

A Two-Year Randomized Weight Loss Trial Comparing a Vegan Diet to a More Moderate Low-Fat Diet

Gabrielle M. Turner-McGrievy,* Neal D. Barnard,† and Anthony R. Sciallii‡

Abstract

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Objective: The objective was to assess the effect of a low-fat, vegan diet compared with the National Cholesterol Education Program (NCEP) diet on weight loss maintenance at 1 and 2 years.

Research Methods and Procedures: Sixty-four overweight, postmenopausal women were randomly assigned to a vegan or NCEP diet for 14 weeks, and 62 women began the study. The study was done in two replications. Participants in the first replication ($N = 28$) received no follow-up support after the 14 weeks, and those in the second replication ($N = 34$) were offered group support meetings for 1 year. Weight and diet adherence were measured at 1 and 2 years for all participants. Weight loss is reported as median (interquartile range) and is the difference from baseline weight at years 1 and 2.

Results: Individuals in the vegan group lost more weight than those in the NCEP group at 1 year [-4.9 (-0.5 , -8.0) kg vs. -1.8 (0.8 , -4.3); $p < 0.05$] and at 2 years [-3.1 (0.0 , -6.0) kg vs. -0.8 (3.1 , -4.2) kg; $p < 0.05$]. Those participants offered group support lost more weight at 1 year ($p < 0.01$) and 2 years ($p < 0.05$) than those without support. Attendance at meetings was associated with im-

proved weight loss at 1 year ($p < 0.001$) and 2 years ($p < 0.01$).

Discussion: A vegan diet was associated with significantly greater weight loss than the NCEP diet at 1 and 2 years. Both group support and meeting attendance were associated with significant weight loss at follow-up.

Key words: weight-reducing diet, women's health, weight maintenance, menopause, weight loss

Introduction

Overweight and obesity are increasingly problematic in the U.S. and other countries. Recent figures reveal that two thirds of U.S. adults are overweight or obese (1). While many studies have assessed short-term weight changes resulting from diet, exercise, or a combination, few have identified effective ways to maintain weight loss (2).

Vegetarian and low-fat diets have proven effective for weight loss, as well as other health endpoints, particularly cardiovascular risk reduction (3,4). However, their long-term effect has not been well studied. The purpose of this study was to examine the extent to which weight loss achieved through a 14-week trial of a low-fat vegan diet or a diet following the guidelines of the National Cholesterol Education Program (NCEP)¹ is maintained at 1 and 2 years after the intervention. The effect of social support, in the form of group meetings, was also examined.

Research Methods and Procedures

The study methods have been reported (5–7). Briefly, 64 overweight or obese ($BMI = 26$ to 44 kg/m²) postmenopausal women were recruited through newspaper advertisements in the Washington, DC, area, and 62 women began the study. Premenopausal women were excluded because of possible hormonal effects on metabolic measures (8). Ad-

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*Department of Nutrition, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina; †Department of Medicine, George Washington University, Washington, District of Columbia; and ‡Department of Obstetrics and Gynecology, Georgetown University, Washington, District of Columbia, and Sciences International, Inc., Alexandria, Virginia.

Address correspondence to Gabrielle M. Turner-McGrievy, University of North Carolina at Chapel Hill, 2217 McGavran-Greenberg Hall, CB 7461, Chapel Hill, NC 27599-7461.

E-mail: brie@unc.edu

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¹ Nonstandard abbreviations: NCEP, National Cholesterol Education Program; FFQ, food frequency questionnaire.

Table 1. Diet adherence criteria, based on food frequency questionnaire

Vegan adherence criteria	NCEP adherence criteria
≤1 dairy serving (i.e., 1 Tbsp sour cream, 1 cup milk, etc.) per week	≥5 servings of grains per day (1 serving = 1 slice of bread or ½ cup cooked grains)
≤3 ounces of meat, fish, or poultry per week	≥5 servings of fruits and vegetables per day
≤1 egg per week	≤6 ounces of lean meat per day
≤2 servings of a high-fat item (such as mayonnaise, margarine, lard, oil, salad dressings, avocados, olives, nuts, or high fat pastry) per day	≤2 servings of a high-fat item (such as mayonnaise, margarine, lard, oil, salad dressings, avocados, olives, nuts, or high fat pastry) per day

ditional exclusionary criteria included unstable medical status, history of eating disorder or substance abuse, severe mental illness, previously diagnosed diabetes, physical conditions affecting body weight (e.g., Cushing's disease), recent use of estrogens, medications affecting appetite or body weight, tobacco use, or already following a vegan diet.

