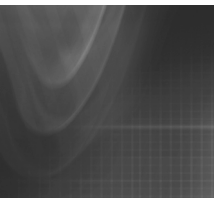
Low–Glycemic Index Carbohydrates

An Effective Behavioral Change for Glycemic Control and Weight Management in Patients With Type 1 and 2 Diabetes



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Purpose

This retrospective study evaluated the incorporation of low–glycemic index (GI) carbohydrates into daily meal planning as an effective behavioral lifestyle change to improve glycemic control and weight management in patients with type 1 and 2 diabetes.

Methods

Twenty-one subjects participated in this study. All office visits and interview sessions took place in a 2-physician private medical practice setting in Wayne, New Jersey. Patients' pre- and postcounseling HbA1c and body mass index (BMI) values and their antidiabetic medication dosages were recorded. Audiotaped interviews were conducted using the 10-question Glycemic Index Foods Quiz (GIFQ) and the 29-question Interview Questionnaire (IQ). The GI values of pre- and postcounseling meals were calculated. Assessment was based on triangulating the subjects' adherence to the low-GI carbohydrate behavioral change and the primary outcome measures: HbA1c and BMI.

Results

Low-GI medical nutrition therapy (LGI-MNT) counseling reduced HbA1c by 19% (mean drop of 1.5 U) and decreased BMI by 8% (mean loss of 17 pounds). This was accomplished by the participants independently

lowering the GI values of their meals by 25% (mean reduction of 15 points). Results were achieved over a time frame of 3 to 36 months from the initial LGI-MNT counseling session.

Conclusions

Daily incorporation of low-GI carbohydrates in meal planning can be an effective diabetes self-management strategy for glycemic control and weight management. The documented responses to the subjects' conceptual and practical knowledge of the GI confirm their acceptance of this approach as a permanent behavioral lifestyle change and not a "diet." The positive results of this study attest to what worked for these subjects, inviting diabetes educators to consider offering low-GI dietary advice to their diabetes patients.

Receiving a diabetes diagnosis puts the patient on notice that some lifestyle changes should be made to improve health. Health care providers inform the patient about the triad of glycemic management options: diet, exercise, and medication. To improve overall glycemia and preserve quality of life, the patient soon realizes that food choices and weight management will affect these goals.

Recent national statistics confirm that Americans are living in concurrent diabetes and obesity epidemics, with no abatement in sight. The prevalence of diabetes in the United States has doubled between 1980 and 2003, from 5.8 million to an estimated 13.8 million Americans,[1] and another 41 million are estimated to have prediabetes.[2] Of equal concern, 65% of adult Americans are overweight or obese, and more than 60 million of these are obese.[3]

To best address the gravity of these statistics, diabetes educators look for flexible, sensitive, and creative ways to motivate their patients to initiate behavioral changes that will foster and maintain improved health. The currently recommended approach for diabetes education is to focus on behavior-centered, rather than knowledge-centered, interventions that are feasible in the "real world."[4] Following this approach, the educator presents basic information and offers appropriate skills training for self-management. It is then the patient who decides what, when, and how to incorporate this knowledge into his or her lifestyle.

What does the patient gain from making self-directed, informed decisions about behavioral changes? Anderson et al[5] provide evidence indicating that glycemic control and quality of life may improve with this type of patient empowerment model. When recommended strategies to improve the patient's health are perceived as meaningful and feasible to the patient and the focus moves away from technical information and toward constructive behavioral modifications that the patient identifies and chooses to implement, the educator has succeeded in empowering the patient, and improved outcomes are more likely to result.

