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ORIGINAL ARTICLE

Feasibility of a home-based versus classroom-based nutrition intervention to reduce obesity and type 2 diabetes in Latino youth

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Abstract

Objectives. The objectives of this pilot study were to compare the dietary, physiological and metabolic effects of 12-week modified carbohydrate nutrition intervention when disseminated in an individualized home-based format versus a group classroom-based format. *Methods.* Twenty-three overweight ($\geq 85^{th}$ percentile BMI) Latina adolescent females (12–17 years of age) were randomized to a 12-week modified carbohydrate dietary intervention delivered in either an individualized home-based format (n = 11) or a group classroom-based format (n = 12). Anthropometrics, dietary intake by 3-day diet records, insulin dynamics by extended 3-hour Oral Glucose tolerance test (OGTT) and body composition by Dual energy X-ray absorptiometry (DXA) were measured before and after intervention; 24-hour diet recalls were collected once or twice per month throughout the program. *Results.* Mixed modeling showed no significant differences in changes in dietary intake between intervention groups, but both groups significantly reduced intake of added sugar, sugary beverages and refined carbohydrates by 33%, 66%, and 35%, respectively, and dietary fiber significantly increased by 44% (p < 0.01) throughout the 12 weeks. There was a significant time effect for BMI z-scores within each intervention group (p < 0.05). There was no significant time*intervention group interaction for any of the physiological or metabolic variables, indicating that change over time was not significantly different between intervention groups. *Conclusions.* Although a culturally tailored, modified carbohydrate dietary intervention led to significant improvements in dietary intake and BMI z-scores, the extremely intensive, individualized, home-based program was no more effective at improving diet, decreasing adiposity or reducing type 2 diabetes risk factors than the traditional classroom-based format.

Key words: *Home-based, classroom-based, Latino, adolescents, dietary intervention, obesity, type 2 diabetes*

Introduction

The most recent data (1) suggest a doubling of those at risk of overweight (BMI percentile $\geq 85^{th}$ for age and gender) (2) and overweight (BMI percentile $> 95^{th}$ for age and gender) among Latino children in the last 10 years. In 2000, 43.8% of Latinos aged 12–19 were at risk of overweight and 23.4% were overweight, and these values were approximately double that of non-Latino whites (1). Type 2 diabetes and pre-diabetes (i.e., fasting glucose ≥ 100 to < 126 mg/dl or post glucose challenge ≥ 140 to < 200 mg/dl) have emerged as significant health issues in overweight adolescents, especially among

certain ethnic groups including Latinos (3). In our previous studies, we have shown that 32% of overweight Latino children have pre-diabetes (4,5) and 30% have metabolic syndrome, the clustering of certain metabolic-related heart disease risk factors (4).

Despite these alarming observations and substantial health risks, few intervention studies have been conducted in overweight Latino adolescents. The majority of treatment or prevention approaches for these high-risk children are general, non-specific advice on diet, physical activity, and weight loss. Most typical "weight management" programs for

youth have used restrictive diets, behavior modification techniques, physical activity, and/or drugs, however, these approaches generally have little success (6) and often don't necessarily address insulin resistance and other disease risk factors for diabetes beyond weight loss. Recent studies have identified new and healthy dietary interventions that have successfully reduced chronic disease risk without necessarily imposing calorie restriction (7–9). There is evidence that the types and quality of carbohydrates in the diet may be effective for reducing obesity and improving glucose control (8,10). In addition, most interventions are traditionally delivered in a community center, school, or health clinic setting. To date, no study has compared an obesity intervention or a type 2 diabetes prevention program in an individualized home-based format with a group classroom-based format.

Therefore, the overall objective of this study is to compare the dietary, physiology, and metabolic effects of a 12-week nutrition intervention delivered in an individualized home-based versus a group classroom-based format. We hypothesized that conducting the intervention in the home would potentially improve the home environment and facilitate more improvements in dietary intakes, reductions in adiposity and type 2 diabetes risk factors compared with the traditional intervention held in a group classroom.

Methods

Nutrition education component

Based on our preliminary analysis and current research, we focused on developing a dietary intervention targeting two goals: 1) $\leq 10\%$ of total daily calorie intake from added sugar, primarily through a modification of beverage intake and reduced intake of candy, syrup, and sweet breads (based on the recommendation of the World Health Organization) (11); and 2) ≥ 14 g/1000 kcal of dietary fiber a day, principally through an increase in fruits and vegetables, and modification of the breads and cereals food group (based on the recommendation of US Institute of Medicine) (12).

