Nutrición Hospitalaria

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Efficacy of photographic educational materials for carbohydrate counting training of adolescents with diabetes mellitus

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Abstract

Background: Carbohydrate counting (CHC) is acknowledged by the American Diabetes Association (ADA) as an important tool.

Objective: To assess the efficacy of photographic educational materials to train adolescents with DM to perform CHC.

Subjects and methods: 76 adolescents were randomly divided into two groups of CHC orientation: by means of photographic materials (Photo) or by a list of foods (List). One month afterwards, the participants were contacted via telephone to answer questions on CHC to reinforce the training (Quiz). Two days after taking the quiz, required the participants to visit an experimental kitchen to observe food portions *in natura* and to respond to a questionnaire on the weights in grams or carbohydrate equivalents of these portions. Statistical significance was established at $p < 0.05$.

Results: 54 adolescents completed the study (79.7% female), with 51.8% allocated to the Photo group and 48.1% to the List group. The mean age was 13.8 ± 2.0 years old, and the mean body mass index (BMI) was 21.0 ± 3.2 kg/m². The participants had average of 7.9 ± 1.5 years of schooling, while their parents had 8.0 ± 3.8 years. The knowledge of CHC was similar in both groups before the intervention. After the intervention, the Photo group achieved a significantly higher hit difference on the CHC assessment test than the List group (Photo: 2.5 *vs* List: 1.0; $p = 0.03$).

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EFICACIA DE MATERIALES EDUCATIVOS FOTOGRÁFICOS PARA ENTRENAR A ADOLESCENTES CON DIABETES MELLITUS CON EL CONTEO DE CARBOHIDRATOS

Resumen

Antecedentes: El conteo de carbohidratos (CCH) es reconocido por la Asociación Americana de Diabetes (AAD) como una herramienta importante.

Objetivo: Evaluar la eficacia de materiales educativos fotográficos en el entrenamiento de adolescentes con DM para realizar el CCH.

Sujetos y Métodos: se distribuyó al azar a 76 adolescentes a dos grupos de orientación de CCH: mediante materiales fotográficos (Foto) o mediante listado de alimentos (Lista). Un mes después, se contactó a los participantes por teléfono para responder a preguntas sobre CCH para reforzar el entrenamiento (Encuesta). Dos días después de la encuesta, se pidió a los participantes que visitaran una cocina experimental para observar las porciones de los alimentos al natural y responder a un cuestionario sobre los pesos en gramos o equivalentes de carbohidratos de estas porciones. Se estableció la significación estadística en un valor de $p < 0,05$.

Resultados: 54 adolescentes completaron el estudio (79,7 % mujeres), siendo el 51,8 % asignados al grupo Foto y el 48,1 % al grupo Lista. La edad promedio fue de 13,8 ± 2,0 años y el índice de masa corporal (IMC) promedio fue de 21,0 ± 3,2 kg/m². Los participantes tenían un promedio de 7,9 ± 1,5 años de escolarización, y sus padres 8,0 ± 3,8 años. EL conocimiento en el CCH fue similar en ambos grupos antes de la intervención. Después de la misma, el grupo Foto consiguió una diferencia significativa en la tasa de aciertos en el test de evaluación del CCH con respecto al grupo Lista (Foto: 2,5 frente a Lista: 1.0; $p = 0,03$).

Conclusions: **The photographic educational material was more effective in helping adolescents with DM understand and learn to perform carbohydrate counting.**

Conclusiones: **el material educativo fotográfico fue más eficaz a la hora de ayudar a los adolescentes con DM a comprender y aprender a realizar el conteo de hidratos de carbono.**

Introduction

Diabetes is a chronic disease requiring treatments that can include nutritional therapy, medication, physical activity, monitoring of serum glucose levels and self-management education[1,2].

The nutritional recommendations for the healthy population are also appropriate for individuals with type 1 diabetes mellitus (DM). The major difference for the latter group is their need for an insulin regime that is adjusted based on the amount of carbohydrates (CHOs) ingested and lifestyle[3]. Individualized dietary planning and intensive insulin regimes might grant children and adolescents with diabetes more flexibility in dealing with meal schedules, appetite variability and different levels of exercise[3].

Carbohydrate counting (CHC) requires correlating the amount of carbohydrates ingested with the quantity of insulin needed to absorb that amount[4]. This nutritional strategy seeks to reduce the variations in postprandial glycemia that result from variations in the type and amount of food ingested[5,6].