Diabetes is a disorder of carbohydrate metabolism. Thus, a balanced diet, with careful attention given to the carbohydrates consumed, plays a prominent role in improving glycemia and other diabetic outcomes. As recently as 2004, the carbohydrate recommendations as stated by the American Diabetes Association (ADA) in their clinical practice recommendations for that year[6] focused on the absolute importance of the total amount of carbohydrate consumption per meal or snack and attributed little importance to its food source. However, since evidence continues to accumulate on the efficacy of the type of carbohydrate consumed in promoting normal or improved glycemia in diabetes patients,[7,8] the 2005 ADA recommendations now indicate that "use of the glycemic index/glycemic load can provide an additional benefit over that observed when total carbohydrate is considered alone."[9]

First presented by Jenkins et al[10] in 1981, the glycemic index (GI) ranks carbohydrates based on their postprandial glucose excursion rate into the bloodstream as compared to a reference food (pure glucose or white bread). Quickly digested high-GI carbohydrates ("gushers") produce a greater and more rapid rise in blood glucose than the more slowly digested low-GI ones ("tricklers").[11] Today, approximately 1750 GI values of tested foods can be found on an online database (www.glycemicindex.com). Alternatively, The New Glucose Revolution provides another reference source for published GI values.[12]

The purpose of this retrospective study was to evaluate the incorporation of low-GI carbohydrates into daily meal planning as an effective behavioral lifestyle change

to improve glycemic control and weight management in patients with type 1 and 2 diabetes.

Research Design and Methods

Setting and Sample

All individuals recruited for this study were adult patients with type 1 or 2 diabetes referred by their primary care physician or endocrinologist for medical nutrition therapy for diabetes. A review of 199 medical charts identified 23 eligible individuals (12%) who met the inclusion criteria. Of those excluded, 74 patients (37%) did not complete the required 2 hours of medical nutrition therapy (MNT); 50 patients (25%) gained weight, 23 patients (12%) did not show improved HbA1c levels, 15 patients (8%) required increased medication, and 14 patients (7%) either refused participation, could not be contacted, were too sick, or had died. The final number of participants was 21; 2 participated in the study but were subsequently disqualified because of inaccurate initial information that, when corrected, did not meet all of the inclusion criteria. Twenty were living at home, either in urban or suburban northern New Jersey communities, and 1 was a third-year college student living in an off-campus apartment in southern New Jersey.

To be eligible for this study, participants had to meet the following criteria: (1) diagnosis of type 1 or type 2 diabetes, (2) stable or improved current HbA1c and body mass index (BMI) values after initiation of low-GI MNT (LGI-MNT) with no increase in number and/or dosages of oral antidiabetic drugs (OADs) and/or insulin, and (3) a minimum of 2 hours of LGI-MNT counseling from the investigator within the time frame of September 1, 2001, through May 1, 2004. Office visits occurred in a 2-physician private medical practice setting in Wayne, New Jersey, where the primary investigator has been an independent nutrition consultant for 16 years.

All eligible subjects received a formal written invitation, and upon acceptance, all signed a written informed consent form prior to their participation in the study. An interview date was scheduled by phone. The descriptive and clinical demographic characteristics are represented in Tables 1 and 2.

Table 1

Descriptive Demographic Characteristics

Demographic	Number	Percentage of Total (N = 21)
Gender		
Male	9	43
Female	12	57
Age, y		
21-39	2	10
40-64	12	57
65-89	7	33
Education level		
8th grade	1	5
1-4 y of high school	5	24
<4 y of college	7	33
College graduate	4	19
Postgraduate	4	19
Occupation		
Retired	7	33
Business and industry	7	33
Public and community service	4	19
Education	1	5
Religious life	1	5
Student	1	5

The time lapse from a subject's initial LGI-MNT session to the interview date was between 3 and 36 months; the average number of MNT office visits was 5, and the average counseling time was 3.6 hours.

Data Collection Procedures

Six different data sources informed this study: pre- and post-LGI-MNT counseling values for (1) HbA1c status, (2) BMI status, (3) pre- and postcounseling dosages of antidiabetic medications, (4) the GI values of pre- and postcounseling meals, and participant responses to (5) the Glycemic Index Foods Quiz (GIFQ) and (6) the Interview Questionnaire (IQ).

Primary Outcome Measures: HbA1c and BMI

Pre- and postcounseling HbA1c and BMI values were retrieved from in-house medical charts for those subjects who were patients in the investigator's medical office; all other information was obtained from the subjects' respective physicians' medical charts via their personal request.