In addition to the target goals stated above, dietary advice worked toward achieving a diet that has 45 to 55% of calories as carbohydrate and 30 to 35% of calories from fat. Also, the dietary intervention was not designed to be energy restrictive in that subjects were advised to eat to satiety and snack when hungry. Nevertheless, by encouraging this intuitive eating approach and by modifying the type and quality of carbohydrate intake, total calorie intake may decrease throughout the intervention.

The culturally tailored curriculum was developed specifically for this population. Each weekly lesson included a hands-on cooking activity, a healthy snack, an interactive game, workbook style handouts, review of dietary recall and a goal setting exercise. Although the focus of the intervention was changing the quality of carbohydrates, other topics were discussed, such as: portion sizes and food labels, fast food and eating out, body image and emotional eating, and societal pressures and situations.

Behavioral modification components

The individualized home-based intervention included Motivational Interviewing (MI), which is a client-centered counseling approach designed to enhance intrinsic motivation for behavior change by exploring and resolving ambivalence (13,14). Participants are encouraged to think about and verbally express their own reasons for or against change and how their current health behavior may conflict with their goals and values. In particular, MI can be especially useful because it allows the educator to help individuals identify dietary intake preferences, encourage realistic dietary goal setting and monitoring, and discuss feelings and progress in regards to behavior changes. Every week, participants in the home-based format would receive 10 to 15 minute MI sessions at the end of each lesson. During these sessions, the nutrition educator would work with the participants to identify potential areas of change in their diet and encourage them to come up with realistic ways to make these changes. In other words, the educator would empower the participant to come up with their own solutions to improve their dietary intake. The group classroom-based format would not receive MI and would partake in a standard 10 to 15 minute goal setting activity.

Subjects

Thirty adolescent females were recruited through clinics and word of mouth around the east and central Los Angeles area. All subjects met the following inclusion criteria: 1) Hispanic origin, (both sets of grandparents required to be of Hispanic heritage as defined by self-report); 2) BMI above the 85th percentile for age and sex according to the Centers for Disease Control (CDC) and Prevention Charts (15); 3) female; 4) absence of diabetes, determined by an oral glucose tolerance test; 5) not presently taking medication(s) or diagnosed with any syndrome or disease that could influence dietary intake, body composition and fat distribution, or

insulin action and secretion; and 6) not currently involved with any dietary or weight loss program or have been in the previous 6 months prior to participation. The Institutional Review Board of the University of Southern California (USC) approved this study. Twenty-seven of the 30 subjects completed the entire 12-week program; one subject was excluded due to a type 2 diabetes diagnosis at baseline, one subject decided not to participate, and one subject tested positive on the pregnancy test at post-intervention. Families with more than one girl eligible for the study were included (n = 4 pairs of sisters), but for logistical reasons the girls were randomized to the same group (i.e., the randomization was by family) and as data from siblings would not be statistically independent, we randomly selected one of the sister's data to be used for further analyses. The final sample was 23 subjects.

Intervention groups

After consents/assents were signed, eligible participants were randomly assigned to either the home-based format (n = 15) or the group classroom-based format (n = 15). In the home-based format, a nutrition educator, who was trained and supervised by a Registered Dietitian (RD), visited the homes of the subjects for a 90-minute weekly nutrition session for 12 weeks. Bilingual nutrition educators were available if preferred by subject and family. Each week, the home-based group also received $25 of grocery items identified to meet the goals of the intervention. A team of 2 or 3 bilingual RD supervised nutrition educators also taught the group classroom-based format in USC classrooms each week, with between 4–12 subjects per group. The group classroom-based format received $25 worth of grocery gift cards weekly. Both intervention groups were taught identical curriculum and received 90-minute lessons weekly. Parents from both intervention groups were required to attend at least 4 of the 12 sessions and invited to attend all sessions. Other family members, i.e., siblings, grandparents, aunts, and cousins, were welcome to attend nutrition sessions as well. As it happened, parents in both groups, primarily the mothers, participated in exactly the same amount, an average of 7 of the 12 sessions or 60%. However, other family members in the group classroom-based format only participated in <5% of the sessions, while other family members in the home-based format participated in ~25% of the sessions.

