, such as improvements in cardiovascular risk factors (24). Studies utilizing low-GL diets for weight loss have also observed improvements in cardiovascular outcomes but not weight loss (25). For example, several randomized controlled trials have found no difference in weight loss between a low-GL diet and a low-fat diet, but have observed improvements in HbA1c (after adjustment for diabetes medications) (26), HDL cholesterol (27), C-reactive protein (28,29), blood pressure (28), and TG (28).

Also, among medication-stable participants, the vegan group decreased its mean HbA1c to a greater degree than did the ADA group (5). Although GI was not a significant predictor of HbA1c after controlling for weight loss, other aspects of the vegan diet may have resulted in beneficial changes in HbA1c. The reduced fat content of a vegan diet has been hypothesized to reduce intramyocellular lipid, a contributor to insulin resistance (30). Type of dietary fat also can affect insulin resistance. Diets high in saturated fat have been associated with increased insulin resistance (31), whereas polyunsaturated fats appear to be protective (32). Increased fiber has been shown to improve glycemic control (10). In the present study, there was a treatment difference in fiber intake, with the vegan group consuming 16 g/d of fiber more than the ADA group. As with GI, so fiber intake may also be significantly related to weight loss. However,

TABLE 3 Relationship of glycemic index (GI) with weight loss after a 22-wk dietary intervention comparing a low-fat vegan diet to diets following the recommendations of the American Diabetes Association (ADA), as determined by linear regression analysis ($n = 99$)

Variable	Unstandardized B	SE (B)	t	P
Model $F(11, 95) = 3.43$, $R^2 = 0.31$				0.001
Gender	1.40	0.87	1.61	0.11
Ethnicity, white vs. non-white	−2.45	0.89	−2.75	0.01
Age, *y*	0.03	0.05	0.62	0.54
Diet group assignment, vegan vs. ADA diet	−0.98	1.14	−0.86	0.39
Changes in energy intake,[1,2] *kcal/d*	0.001	0.01	0.25	0.80
Changes in GI[1]	0.19	0.05	3.48	0.001
Changes in carbohydrate,[1] *g/d*	−0.01	0.02	−0.37	0.71
Changes in total fat,[1] *g/d*	−0.01	0.06	−0.19	0.85
Changes in fiber,[1] *g/d*	0.02	0.04	0.35	0.73
Changes in alcohol intake,[1] *g/d*	0.04	0.09	0.44	0.66
Changes in physical activity,[3] *steps/d*	0.0001	0.0001	−2.35	0.02

[1] All dietary variables in the model are changes in intake from baseline to 22 wk (22 wk intake – baseline intake).
[2] 1 kcal = 4.184 kJ.
[3] Physical activity (assessed using a pedometer) in the model is change in mean steps per day from baseline to 22 wk (22 wk mean steps per day –baseline mean steps per day).

TABLE 4 Relationship of glycemic index (GI) with glycated hemoglobin (HbA1c) after a 22-wk dietary intervention comparing a low-fat vegan diet to diets following the recommendations of the American Diabetes Association (ADA), as determined by linear regression analysis (n = 99)

Variable	Unstandardized B	SE (B)	t	P
Model, $F(12, 95) = 2.40$, $R^2 = 0.26$				0.01
Gender	−0.34	0.23	−1.51	0.14
Ethnicity, white vs. non-white	−0.12	0.24	−0.50	0.63
Age, *y*	0.01	0.01	0.50	0.62
Diet group assignment, vegan vs. ADA diet	−0.02	0.30	−0.07	0.94
Changes in energy intake,[1,2] *kcal/d*	0.0001	0.001	−0.29	0.73
Changes in GI[1]	0.01	0.02	0.98	0.33
Changes in carbohydrate,[1] *g/d*	0.002	0.01	0.39	0.70
Changes in total fat,[1] *g/d*	0.01	0.02	0.39	0.70
Changes in fiber,[1] *g/d*	−0.02	0.01	−1.41	0.16
Changes in alcohol intake,[1] *g/d*	0.03	0.02	1.14	0.26
Changes in physical activity,[3] steps per day	−0.0001	0.0001	−1.61	0.11
Weight loss, *kg*	0.06	0.03	2.02	0.047

[1] All dietary variables in the model are changes in intake from baseline to 22 wk (22 wk intake – baseline intake).
[2] 1 kcal = 4.184 kJ.
[3] Physical activity (assessed using a pedometer) in the model is change in mean steps per day from baseline to 22 wk (22 wk mean steps per day – baseline mean steps per day).

GI was a significant predictor of weight loss after adjustment for changes in fiber intake. In addition, decreasing GI may promote other beneficial health effects for those with diabetes. A previous clinical trial also found that altering the GI of the diet had no significant effect on HbA1c, possibly related to a low HbA1c at study entry (33). But the study did observe beneficial effects on postprandial glucose, C-reactive protein, and β-cell function (33) and a further study with higher HbA1c entry levels reported a benefit for both HbA1c and HDL cholesterol (13). In the present study, GL did not seem to be associated with changes with HbA1c, even after adjusting for changes in diabetes medications. Other studies have found no differences in weight loss between those consuming a low-GL diet compared with a low-fat diet but have found beneficial effects of a low-GL diet on HbA1c, after adjustment for diabetes medication (26).

The present study has several strengths, including controlling for fiber intake, an intention-to-treat design, and applicability outside the research setting. A study limitation is that the effect of GI or GL on glycemic control was not the primary objective of this study. Other limitations include the reliance on self-reported dietary intake.

The results of this study suggest that low-GI vegan diets may have specific advantages given the high prevalence of obesity in type 2 diabetes (34), the beneficial effect of weight loss on all aspects of metabolism, and the tendency of hypoglycemic medications (with the exception of metformin and α glycosidase inhibitors) to promote weight gain (35). These findings provide additional support for the use of low-GI diets in the treatment of obesity. Even the relatively small reductions in GI in the present study corresponded with weight loss, which in turn appeared to aid in lowering HbA1c levels. These findings provide support for encouraging patients with diabetes to favor low-GI foods. Nonpharmacologic means of improving diabetes control have become increasingly attractive given questions regarding the cardiovascular benefits and risks of currently used hypoglycemic drugs to achieve tight glycemic control (36).

In conclusion, consumption of low-GI foods, but not a low-GL diet, appears to be one of the determinants of success of vegan or ADA diets in reducing HbA1c and body weight. Additional studies to lower the dietary GI further than was accomplished in the present study by specifically incorporating low-GI foods, such as peas, beans, and lentils, would be of interest to examine the extent to which they can demonstrate further improvements in the metabolic advantages of therapeutic diets.

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