Antidiabetic Medications and GI Values of Meals

Precounseling antidiabetic medications and 1-day food diaries were collected from the initial assessment forms completed during the first LGI-MNT appointment of each subject and retained either in the in-house medical charts or in the investigator's separate MNT files. Postcounseling antidiabetic medication information was collected from in-house medical charts or other physicians' documentation. Precounseling 1-day food diaries were retrieved from each subject's initial assessment form. Postcounseling 1-day food diaries were reported by each subject either on or after the interview day and retained as documentation for this study. The average daily GI values for each subject's typical pre- and postcounseling meals were calculated from published tables.[12]

Table 2

Clinical Demographic Characteristics

Demographic	Number	Percentage of Total (N = 21)
Diabetes diagnosis		
Type 1	3	14
Type 2	18	86
Duration of diabetes, y		
Type 1		
New onset	1	5
25+	2	10
Type 2		
<1	8	38
1-10	7	33
11-19	1	5
20-45	2	10
Treatment strategies (excluding exercise)		
Type 1		
Diet + insulin only	2	10
Diet + combination therapy	1	5
Type 2		
Diet only	4	19
Diet + 1 oral antidiabetic drug	10	48
Diet + 2 oral antidiabetic drugs	3	14
Diet + insulin only	0	0
Diet + combination therapy	1	5

Glycemic Index Foods Quiz

The GIFQ, a 10-item measure, was constructed as a quantifying tool for each subject's conceptual and practical knowledge about the GI.

Interview Questionnaire

The IQ was designed to elicit each participant's subjective appraisal of his or her use of low-GI carbohydrate choices as an effective self-management strategy for his or her glycemic control and weight management. This qualitative tool looked at 7 categories of acceptance and efficacy: (1) the patients' knowledge of the GI concept; (2) their facility in incorporating low-GI carbohydrates into their lifestyle; (3-6) their perceptions of the healthfulness and effectiveness on glycemic control, weight management, and energy level of low-GI carbohydrates; and (7) their perceptions of the efficacy and acceptability of choosing low-GI carbohydrates as a permanent behavioral change for glycemic and weight control.

A one-on-one structured interview, consisting of the GIFQ and the IQ, was conducted by the investigator with

Table 3

Changes in HbA1c, Body Mass Index, and Glycemic Index Values of Meals

	Pre–LGI-MNT		Post–LGI-MNT		Mean Decrease	
	Mean	SD	Mean	SD	n	%
HbA1c	7.5	1.3	6.0	0.7	1.5 U	19.4*
Body mass index	35.1	11.4	32.3	9.1	17 lb	8.0†
Glycemic index values of meals	59	7.7	44	0.2	15 points	25.2*

LGI-MNT = low-glycemic index medical nutrition therapy.
*$P < .0005$.
†$P = .002$.

each participant. The interview time varied from 45 to 60 minutes. No subject received any review of GI information. Their answers were based exclusively on what they remembered from their LGI-MNT counseling sessions, 62% of which occurred more than 1 year prior to the interview date, and also on the carbohydrate choices they subsequently had been making based on that knowledge.

The investigator was not present while the participants were recording their answers except to assist the 2 octogenarian subjects with discrete visual impairment and 1 Hispanic subject with a minor language barrier. In these cases, every attempt was made through neutral body language and voice tone to neither encourage nor discourage certain responses from the subjects. All responses and comments were audiotaped and transcribed verbatim and coded for accurate data collection.

Enhancing Trustworthiness of the Interview Findings

Six randomly selected subjects (n = 6, 29%) retook the GIFQ after 6 to 8 months had lapsed from their original interview date. This recall was designed to rule out that the subjects were guessing or answering just to please the investigator during their initial interview. It was also intended to ensure the reproducibility of the GIFQ results.

As a measure of quality control, all interview texts and test answers were independently reviewed by 2 registered dietitians, certified diabetes educators who were not associated with the study. Both signed a form attesting to the candor of the investigator's data representation.