Volunteers were recruited in two replications. Using a random-number table, participants were assigned to a low-fat vegan diet or a diet following the guidelines of the NCEP (9) for 14 weeks. The low-fat vegan diet consisted of fruits, vegetables, legumes, and grains. Animal products were proscribed, and the use of unrefined foods was encouraged. Participants were asked to limit high-fat plant foods, such as avocados, nuts, and seeds. The NCEP diet followed the former NCEP Step II guidelines, which are similar to the current NCEP Therapeutic Lifestyle Changes diet (10). There was no restriction on energy intake for either diet group, and participants were encouraged to eat to satiety.

No meals were provided. During the 14-week intervention, participants met weekly as a group with a physician and registered dietitian for instruction in nutrition and meal preparation. Diet sheets listing allowed and disallowed foods were provided, along with recipes and tips for following the assigned diets at work, at home, at restaurants, and while traveling. Participants were asked to maintain their habitual physical activity levels during the 14-week intervention.

At baseline and 14 weeks, dietary intake was recorded on 2 weekdays and 1 weekend day, using a food scale, after participants had completed a full practice record. Records were analyzed using Nutritionist V, Version 2.0, for Windows 98 (First DataBank, Inc., Hearst Corporation, San Bruno, CA). At the same time-points, body weight was determined, with patients in light clothing without shoes, using a digital scale accurate to 0.1 kg.

In the first replication, participants (14 vegan and 14 NCEP) were offered no support group meetings after the initial 14-week intervention period (Unsupported). In the second replication (17 vegan and 17 NCEP), all participants were offered group meetings for 1 hour every 2 weeks for 1 year after the initial intervention (Supported). After the

initial 14-week intervention, all participants were encouraged to include physical activity as tolerated and maintain their assigned diets. At 1 and 2 years, body weight was measured as described above, and diet adherence was assessed using the Nutritionist V, Version 2.0, for Windows 98 food frequency questionnaire (FFQ) (First DataBank, Inc., Hearst Corporation). Participants were given an adherence score based on food groups consumed or not consumed on the FFQ. Four food group categories were assessed for each diet, and participants were given a score of 0 to 4, with 4 being the highest compliance score (Table 1). A score of 3 or higher was considered compliant. Participant attendance was recorded at all meetings.

All analyses were done on an intention-to-treat basis by bringing the last value forward. Change scores were calculated between baseline and 1-year weights as well as between baseline and 2-year weights. Because of skewed distributions of some data, non-parametric statistical tests were used, with α set at 0.05, with the exception of age data, which were normally distributed. Student *t* test was used for age, χ^2 for other demographic data, and the Wilcoxon test for weight and weight change data. Weight changes were calculated within and between the 2 diet groups as well as between Supported and Unsupported participants, meeting attenders and non-attenders, and diet adherers and non-adherers. SAS was used for all analyses (SAS system for Windows, Version 8.2; SAS Institute, Inc., Cary, NC).

Results

Fifty-nine participants completed the 14-week intervention. There were no significant demographic differences between the NCEP and vegan groups (Table 2). The intention-to-treat analysis included all participants with baseline data: 31 vegan (17 Supported and 14 Unsupported) and 31 NCEP (17 Supported and 14 Unsupported) participants. One-year follow-up data were available for a total of 26 vegan (17 Supported and 9 Unsupported) and 27 NCEP (14 Supported and 13 Unsupported) participants. Two-year follow-up data were available for 23 vegan (15 Supported and 8 Unsupported) and 25 NCEP (17 Supported and 11 Unsupported) participants.

Table 2. Baseline demographic characteristics

	Vegan group (<i>n</i> = 31)	NCEP group (<i>n</i> = 31)
Mean age (years) (mean ± SD)	57.4 ± 4.7	55.7 ± 6.4
Age range	47–71	44–73
Race [<i>N</i> (%)]		
White, non-Hispanic	20 (65)	18 (58)
Black, non-Hispanic	9 (29)	12 (39)
White, Hispanic	0 (0)	1 (3)
Other	2 (6)	0 (0)
Marital status [<i>N</i> (%)]		
Single	8 (26)	5 (16)
Married	13 (42)	18 (58)
Separated, divorced, widowed	10 (32)	8 (26)
Education [<i>N</i> (%)]		
High school graduate	1 (3)	2 (7)
Partial college	6 (19)	9 (29)
College graduate	15 (49)	10 (32)
Advanced degree	9 (29)	10 (32)
Occupation [<i>N</i> (%)]		
No current employment	14 (45)	9 (30)
Service occupation	4 (13)	6 (19)
Technical, sales, administrative	4 (13)	6 (19)
Professional specialty	3 (10)	4 (13)
Executive, managerial	6 (19)	6 (19)

Results are presented in Table 3. The vegan group participants lost more weight than the NCEP group at 1 year [−4.9 (−0.5, −8.0) kg vs. −1.8 (0.8, −4.3) kg, respectively; $p < 0.05$] and at 2 years [−3.1 (0.0, −6.0) kg vs. −0.8 (3.1, −4.2) kg, respectively; $p < 0.05$]. Within-group analyses revealed that the vegan group had weight loss at both 1 year and 2 years, whereas the NCEP group had significant weight loss at 1 year but not at 2 years.

