

Impact of a Plant-Based Diet and Support on Mitigating Type 2 Diabetes Mellitus in Latinos Living in Medically Underserved Areas

Edelweiss Ramal, PhD, RN¹, Andrea Champlin, MPH¹,
and Khaled Bahjri, MD, DrPH, MPH¹

American Journal of Health Promotion
2018, Vol. 32(3) 753-762
© The Author(s) 2017
Reprints and permission:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/0890117117706793
journals.sagepub.com/home/ahp



Abstract

Purpose: To determine the impact that a high-fiber, low-fat diet, derived from mostly plant-based sources, when coupled with support has upon self-management of type 2 diabetes mellitus in Latinos from medically underserved areas (MUAs).

Design: Experimental randomized controlled community pilot study.

Setting: Three community clinics in MUAs located within San Bernardino County, California.

Participants: Thirty-two randomly assigned Latinos with A1_C greater than 6.4: 15 control and 17 experimental.

Intervention: Participants completed a 5-week education program. Researchers provided follow-up support for 17 randomly assigned experimental group participants through focus groups held at participating clinics—1, 3, and 6 months posteducation.

Measures: Changes in fat and fiber consumption were measured using a modified Dietary Screener for Mexican Americans. Self-management was measured through the Self-Efficacy for Exercise Scale and Diabetes Quality of Life Measure.

Analysis: Baseline characteristics for both groups were analyzed using independent *t* tests and χ^2 tests. A 2-way repeated-measures analysis of variance was used to analyze biometric data between baseline and 6 months for both groups.

Results: Mean A1_C levels decreased from baseline to 6 months for both groups: control, $\mu_1 = 9.57$, $\mu_2 = 9.49$; experimental, $\mu_1 = 8.53$, $\mu_2 = 7.31$.

Conclusion: The experimental group demonstrated a statistically significant reduction in mean A1_C levels ($P = .002$) when compared to the control group.

Keywords

type 2 diabetes, plant-based diet, medically underserved population, support groups, focus groups, diabetes self-management education, Latinos, randomized controlled community trial

Purpose

The purpose of this pilot study was to determine the impact a high-fiber, low-fat diet, derived from mostly plant-based sources, has upon controlling type 2 diabetes mellitus (T2DM) in Latinos in medically underserved areas (MUAs) as evidenced by biomarkers pre- and poststudy. Researchers also sought to assess whether facilitated follow-up focus group sessions as an intervention strategy improved participants' outcomes. Although the use of focus groups in research is not innovative, their primary use is program development and evaluation.^{1,2} Researchers used a novel approach by pairing the Diabetes Self-Management Education Program (DSMEP) with focus group intervention as a follow-up strategy to address the concerns of participants, identify achievable self-care

behaviors, and promote and maintain lifestyle change, rather than merely for data collection.

Self-care behaviors such as consuming a healthy diet and engaging in physical activity that lead to weight loss can increase insulin sensitivity and prevent T2DM and related complications.³ There is an increasing body of evidence linking the benefits of a high-fiber, low-fat diet, primarily from plant-based

¹ Loma Linda University, Loma Linda, CA, USA

Corresponding Author:

Andrea Champlin, Loma Linda University, 11262 Campus St, Loma Linda, CA 92324, USA.

Email: achamplin@llu.edu

sources, to the prevention and management of diabetes.⁴⁻¹² Nonetheless, the application of these research-validated interventions for Latinos with T2DM living within MUAs is limited. In addition to dietary and exercise recommendations, current American Diabetes Association (ADA) clinical practice recommendations specify that diabetes care should include self-management education that addresses psychosocial issues and provides ongoing support.¹³

“There is a social gradient to health; health is correlated with education, income and the place in which one lives” (p. 10). “Californians who live in neighborhoods where educational achievement is low, unemployment is high and poverty is widespread die at a younger age and are often racial/ethnic minorities” (p. 8).¹⁴ According to the San Bernardino Community Indicators Report, these circumstances characterize conditions for many living in San Bernardino County, which has the second lowest proportion of high school graduates (79%) when compared to other regions in the state and falls below both the state (82%) and national averages (87%). Fewer residents in the county have college degrees (19%) when compared to the state (31%) and nation (30%). Unfortunately, a larger gap in educational attainment is noted for ethnic minorities like African Americans (17%) and Latinos (14%). Latinos are the predominant ethnicity (51%) in the county where many inhabitants are foreign born (21%) and speak a language other than English at home (41%). San Bernardino County also has a higher percentage of residents living in poverty than the state, and the poverty level increased from 13.7% in 2007 to 19.7% in 2013. The unemployment rate in the county has been consistently higher than the state and the nation since 2007 and was 6.3% in May 2015, which ranks the county 23rd of all 58 counties in California.¹⁵