Data Analysis

The primary outcome measures, HbA1c and BMI, as well as the pre- and post-LGI-MNT counseling GI values of meals, were analyzed by paired-samples t tests between pre- and postcounseling values. The antidiabetic medication variations as well as the GI values of pre- and postcounseling meals were tabulated and compared in an Excel spreadsheet format.

Since the GIFQ is a short 10-item measure, an interitem correlation was used to determine the reliability of the GIFQ. A *t* test was used to compare the test-retest results of the GIFQ for the 6 recalled subjects. Descriptive statistics were used to explain the qualitative findings of the IQ responses.

Results

Summary of Quantitative Data

Primary Outcome Measures: HbA1c and BMI

Two paired-samples *t* tests were conducted to evaluate the impact of LGI-MNT counseling on the HbA1c and BMI statuses of the 21 participants (Table 3).

HbA1c

A 19.4% reduction in HbA1c (mean decrease of 1.5 U) was calculated. There was a statistically significant change from the precounseling HbA1c values (mean = 7.5, SD = 1.3) to the postcounseling HbA1c values (mean = 6.0, SD = 0.7; $t[20] = -4.9$, $P < .0005$). The η^2 statistic value (0.55) indicated a very large effect size. Figure 1 illustrates the HbA1c improvement of these statistical differences.

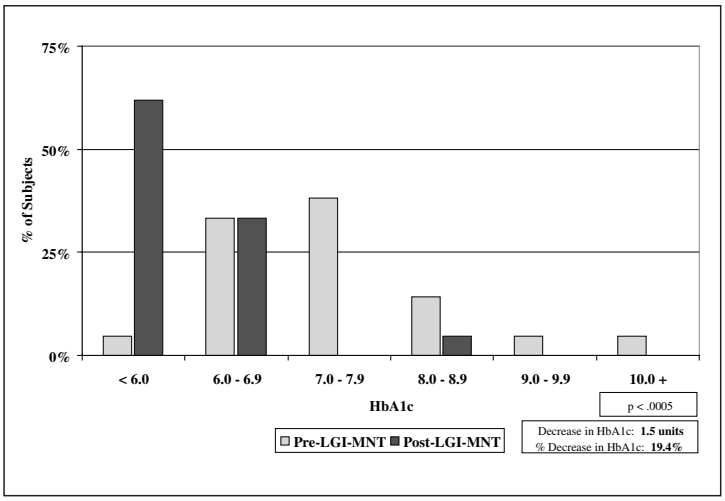

Figure 1. Differences in pre– and post–low glycemic index medical nutrition therapy (LGI-MNT) HbA1c.

Body Mass Index

An 8% reduction in BMI (mean weight loss of 17 lb) was calculated. Sixteen subjects (76%) succeeded in losing weight, 4 subjects (19%) achieved stable weight, and 1 subject (5%) gained weight. This final subject's weight gain was tolerated because the BMI remained less than 25.0. There was a statistically significant change from the precounseling BMI values (mean = 35.1, SD = 11.4) to the postcounseling BMI values (mean = 32.3, SD = 9.1; $t[20] = -3.7$, $P = .002$). The η^2 statistic (0.40) indicated a very large effect size. Figure 2 illustrates the BMI improvement of these statistical differences.

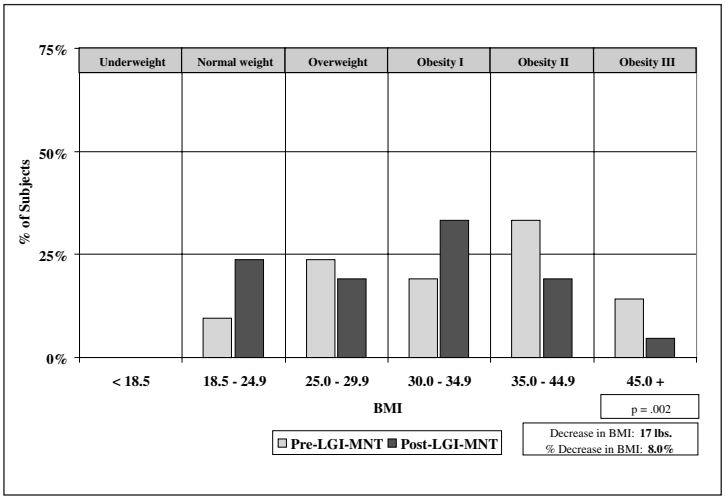

Figure 2. Differences in pre– and post–low glycemic index medical nutrition therapy (LGI-MNT) body mass index (BMI).

