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Can limiting dietary variety assist with reducing energy intake and weight loss?★

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Abstract

Due to the high prevalence of overweight and obesity, developing strategies to improve weight loss and weight loss maintenance is imperative. One dietary environmental variable that has received little attention in being targeted in an intervention to assist with obesity treatment is dietary variety. Experimental research has consistently shown that greater dietary variety increases consumption, with the effect of variety on consumption hypothesized to be a consequence of the differential experience of the more varied sensory properties of food under those conditions with greater dietary variety. As reduced energy intake is required for weight loss, limiting variety, particularly in food groups that are high in energy-density and low in nutrient-density, may assist with reducing energy intake and improving weight loss. A series of investigations, both observational and experimental, were conducted to examine if limiting variety in an energydense, non-nutrient-dense food group, snack foods (i.e., cookies, chips), assisted with reducing energy intake of the food group and improving weight loss. Results of the investigations suggest that a prescription for limiting variety in a food group can be implemented during obesity treatment, limiting variety is associated with the occurrence of monotony, and that reducing food group variety is related to decreased consumption of that food group. Future research is needed to ascertain the long-term effect of prescriptions targeting dietary variety on weight loss and weight loss maintenance.

Keywords

Variety; Food group; Energy intake; Weight loss; Monotony

1. Introduction

Approximately two out of every three adults in the U.S. are overweight or obese [1]. The high prevalence of overweight and obesity negatively affects the health of the population, as obese individuals are at increased risk for developing several chronic diseases, such as type 2 diabetes [2], cardiovascular disease, and certain forms of cancer [3–5]. Due to its impact on health, medical costs, and longevity, obesity is considered to be the number one health problem in the U.S. [6], and has become a public health priority [7].

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Americans now live in a “toxic environment” that produces passive overeating and physical inactivity [8,9]. Increased exposure to these adverse environmental conditions, such as decreased opportunities for physical activity, changes in food portion size and dietary variety, is believed to contribute to the shift towards positive energy balance and the consequential obesity epidemic [10]. Indeed, portion size in foods has significantly grown since the 1970s [11,12]. Moreover, the variety of high-energy-dense, low-nutrient-value foods available in the U.S. market has significantly increased [13]. As these environmental factors have changed, the prevalence of obesity has grown.

2. Greater dietary variety increases food intake

One dietary environmental variable that has received little attention in being targeted in an intervention to assist with obesity treatment is dietary variety. In animal experimental research, greater dietary variety has been consistently found to increase consumption, weight, and body fat [14]. Initial studies of dietary variety with animals compared a diet of animal chow (non-variety) to a “cafeteria diet,” a diet composed of a several energy-dense, non-nutrient-dense human foods (i.e., cookies, cakes, etc.) (variety). Later studies controlled macronutrient composition of the diet and manipulated variety by varying the flavors and textures of the diet. Even in these more carefully controlled investigations, animals receiving the diet that had greater variety in terms of flavors and/or textures of food still consumed more energy.

In humans, most of the experimental research in dietary variety has investigated the effect of variety within a meal [14]. In these investigations, meals have generally been provided in three to four successive courses, with a different food served at each course in the variety condition, and the same food served at each course in the non-variety condition. As with the animal experimental studies, the conditions that contain greater meal variety result in greater consumption.

It has been proposed that the effect of variety is due to the differential experience of the more varied sensory properties of food [14,15]. This differential experience has traditionally been assessed via change in hedonic ratings of foods. It is theorized that the decrease in hedonics is responsible for the decreased food consumption in situations with less variety [14]. Thus, with limited variety, there should be a rapid decrease in hedonics for the few foods consumed; therefore, intake from these few foods should more rapidly decrease, causing an overall decrease in the amount eaten, as compared to those situations with greater variety.

Two phenomena regarding reductions in food hedonics have been documented in conditions with varying degrees of dietary variety. The first is sensory-specific satiety, in which there is a greater reductions in hedonics of a food consumed as compared to foods not consumed within an eating bout [15]. The second is monotony, where with repeated consumption of the same food over time (i.e., days, weeks, etc.) a decrease in hedonics for the consistently eaten food occurs. Thus, while these two phenomena measure changes in food hedonics, they have two distinct differences: 1) the change in hedonics is either compared to other foods (sensory-specific satiety) or to the same food (monotony); and 2) the time frame of measure is either within an eating bout (sensory-specific satiety) or across time (monotony).