Given the economic disadvantages faced by many of the county’s residents, it is not surprising that the county is ranked second to last in the state for diabetes-related mortalities.¹⁶ The California Department of Public Health Chronic Diseases Branch also gave the county the fourth highest ranking for diabetes prevalence in 2012.¹⁶ Further compounding these issues is the shortage of primary care physicians. The ratio of primary care physicians to people in San Bernardino County is 1:1736. This patient to provider ratio is higher than the national target (1:1067), the state ratio (1:1294), and all neighboring counties except Riverside, which along with San Bernardino comprises the Inland Empire.¹⁵ The regions’ primary care workforce shortage is compounded by the rapidly growing population, some of the lowest provider reimbursement rates in the nation for Medi-Cal,¹⁷ and lack of English language proficiency among residents. The county’s population has increased by 8% in the last year alone to 2 091 618, which makes it the fifth largest population in the state, the majority of whom live in the Central Valley region.¹⁵ The Health Resources and Services Administration has given much of this region the designations of health professional shortage area and MUA.¹⁸ When considering the county’s demographic profile, it is not surprising that diabetes is increasing in San Bernardino, especially for Latinos in the Central Valley region, where the 3

cooperating clinics in this study are located. Therefore, it is essential to identify achievable self-care behaviors that lead to weight loss and can increase insulin sensitivity, such as consuming a healthy diet and engaging in physical activity, to manage T2DM and its related complications among the medically underserved members of this population.

Methods

Design

The university’s institutional review board approved the study design prior to the start of the project. This pilot study used a mixed-method, experimental, randomized controlled community trial design to test the effect of diet and support upon outcomes; however, for the purpose of this article, reporting is limited to the quantitative outcomes. Diet functioned as the within-group factor, while support constituted the between-group factor: those who did not receive follow-up focus group support (control group) versus those who did (experimental group). A priori power analysis using PASS revealed that a minimum of 40 participants were needed to achieve a small Cohen *d* effect size of .23 for repeated-measures analysis of variance (ANOVA) with 1 within-subject factor and 1 between-subject factor to achieve 80% power at an α of .05. An effect size of at least .23 was deemed necessary to demonstrate a level of improvement in outcomes that is large enough to justify the additional effort and expenditures required to conduct the follow-up focus group intervention. Data collected prestudy and 6 months poststudy consisted of A1_C, a lipid panel, blood pressure, and anthropometric measurements (body mass index, hip and waist circumference) for both the control and experimental groups. Clinical personnel from participating clinics, who were blinded to participants’ status (control vs experimental), collected A1_C and lipid panel profiles on all participants prior to randomization and at the 6-month follow-up.

Directors of 3 community clinics and a pastor of a local Spanish church promoted the DSMEP through posting fliers in their waiting areas and church narthex. Providers from the 3 participating clinics assisted with recruitment by referring Latinos with T2DM to the classes. At the first session of the DSMEP, the nurse educator explained the study to attendees and invited them to participate. Attendees who did not choose to participate or who did not meet inclusion criteria could continue to attend the classes along with the individuals who chose to participate in the study. The criteria for participating in the study included (1) self-identified Latino, (2) Spanish speaking, (3) living within the County of San Bernardino, (4) attending at least 3 of the 5 DSMEP classes, and (5) having an A1_C of 6.5% (48 mmol/mol)¹⁹ or more at the beginning of the DSMEP.

Sample

Sixty-eight Latinos with diabetes signed the informed consent and initiated the DSMEP. Of the original 68, only 60 completed

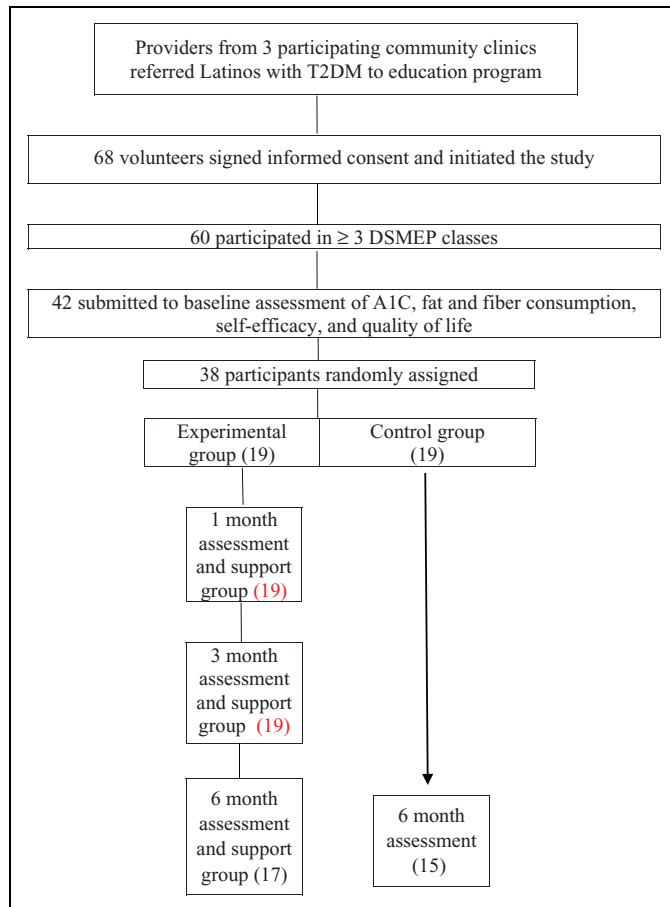


Figure 1. Flowchart of the study.