In practice, nutritionists still encounter difficulties in teaching adolescents with diabetes to be aware of the amount of food they ingest and to count their dietary carbohydrates. Therefore, the use of teaching materials that focus on the treatment and control of DM and that employ alternative formats adjusted for each patient is clearly justified.

This study aimed to assess the efficacy of photographic educational materials used to train adolescents with type 1 DM who are subjected to intensive insulin therapy to perform CHC.

Methods

Study design

This was a randomized clinical trial performed with 76 adolescents with DM at the diabetes outpatient clinic of the Children's Institute of the Clinics Hospital of the University of São Paulo Faculty of Medicine (Hospital das Clinicas da Faculdade de Medicina da Universidade de São Paulo — HCFMUSP) in São Paulo between January 2008 and February 2010.

To calculate the required sample size, the alpha error probability was set at 0.05, and the study power was set at 90%. The study sample size was established based on the hypothesis that the average score would be 10% higher in participants using the photographic learning material.

Inclusion criteria

The inclusion criteria consisted of any adolescent with DM who was subjected to intensive insulin therapy and showed an interest in participating in this study.

Exclusion criteria

The exclusion criteria consisted of adolescents with less than six years of education who were never given training for CHC as a part of their dietary plan or who exhibited delayed neuropsychomotor development. Additionally, those who were diagnosed with diabetes less than one year prior to the study were excluded.

Variables

The following data were collected: sex, age, weight, height, educational level of participants, educational level of their parents, duration of diabetes, number of previous CHC training sessions, duration of training with the tested educational materials, number of hits regarding CHO amounts in food portions in the applied score, value of glycated hemoglobin and the interval of time between training with the educational materials and the performance assessment.

All participants had their weights and heights measured in a medical office by means of a Filizola digital scale with a 200 kg capacity and a Tonelli wall stadiometer, respectively. The AnthroPlus software from the World Health Organization[7] was used to assess the nutritional status of each subject; the measurements were expressed as Z-scores. The nutritional status was classified based on the body mass index (BMI) according to WHO[7] as follows: an adequate weight was defined as a BMI Z-score between -2.0 and +1.0 standard deviations; overweight was defined as a BMI Z-score higher than +1.0 and lower than +2.0 standard deviations; and obesity was defined as a BMI Z-score equal to or higher than +2.0 standard deviations.

The level of glycated hemoglobin was measured pre-intervention by high-performance liquid chromatography (HPLC). According to the International Society for Pediatric and Adolescent Diabetes (ISPAD) 2000 consensus[8], the metabolic control of adolescents with diabetes is rated "adequate" when the HbA1c level is below 7.5%.

Clinical trial

Each patient was allocated to a treatment group upon his or her arrival at our outpatient clinic. Paired block randomization was used to ensure that the groups were balanced. The flowchart for the study is shown in figure 1, below:
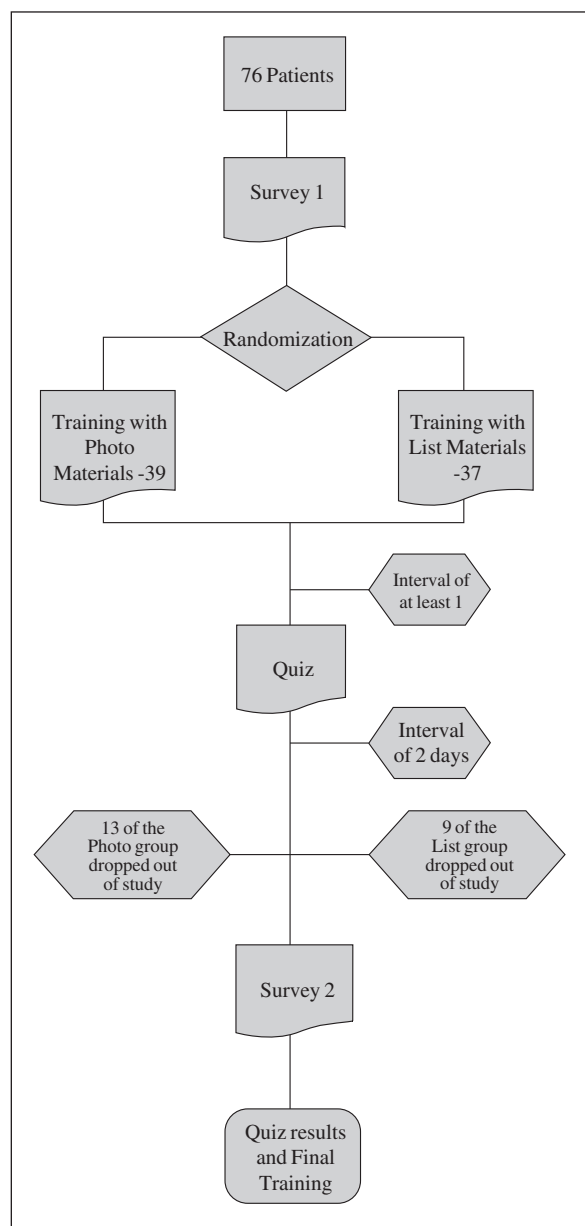