Potentially, the underlying mechanisms behind these reductions in hedonics is habituation [14]. Habituation is a basic form of learning, in which behavioral and physiological responses decrease in response to repeated presentations of a stimulus, with the decrease in response unrelated to sensory adaptation/fatigue or motor fatigue [16]. There are many paradigms that have been used to test for the occurrence of habituation [17]. One paradigm is dishabituation, in which two stimuli are presented in the following order: the first stimulus

is presented repeatedly, a new stimulus is presented (dishabituator), and then the initial stimulus is presented again. In this paradigm, habituation is documented when responding to the initial stimulus decreases with the repeated presentations, but then responding for the initial stimulus recovers (increases) after presentation of the dishabituator. The recovery in responding demonstrates that the initial response decrease is not related to adaptation or fatigue. Epstein and colleagues have demonstrated dishabituation in the salivary response to food cues [18]. In this investigation lemon and lime juice were the stimuli, and after 10 presentations of the same juice, salivation decreased. When a new juice was presented, salivation increased, and when the original juice was presented again, salivation increased to its initial level, demonstrating recovery of responding.

Another habituation paradigm, considered to be the most basic paradigm, is stimulus specificity. With stimulus specificity, one stimulus is repeatedly presented and is followed by the presentation of a new stimulus. This paradigm tests if responding increases when a new stimulus is presented, demonstrating that a decrease in responding to the initially stimulus is not related to adaptation or fatigue. For example, Bond and colleagues [19] presented lemon and green apple flavored lollipops to participants and collected salivary response to the presentations. Salivation decreased during the 10 presentation trials of the lemon flavored lollipop, but salivation significantly increased after the presentation of the green apple flavored lollipop.

A final habituation paradigm is the variety paradigm, in which stimulus characteristics are varied across repeated presentations in comparison to the same stimulus being presented across repeated presentations (i.e., presenting multiple flavors of lollipops and comparing that to presenting only one flavor of lollipop). This paradigm is expected to produce a lower rate in the decrease of responding in the condition that contains greater variety. It has been proposed that the varied characteristics of the stimuli act as novel stimuli or as dishabitators [17]. The presentation of the greater variety then prevents, or slows down, the occurrence of habituation [20].

Thus, using the framework of habituation, with presentations of new orosensory stimuli, dishabituation would occur, and the rate of consummatory response would decrease at a slower pace [18]. Therefore, eating bouts involving different foods (greater variety of orosensory stimulation) would be expected to have a reduced rate of habituation and slower occurrence of termination as compared to eating bouts with fewer foods and less variety in orosensory stimulation. To support this premise, recent research has found that increasing orosensory variety in an eating bout does slow habituation and increases consumption [21].

3. Types of dietary variety

Dietary variety can be conceptualized in many ways [15]. As mentioned previously, the overall number of different items within the diet, or overall dietary variety, is one type of variety. Also, the number of different items consumed within an eating bout can be classified as eating bout or meal variety. The number of different items consumed within a food group, or food group variety, is yet another type of dietary variety. Finally, the number of different types of main items, or entrees, served at a meal across time (i.e., days, weeks), entrée variety, is also a form of dietary variety.

What is still unclear regarding the concept of variety is how different the sensory characteristics of foods need to be to for greater variety to impact on consumption. Several studies suggest that even small sensory differences, such as differences within the color or texture of foods, is enough difference in sensory variety to increase consumption [22,23]. For example, Epstein and colleagues provided elbow macaroni and cheese to children aged 8 to 12 years during a habituation task, in which children worked to have access to as much

of the elbow macaroni and cheese as they desired to consume [23]. After this task was completed and children had consumed the amount of elbow macaroni and cheese they had gained access to, children could then work for access to consume the same macaroni and cheese, spiral macaroni and cheese, or chicken nuggets. In this second access condition, children worked to gain access and consumed significantly more spiral macaroni and cheese and chicken nuggets than the elbow macaroni and cheese, with no difference occurring between the spiral macaroni and cheese and chicken nuggets. What is important to note is that the only difference between the two macaroni and cheese entrees served to the children is the shape of the macaroni. Thus, just the difference in shape, not color or flavor, was enough to increase consumption.