3 or more of the DSMEP classes. Forty-two participants completed their baseline laboratory tests, after which 2 with pre-diabetes, 1 with type 1 diabetes, and 1 who refused to be randomized were dropped from the study. The remaining 38 were randomly assigned to either the control or experimental group. Of these, only 32 successfully completed the study. The 6 who did not complete the study lacked complete follow-up laboratory tests and paperwork (Figure 1). The sample’s characteristics at baseline reflected those delineated in the literature for this population in that most were unemployed, lacked health insurance, and experienced worse health than the general population (Table 1). Tables 1 and 2 demonstrate a nonstatistically significant difference at baseline between the demographic composition of the control and experimental groups for qualitative and quantitative measures, respectively.

Measures

Forty-two participants completed a demographic information form and submitted to testing for A1C, triglycerides, total cholesterol, blood pressure, and anthropometric measurements prior to randomization, of which 32 remained at the 6-month follow-up. To ascertain changes in their perceived quality of life, every participant completed the Satisfaction with Treatment scale of the Diabetes Quality of Life (DQOL)

Table 1. Contingency Table: Characteristics at Baseline for Control Versus Experimental Group.

	Control n = 15 (%)	Experimental n = 17 (%)	P Value
Gender			
Male	3 (20.0)	4 (23.5)	.576
Female	12 (80.0)	13 (76.5)	
Employment			
Employed	2 (20.0%)	2 (16.7%)	.632
Unemployed	8 (80.0)	10 (83.3)	
Marital status			
Single	3 (20.0)	2 (11.8)	.364
Married	8 (53.3)	6 (35.3)	
Widowed/separated/divorced	4 (26.7)	9 (52.9)	
Education			
None/primary	6 (40.0)	7 (41.2)	.276
Secondary	7 (46.7)	4 (23.5)	
Technical career	2 (13.3)	6 (35.3)	
Insurance			
Yes	3 (20.0)	1 (5.9)	.319
No	12 (80.0)	16 (94.1)	
Country of origin			
Mexico	12 (80.0)	13 (76.5)	.372
Other North American Countries	2 (13.3)	0 (0.0)	
South America Central America	1 (6.7) 0 (0.0)	2 (11.8) 2 (11.8)	
Exercise (walk)			
Yes	4 (26.7)	9 (52.9)	.131
No	11 (73.3)	8 (47.1)	
Ever smoke			
Yes	1 (20.0)	0 (29.4)	.469
No	14 (80.0)	17 (70.6)	
Alcohol			
Yes	13 (86.7)	16 (94.1)	.589
No	2 (13.3)	1 (5.9)	
Nutritional status			
Poor	5 (33.3)	6 (35.3)	.886
Fair	8 (53.3)	10 (58.8)	
Good	2 (13.3)	1 (5.9)	
Diagnosis of T2DM prior to baseline			
Yes	13 (86.7)	14 (82.4)	.563
No	2 (13.3)	3 (17.6)	
Medications			
Yes	13 (86.7)	15 (88.2)%	.65
No	2 (13.3)	2 (11.8)	
Herbal supplements			
Yes	4 (26.7)	7 (43.8)	.32
No	11 (73.3)	9 (56.3)	
Do you live with someone who is a diabetic			
Yes	3 (20.0)	4 (23.5)	.576
No	12 (80.0)	13 (76.5)	

Abbreviation: T2DM, type 2 diabetes mellitus.

questionnaire prior to randomization and upon completion of the study. This area of the DQOL contains 15 items and has an internal consistency (Cronbach α) of .88.²⁰ This study used the modified Self-Efficacy for Exercise (SEE) scale, a 9-item

Table 2. Independent *T* Test for Sample Characteristics of Control Versus Experimental Group.

	Groups		<i>P</i> Value
	Control (<i>n</i> = 15)	Experimental (<i>n</i> = 17)	
Age	52.93 ± 13.11	53.35 ± 6.74	.912
Time in the United States (months)	27.29 ± 12.64	21.21 ± 9.51	.137
How many hours do you typically sleep per night?	7.96 ± 2.88	6.82 ± 1.07	.141
How many 8 oz glasses of water do you typically drink per day?	6.54 ± 5.23	5.71 ± 2.18	.556
How many cups of coffee do you drink a day?	0.57 ± 0.65	0.97 ± 0.91	.179
How long since you were diagnosed	15.63 ± 12.16	8.79 ± 6.30	.095

self-report scale with an α coefficient of .92, to measure perceived self-efficacy for exercise.²¹ However, in that many people living with diabetes experience diabetic neuropathy in their extremities as the disease progresses,²² the researchers eliminated the question regarding avoiding exercise while in pain due to the intervention's emphasis on exercising at a level deemed safe by their health-care provider. Experimental group participants kept a nutritional history and physical activity record for 1 week during the DSMEP and at 1, 3, and 6 months post-DSMEP to coincide with the focus group support sessions. One week before each focus group intervention, research assistants called participants to remind them to record their nutritional history and physical activity log during that week. This enabled them to track their progress and report more accurately at the ensuing focus group discussions. A modified Dietary Screener for Mexican Americans assessed participants' fat and fiber intake.²³ Modifications to the dietary assessment tool consisted of the conversion of the month measurement categories to a category entitled "never" and the further disaggregation of the "5 or more times per week" category into 2 separate measurements of "5 to 6 times per week" and "7 or more times per week." Researchers standardized the measurement scales for both the fat and fiber intake portions of the scale. The rationale for these modifications included the need to correlate the participants' weekly dietary recall with the measurement tools, the desire to further facilitate participants' completion of the scales, and the need to enhance readability for low-literacy individuals by omitting the disparate measurement between the fat and fiber scales.