Antidiabetic Medications

A comparison of the pre- and postcounseling dosages of antidiabetic medications is highlighted in Table 4. On average, all 3 type 1 subjects reduced their daily insulin dosages (premeals and bedtime) postcounseling between 33% to 58%. One of the type 1 subjects wears an insulin pump and was able to increase his insulin-to-carbohydrate ratio from 1:15 to 1:20. The type 2 subject on insulin also achieved a dosage reduction of 20%. It is noteworthy that all 4 subjects who started with no OADs experienced no change in that status and 2 subjects who were taking an OAD prescription precounseling were able to discontinue them completely. The other notable result is that 2 subjects decreased their OADs from 2 medications to 1 after counseling. Eight subjects experienced no change in their prescriptions; 1 subject's metformin (Glucophage; Bristol-Myers Squibb, Princeton, NJ) dose was increased; this was acceptable because this OAD frequently requires upward titration from the initial dosage based on patient tolerance. There were no consistent differences noted in caloric and carbohydrate intakes between pre- and postcounseling meals: 11 subjects consumed fewer calories, and 8 consumed fewer carbohydrates in their postcounseling meals.

Table 4

Changes in Oral Antidiabetic Medications (OADs) and Insulin

	Pre–LGI-MNT		Post–LGI-MNT	
Subject	**n**	**%**	**n**	**%**
Type 1				
Diet + insulin only	2	10	2	10*
Diet + combination therapy	1	5	1	5†
Type 2				
Diet only	4	19	6	29‡
Diet + 1 OAD	10	48	10	48§
Diet + 2 OADs	3	14	1	5
Diet + insulin only	0	0	0	0
Diet + combination therapy	1	5	1	5‖

LGI-MNT = low-glycemic index medical nutrition therapy; combination therapy = insulin + OADs.
*Average reduction in daily insulin dosage = 33%.
†Average reduction in daily insulin dosage = 58%; no change in OAD dosages.
‡Two subjects discontinued their OAD medication.
§Two subjects decreased their OAD medications from 2 to 1; 8 subjects' dosages remained unchanged.
‖Reduction in daily insulin dosage = 20%; no change in OAD dosages.

GI Values of Meals

A paired-samples *t* test was conducted on the GI values of the subjects' pre- and postcounseling meals (Table 3). A 25% drop in GI (mean decrease of 15 points on the GI scale) was calculated. There was a statistically significant change from the precounseling meals' GI values (mean = 59, SD = 7.7) to the postcounseling meal's GI values (mean = 44, SD = 4.2; $t[19] = 7.9$, $P < .0005$). The η^2 statistic value (0.77) indicated a very large effect size. Figure 3 illustrates the reduction in the meal GI values of these statistical differences.

Prior to LGI-MNT instruction, 5 subjects (24%) were haphazardly following a low-GI diet (either their spouse had already received LGI-MNT or some of their personal food preferences happened to be low-GI), 14 (67%) were in the intermediate-GI range, and 2 (10%) were consuming high-GI meals. It is noteworthy that several subjects started making changes in their diets when they were first diagnosed with diabetes even before initiating medical nutrition therapy by eating more whole grains, fruits, and vegetables and less refined starches and concentrated sweets. Twenty subjects (95%) succeeded in lowering the GI values of their daily food intake. One subject, with type 1 diabetes and a remarkable history for severe hypoglycemic episodes, showed a 6% increase in overall GI but still remained in the low-GI category. At the end of the study, all participants were eating low-GI meals and snacks (average postcounseling daily GI value = 45).