Protocol

Each child underwent testing at the USC General Clinical Research Center (GCRC, i.e., study center)

after an overnight fast at baseline and post-intervention (within 1-week of last nutrition session). Height and weight were measured using a beam medical scale and wall-mounted stadiometer, to the nearest 0.1 kg and 0.1 cm, respectively. BMI and BMI z-scores for age and gender were determined using EpiInfo 2000, Version 1.1 (CDC, Atlanta, GA). Waist circumference was assessed (to the nearest 0.5 cm) using a tape measure. Sitting blood pressure, using a Dinamap automated blood pressure monitor (Critikon Inc., Tampa, FL), and heart rate were measured in duplicate on the right arm after the subject had rested quietly for 5 minutes and the average was recorded. A detailed medical history was obtained, and a physical examination was performed by a licensed healthcare provider (including Tanner staging based on breast stage and pubic hair) (16) at pre-testing only. Body composition was assessed with a total body DXA scan, using a Hologic QDR 4500W (Hologic, Bedford, MA). A urine pregnancy test was done on all participants who had begun to have menstrual periods before performing the DXA scan.

Dietary intake

Two measures of dietary intake were used. Three-day diet records (2 weekdays, 1 weekend day) were collected at baseline and post-intervention. A nutrition educator clarified all diet records with participants. Twenty-four hour recalls were always conducted in person in the individualized home-based format at least once a month throughout the intervention. In the group classroom-based format, 24-hour diet recalls were also conducted at least once a month, but only conducted in person in the first month and over the phone for the remaining months. In the individualized home-based format, the 24-hour recalls were analyzed and reviewed with participants to provide quick feedback on suggested dietary modifications during intervention sessions. All dietary recalls were conducted using the "multiple pass" method, developed by the USDA for use in National Surveys of food intake. The "multiple pass" method has been validated against the doubly labeled water method and described in detail by Johnson et al. (17). All subjects were given measuring cups and 12-inch rulers to assist in proper portion size estimations.

Nutrition data were analyzed using the Nutrition Data System for Research (NDS-R), a Windows based software program developed by the Nutrition Coordinating Center at the University of Minnesota. This program is particularly suited for this study because it calculates key nutrients targeted in this intervention, such as: added sugar content (defined

as those sugars/syrups added to foods during food preparation or commercial food processing not including naturally occurring sugars like lactose and fructose), refined carbohydrates (defined as any carbohydrate made with white flour, corn meal, and white rice) and sugary beverages (defined as any beverage that is sweetened, including sodas, sweetened juice, tea, or coffee, and sports drinks and excluding artificial sweeteners).

Oral glucose tolerance test (OGTT)

Glucose tolerance and insulin dynamics were determined during an extended (3-hour) oral glucose tolerance test. A flexible intravenous catheter was placed in one arm and fasting blood samples were collected for determination of basal lipids, glucose and insulin concentrations. At time zero, subjects ingested 1.75 g of oral glucose per kg of body weight (to a maximum of 75 g). Blood samples were drawn via the antecubital vein catheter at baseline and every 10 minutes for 3 hours, for a total of 18 samples, and were assayed for glucose, insulin, and c-peptide. The fasting and 2-hour glucose values from the extended OGTT also served as a diabetes screen test and according to established guidelines (3), one subject was excluded from the study based on the presence of type 2 diabetes and referred for further care to her primary pediatrician. Participants with pre-diabetes were eligible to participate in the study.

Homeostatic model assessment (HOMA-IR) was used as a measure of insulin resistance; (HOMA-IR = fasting insulin [μU/ml] X fasting glucose [mmol/l]/22.5) (18). Pre-hepatic insulin secretion rates were calculated using the extended combined model approach (19,20). This model uses kinetic analysis of both plasma insulin and two compartmental C-peptide disappearance rates to estimate the pre-hepatic insulin secretion. The insulin secretion rates were per unit C-peptide distribution volume and were corrected to mass per time by assuming a 6.5% body weight C-peptide distribution space (21). Modeling was performed using the MLAB software (Civilized Software, Bethesda, MD). Model-predicted insulin secretion rates are reported in incremental insulin area under the curve (IAUC) in nmol/min per L units.