Intervention

Both the control and experimental groups participated in the DSMEP. Participants who completed baseline assessment were randomly assigned to the control or the experimental group. The DSMEP consisted of a series of five 150-minute sessions held weekly for 5 weeks taught entirely in Spanish. The first half of each session covered theoretical content including

pathophysiology of diabetes; complications; treatment; diet, focusing on the benefits of consuming mainly plant-based foods; and exercise, stress management, diabetes self-management strategies, and methods to increase self-efficacy (Table 3). The researchers used the content of the US Diabetes Conversation Map Tools in Spanish, created by Healthy Interactions Inc in collaboration with the ADA,²⁴ for portions of the theoretical content. PowerPoint presentations supplemented aspects not fully addressed in the Conversation Map Tools, such as the benefits of a plant-based diet, stress management, and self-efficacy. Participants shared their experiences and actively engaged in acquiring or reinforcing knowledge about diabetes management. With the assistance of a Latino nutritional instructor, participants engaged in the preparation and sampling of low-fat, high-fiber, plant-based foods during the second hour of each session of the DSMEP. Educators provided participants with recipes and menus adapted from *The 30-Day Diabetes Miracle Cookbook*,²⁵ with the needed modification of ethnic foods to a plant-based diet. Seven cohorts completed the DSMEP conducted at 3 different community clinics and 1 Spanish church.

Literature supports better outcomes for participants who receive not only education but also follow-up support for implementing lifestyle change.²⁶ The researchers conducted a series of follow-up support focus groups by cohort at 1, 3, and 6 months after the DSMEP for those assigned to the experimental group. One facilitator met with 3 to 6 participants per session, each lasting between 30 and 60 minutes depending upon focus group size. The purpose of these focus groups was to determine whether facilitated follow-up support as an intervention strategy improved experimental participant outcomes. A Spanish-speaking researcher used a semistructured interview guide to facilitate the first focus group discussion, the results of which informed the content of subsequent discussions. The semistructured interview guide used to facilitate the initial focus group addressed the following:

1. What has been the greatest benefit of participating in the diabetes education classes?
2. What changes have you made as a result of participating in the DSMEP?
3. What have been some of the results of these changes?
4. What do you consider are your strengths that have helped you make these changes?
5. What difficulties have you encountered in trying to make the changes?
6. What have you done to overcome these difficulties?
7. What else do you think you can do to face these difficulties?
8. What can we do to help you face these difficulties you have mentioned?
9. What else would facilitate and prepare you to implement the changes necessary to manage or prevent diabetes?
10. In what ways would you like to become involved in helping your community decrease the incidence of diabetes in the present and future generations?

Table 3. Topics and Learning Objectives for the Theoretical Content of the Diabetes Education Program.

Topics	Learning Objectives
Understanding and managing your diabetes Pathophysiology	<ul style="list-style-type: none"> Define diabetes. Identify common myths and facts about diabetes. Discuss feelings about living with diabetes. Identify target fasting and postprandial blood glucose levels. Assess symptoms of hypoglycemia and hyperglycemia. Describe causes and treatment of hypoglycemia and hyperglycemia. State the effect of exercise on blood glucose levels. Identify personal barriers and supports for healthy eating and physical exercise. List members of personal support network.
Healthy eating (2 sessions)	<ul style="list-style-type: none"> Set an action plan to achieve short-term and long-term diabetes self-management goals Describe the effect of high- and low-fiber foods and high- and low-fat foods on blood glucose. Identify low-fat, high-fiber foods. Identify nutrients in foods commonly eaten. Create culturally aligned menus of high-fiber, low-fat foods. Describe feelings about food and how it influences behavior. Describe family, cultural, and religious practices that affect food choices and habits. Identify support needed and how to obtain support. Identify challenging situations and strategies to deal with the challenges in making food choices
Monitoring blood glucose and complications of diabetes	<ul style="list-style-type: none"> Define blood glucose, insulin, pancreas, A1_C, triglycerides, and cholesterol. Identify personal and recommended target levels of blood glucose, A1_C, triglycerides, and cholesterol. Identify the effect of food, exercise, stress, and medications on blood glucose. Describe the relationship of blood glucose levels to the long-term complications of diabetes. Define each of the long-term complications of diabetes. Identify risk factors other than blood glucose levels for each of the long-term complications. Identify screening needed and recommended schedule for each of the long-term complications
Stress management and perceived self-efficacy	<ul style="list-style-type: none"> Define stress, eustress, and perceived self-efficacy. Identify parts of the body that are affected by stress and its effect on blood glucose. Identify coping mechanisms for dealing with stress. Recommend strategies for reducing and managing stress and increasing perceived self-efficacy. Set an action plan to help achieve short-term and long-term goals for managing stress. Identify support needed and how to obtain this support.