Glycemic Index Foods Quiz

The average GIFQ score was 86.2%; no one scored less than 60%. The participants' underlying conceptual understanding of the relationship between diabetes and carbohydrates was assessed at 96%, based on their answers to questions 1 to 5, and their practical knowledge of low-/high-GI carbohydrates was assessed at 76% based on their answers to questions 6 to 10. The mean interitem correlation for the 10 items in the GIFQ was 0.31. According to Briggs and Cheek,[13] this

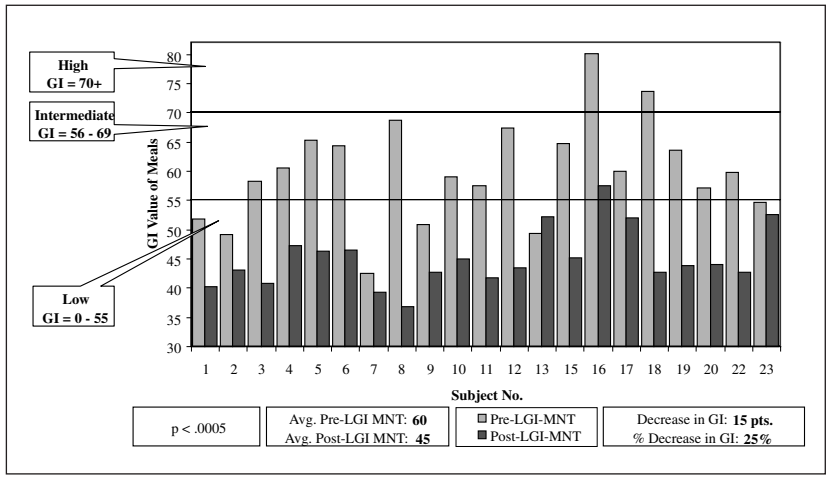

Figure 3. Differences in pre– and post–low glycemic index medical nutrition therapy (LGI-MNT) glycemic index (GI) values of meals.

Table 5

Summary of Findings From the Interview Questionnaire

Interview Categories and Questions	% (n)	% (n)	% (n)
Pre- and post–LGI-MNT knowledge of the glycemic index concept	**Never heard of it/heard but didn't understand**	**Heard of it and tried to make changes**	**Heard and made changes; good understanding**
1. Before our first nutrition counseling appointment [give date], how would you describe your understanding of the glycemic index?	90 (19)	10 (2)	0 (0)
	Very good/good	**Fair**	**Poor/very poor**
2. At the end of our first appointment, how would you rank your understanding of the glycemic index?	86 (18)	14 (3)	0 (0)
Facility of incorporating LGI carbohydrates into current lifestyle	**Very easy/easy**	**Same**	**Difficult/very difficult**
3. How do you find planning for low–glycemic index meals?	67 (14)	29 (6)	5 (1)
4. How do you find planning for low–glycemic index snacks?	62 (13)	19 (4)	19 (4)
5. How do you find shopping for low–glycemic index carbohydrates?	52 (11)	33 (7)	14 (3)
6. How do you find identifying/recognizing low–glycemic index carbohydrates when you shop?	57 (12)	14 (3)	29 (6)
7. How do you find preparing/cooking low–glycemic index meals?	57 (12)	43 (9)	0 (0)
8. How do you find selecting low–glycemic index meals when eating out?	33 (7)	19 (4)	48 (10)
9. How do you find selecting low–glycemic index snacks when not at home?	19 (4)	24 (5)	52 (11)
22. When planning your low–glycemic index meals, you have adequate carbohydrate choices.	95 (20)	0 (0)	5 (1)
23. Planning your low–glycemic index meals does not interfere with your dining out plans.	76 (16)	0 (0)	24 (5)
24. Preparing your low–glycemic index meals does not require more time than any other type of meal.	90 (19)	0 (0)	10 (2)
25. Eating your low–glycemic index meals does not require you to eat differently from the rest of the family.	67 (14)	0 (0)	33 (7)
26. Low–glycemic index meals cost the same as other types of average meals.	76 (16)	10 (2)	14 (3)
Perception of healthfulness of LGI carbohydrates	**Very good/good**	**Do not affect health**	**Bad/very bad**
10. In your opinion, how good are low–glycemic index carbohydrates for your health?	100 (21)	0 (0)	0 (0)
	Improved blood glucose levels	**Helped with weight loss**	—
11. In what way(s) do you feel that incorporating low–glycemic index carbohydrates into your diet has helped to improve your health?	100	76	—