Blood samples taken during the OGTT were separated for plasma and immediately transported on ice to the USC General Clinical Research Center Core Laboratory. Glucose was assayed using a Yellow Springs Instruments analyzer (Yellow Springs, OH) and insulin and C-peptide were assayed using an automated random access enzyme immunoassay system analyzer (Tosoh Bioscience, Inc San Francisco, CA). Total cholesterol, high-density lipoprotein cholesterol (HDL), and triglyceride levels were measured using the Vitros chemistry DT slides (Ortho Clinical Diagonstics Inc., Rochester, NY). Low-density lipoprotein (LDL) was calculated using the Friedwald formula.

Statistics

The first objective of this study was to determine if dietary intake improved, specifically if added sugars decreased and dietary fiber intake increased, throughout the 12-week program. Intakes of nutrients and food groups were calculated as individual mean values of the 3-day diet records pre- and post-study and weekly 24-hour recalls. Proc Mixed Modeling (SAS, version 9.1; SAS Institute, Cary, NC) was used to assess changes in dietary intake over time and to detect whether the changes were significant between intervention groups.

Further analyses were conducted using SPSS version 13.0, (SPSS, Chicago, IL). Paired t-tests and Chi-Square tests were used to compare baseline descriptives and nutrient intake at baseline between intervention groups. Repeated measures analysis of co-variance (ANCOVA) were used to examine the influence of time and time*intervention group (i.e., group classroom-based vs. home-based format) on each of the dependent variables (i.e., BMI, total fat, total lean tissue, fasting and 2-hour glucose, fasting insulin, HOMA-IR, insulin secretion, and lipids) after controlling for covariates including Tanner stage, baseline total fat and lean tissue mass. Inter-action effects (i.e., time*intervention group) were examined to determine whether changes in outcomes were similar across intervention groups. Significance was set at $p < 0.05$.

A major goal of this study is to test the differences in response to various health outcomes (i.e., adiposity measures and insulin dynamics) between an individualized home-based format versus a group classroom-based format. However, this is the first study to compare these two formats and there are currently no data available to conduct a power analysis. Hence, the reason for this feasibility study is to provide preliminary data needed to power a much larger intervention study.

Results

Data are presented on 23 overweight Latina girls; 11 girls who completed the home-based format and 12 who completed the group classroom-based format. Baseline descriptive and dietary intake data from subjects in the 2 different intervention groups are shown in Table I. There were no significant differences in baseline age, BMI, BMI z-score, or dietary

Table I. Baseline descriptive and dietary intake for each intervention group.

Baseline descriptive	Group classroom-based format (n =12)	Home-based format (n =11)	P
Age (years)	14.2±1.7	15.1±1.3	0.205
Height (cm)	156.5±5.7	160.4±5.2	0.095
Weight (kg)	80.4±25.0	86.9±12.8	0.440
BMI (kg/m^2)	32.6±8.4	33.8±5.4	0.671
BMI z-score	2.0±0.4	2.1±0.5	0.700
Tanner Stage			0.038
3	4	0	
4	7	8	
5	1	3	
Dietary variable			
Energy intake (kcal/day)	1840.0±819.7	1859.0±669.8	0.365
Fat (% of kcals)	29.4±3.6	32.7±8.3	0.265
Carbohydrates (% of kcals)	56.1±5.1	54.2±10.3	0.603
Protein (% of kcals)	15.8±3.1	14.6±3.8	0.882
Total Sugars (% of kcals)	28.9±5.2	23.3±6.7	0.301
Added Sugars (% of kcals)	20.3±6.3	16.5±9.8	0.255
Dietary Fiber (g/1000 kcal)	7.6±2.8	9.5±2.7	0.115

Data are mean ± standard deviation (SD).
Independent t-tests found no significant differences in descriptive or nutrient intake at baseline between intervention groups.
Chi-square analyses showed that Tanner staging was significantly different between groups.

intake variables between intervention groups, whereas Tanner stage was significantly different between the two groups ($p < 0.05$).