Analysis

Researchers analyzed the quantitative data using the Statistical Package for Social Sciences version 24 (SPSS, 24). They assessed differences in sample characteristics at baseline (control vs. experimental) using independent *t* tests for quantitative variables and contingency tables and their associated χ^2 *P* values to test for homogeneity of qualitative variables (Tables 1 and 2). The authors conducted reliability analysis of the modified SEE and dietary assessment tools to assess the consistency of the items at baseline and 6 months using split-half reliability, which splits the items in half and assesses the Cronbach α for each half. Additionally, researchers calculated Spearman-Brown coefficients to measure correlations between the 2 groups of split items (Table 4). They conducted correlation analysis of A1_C at 6 months with the nutritional items of mean fat intakes after controlling for baseline measurements using partial Pearson correlations. Two-way repeated-measures ANOVA assessed changes in fat and fiber intake for control

versus experimental participants from baseline to 6 months and the effects of diet and intervention between the experimental and control groups upon the self-management of T2DM, as evidenced by changes in A1_C, lipid panel, and anthropometric measures. Using 2-way repeated-measures ANOVA, researchers analyzed changes in participant's SEE scale and perceived quality of life using baseline and 6-month follow-up answers to the SEE and DQOL questionnaires (Table 5).

Results

As demonstrated in Tables 1 and 2, there was a lack of statistically significant difference between the control and experimental groups at baseline, indicating that both groups were equivalent. The results of the contingency tests (Table 1) demonstrated that fewer controls (26.7%) than experimental participants (52.9%) reported walking 30 minutes/d or 6 d/wk preintervention; however, this difference was statistically

Table 4. Split-Half Reliability for Fat, Fiber, and Exercise.

	Baseline Cronbach α	Baseline Spearman- Brown Coefficient	6-Month Cronbach α	6-Month Spearman-Brown Coefficient
Fat items				
Pastries, sweet rolls, etc. Eat eggs per week. Drink whole milk/chocolate milk per week. Eat flour tortillas per week. Eat hamburgers or cheeseburgers per week. Eat tacos, burritos, or enchiladas per week. Meat dishes. Eat pork or barbecue per week Eat fried chicken per week. Eat cheese per week. Eat pizza per week. Eat refried beans per week. Eat French Fries per week. Eat chips of any kind including corn and peanuts. Use fat or oil in cooking, frying, or to season food. Use salad dressings or salsas for salads	.633	.823	.807	.950
Fiber items				
Natural fresh squeezed, frozen, canned without carbonation. Not including juices, fresh, canned, frozen, or smoothie. Greens such as spinach or green leaf. Tomatoes or fresh tomato salsa. Soups or stews made from vegetables Baked, mashed, or scalloped potatoes. Asparagus, green beans, corn, broccoli, and so on. Legumes such as garbanzos, lentils, and so on. Whole grains such as oats, wheat, quinoa, and so on.	.698	.862	.923	.945
Exercise				
Exercise 3 times a week for 20 minutes if temperature bothers you. Exercise 3 times a week for 20 minutes each if you are bored with the activity. Exercise 3 times a week for 20 minutes by yourself. Exercise 3 times a week for 20 minutes each time if you do not enjoy the activity Exercise 3 times a week for 20 minutes each time if you are very busy. Exercise 3 times a week for 20 minutes if you are tired. Exercise 3 times a week for 20 minutes if you are stressed. Exercise 3 times a week for 20 minutes if you are stressed	.881	.893	.638	.793

insignificant ($P = .131$). Only 20% of controls and 29.4% of experimental participants reported having ever smoked ($P = .469$), which also lacked statistical significance. More experimental participants reported consuming alcohol (94.1%) than those in the control group (86.7%); however, this difference was not statistically significant ($P = .589$). Thirty-three percent of controls reported their nutritional status as poor at baseline, while 53.3% reported that they were in fair health and 13.3% were in good health. Thirty-five percent of experimental participants reported poor health at baseline, 58.5% reported fair health, and 6% reported good health. Neither group had participants who reported excellent health at baseline nor were the differences in their reported health status statistically significant ($P = .886$). Of those who reported a doctor's diagnosis for

T2DM prior to commencing the study, 86.7% of controls and 82.4% of experimental participants knew their condition ($P = .563$); however, there was a small percentage in each group (13.3% controls and 17.6% experimental) who learned of their diagnosis through enrolling in the study and completing baseline blood work. The majority of controls (86.7%) and experimental (88.2%) participants reported taking medication to control their diabetes ($P = .650$), which researchers instructed them to continue taking as prescribed by their doctor. Only a very small percentage of controls (26.7%) or experimental participants (43.8%) reported taking herbal supplements ($P = .32$). Most controls (80.0%) and experimental participants (76.5%) reported being the only diabetic in their household ($P = .576$).