(continued)

Table 5 continued

Perception of efficacy of LGI carbohydrates on glycemic control	**100%-75%**	**50%**	**25%-0%**
12. Based on your own personal experience, to what degree do you think eating low–glycemic index carbohydrates has helped your blood sugar control?	76 (16)	24 (5)	0 (0)
	Completely/somewhat agree	**No opinion**	**Disagree/strongly disagree**
16. Since you have been eating low–glycemic index carbohydrates, you are less fearful of high blood sugar readings.	95 (20)	5 (1)	0 (0)
17. Since you are eating low–glycemic index carbohydrates, you are less fearful of low–blood sugar readings.	81 (17)	10 (2)	10 (2)
18. Since you are eating low–glycemic index carbohydrates, your blood sugar readings have improved.	95 (20)	5 (1)	0 (0)
Perception of efficacy of LGI carbohydrates on weight control	**Completely/somewhat agree**	**No opinion**	**Disagree/strongly disagree**
13. Based on your own personal experience, to what degree do you think eating low–glycemic index carbohydrates has helped with your weight management?	67 (14)	24 (5)	10 (2)
19. Since you have been eating low–glycemic index carbohydrates, you are less hungry between meals.	95 (20)	0 (0)	5 (1)
20. Since you have been eating low–glycemic index carbohydrates, you feel more in control of your weight.	86 (18)	10 (2)	5 (1)
21. You are still losing weight or you have been able to maintain the weight you have lost.	81 (17)	19 (4)	0 (0)
Perception of efficacy of LGI carbohydrates on energy level and exercise	**Completely/somewhat agree**	**No opinion**	**Disagree/strongly disagree**
14. Since you have been eating low–glycemic index carbohydrates, you have more energy.	76 (16)	14 (3)	10 (2)
15. Since you have been eating low–glycemic index carbohydrates, you are more physically active.	76 (16)	14 (3)	10 (2)
Perception of efficacy and acceptability of choosing LGI carbohydrate as a behavior (lifestyle) change to improve/maintain glycemic weight control	**Completely/somewhat agree**	**No opinion**	**Disagree/strongly disagree**
27. Behavior (lifestyle) change, rather than "going on a diet," is the most effective way to improve/maintain your diabetes and weight management.	100 (21)	0 (0)	0 (0)
28. Choosing low–glycemic index carbohydrates is a behavior (lifestyle) change that you have found has helped you to improve/maintain your diabetes and weight control.	100 (21)	0 (0)	0 (0)
29. You believe you will continue to choose low–glycemic index carbohydrates as an acceptable and permanent behavior (lifestyle) change to improve/maintain your diabetes and weight control.	100 (21)	0 (0)	0 (0)

LGI-MNT = low-glycemic index medical nutrition therapy.

falls within the optimal range for the interitem correlation (0.2-0.4). No statistical difference was found between the original test scores and the retest scores for the 6 recall subjects (GIFQ: mean= 9.3, SD = 0.5; retest: mean = 9.8, SD = 0.4; P = .08).

Summary of Qualitative Data

Interview Questionnaire

The descriptive statistics of the IQ are highlighted in Table 5. The participants' responses clearly reveal the following: 90% of them lacked understanding of the GI concept pre–LGI-MNT counseling (question 1) but 86% felt that their postcounseling comprehension was good or very good (question 2); their 19% to 95% effective capacity to incorporate this knowledge into their current lifestyle (questions 3-9, 22-26); their 100% overwhelming belief that low-GI carbohydrates are healthful (question 10); their conviction that low-GI carbohydrates improved their glycemic levels and weight loss 100% and 76%, respectively (question 11); their 76% to 95% confidence in low-GI carbohydrate choices being an efficacious strategy for glycemic control (questions 12, 16-18), as well as 67% to 95% for weight management (questions 13, 19-21); and their 76% conviction that low-GI carbohydrates give them more energy to exercise (questions 14, 15). Most important, there was unanimous agreement among all 21 participants that behavioral change is a more effective approach to glycemic and weight control than "dieting" (question 27). They found that choosing low-GI carbohydrates helped them manage their blood glucose and weight (question 28), and they believed they would continue to use the GI concept as a permanent lifestyle change (question 29).

