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Comparative effectiveness of plant-based diets for weight loss: A randomized controlled trial of five different diets

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ABSTRACT

Objective: The aim of this study was to determine the effect of plant-based diets on weight loss.
Methods: Participants were enrolled in a 6-mo, five-arm, randomized controlled trial in 2013 in South Carolina. Participants attended weekly group meetings, with the exception of the omnivorous group, which served as the control and attended monthly meetings augmented with weekly e-mail lessons. All groups attended monthly meetings for the last 4 mo of the study. Diets did not emphasize caloric restriction.
Results: Overweight adults (body mass index 25–49.9 kg/m^2; age 18–65 y, 19% non-white, and 27% men) were randomized to a low-fat, low-glycemic index diet: vegan (n = 12), vegetarian (n = 13), pesco-vegetarian (n = 13), semi-vegetarian (n = 13), or omnivorous (n = 12). Fifty (79%) participants completed the study. In intention-to-treat analysis, the linear trend for weight loss across the five groups was significant at both 2 ($P < 0.01$) and 6 mo ($P < 0.01$). At 6 mo, the weight loss in the vegan group (−7.5% ± 4.5%) was significantly different from the omnivorous (−3.1% ± 3.6%; $P = 0.03$), semi-vegetarian (−3.2% ± 3.8%; $P = 0.03$), and pesco-vegetarian (−3.2% ± 3.4%; $P = 0.03$) groups. Vegan participants decreased their fat and saturated fat more than the pesco-vegetarian, semi-vegetarian, and omnivorous groups at both 2 and 6 mo ($P < 0.05$).
Conclusions: Vegan diets may result in greater weight loss than more modest recommendations.

Introduction

Well-planned vegan and vegetarian diets can provide adequate nutrition, and have demonstrated health benefits in disease prevention and treatment [1]. Vegan and vegetarian diets have been used effectively for weight loss and maintenance [2,3]. Anchoring the two ends of the plant-based dietary spectrum are vegan diets (exclude all animal products) and omnivorous diets (omni: no foods excluded). Between these two diets are other plant-based diets, such as semi-vegetarian (semi-veg: occasional meat intake), pesco-vegetarian (pesco-veg: excludes meat except seafood), and vegetarian (veg: excludes all meat and seafood, but contains eggs and dairy products). Several epidemiologic studies have examined differences in weight-related outcomes among these diets, finding lower body weights [4] and less weight gain over time among vegans compared with other groups [5].

These prospective cohort studies [4,5] examining the five diets along the plant-based dietary spectrum have categorized participants according to their preexisting dietary patterns, making it difficult to account for the inherent differences that may exist among individuals who self-select different patterns. To date, there have been no randomized trials comparing the effectiveness of these five different diets on weight loss. Therefore, the goal of this study was to examine the differences in weight loss among participants randomized to adopt an omnivorous, semi-vegetarian, pesco-vegetarian, vegetarian, or

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vegan diet. Transitioning to plant-based diets may lead to greater increases in fiber [6–8], with high-fiber diets being associated with lower body weights in epidemiologic studies [9], and greater decreases in dietary fat [6–8], with studies showing that low-fat diets are associated with weight loss [10]. Because of these potential changes in nutrients among groups, we hypothesized that differences in weight loss would follow similar patterns seen in epidemiologic studies with weight loss being incrementally greater along the plant-based dietary spectrum from omni to semi-veg to pesco-veg to veg to vegan diets. Furthermore, we hypothesized that the vegan group would have significantly greater weight loss compared with the pesco-veg, semi-veg, and omni groups.

Materials and methods

The New DIETs (New Dietary Interventions to Enhance the Treatments) for weight loss study was a 2-mo weight loss intervention with a 4-mo follow-up period. Recruitment and exclusion criteria are described elsewhere [11]. Briefly, overweight or obese (body mass index [BMI] 25–49.9 kg/m^2) adults, who were interested in losing weight, were between the ages of 18 and 65 y with a stable medical status (e.g., no uncontrolled thyroid conditions or diabetes), and were willing to accept random assignment of diet, were recruited through worksite listserv messages and newspaper ads. Participants attended an orientation session to learn about questionnaires and complete a consent form. Participants were informed that the purpose of the study was to assess changes in body weight after randomization to one of five different diets. Questionnaires assessed demographic characteristics, dietary intake from 2 d of unannounced 24-h dietary recalls (one weekday and one weekend day) collected and analyzed using the automated self-administered 24-h dietary recall [12], and physical activity (Paffenbarger Physical Activity Questionnaire) [13].

Once all participants completed baseline questionnaires, they were randomized to one of the five diets using a computerized random-number generator and stratified by BMI and sex (both self-reported on screening questionnaires). Before revealing randomization assignment, weight was measured in light street clothes without shoes using a calibrated digital scale (SECA 869, Hamburg, Germany) accurate to 0.1 kg. Height was measured using a stadiometer (SECA 213) after participants had removed hats and shoes. All measures (with the exception of height and demographic characteristics) were assessed at baseline, 2 mo, and 6 mo. A university Institutional Review Board approved the study, and all the participants gave written informed consent. Participants received a $20 incentive payment for completion of all 2-mo assessment activities, but did not receive any incentives for completion of 6-mo assessments.