Changes in added sugar (% of kcals), dietary fiber (g/1000 kcal), refined carbohydrate (serving/day) and sugary beverage (serving/day) over time and

between intervention groups are shown in Figure 1. There were no interaction effects of intervention group on pattern of change in any of the dietary variables of interest, i.e., the intervention groups had similar changes in dietary intake. Overall, added sugar intake (% of kcals) significantly decreased
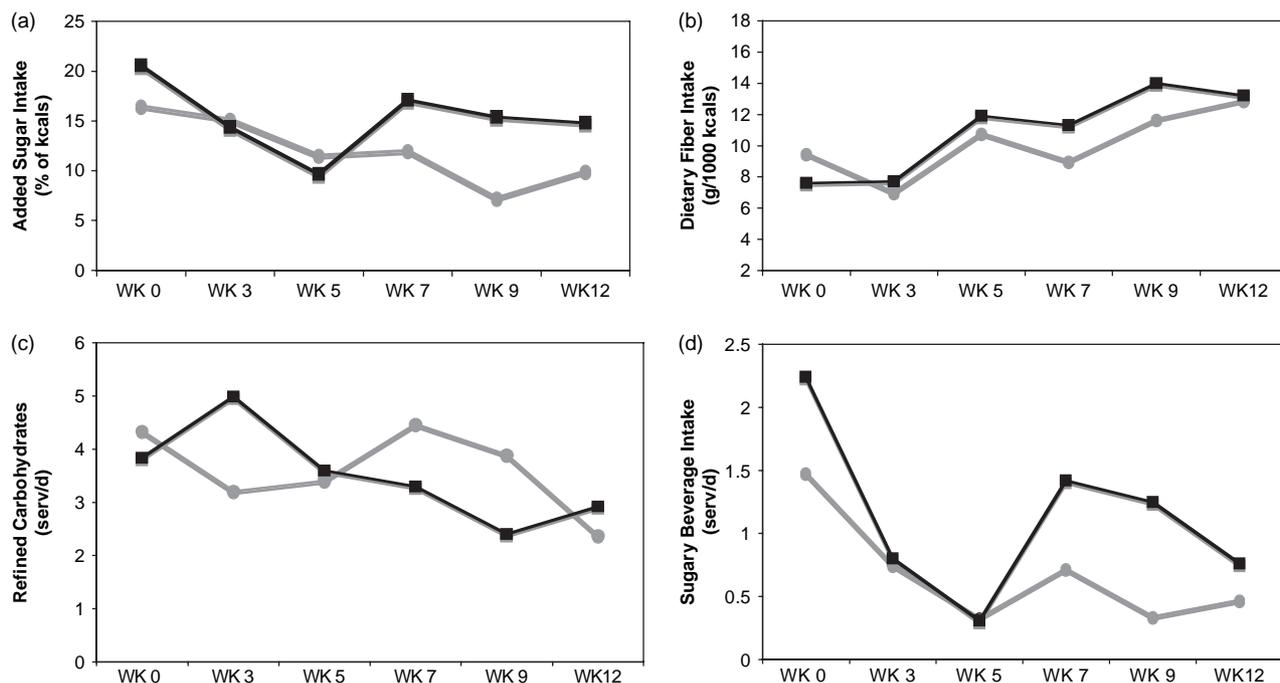
Figure 1. Dietary changes over intervention. Proc Mixed Modeling (SAS version 9.1) examined the interaction between dietary variables, time, and dissemination groups. Black line (■) represents group classroom-based format and dark gray line (●) represents individualized home-based format. There were no significant differences in changes in dietary intake between intervention groups, but both groups significantly reduced intake of added sugar, sugary beverages and refined carbohydrates by 33%, 66%, and 35%, respectively, and dietary fiber significantly increased by 46% (<0.01) throughout the 12 weeks.

from 18.6% to 12.5% of kcals ($\beta = -0.50$; p <0.01) (Figure 1A), while dietary fiber (g/1000 kcals) significantly increased from 8.6 g/1000 kcals to 12.4 g/1000 kcals ($\beta = 0.20$; p <0.01) (Figure 1B). Refined carbohydrates (serving/day) significantly decreased from 4.1 ± 2.8 to 2.7 ± 1.4 serving/day ($\beta = -0.16$; p <0.01) (Figure 1C) and servings of sugary beverages significantly decreased from 1.9 ± 1.7 to 0.6 ± 0.6 serving/day ($\beta = -0.10$; p <0.01) (Figure 1D) throughout the 12-week program. Energy intake also significantly decreased from 1878 ± 737 kcal/day to 1456 ± 469 kcal/day over time ($\beta = -0.35$; p <0.001) (data not shown).