Conclusions

This retrospective study set out to evaluate whether LGI-MNT counseling could improve glycemic control and weight management in noninstitutionalized patients with type 1 and 2 diabetes. Five pre- and postcounseling quantitative data sources were compared to attain this objective: HbA1c, BMI, antidiabetic medications, GI values of meals, and GIFQ scores. One qualitative data source was also compared, the IQ. Since the primary inclusion criteria dictated that participants must have achieved improved glycemic control (HbA1c) and a stable or reduced weight status (BMI), only successful patients were tracked in this study to evaluate the impact of LGI-MNT on their success.

With regard to weight management, a recently published study[14] failed to show a significant improvement with GI education in a 1-year posttreatment weight loss in a behavioral weight management program. However, there are animal[15] and human[16-18] intervention studies that point to a positive impact of low-GI diets on weight loss, resting energy expenditure, and body fat deposition. These studies support the weight loss results of this intervention.

The participants were questioned in depth whether they believed learning about high-/low-GI carbohydrates helped them with their glycemic control and weight management. Their documented responses were overwhelmingly positive about the usefulness of knowledge about the GI.

Of paramount interest to this study was the participants' unanimous 100% consensus regarding behavioral changes in their lifestyles: (1) behavioral changes work better than going on a diet for their diabetes control and weight management, (2) choosing low-GI carbohydrates helped them improve their diabetes and weight statuses, and therefore, (3) they plan on continuing to use this efficacious self-management strategy.

Strengths of the Study

The diverse number of data sources informing this study lends credibility to its findings. Comparisons of quantitative and qualitative data provide strong proof of the utility of LGI-MNT for the participants' postcounseling improved glycemic control and weight management. There is also an important degree of relationship and coherence between the findings of the quantitative and qualitative results.

The subjects are either living at home or away at college, making ad libitum carbohydrate choices at every meal and snack opportunity. This was not a clinical trial but rather a report of what these patients chose to do for themselves "out there" while living their daily lives. Their choices were influenced by knowledge about the GI concept that they received 3 to 36 months prior to the onset of the study. The positive primary outcome measures of these participants (HbA1c and BMI) attest to the efficacy of the patient empowerment model.

Limitations of the Study

Exercise was not included in the scope of this study. As a result, there was limited, albeit positive, participant input on this essential self-management behavior. This study did not set limits on the duration of each participant's diabetes diagnosis, suggesting that the degree of glycemic improvement might vary from the newly diagnosed patients to those with a longer duration of diabetes. The same diabetes educator was responsible for providing all LGI-MNT instruction, collection, and reporting of the study's data and results. Using several educators and data collection assistants, as would be warranted in a larger study, would rule out the possibility of personal bias. There is the possibility that the self-reported food records of the participants in this study may be biased, as in any study. A more formal protocol, using investigators unrecognized by the participants, may help to eliminate the participants' unintentional bias.

Hopefully, future studies will address these issues and others, such as waist circumference measurements and the glycemic load of meals.

Implications for Practice

The findings of this study clarify the benefit of incorporating low-GI carbohydrates into the daily food choices of free-living diabetes patients. Once presented with basic information, the subjects made their own decisions in their respective daily lives and over time converted their new behavioral change into an accepted way of life.

Results of this study also support the value of the patient empowerment model. In most cases, patients want to succeed in their diabetes self-management care. When the diabetes educator presents practical behavior-centered information in a nonthreatening manner, the patient is more likely to accept this guidance and feel motivated toward positive change.

Learning to incorporate low-GI carbohydrates affords patients a practical skill that is within their grasp. It empowers them to "own" their diabetes and actively contribute to their control over it.

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