Table 5. Study Outcomes at Baseline and 6 Months.^a

	Control (n = 15)				Experimental (n = 17)				P Value (Group)	P Value (Time)	P Value (Group × Time)
	Mean	Standard Error	95% Confidence Interval		Mean	Standard Error	95% Confidence Interval				
			Lower Bound	Upper Bound			Lower Bound	Upper Bound			
Baseline BMI	30.84	1.08	28.63	33.04	31.81	1.01	29.74	33.88	.478	.746	.699
6-Month BMI	30.68	1.10	28.43	32.93	31.83	1.04	29.71	33.94			
Baseline waist (cm)	104.95	3.40	97.99	111.91	107.54	3.09	101.22	113.85	.562	.067	.915
6-Month waist (cm)	102.53	3.07	96.26	108.80	104.82	2.78	99.13	110.52			
Baseline hip (cm)	112.27	3.03	106.07	118.47	112.63	2.75	107.01	118.26	.880	.028 ^b	.747
6-Month hip (cm)	110.34	2.90	104.41	116.27	111.18	2.63	105.80	116.56			
Baseline systolic BP	129.69	3.37	122.78	136.61	132.38	3.04	126.14	138.61	.466	.244	.989
6-Month systolic BP	126.08	3.69	118.50	133.65	128.88	3.33	122.05	135.70			
Baseline diastolic BP	78.15	2.12	73.80	82.51	80.00	1.91	76.08	83.92	.211	.154	.482
6-Month diastolic BP	74.54	2.17	70.09	78.99	78.75	1.96	74.74	82.76			
Baseline total cholesterol	204.07	8.99	185.68	222.46	191.75	8.71	173.94	209.56	.248	.583	.568
6-Month total cholesterol	210.20	11.27	187.16	233.24	191.63	10.91	169.31	213.94			
Baseline triglycerides	189.00	26.80	134.19	243.81	236.00	25.95	182.93	289.07	.410	.983	.403
6-Month triglycerides	207.73	31.30	143.71	271.76	218.19	30.31	156.20	280.18			
Baseline A1 _C	9.57	0.45	8.65	10.48	8.53	0.42	7.67	9.39	.002 ^b	.027 ^b	.05
6-Month A1 _C	9.49	0.37	8.74	10.24	7.31	0.35	6.60	8.01			
Baseline fat	13.60	2.12	9.27	17.93	13.28	1.94	9.33	17.23	.771	.031 ^b	.870
6-Month fat	10.00	1.83	6.26	13.74	9.11	1.67	5.70	12.52			
Baseline fiber	11.87	1.78	8.23	15.50	13.94	1.63	10.63	17.26	.340	.607	.933
6-Month fiber	11.27	1.86	7.46	15.07	13.00	1.75	9.43	16.58			
Baseline DQOL	2.89	0.22	2.43	3.34	2.61	0.20	2.20	3.03	.597	<.001 ^b	.383
6-Month DQOL	3.41	0.24	2.92	3.90	3.39	0.21	2.95	3.83			
Baseline SEE	6.65	0.77	5.01	8.22	5.98	0.67	4.61	7.35	.937	.126	.122
6-Month SEE	6.65	0.43	5.78	7.52	7.43	0.37	6.67	8.19			

Abbreviations: BMI, body mass index; BP, blood pressure; DQOL, Diabetes Quality of Life; SEE, Self-Efficacy for Exercise.

^an = 32.

^bSignificant at an α of .05.

Table 2 demonstrates a nonstatistically significant difference between the demographic composition of the control and experimental groups for quantitative measures. The mean age for control (52.93 ± 13.11) and experimental (53.35 ± 6.74) participants at baseline was not statistically significant ($P = .912$). The difference in the mean length of time in months that participants resided in the United States was not significantly different for the control group (27.29 ± 12.64) when compared to the experimental group (21.21 ± 9.51 ; $P = .137$). Both groups reported similar average hours of sleep per night: controls 7.96 ± 2.88 versus experimental 6.82 ± 1.07 , $P = .141$. Neither group’s baseline mean water intake (controls 6.54 ± 5.23 and experimental 5.71 ± 2.18) nor coffee consumption (controls 0.57 ± 0.65 and experimental 0.97 ± 0.91) was significantly different ($P = 0.179$). Although the mean length of time since controls (15.63 ± 12.16) had been diagnosed with T2DM was almost twice that of experimental participants (8.79 ± 6.30), this difference was not statistically significant ($P = .095$).

The results of the repeated-measures ANOVA (Table 5) indicated that there was a significant effect of diet on A1_C levels ($F_{1,30} = 5.43$, $P = .027$), such that the mean A1_C levels

improved from baseline to postintervention for both the experimental and control groups. Additionally, there was a significant effect of intervention on A1_C levels. The experimental group demonstrated a statistically significant reduction in mean A1_C levels when compared to the control group ($F_{1,30} = 10.90$, $P = .002$). The interaction between diet and intervention for A1_C levels lacked statistical significance ($F_{1,30} = 4.18$, $P = .050$). Both the experimental and control groups perceived an increase in quality of life as demonstrated by the significant effect of diet on the DQOL ($F_{1,27} = 21.41$, $P < .001$). Researchers found a lack of statistical significance for all other variables, except for the main effect of diet on hip circumference ($F_{1,29} = 5.34$, $P = .028$) and fat intake ($F_{1,30} = 5.35$, $P = .031$), such that hip circumference and fat intake decreased for both groups’ participants over the course of the study.

The results of the split-half reliability analysis indicated mostly high reliability (Cronbach α greater than .7) for the SEE, mean fat scale, and fiber scale at both baseline and 6 months (Table 4). The correlation of mean fat and fiber intakes with A1_C at 6 months demonstrated a nonsignificant positive correlation of A1_C with fat intake ($r = .122$, $P = .507$) and an inverse correlation with fiber intake ($r = -.132$, $P = .571$).