We conducted repeated measures ANCOVA to assess whether physiological and metabolic changes occurred over time within intervention groups and whether this change was significant between groups. Covariates used were Tanner stage, baseline total fat (for lean tissue mass, glucose and insulin values, and lipids) and baseline lean tissue mass (for fat mass, glucose and insulin values, and lipids). As shown in Table II, there was a significant time effect for BMI z-scores within each intervention group (p <0.05).

Although many of the other physiological and metabolic outcomes also improved over time in both groups (i.e., blood pressure, fasting insulin, HOMA insulin resistance, insulin secretion, fat mass, percent fat, and total cholesterol), these changes over time were not significant. There was also no significant time*intervention group interaction for any of the physiological or metabolic variables; indicating that change over time was not significantly different between intervention groups. However, there was a trend for change in high density lipoprotein cholesterol (HDL) between groups (p =0.08), the group classroom-based format had a 0.1 mg/dl increase in HDL while the home-based format had a 6.2 mg/dl decrease in HDL (p =0.08). All of the above findings remained after adjusting for covariates.

Discussion

For the first time, the effects of a nutrition intervention delivered in an intensive, individualized, home-based format versus a group classroom-based format

Table II. Physiological and metabolic parameters of subjects in the group classroom-based format versus the home-based format over time.

Variable	Group classroom-based format (n =12)		Home-based format (n =11)	
	Week 0 (n =12)	Week 12 (n =12)	Week 0 (n =11)	Week 12 (n =11)
Weight (kg)	80.4 ± 25.0	80.5 ± 24.8	86.9 ± 12.8	86.6 ± 13.7
Height (cm)	156.5 ± 5.7	156.8 ± 5.5	160.4 ± 5.2	160.5 ± 4.7
BMI (kg/m^2)	32.6 ± 8.4	32.5 ± 8.6	33.8 ± 5.4	33.7 ± 5.4
BMI (z-score)*	$\mathbf{2.0 \pm 0.4}$	$\mathbf{1.9 \pm 0.4}$	$\mathbf{2.1 \pm 0.5}$	$\mathbf{2.0 \pm 0.5}$
BP (systolic/diastolic)	113 / 64	109 / 67	118 / 66	116 / 64
Waist Circumference (cm^2)	92.8 ± 9.8	93.0 ± 10.7	90.2 ± 16.9	89.0 ± 15.5
Fasting glucose (mg/dl)	93.1 ± 5.8	89.5 ± 4.8	87.7 ± 9.3	88.6 ± 7.6
2-hr glucose (mg/dl)	118.9 ± 12.8	113.3 ± 21.8	121.3 ± 16.6	124.6 ± 22.5
Fasting Insulin (µU/ml)	12.0 ± 3.4	12.0 ± 7.5	17.9 ± 8.1	14.6 ± 7.7
HOMA-IR	2.8 ± 0.8	2.7 ± 1.8	4.0 ± 2.1	3.2 ± 1.8
†Insulin secretion (nmol/min per L)	638.8 ± 542.3	557.1 ± 633.9	628.2 ± 485.7	461.8 ± 253.3
†† Total fat mass (kg)	29.7 ± 7.6	29.5 ± 7.9	34.7 ± 8.3	34.4 ± 9.0
†† Percent fat (%)	40.3 ± 3.5	39.9 ± 4.0	40.2 ± 4.6	39.9 ± 5.0
†† Total lean tissue mass (kg)	41.2 ± 5.7	41.4 ± 5.5	48.4 ± 5.1	48.4 ± 5.3
Tryacylglycerol (TAG) (mg/dl)	103.4 ± 30.5	100.3 ± 43.2	111.5 ± 34.9	123.0 ± 61.8
Total cholesterol (mg/dl)	151.9 ± 23.9	150.4 ± 24.6	156.7 ± 26.0	154.1 ± 24.9
LDL cholesterol (mg/dl)	90.3 ± 24.3	89.4 ± 15.5	90.8 ± 18.9	92.1 ± 21.4
VLDL cholesterol (mg/dl)	20.7 ± 6.1	20.1 ± 8.6	22.3 ± 7.0	24.6 ± 12.4
HDL cholesterol (mg/dl)	40.9 ± 7.1	41.0 ± 7.9	43.6 ± 21.6	37.4 ± 11.7