Fig. 1.—Study flowchart.

One group of 39 adolescents was given CHC training by means of photographic educational material (Photo), and another group of 37 participants was trained by a list of equivalent foods (List).

A nutritionist intern who was specially trained for this study conducted a survey to assess the previous knowledge of CHC. This survey included 11 food groups that were each represented by an in-home serving size of a single food. Foods commonly consumed by adolescents were emphasized. If the participants could not specify the amount of carbohydrates in a particular food during the survey, they were then asked to respond for another food that they knew.

Next, a specifically trained nutritionist gave the participants CHC training using either the Photo or List materials, and the time spent on the training was recorded. The participants were asked to return after at least one month. One month after the participants used the allocated materials, they responded to a telephone survey on the study topic (Quiz) to reinforce the training. Whenever the participants missed a question, they were provided with the correct answer.

The quiz was composed of three questions. After having been shown a list with 11 food groups, participants were asked the first question: "In which groups do we count carbohydrates?" The possible answers were *yes* for the CHO-counting food groups; no for CHO non-counting groups; and *exception* for groups containing both CHO-counting and non-counting foods. Other exceptions included the group of meats for which carbohydrates are counted when their preparation includes flour or when the intake is larger than the prescribed serving and the group of vegetables for which carbohydrates are counted only when the intake is larger than 1.5 cups of cooked vegetables. The second and third questions were open-ended: "What group is the most difficult for you to count carbohydrates?" and "How many carbohydrates, in grams or carbohydrate equivalents, are in six saltine crackers?"

Two days after taking the quiz, the participants were taken to an experimental kitchen to observe food portions *in natura* and to respond again to the same survey that had been conducted before the intervention on the amounts of carbohydrate equivalents contained in food portions. The survey was conducted by two interns who were blinded to the type of intervention.

The post-intervention survey included a hedonic scale (excellent, good, fair, poor and very poor) to assess the opinions of the participants regarding the educational material they had been given and three more open-ended questions: 1) "What did you like best in the material?", 2) "What did you not like in the material?" and 3) "Do you have suggestions to improve the material?".

Statistical analysis

A Student's t-test was applied to parametric variables, and the Kruskal-Wallis and Mann-Whitney tests

were applied to nonparametric variables, with statistical significance established as $p < 0.05$. Multivariate logistic regression analyses were performed to test whether the results could be explained by confounding variables, and the dependent variable was the difference in the number of hits between the first and last test.

This clinical trial was registered at ClinicalTrials.gov under the access number 118207 NCT 01102959.

Results

Of the original 76 adolescents, only 54 participated in all stages and completed the study. There were no differences in the investigated variables between the group that completed the study and the group that dropped out of the study.

All participants had been diagnosed with diabetes at least one year earlier. One female participant used an insulin pump, while the rest received multiple daily insulin doses (at least three per day). One female participant had diabetes associated with cystic fibrosis, and the rest had type 1 diabetes. There were no significant differences in the variables of sex, age, BMI, years of schooling and duration of diabetes between the Photo and List groups.

