



Applied nutritional investigation

Impact of advanced and basic carbohydrate counting methods on metabolic control in patients with type 1 diabetes

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ABSTRACT

Objective: Diets based on carbohydrate counting remain a key strategy for improving glycemic control in patients with type 1 diabetes. However, these diets may promote weight gain because of the flexibility in food choices. The aim of this study was to compare carbohydrate counting methods regarding anthropometric, biochemical, and dietary variables in individuals with type 1 diabetes, as well as to evaluate their knowledge about nutrition.

Methods: Participants were allocated in basic or advanced groups. After 3 mo of the nutritional counseling, dietary intake, anthropometric variables, lipemia, and glycemic control were compared between groups. A questionnaire regarding carbohydrate counting, sucrose intake, nutritional knowledge, and diabetes and nutrition taboos also was administered.

Results: Ten (30%) participants had already used advanced carbohydrate counting before the nutritional counseling and these individuals had a higher body mass index (BMI) ($P < 0.01$) and waist circumference (WC) ($P = 0.01$) than others ($n = 23$; 69.7%). After 3 mo of follow-up, although participants in the advanced group ($n = 17$; 51.52%) presented higher BMI ($P < 0.01$) and WC ($P = 0.03$), those in the basic group ($n = 16$; 48.48%) showed a higher fat intake ($P < 0.01$). The majority of participants reported no difficulty in following carbohydrate counting (62.5% and 88% for basic and advanced groups, respectively) and a greater flexibility in terms of food choices (>90% with both methods).

Conclusions: Advanced carbohydrate counting did not affect lipemic and glycemic control in individuals with type 1 diabetes, however, it may increase food intake, and consequently the BMI and WC, when compared to basic carbohydrate counting. Furthermore, carbohydrate counting promoted greater food flexibility.

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Introduction

According to individuals with type 1 diabetes, diet adherence is one of the more difficult aspects of treatment [1,2]. However, nutrition therapy is essential in the management of diabetes [3], and meal-planning strategies for type 1 diabetes emphasize the

relationship between prandial insulin dose selection and the anticipated amount of carbohydrates to be consumed [3,4].

Carbohydrate counting is a meal-planning method that focuses on carbohydrates, and the American Diabetes Association recommends meal plans based on carbohydrate counting as a key strategy to achieving glycemic control [3,4].

There are two levels of carbohydrate counting. At the basic level, individuals must eat a consistent amount of carbohydrates at meals. It is useful to understand the effect of food and medication and to identify normal portion sizes, considering that one serving is equal to 15 g of carbohydrates. The advanced level includes pattern management and understanding how to use insulin-to-carbohydrate ratios. Carbohydrate counting requires the ability to determine the amount of carbohydrates in each food, and it may promote weight gain when patients don't pay attention to their food choices [3,4].

DLS conceived, performed, and coordinated the study, and drafted the manuscript. LZ and MR helped collect data and contributed to drafting the manuscript. ELR participated in design and coordination, and contributed to drafting the manuscript.

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Several studies have assessed knowledge of carbohydrate counting and insulin dosing [5–8] and patient satisfaction [9–11]. However, no study has paired these results with issues about nutrition knowledge and sucrose intake.

In this study, we compared the basic and advanced carbohydrate-counting methods regarding anthropometric, biochemical, and dietary variables in individuals with type 1 diabetes. We also evaluated patient knowledge of nutrition and carbohydrate counting among those who followed either of these methods.

Materials and methods

Participants

This was a controlled, open-label, clinical trial that included individuals with type 1 diabetes who were recruited at the waiting room of the Clementino Fraga Filho University Hospital, Brazil. Participants with body mass index (BMI) ≥ 30 kg/m² and with disease duration <2 y were excluded from the study, as were smokers, alcoholics, users of lipid-lowering or oral hypoglycemic medications, and those with other diseases (such as hypertension, celiac disease, hypo- and hyperthyroidism).

The hospital database updated on January 2010 included 200 outpatients as potential participants. Of these, only 80 (40%) were eligible and were contacted and invited to participate. Forty-seven (23.5%) refused, and 33 (16.5%) agreed to participate and completed the study. All signed an informed consent, and the protocol was approved by the Ethical Committee (Institutional Review Board, protocol 050/09).

Thirty-three volunteers with type 1 diabetes were assessed at baseline and after 3 mo of nutritional counseling. They were assigned to either the basic or advanced group, according to their ability to understand pattern management and how to use insulin-to-carbohydrate ratios.

All participants received three individual face-to-face consultation sessions, which included individualized diet prescriptions based on current recommendations (dietary energy content of 50%–60% carbohydrates, 15%–20% protein, and 25%–35% total fat) [3]. They also received advice on food selection, portion sizes, cooking methods, and the effect of food on glycemic control.

Baseline dietary intake was evaluated from 3-d diet records, and 24-h recalls were performed monthly. Additionally, volunteers were followed weekly by telephone calls [12] to resolve any doubt about carbohydrate counting. Diets and dietary records were analyzed using Software DietPró 5.5i (version 2008–2011, Rio de Janeiro, Brazil).

All participants were provided insulin, glucometer, and test strips for self-monitoring of blood glucose (SMBG) four times daily. The insulin sensitivity factor was calculated as 1800 or 1500 (used for rapid-acting and for regular insulin, respectively) divided by total daily dose of insulin. Insulin-to-carbohydrate ratios were determined by dividing the total daily insulin dose into 500 and were adjusted frequently on the basis of 2-h postprandial glycemia. Participants were instructed to calculate premeal insulin bolus doses according to carbohydrate ingestion and individualized insulin-to-carbohydrate ratios [13].