Data are mean $\pm$ SD. Statistical analyses were performed using log-transformed data (i.e., BMI percentile, Low density lipoprotein (LDL), Very low density lipoprotein (VLDL), and High density lipoprotein (HDL) cholesterol) but data are shown as non-transformed values for ease of interpretation.
†Insulin secretion data were only available for 16 out of the 23 subjects (i.e., group classroom-based format [n =9] and home-based format [n =8]) due to 7 subjects having inaccurate physiologically reasonable parameter estimates for the extended model.
††Body composition is only available for 22 subjects (n =11 in both groups) due to one subject exceeding the 140 kg weight limit of the DXA scan.
Changes over time within each group and between each group were from repeated-measures analysis of variance (ANCOVA) after adjusting for Tanner stage, baseline total fat (for Lean tissue mass (LTM), glucose, lipids) and lean tissue mass (for fat mass, glucose and lipids). There was a significant time effect within each group for BMI z-score; *p values <0.05.
There were no significant effects of time*intervention group interaction; indicating that change over time was not significantly different among intervention groups.

on adiposity and type 2 diabetes risk factors were tested. While both groups exhibited significant improvements in dietary intake and BMI z-scores, change in all major health outcomes, i.e., dietary intake, physiological and metabolic variables, did not differ between groups. These results suggest that a culturally tailored, modified carbohydrate nutrition intervention can successfully improve diet and reduce obesity but there is no added benefit to conducting an intervention individually in the home environment.

There is good evidence to suggest that modification of the types and quality of carbohydrates in the diet may be effective for reducing obesity and improving glucose control (8,10). We have previously shown that overweight Latino children in this population consume approximately 16% of their daily caloric intakes from simple sugars and 50% of this amount comes from sugary beverages. These high intakes of total and added sugar and sugary beverages were the only dietary components associated with poor beta-cell function, after controlling for adiposity, gender, and Tanner stage (10). These results suggested that a modest reduction of sugar per day could have an impact on preserving beta-cell function and on decreasing the risk of type 2 diabetes in Latino youth. In addition, diets enriched with whole grain carbohydrates and foods higher in fiber have been shown to have beneficial effects. In a cross-sectional study in adolescents, whole grain intake was associated with a lower BMI and fat mass as well as improved insulin sensitivity (22). Epidemiological adult studies show that intake of whole grains is associated with protection from type 2 diabetes (23) as well as coronary artery disease (24). However, these diets have generally not been designed for children, nor to more specifically meet the health and cultural needs of the Latino population.

Most of the dietary interventions using a modified carbohydrate approach to reduce risk of type 2 diabetes have been conducted with adults (25–27), and only one of these studies was conducted using primarily minority populations (25). Only a couple of studies have tested the modified carbohydrate approach in children. Most notably, the study conducted by Spieth et al. (28) on 64 primarily Caucasian children found that BMI and weight decreased more on a low-glycemic index diet compared with the conventional low-fat diet, but no assessment beyond weight loss was noted. Another noteworthy study by Ebbeling et al. (22) on overweight, primarily Caucasian adolescents showed that a reduced glycemic load diet (n = 7) resulted in greater reductions in fat mass, as measured by DXA, and improvements in HOMA insulin resistance,

when compared with conventional low-fat diets (n = 7). To date, this is the first study to develop and implement a culturally tailored, modified carbohydrate diet for high-risk Latino adolescents.

Although, baseline macronutrient intake was in line with current Institute of Medicine (IOM) recommendations for 45–65% of calories from carbohydrates, 10–30% from protein and 25–35% fat (29), the type of carbohydrate being eaten were definitely not in line with recommendations. Specifically, mean baseline dietary fiber for both groups was 8.6 g/1000 kcal, which is lower than the recommended 14 g/1000 kcals, and mean baseline added sugar intake was 18.4% of kcals, which is higher than the recommended 10% of kcals (30). The modified carbohydrate approach used in this intervention resulted in a 34%, 30% and 68% decrease in added sugar, refined carbohydrates and sugary beverages, and a 44% increase in dietary fiber, respectively. Although the current recommendations for added sugar and dietary fiber were not fully achieved, participants were able to significantly improve in both dietary areas, i.e., 12.5% of kcal from added sugar and 12.4 g/1000 kcal from dietary fiber. Energy intake also significantly decreased by 22% throughout the 12-week program. This is noteworthy, since the intervention was not designed to be energy restrictive and subjects were advised to eat to satiety and snack when hungry. This supports other studies in both adults and youth suggesting that a "non-diet" approach to obesity intervention can be effective while avoiding potential risks of calorically restricted diets (9,22,31). We suspect that if this intervention were longer in duration or if we had had a larger sample size, the reduction in energy intake would have eventually led to significant reductions in body weight and adiposity. Nevertheless, this study further demonstrates that the modified carbohydrate approach, which focuses on changing quality of carbohydrates rather than caloric restriction, might be particularly suited to growing children.