Discussion

Participating in the DSMEP conducted before the randomization of the participants seemed to have motivated both groups to adopt and continue self-care behaviors that positively impacted 3 of the variables measured in this study as demonstrated by the statistically significant reduction in fat intake, A1_C levels, and hip circumference for both groups. In addition to knowledge about the benefits of a plant-based diet, the DSMEP provided participants with the opportunity to prepare and sample tasty culturally aligned plant-based foods, thus enhancing their likelihood of preparing and consuming a high-fiber, low-fat diet at home. Although the correlation between mean fat and fiber intake and A1_C levels at 6 months lacked statistical significance, there was a positive correlation of A1_C with fat intake and an inverse correlation with fiber intake. The positive correlation between fat intake and A1_C levels is consistent with research findings in the literature that diets high in animal fat are a risk factor for T2DM and are detrimental to controlling one's blood glucose.⁴⁻¹² The inverse correlation between fiber intake and A1_C levels at 6 months concurs with research findings that diets high in fiber may have a positive impact on lowering A1_C levels for those with T2DM.^{6,8}

The statistically significant effect of support on A1_C levels suggests that other factors besides the DSMEP were instrumental in this decrease, such as the focus group support offered to the experimental group. Findings from the literature suggest that social support by itself is insufficient to positively impact A1_C levels.²⁷ On the other hand, a meta-analysis of diabetes self-management programs for older adults concluded that an education program when paired with other therapies such as tailored interventions and psychological support results in outcomes of greater clinical relevance than the DSMEP by itself.²⁸

This study has some limitations relevant to the impact of the DSMEP on biomarkers. The uncertain reliability of dietary recall may have impacted the accuracy of participants reported dietary intake of fat and fiber affecting outcomes. Participants may in fact have been consuming less fiber and more fat than reported. Information bias may have also influenced experimental participants' reporting and compliance, given their participation in the focus group follow-up at which they were being assessed. The study's findings lack generalizability to a larger population with T2DM due to the specific target population—Latinos with T2DM living in MUAs. Limited sample size and the presence of a significant dropout rate may have affected the internal validity of the study. Consequently, the researchers cannot completely exclude significant differences in some variables at baseline, despite being statistically not significant (due to lack of statistical power), or perform multivariate analysis to provide effect size of the intervention. Hence, the investigators recommend that future studies be performed to conduct multivariate analysis and examine the differences in some of the variables at baselines between the 2 groups.

Conclusion

Participating in the post-DSMEP focus group support facilitated participants' ability to implement and maintain the recommended dietary and self-management behaviors as evidenced by their statistically significant improvement in mean A1_C when compared to the control group. These findings are supported by existing research that states that DSMEP when paired with psychological support provided by health-care professionals has significant positive patient outcomes.²⁸

The adoption of a mostly plant-based, high-fiber, low-fat diet proved challenging for many study participants, as evidenced by participants' comments in the follow-up focus group discussions. However, results of existing research demonstrate effective solutions to this challenge that merit further investigation with this target population,^{5,29-31} as well as other ethnic groups living in MUAs. Dietary habits can be modified if providers, patients, and families are aware of the benefits of the recommended diet and the clients receive the necessary support.³² The acceptability of a plant-based diet is similar to that of other therapeutic diets,⁵ and culturally tailoring foods can enhance patient's adherence to dietary modifications.²⁹ Hence, the acceptability of a mainly plant-based diet need not be

So What? Implications for Health Promotion Practitioners and Researchers

What is already known on this topic?

Consuming a high-fiber, low-fat diet, primarily from plant-based sources, and engaging in physical activity can increase insulin sensitivity and prevent T2DM and related complications as reported in the literature.

What does this article add?

In Latinos with T2DM living in MUAs, follow-up support for 6 months post-DSMEP that focused on a high-fiber, low-fat, plant-based diet and exercise contributed to significantly lowering participants A1_C levels.

What are the implications for health promotion practice or research?

Health-care professionals should not only continue to provide DSMEP for their patients with T2DM but also seek ways to increase post-DSMEP support by encouraging them to set goals and join support groups that will hold them accountable. Pairing DSMEP that focuses on a plant-based diet with follow-up support is an acceptable option for obtaining positive outcomes in Latinos with type 2 diabetes living in MUAs. Further investigation with Latinos as well as other ethnic groups living in MUAs is needed.

considered a barrier to diabetes management among Latinos with T2DM living in MUAs.³¹

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was funded by the Diabetes Action Research and Education Foundation and Loma Linda University School of Nursing.