Regardless of diet assignment, participants in Supported groups lost more weight than Unsupported participants at 1 year and at 2 years. Supported vegan group participants lost significantly more weight than the Unsupported vegan participants at 1 year and at 2 years. Supported NCEP participants also lost significantly more weight than Unsupported NCEP participants at 1 year but not at 2 years ($p = 0.214$). In the within-group analyses, there was significant weight loss at 1 year for both Supported and Unsupported, but only the Supported group still had a significant weight loss at year 2.

For both diet groups combined, Supported participants who attended more than one-half of the follow-up meetings

(attenders) were more likely to lose weight than those who attended fewer than one-half (non-attenders) at 1 year and at 2 years. There was no significant difference between vegan attenders and non-attenders at 1 year ($p = 0.08$) or 2 years ($p = 0.08$). Weight loss was significantly greater in NCEP attenders vs. NCEP non-attenders at 1 year but not at 2 years ($p = 0.09$).

At both 1 and 2 years, 12 vegan and 14 NCEP participants were non-adherent, while 19 vegan and 17 NCEP were adherent. With both diet groups combined, there was no significant weight loss difference at any follow-up point between those who reported adherence to their respective diets and those who were non-adherent at 1 year ($p = 0.09$) or 2 years ($p = 0.09$). Within the vegan group, there was no significant difference between adherers and non-adherers at year 1 ($p = 0.08$), but there was a difference at year 2 ($p < 0.05$). Within the NCEP group, there were no significant differences between non-adherers and adherers at 1 year ($p = 0.41$) or 2 years ($p = 0.42$).

Discussion

In the present study, the vegan diet was associated with significantly greater weight loss compared with the NCEP diet at both 1 and 2 years. Group support and meeting attendance were associated with sustained weight loss.

Epidemiological studies show that vegetarians and vegans tend to have lower body mass, compared with omnivores (11,12). Such studies, however, may be confounded by exercise and other healthful behaviors (13). To our knowledge, this is the first randomized, controlled trial to examine the effects of a low-fat vegan diet on weight-loss maintenance.

The primary mechanism by which a low-fat, vegan diet leads to a reduction in body weight is likely a reduction in dietary energy density, due to its low fat content and high fiber content (6). Low-fat diets have been shown to produce significant weight loss in older women (14,15). Studies that have examined weight-loss maintenance using a variety of weight-loss diets have found an average 5-year weight-loss maintenance of 3 kg or 3% of original body weight (16). Improved weight loss maintenance has been seen among women who continue on a low-fat diet. In a study examining weight maintenance, women in the lowest tertile of fat intake (<25% of energy) regained the least amount of weight (17). In the present study, both diets were low in fat, but the vegan diet contained significantly less fat during the 14-week intervention (7). At the 14-week point, both groups reported equal decreases in calorie intake but the vegan group reported significantly greater fiber intake (7). It should be noted, however, that dietary data at this single time-point might not reflect dietary intake at other points in the study. This dietary profile (low-fat, high-fiber) can lead to a diet that is less energy-dense. Therefore, the vegan group may have been taking in somewhat less energy,

Table 3. Median (Q1, Q3) body weight and weight loss from baseline by diet, support group attendance, and diet adherence at years 1 and 2