Additionally, after the nutritional counseling, a questionnaire adapted from a survey posted on the Brazilian Diabetes Society website [14] was administered to all volunteers. The questionnaire contained 3 open-ended and 37 closed issues. Almost all closed issues were dichotomized and reported in the form of yes/no (9 items related to the effects of carbohydrate counting on glycemic control, 8 about the meal plan based on carbohydrate counting) and true/false (17 items related to general nutrition knowledge and diabetes nutrition taboos). Another item referred to sucrose intake, with the options “never,” “once a week,” “2 d/wk,” and “more than 2 d/wk.” The third item was also dichotomized as “yes/no.”

Blood samples were obtained after 8 h fasting, and events that could influence the results were considered (e.g., infections, flu, fever). Glycated hemoglobin was measured by high-performance liquid chromatography [15]. Fasting glucose, total cholesterol, high-density lipoprotein (HDL), and triglycerides were measured by an enzymatic colorimetric method, and low-density lipoprotein cholesterol (LDL-C) was calculated [16].

Body mass index was calculated as body weight in kilograms divided by the square of height in meters [17]. Waist circumference (WC) was determined as the average of two measurements calculated to the nearest 0.1 cm midway between the lower rib margin and the iliac crest after a normal expiration [18]. Body composition was measured by tetrapolar bioelectrical impedance (Bioimpedance Analyzer 450, Biodynamics Corporation, Shoreline, WA, USA) [19].

Statistical analyses were performed in SPSS software (version 16.0; SPSS Inc, Chicago, IL, USA), with a significance level of 5%. Qualitative variables were described as frequency, whereas quantitative variables were described as the mean and SD. The Mann–Whitney test was used for between-group comparison

and the Wilcoxon test was used to compare the effects of nutrition knowledge in each group.

Results

Characteristics of participants at baseline

Thirty-three participants with type 1 diabetes (21 men and 12 women) were evaluated, with a mean age of 21.7 ± 5 y (range, 15–37) and a mean duration of disease of 11.9 ± 6.4 y (range, 2–18). All were in a basal-bolus plan, with 32 using multiple daily injections and 1 on an insulin pump.

Ten (30%) participants already used advanced carbohydrate counting before the study, and these individuals had a higher BMI ($P < 0.01$) and WC ($P = 0.01$) than patients who had never received guidance about carbohydrate counting ($n = 23$; 69.7%) (Table 1).

Using the method of carbohydrate counting, the dietary, biochemical, and clinical basal characteristics were similar between the basic and advanced groups, except for BMI ($P = 0.01$) and WC ($P = 0.02$), which were higher in the basic group (Table 2).

Characteristics of participants after 3 mo of nutritional counseling following carbohydrate counting

The basic group was comprised of 16 volunteers (48.48%). These individuals had not received guidance about carbohydrate counting before the study. The advanced group was comprised of 17 individuals (51.52%). Of these, 7 (41.17%) had not received

Table 1
Baseline characteristics of participants with type 1 diabetes*

	Participants who used the carbohydrate-counting method before the study (n = 10)	Participants who had never received guidance about carbohydrate counting before the study (n = 23)	P-value [†]
Age (y)	23.40 $\pm$ 61.16	21.04 $\pm$ 4.39	0.27
Body mass index (kg/m ²)	24.89 $\pm$ 2.38	22.37 $\pm$ 2.50	<0.01
Waist circumference (cm)	81.80 $\pm$ 6.72	74.26 $\pm$ 6.93	0.01
Body fat (%)	23.77 $\pm$ 9.24	19.90 $\pm$ 7.69	0.33
Total body water (%)	40.16 $\pm$ 7.38	36.98 $\pm$ 7.76	0.24
Glycosylated hemoglobin (%)	7.74 $\pm$ 2.13	7.61 $\pm$ 1.45	0.98
Total cholesterol (mmol/L)	164.30 $\pm$ 34.81	159.52 $\pm$ 40.65	0.55
HDL (mmol/L)	51.40 $\pm$ 9.28	50.91 $\pm$ 14.19	0.75
LDL (mmol/L)	93.70 $\pm$ 33.10	86.91 $\pm$ 26.85	0.59
Triglycerides (mmol/L)	77.30 $\pm$ 30.32	78.43 $\pm$ 41.08	0.84
Insulin-to-carbohydrate ratio	12.34 $\pm$ 3.09	13.66 $\pm$ 4.53	0.70
Correction factor	40.00 $\pm$ 11.18	36.95 $\pm$ 6.34	0.35
SMBG (mmol/L)	152.82 $\pm$ 29.42	156.80 $\pm$ 31.20	0.81
Energy intake (kcal)	2,158.22 $\pm$ 386.30	2,126.42 $\pm$ 511.17	0.63
Carbohydrate intake (%)	50.39 $\pm$ 4.05	51.04 $\pm$ 7.33	0.44
Sucrose intake (%)	9.96 $\pm$ 11.47	11.04 $\pm$ 12.61	0.38
Protein intake (%)	18.85 $\pm$ 3.05	18.74 $\pm$ 2.88	0.92
Fat intake (%)	30.38 $\pm$ 3.50	29.48 $\pm$ 7.98	0.27
Fiber intake (g)	24.99 $\pm$ 8.17	25.39 $\pm$ 12.03	0.63

HDL, high-density lipoprotein; LDL, low-density lipoprotein; SMBG, self-monitored blood glucose at last month

* Data are means $\pm$ SD.

[†] P-value was derived by Mann–Whitney test.

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