To our knowledge, this is the first obesity and type 2 diabetes intervention study to compare the health effects of an intensive home-based format with a group classroom-based format. Despite the extensive research that suggests the home environment plays a substantial role in the development of childhood obesity (32–34), most interventions are traditionally delivered in a community center, school, or health clinic setting. To date, only one prior study has shown that a 16-week weight loss program delivered in the homes of the families significantly reduced energy intake and weight for height z-scores (35). However, this study was conducted in mothers and their preschool-age children and a comparison with a

standard group classroom-based format was not examined. For this study, we hypothesized that conducting the intervention in the home would be more individualized and potentially improve the home environment to facilitate more improvements in health outcomes compared with the traditional intervention held in a group classroom. Surprisingly, we saw no differences in dietary intake, adiposity or metabolic changes between the two intervention groups.

The peer interaction and support in the group class might have been one explanation for the similar effects, or lack there of, on adiposity and metabolic parameters between intervention groups. Research has shown that group dynamics and peer modeling foster successful management of obesity in youth (36,37). Another explanation is that although we assumed that there would be more parental involvement in the home-based format, this was not the case and parental attendance was similar (60% of nutrition sessions) in both groups. However, the attendance of other family members, specifically siblings and grandparents, was higher in the home-based format compared with the group classroom-based format, which suggests that teenagers may be more influenced by parental participation than other family members. We also hypothesized that giving out actual healthy groceries, as with the home-based group, would result in more dietary changes than simply giving the grocery gift cards, as with classroom-based sessions, which was not the case either, and both groups improved dietary intake patterns similarly. One could argue that giving out gift cards fostered more autonomy in the classroom-based group, and our teens might have felt empowered to pick their own healthy foods.

The fact that an intensive home-based program did not have any additional health effects compared with a group classroom-based format is of benefit for cost-effective purposes. As we designed this pilot trial as an efficacy trial, both interventions were rather expensive based on the costs of transportation offered to and from class and the distribution of $25 weekly in groceries or grocery gift cards. However, the estimated cost of the home-based intervention was 35% more expensive compared with the group classroom-based intervention ($1425 vs. $945 per child). As expected, the intense staffing of the home-based format contributed most to the high cost. Ultimately, the traditional group classroom-based format resulted in similar reductions in BMI and BMI percentile and was considerably cheaper than the home-based format. However, we cannot rule out potential benefits of the home program, e.g., changes in family dynamics or psychosocial out-comes that were not measured, that may be significant in the long-term.

Some limitations of this study should be noted. One limitation of this study was we used a relatively small sample size of adolescents (n = 23). As this is the first study comparing nutrition intervention disseminated in an individualized home-based format to a group classroom-based format, there was no available data to power this study. The limitation of a small sample size is somewhat offset by precise measures of body composition (DXA), glucose and insulin values (OGTT) and the use of an under-studied, high-risk population. In addition, the intervention was relatively short, only 12 weeks, and a longer study might have produced more desirable adiposity and metabolic changes. Nevertheless, this was a pilot feasibility study and we intend to test this modified carbohydrate nutrition education in much larger and longer intervention studies, using both genders and with the appropriate control group.

In conclusion, the culturally tailored carbohydrate modification program resulted in significant improvements in dietary intake and BMI z-scores, and slight improvements in body fat and insulin dynamics, although not significant, in both intervention groups. However, the intensive home-based nutrition intervention provided no additional health benefit beyond the group classroom-based nutrition intervention. These results suggest that the content of the nutrition curriculum is more important than the location the intervention is disseminated. More research needs to be conducted using culturally tailored novel dietary interventions focused on reducing obesity and preventing type 2 diabetes in these high-risk minority populations.

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