	Baseline (kg)	1 year (kg)	Difference (kg)	p§	2 years (kg)	Difference (kg)	p§
Comparison by diet							
Vegan group (n = 31)	87.4 (79.0, 97.2)	82.1 (73.3, 93.2)*	-4.9 (-0.5, -8.0)		81.6 (72.6, 93.1)†	-3.1 (0.0, -6.0)	
NCEP group (n = 31)	86.4 (77.2, 95.6)	80.8 (71.3, 93.1)‡	-1.8 (0.8, -4.3)	0.021	85.6 (74.2, 93.9)	-0.8 (3.1, -4.2)	0.022
Comparison by support							
Unsupported (n = 28)	79.5 (74.4, 88.1)	78.0 (71.4, 86.4)‡	-1.4 (0.4, 3.2)		79.0 (72.2, 86.8)	-0.4 (0.9, -2.7)	
Supported (n = 34)	93.3 (82.6, 98.4)	86.0 (73.3, 93.2)*	-5.5 (-2.1, -8.0)	0.0001	87.4 (77.8, 94.1)*	-3.9 (-0.6, -6.8)	0.016
Comparison by diet and support							
Vegan unsupported (n = 14)	80.1 (74.5, 88.8)	78.3 (72.5, 83.5)	-2.1 (0.0, -4.3)		79.3 (72.5, 83.5)	-0.35 (0.5, -4.3)	
Vegan supported (n = 17)	94.3 (83.7, 99.3)	85.7 (79.2, 93.7)†	-6.2 (-5.2, -8.1)	0.005	86.3 (80.4, 96.2)†	-5.3 (-2.6, -7.0)	0.023
NCEP unsupported (n = 14)	78.9 (74.3, 87.3)	77.5 (70.0, 94.0)	-1.0 (0.8, -2.5)		77.8 (71.9, 94.3)	-0.5 (1.2, -2.0)	
NCEP supported (n = 17)	92.2 (82.6, 95.9)	87.1 (72.8, 92.6)‡	-3.3 (-1.1, -6.4)	0.040	88.1 (74.9, 93.2)	-2.7 (3.1, -4.7)	0.214
Comparison by support group attendance (support groups only)							
Non-attenders (attended ≤13 meetings) (n = 17)	89.0 (82.6, 96.5)	86.2 (79.2, 93.7)	-3.3 (1.7, -5.2)		88.5 (78.4, 93.9)	-3.1 (3.6, -9.4)	
Attenders (attended >13 meetings) (n = 17)	94.7 (86.9, 101.4)	85.7 (72.5, 92.6)*	-6.7 (-5.9, -11.1)	0.001	86.7 (77.8, 94.1)*	-5.8 (-2.6, -9.4)	0.011
Comparison by diet and support group attendance (support groups only)							
Vegan non-attenders (n = 7)	87.4 (81.4, 96.5)	82.2 (73.3, 93.7)	-5.2 (1.7, -8.1)		81.9 (72.0, 96.2)	-3.1 (0.4, -7.0)	
Vegan attenders (n = 10)	97.8 (87.5, 108.9)	88.7 (81.6, 102.5)†	-6.75 (-5.9, -9.4)	0.079	87.5 (81.0, 102.5)†	-5.85 (-5.0, -7.0)	0.079
NCEP non-attenders (n = 10)	91.0 (82.6, 97.1)	89.7 (80.1, 96.0)	-1.45 (3.1, -3.3)		88.8 (78.4, 93.9)	-0.1 (3.8, -4.2)	
NCEP attenders (n = 7)	92.2 (81.5, 95.9)	84.0 (68.6, 89.5)‡	-6.6 (-2.9, -13.5)	0.005	86.7 (74.7, 93.2)‡	-2.7 (-0.6, -13.3)	0.094
Comparison by diet adherence							
Diet non-adherers (score of <3) (n = 26)	83.6 (72.5, 94.3)	80.8 (72.5, 92.3)‡	-2.3 (0.0, -4.9)		82.0 (73.7, 90.4)	-1.1 (0.4, -4.2)	
Diet adherers (score of ≥ 3) (n = 36)	88.2 (78.7, 97.8)	83.1 (74.5, 94.0)*	-3.75 (-1.0, -6.8)	0.092	81.3 (74.8, 94.2)†	-2.65 (0.2, -6.5)	0.089
Comparison by diet and adherence							
Vegan non-adherers (n = 12)	86.7 (76.8, 94.8)	82.8 (76.3, 90.9)	-3.6 (-0.2, -5.3)		82.8 (76.5, 92.8)	-2.5 (0.3, -4.1)	
Vegan adherers (n = 19)	87.5 (79.0, 98.4)	81.6 (72.5, 93.2)‡	-5.9 (-2.1, -9.2)	0.075	80.4 (72.6, 94.6)	-5.3 (0.5, -11.3)	0.0502
NCEP non-adherers (n = 14)	82.1 (71.2, 89.0)	80.4 (68.6, 92.3)	-1.7 (-0.3, -4.3)		79.4 (73.7, 88.5)	-0.1 (3.4, -4.2)	
NCEP adherers (n = 17)	92.2 (77.8, 97.1)	87.1 (74.7, 94.8)‡	-2.1 (-0.4, -4.3)	0.414	88.1 (74.9, 94.1)‡	-2.0 (-0.2, -3.8)	0.421

Significance of within-group weight differences from baseline calculated using Wilcoxon nonparametric test: * $p < 0.001$, † $p < 0.01$, ‡ $p < 0.05$. § p values for differences in change scores between diet groups were calculated using Wilcoxon nonparametric test.

despite the fact that this was not detected in the diet records. They were also able to eat a greater volume of food than the NCEP group, without taking in extra calories. This may explain why the vegan group was able to be more successful long-term on the diet than the NCEP group. Aside from dietary changes, exercise may have also contributed to weight loss. Both groups were encouraged equally to increase physical activity after the 14-week intervention. Exercise, however, was not measured during the follow-up period.