Intervention diets

After all baseline measurements were assessed, participants met with their randomized group. All participants received a handout that provided details on their assigned diet, including food groups that can be included and ones that should be avoided, and details on low-fat cooking instructions and the glycemic index [14]. Two registered dietitians with graduate degrees and expertise in all the study diets led the classes. These research dietitians provided participants with the orientation presentation that detailed menu planning and reviewed recipes given to each group. All groups were provided with several foods to sample during the first class. Self-monitoring dietary or energy intake was not required by any of the groups and was not discussed at group meetings. Participants were free to eat whenever they wanted and at a frequency of their own choosing as long as it adhered to their diet assignment. All participants were encouraged to limit fast foods and processed foods in favor of more minimally processed foods to meet low-fat and low-glycemic index dietary recommendations. Participants could dine out and were instructed on how to make healthy choices at restaurants.

Table 1 provides an overview of the five intervention diets used in the New DIETs study as well as sample dinner menus. Because both low-glycemic index [15] and low-fat diets [10] are associated with weight loss, all participants were instructed to follow diets that favored low-glycemic index and low-fat foods. Participants were told they could include limited amounts of nuts and nut butters, avocados, seeds, and olives in their diets but were encouraged to focus on lower fat food options. There was no recommended restriction on energy intake for any of the five groups. All groups attended weekly 1-h meetings for 8 wk, with the exception of the omni group. The omni group allowed for the examination of consuming a usual diet (as all participants were following an omnivorous diet at baseline), while at the same time controlling for the selection made by all participants to participate in a weight loss study. The omni group attended meetings at baseline, 1 mo, and 2 mo, and received their dietary information by e-mail, which included a weekly lesson plan covering the same topics addressed in the group sessions as well as an e-mail message providing an overview of the lesson information. Previous research studies have used this method of providing weekly e-mail lessons for a weight loss intervention [16,17]. In summary, the omni group allowed for the examination of what would occur via minimal intervention with no recommendation to limit food groups (i.e., usual diet).

Although only vegan diets require supplementary vitamin B_{12} [1], to control for supplement intake across groups, all participants were required to purchase and take a multivitamin or other form of vitamin B_{12} daily. After the 2-mo main intervention was completed, all participants (including the omni group) were offered monthly meetings to assist with dietary maintenance. Participants were also provided with a private Facebook group for their diet group after the 2-mo mark to provide social support in between monthly meetings (joining was optional). After the 2-mo intensive intervention phase, participants were encouraged to continue following their assigned diet and meet with their diet group each month. Participants were told they could make alterations to the diet if they needed to but were encouraged to maintain their dietary changes. Participants received handouts and recipes related to the session topic for every meeting during the 6-mo study. Topic sessions for all the group meetings were informed by the Diabetes Prevention Program [18] and were grounded in social cognitive theory [19]. Each class included food samples or a cooking demonstration. All group sessions covered identical topics among the five groups with the only difference being the type of diet discussed. The first eight topic sessions for all groups were as follow:

1. Overview of assigned diet
2. Grocery shopping tips
3. Meal planning and dining out
4. Recipe modification
5. Grocery store tour
6. Problem solving: handling holidays and family pressures
7. Dealing with weight plateaus and the slippery slope
8. Ways to stay motivated.

Participants met with only their assigned diet group, which corresponded to a day of the week. Dietary adherence was measured as the absence of any proscribed foods from the dietary recalls (e.g., absence of meat, dairy, and eggs from vegan participants' food records). Participants in the omni group were considered adherent if their percent energy from fat was $\leq$40%. This method of assessing dietary adherence has been used in previous studies [3,20].

Statistical analyses

The study was powered to detect a significant difference in weight loss at 2 mo among the five groups with a significant trend in weight loss demonstrating a decrease in percent body weight incrementally going from the omni, semi-veg, pesco-veg, veg, through the vegan group. Assuming a mean incremental difference in change in body weight of 1% successively between each of the five groups (corresponding to an effect size of 0.57), a pooled SD of 2.5%, and significance at $\alpha = 0.05$, a sample size of 60 participants (12 per group) was estimated to provide 94% power for the linear trend among the five groups [21]. The sample size of 12 per group provided 80% power for differences of $\geq$2.85% for linear contrasts between two groups. Attrition was defined as a participant not completing the main outcome of body weight at either 2 mo (for 2-mo outcomes) or 6 mo (for 6-mo outcomes).

For differences in baseline demographic characteristics, analysis of variance (ANOVA) was used with the Tukey's test for post hoc analyses of continuous variables and χ^2 test of independence was used for categorical variables. Change in percent weight loss among the five groups was analyzed at both 2 mo (after the intensive intervention) and at 6 mo (to assess weight loss maintenance) using one-way ANOVA. To test that weight loss would be incremental among the five groups (going from the vegan group losing the most to omnivores losing the least), an a priori linear contrast for trend was used at each time point. Additionally, three a priori linear contrasts among the specific groups were examined at each time point: vegan versus omni, vegan versus semi-veg, and vegan versus pesco-veg. Because weight loss differences between veg and vegan participants were expected to be smaller than the other groups, this study was not powered to detect weight loss differences between veg and vegan. Missing data for body weight was handled in two ways: 1) baseline observation carried forward for missing values at each time point (assuming no change) and 2) weight gain imputed at a rate of 0.3 kg/mo. This rate of weight gain has been shown to commonly occur during behavioral weight loss interventions [22,23] and has been used as the weight gain amount for other large, dietary weight loss trials [24,25]. Weight gain was extrapolated from time of attrition up through the 2- and 6-mo assessment