References

- Ardeña GJRA, Paz-Pacheco E, Jimeno CA, Lantion-Ang FL, Paterno E, Juban N. Knowledge, attitudes and practices of persons with type 2 diabetes in a rural community: phase I of the community-based Diabetes Self-Management Education (DSME) Program in San Juan, Batangas, Philippines. *Diabetes Res Clin Pract.* 2010;90(2):160-166.
- New N. Teaching so they hear: using a co-created diabetes self-management education approach. *J Am Acad Nurse Pract.* 2010; 22(6):316-325.
- Kahleova H, Matoulek M, Malinska H, et al. Vegetarian diet improves insulin resistance and oxidative stress markers more than conventional diet in subjects with type 2 diabetes. *Diabet Med.* 2011;28(5):549-559.
- De Natale C, Annuzzi G, Bozzetto L, et al. Effects of a plant-based high-carbohydrate/high-fiber diet versus high-monounsaturated fat/low-carbohydrate diet on postprandial lipids in type 2 diabetic patients. *Diabetes Care.* 2009;32(12): 2168-2173.
- Barnard ND, Katcher HI, Jenkins DJ, Cohen J, Turner-McGrievy G. Vegetarian and vegan diets in type 2 diabetes management. *Nutr Rev.* 2009;67(5):255-263.
- Trapp C, Barnard N, Katcher H. Nutrition update. A plant-based diet for type 2 diabetes: scientific support and practical strategies. *Diabetes Educ.* 2010;36(1):33.
- Esposito K, Giugliano D. Mediterranean diet and type 2 diabetes. *Diabetes Metab Res Rev.* 2014;30(suppl 1):34-40.
- Tonstad S, Butler T, Yan R, Fraser GE. Type of vegetarian diet, body weight, and prevalence of type 2 diabetes. *Diabetes Care.* 2009;32(5):791-796.
- Trapp C, Barnard N. Usefulness of vegetarian and vegan diets for treating type 2 diabetes. *Curr Diab Rep.* 2010;10(2): 152-158.
- Mishra S, Xu J, Agarwal U, Gonzales J, Levin S, Barnard ND. A multicenter randomized controlled trial of a plant-based nutrition program to reduce body weight and cardiovascular risk in the corporate setting: the GEICO study. *Eur J Clin Nutr.* 2013; 67(7):718-724.
- Orlich MJ, Fraser GE. Vegetarian diets in the Adventist Health Study 2: a review of initial published findings. *Am J Clin Nutr.* 2014;100(suppl 1):353S-358S.
- Barnard ND, Cohen J, Jenkins DJ, et al. A low-fat vegan diet and a conventional diabetes diet in the treatment of type 2 diabetes: a randomized, controlled, 74-wk clinical trial. *Am J Clin Nutr.* 2009;89(suppl):1588S-1596S.
- American Diabetes Association Standards of Medical Care in Diabetes-2016. *Diabetes Care.* 2016;39(1):6-12.
- California Department of Public. *The California Wellness Plan, 2014.* Sacramento, CA: California Department of Public; 2014.
- County of San Bernardino. *Community Indicators Report 2015.* San Bernardino, CA; 2015.
- Health CDoP. *County Health Status Profiles.* Sacramento, CA: California Department of Public Health; 2016.
- Forte G, McGinnis S, Beaulieu M, Hernandez B, Salsberg E. *California Physician Workforce: Supply and Demand Through 2015.* Albany, NY: Author; 2004.
- HRSA Data Warehouse. Rockville, MD: Health Resources & Services Administration; 2016. <https://datawarehouse.hrsa.gov>.
- American Diabetes Association Classification and Diagnosis of Diabetes. Sec 2 in Standards of Medical Care in Diabetes-2016. *Diabetes Care.* 2016;39(suppl 1):13-22.
- Jacobson A. The diabetes quality of life measure. In: Bradley C, ed. *Handbook of Psychology and Diabetes: A Guide to Psychological Measurements in Diabetes Research and Management.* London, UK: ISN Psychology Press; 2006:65-87.
- Resnick B, Jenkins LS. Testing the reliability and validity of the Self-Efficacy for Exercise Scale. *Nurs Res.* 2000;49(3): 154-159.
- National Diabetes Information Clearinghouse. *Diabetic Neuropathies: the nerve damage of diabetes.* Bethesda, MD: National Institute of Diabetes and Digestive and Kidney Diseases; 2009. <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/nerve-damage-diabetic-neuropathies>. 2009. Updated 2013. Accessed April, 27, 2016.
- Wakimoto P, Block G, Mandel S, Medina N. Development and reliability of brief dietary assessment tools for Hispanics. *Prev Chronic Dis.* 2006;3(3):A95.
- Conversation Map Program. Journey for Control Educator. *Merk & Co. Inc.* 2015. <http://educator.journeyforcontrol.com/diabetes-educator> 2008. Updated 2016. Accessed 2008.
- House F, Seale SA, Newman IB. *The 30-Day Diabetes Miracle: Lifestyle Center of America's Complete Program to Stop Diabetes, Restore Health, and Build Natural Vitality.* New York, NY: Penguin; 2008.
- Foundations of care and comprehensive medical evaluation. Sec 3 in Standards of Medical Care in Diabetes-2016. *Diabetes Care.* 2016;39(suppl 1):23-35.
- Ing CT, Zhang G, Dillard A, et al. Social support groups in the maintenance of glycemic control after community-based intervention. *J Diabetes Res.* 2016;2016:7913258.
- Sherifali D, Bai JW, Kenny M, Warren R, Ali M. Diabetes self-management programmes in older adults: a systematic review and meta-analysis. *Diabet Med.* 2015;32(11):1404-1414.
- Khazrai Y, Defeudis G, Pozzilli P. Effect of diet on type 2 diabetes mellitus: a review. *Diabetes Metab Res Rev.* 2014; 30(suppl):24-33.

30. Kahleova H, Hrachovinova T, Hill M, Pelikanova T. Vegetarian diet in type 2 diabetes—improvement in quality of life, mood and eating behaviour. *Diabet Med*. 2013;30(1):127-129.
31. Barnard ND, Gloede L, Cohen J, et al. A low-fat vegan diet elicits greater macronutrient changes, but is comparable in adherence and acceptability, compared with a more conventional diabetes diet among individuals with type 2 diabetes. *J Am Diet Assoc*. 2009;109(2):263-272.
32. Rosland AM. *Sharing the Care: The Role of Family in Chronic Illness*. Oakland CA: California Health Care Foundation; 2009.