All participants had received prior CHC training, and there was no significant difference between the

Table I
Comparison between the group that completed the study (complete analysis) and the group that dropped out of the study (incomplete analysis)

	Complete analysis N = 54	Incomplete analysis N = 22	p
Age			
Mean in years (SD)	13.9 (1.9)	14.9 (2.1)	0.363*
Sex			
% female	77.8	68.2	0.381#
HbA1c			
mean (SD)	9.9 (2.1)	10.8 (2.2)	0.128*
BMI			
mean (SD)	21.0 (3.2)	21.3 (2.5)	0.712*
Schooling			
Years of education – p50 (p25-p75)	8 (7-9)	7 (7-10)	0.944**
Initial knowledge			
Number of hits – mean (SD)	5.0 (2.0)	4.1 (2.7)	0.180*
Photo intervention			
%	48.1	59.0	0.387#

*Student's t-test; #chi-squared test; **Mann-Whitney U-test

Table II
The distribution of adolescents with diabetes according to sex, age, BMI, level of education and duration of diabetes, which is stratified by the educational material provided for the CHC orientation

Variables	Photo Material N = 26	List Material N = 28	p
Female sex *	21 (80.8)	21 (75.0)	n.s.
Age (years)#	13.9 (2.0)	13.9 (1.9)	n.s.
BMI (kg/m²)#	20.9 (3.3)	21.0 (2.9)	n.s.
Overweight + obesity *	6 (23.1)	7 (25)	n.s.
Schooling (years) **	8 (7-9)	7 (7-9)	n.s.
Duration of diabetes (years)#	6.5 (3.7)	7.3 (4.3)	n.s.
HbA1c (%) **	9.6 (8.2-11)	9.7 (8.3-10.8)	n.s.

*N (%); #mean (sd); ** median (p25-p75); n.s. = non-significant

Table III
Variables related to the CHC training

Variables	Photo Material	List Material	p
Female sex *	21 (80.8)	21 (75.0)	n.s.
Number previous training sessions N*	5.0 (3.5-9) 21	6.0 (4.8-8.3) 22	0.434
Duration of training (minutes) N	13.8 (10.6-16.5) 25	10.6 (8.1-13) 26	0.005
Time to return (months) N	1.0 (1-2.75) 26	1.5 (1-4) 28	0.500

Estimates are median and P25-p75); Mann-Whitney test.
* N means number of subjects with information.

Table IV
The participant performances: numbers of correct answers before and after CHC training with the Photo or List educational materials

Variables	Comparison	Photo Material	List Material	p
Hits before training				
mean (sd)	Between groups	4.6 (2.1)	5.3 (1.8)	0.14*
Hits after training				
mean (sd)	Between groups	7.1 (2.4)	6.3 (2.4)	0.19*
Hits				
Before × after	Intragroup			Photo-0.0001# List-0.02#
Hit difference				
median (p25-p75)	Between groups	2.5 (0.75-4)	1 (-0.75-2)	0.03†
Hit difference				
analysis adjusted for confounding variables	Between groups			0.04** β = 1.63

*Student's t-test; #paired Student's t-test; †Kruskal-Wallis H-test;
**linear regression adjusted for age, sex, years of schooling, BMI and duration of orientation

two groups. The training for the Photo group lasted significantly longer than that for the List group because the illustrations in the photographic material attracted more participant attention. There was no significant difference in the length of the interval between the first and last stages of the study between the groups.

There was no significant difference in the level of education of the parents between the groups.

The scores were similar, with no significant differences, for both the Photo and List groups at the beginning and the end of the study. Separate analyses of the pre- to post-intervention performances of the two groups revealed that both groups improved significantly after intervention. However, a comparison between groups showed that the improvement was greater in the Photo group (2.5 *vs* 1.0). This improvement was still statistically significant after adjusting for the potential confounding effects of the variables age, sex, years of schooling, BMI and duration of training.

Most adolescents in both groups self-managed CHC in their dietary plan.

The opinion of the participants regarding the educational material provided was conveyed by the answers given on the hedonic scale. The material was rated excellent by 77% of participants in the Photo group and by 43% of participants in the List group; this difference was statistically significant (p = 0.03, chi-squared test). Regarding the preference for the educational material, the Photo group reported that the photographs were helpful for counting CHO and provided a better idea of serving size. Both groups reported the limited number of foods shown as a negative aspect. Additionally, both groups suggested including a broader range of foods in the educational materials.

Discussion

This study showed that adolescents subjected to CHC training increased their knowledge of the use of this technique and that this increase was significantly greater in the participants who used the photographic educational material. Additionally, the adolescents reported liking the photographic educational material more than the group who used the traditional tables.

Adolescence is a time of physical, psychological and social changes that could compromise diabetes treatment if clinical guidance is inadequate. Therefore, we aimed to test an educational material format for CHC training that is more illustrative and more attractive for adolescents to increase their understanding and facilitate the learning of the food portions that are equivalent to a given CHO amount. Improving the visual assessment of the amount of ingested CHOs through training, along with communication and education regarding diabetes, are of paramount importance in overcoming obstacles and improving the control of glycemia[9].