It has also been observed that diets with a high glycemic load or that contain a large amount of foods with a high glycemic index can lead to weight gain and insulin resistance (18,19). Although neither diet group was encouraged to consume a low glycemic diet, the vegan group did consume more fiber during the 14-week intervention (7), which may have resulted in a lower glycemic load, leading to a greater weight loss. Indeed, during the 14-week intervention period, the vegan group did see a greater improvement in insulin sensitivity than the NCEP group (6). Both groups, however, were encouraged to limit refined grains in favor of their high-fiber counterparts, and both groups had an increase in carbohydrate intake (although more so in the vegan group) during the 14-week intervention (7). The type of carbohydrate (refined vs. non-refined), however, was not assessed.

Prior studies have demonstrated the effect of social support (through support groups, friends, family, or spouses) on both short- and long-term weight loss (20). In the present study, there was a clear association between social support and weight-loss maintenance. Regardless of diet assignment, participants who received support in the form of biweekly meetings had lost significantly more weight at 1 and 2 years than Unsupported participants. Support group participants received biweekly meetings for only 1 year post-intervention. The apparent benefit of this support, however, continued to be evident for an additional year, suggesting that prolonged support and instruction can help promote weight loss maintenance.

Those who had attended at least one half of the follow-up group meetings had a significantly greater weight loss at 1 year than non-attenders. After an additional year without meetings, the attenders still had lost significantly more weight than non-attenders at 2 years. The directionality of effect of attendance is unclear. While group support may have facilitated weight loss, it is also possible that individuals who had persistent difficulties with weight may have been more likely to avoid meetings. Although the effect of support meeting attendance on weight loss has not been extensively studied, other aspects of the group meetings, such as self-monitoring and social support, have been examined. Frequent weighing, which was part of the group support structure, has been shown to greatly increase weight loss (21). Within-group analyses show that attendance was

associated with weight loss for both diet groups at 1 and 2 years. Looking between groups, only the NCEP group at 1 year seemed to benefit from attending the group meetings more so than non-attenders. This trend was not apparent in the vegan group as there were no significant differences between vegan attenders and non-attenders at 1 and 2 years. The *N* values for each group were low; it is possible that, with a larger group, we would have seen a greater impact of meeting attendance. It is also possible that those in both diet groups who did not attend the meetings were not as adherent to the diet. Non-adherence in the vegan group may have still led to significant dietary changes that resulted in greater weight loss than those in the NCEP group who did not attend and were non-adherent.

Dietary adherence, as defined, was not significantly associated with weight loss at 1 or 2 years when both diet groups were combined. When examining adherence by diet, those members of the vegan group who reported adherence did not lose significantly more weight at 1 year but did at 2 years. In the vegan group, both reported adherers and non-adherers had significant weight loss at 1 and 2 years. Reported adherence had no effect in the NCEP group on weight loss. It is possible that our criteria were not sufficient for measuring adherence or that participants who failed to meet adherence criteria still changed their diets in a way that decreased weight regain. Our sample sizes were also small in this study; with a larger sample, we may have found that adherence played a bigger role in preventing weight regain. The use of an FFQ (vs. a 3-day diet record) may also not have provided accurate dietary intake. The goal of measuring adherence, however, was to examine long-term past intake of food groups, and so the FFQ was appropriate for this purpose.

Strengths of the study included the ability to examine a variety of factors that may be associated with weight loss maintenance after an initial intervention. We also used an intention-to-treat design, which can help to avert the biases seen with non-random dropout rates in either group. The results are applicable outside the research setting because participants were not provided food; they prepared their own meals or ate at restaurants. There were some limitations to our study. We measured body weight, not body fat, and adherence was based on self-report using an FFQ.

As the rates of obesity rise, it is increasingly important to find diets that produce effective weight loss and that can continue to produce weight loss or weight loss maintenance over the long-term. In this study, a vegan diet was associated with a greater weight loss at both 1 and 2 years post-intervention, compared with a more conventional, low-fat diet (NCEP). Both group support and meeting attendance were associated with sustained weight loss, demonstrating the value of follow-up support after a dietary intervention.

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