Currently, professionals in Brazil use food tables containing in-home serving sizes and the amounts of CHOs contained within the servings as supporting materials for CHC training. Several studies have shown that including photographs of the food portions with the educational and supporting materials is a valuable tool for helping patients estimate and monitor the diets of their children[10-17].

A literature review of health information that is conveyed by images revealed that this technique succeeded in attracting the attention of patients and their families and stimulated them to follow the prescribed training. In addition to improving the recollection of the concepts, the illustrated version increases the chance
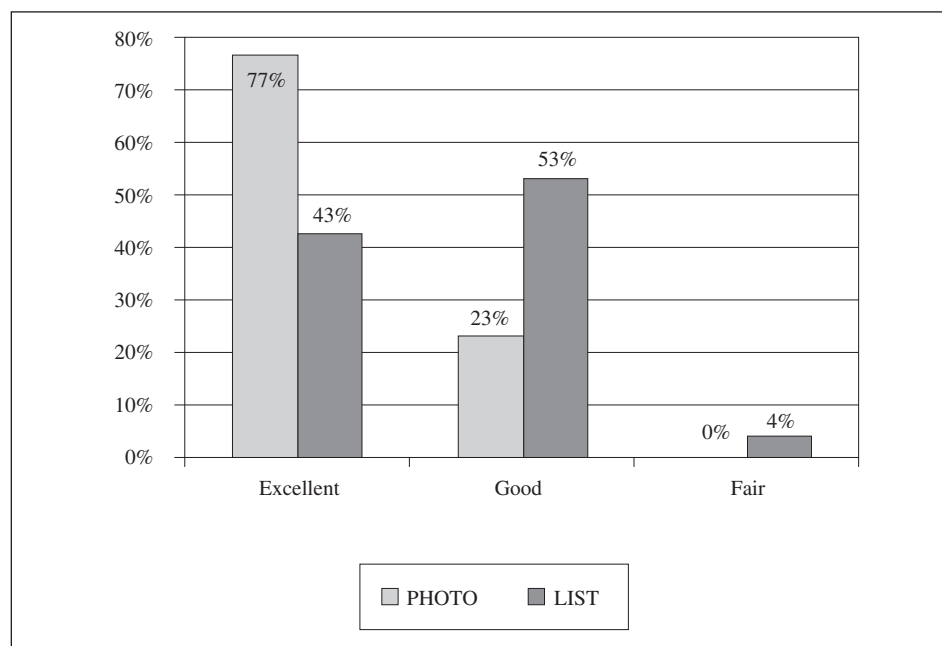

Fig. 2.—The opinion of particpants regarding the educational material used (Hedonic Scale).

that materials will be read. This resource was shown to be more beneficial for a population with less schooling than a population with more schooling. Therefore, images may improve treatment compliance in populations with low educational levels. The studies cited in the literature review revealed that the addition of images to text or the use of a colloquial writing style could increase the attention to, learning of and adherence to health treatments. Several studies showed that content is better assimilated when images are combined with text. The effectiveness of health communication might increase when images are included in the design of health educational materials[18].

Another review showed that low educational levels are associated with poorer health results, including knowledge, the overall state of health and the use of health resources[19].

Several studies on diabetes have shown that the educational levels of the parents correlated with glycemic control in their children; a lower educational level resulted in worse control of glycemia[20]. A study performed on 200 caretakers of children with type 1 diabetes showed that their educational level was significantly associated with the control of glycemia. The children who were cared for by individuals with a low or average educational level exhibited higher levels of glycated hemoglobin[21]. Our study found that parents had a low level of schooling. This factor might have enhanced the difficulties of achieving proper glycemic control. Low educational levels are a widespread phenomenon in Brazil. Some studies have shown that by 16 years of age, little more than 50% of the population had the level of schooling that would be expected for that age range[22].

Our results show that the photographic material contributed to adapting to the CHC more than lists without images. We acknowledge three benefits in the photo material: it is easier for teenagers who have no experience in portioning of food; second, it helps low educational level parents; and third, it is a useful tool for dietitian to explain the portion's size of equivalents carbohydrates choices. It attracts the teenagers' attention, promoting greater interaction during the assessment. It is an alternative tool to accomplish the intended goal.

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