4. Reducing dietary variety and obesity treatment

If greater variety increases consumption, then potentially reducing variety may decrease consumption. This may be particularly important in those situations in which there is a purposeful need to decrease energy intake, such as during obesity treatment. As the impact of variety on consumption appears to occur without conscious effort, this could be one strategy that may assist with maintaining long-term reduced energy intake and improve long-term weight loss maintenance.

In lifestyle interventions, in which participants make changes in dietary intake and physical activity to achieve weight loss, a hypocaloric (1200–1500 kcals/day), low-fat (30% kcals from fat) diet is prescribed [24,25]. Additionally, participants are instructed about recommended servings to consume from different food groups to meet their energy and fat goals, and to assist with consuming a diet meeting the Dietary Guidelines [26]. With these recommendations, participants are encouraged to consume fewer servings from specific food groups, particularly those that are high in energy-density and low in nutrient quality (i.e., fats, oils, and sweets). Thus, reducing variety in these food groups may be a strategy that can assist participants with reducing intake from these food groups that are usually targeted for reduction during the intervention, and thereby also decrease overall energy and/or fat intake. If reducing variety in particular food groups does indeed reduce overall energy intake, this dietary strategy would improve weight loss.

4.1. The relationship between food group variety and anthropometrics

The first study investigating the relationship between food group variety and anthropometrics in humans was conducted by McCrory et al. [27]. In this cross-sectional investigation, food group variety within 10 food groups, assessed by a food frequency questionnaire (FFQ), was determined in 71 healthy males and females. Greater variety in each food group was associated with greater energy intake from that food group. Additionally, a variety ratio (variety of vegetables/variety of sweets, snacks, condiments, entrées, and carbohydrates) was related to body fatness, such that consuming less variety of vegetables combined with consuming greater variety in sweets, snacks, condiments, entrées, and carbohydrates was associated with greater body fatness. This study provided support for the hypothesis that variety within specific food groups may be problematic for weight status.

4.2. Developing a food group variety prescription for a lifestyle intervention

The outcomes regarding food group variety and anthropometrics reported by McCrory and colleagues [27] lead to our work to develop a dietary prescription for food group variety that could be implemented within a lifestyle intervention. This work started with secondary data analyses of food group variety in the diet of participants participating in a lifestyle intervention and participants in the National Weight Control Registry (NWCR). These analyses led to experimental studies which tested the potential mechanisms by which

reducing variety may impact on consumption and piloted a reduced food group variety prescription within a brief lifestyle intervention.

4.2.1. Food group variety and weight loss and weight loss maintenance—The first step in developing a prescription to limit food group variety was to examine changes in food group variety in overweight and obese adults participating in an 18-month lifestyle intervention trial, and investigate how changes in food group variety may be related to changes in energy intake and weight loss [28]. These participants were prescribed a hypocaloric (1000 to 1500 kcals/day), low-fat (20% kcals from fat) diet and were given no recommendations regarding dietary variety. Dietary intake was assessed with a self-administered, 60-item, semi-quantitative FFQ at 0, 6 and 18 months. Variety was calculated for seven main food groups using the Food Guide Pyramid (FGP) [29] as a reference: (1) low-fat bread, cereal, rice, and pasta (LFB); (2) fruits; (3) low-fat vegetables (LFV); (4) low-fat meat, poultry, fish, dry beans, eggs, and nuts (LFM); (5) high-fat foods from the five main groups of the FGP (HFF); (6) fats, oils, and sweets (FOS); and (7) combination foods. Variety for each food group was calculated as a percentage, with the number of different food items consumed on at least a weekly basis in the past 6 months within each food group contributing to the percentage.

Results indicated that participants lost a significant amount of weight (−22.2 lbs. at 6 months, −15.0 lbs. at 18 months). Energy intake also significantly decreased (−533 kcals at 6 months, −435 kcals at 18 months). Food group variety also significantly changed during intervention (Table 1). In general, food groups that were lower in fat significantly increased variety (LFB and LFV) and food groups that were higher in fat significantly decreased variety (HFF and FOS) during the intervention. Moreover, after controlling for demographic variables, decreases in variety in HFF from 0 to 6 and 6 to 18 months were significantly related to decreases in energy and fat intake and weight during those same time points.

Next, we examined food group variety in the diet of participants in the NWCR [30]. The NWCR was established in 1994 and is the largest ongoing observational study examining successful long-term weight loss maintainers [31]. To enter the registry, participants must have maintained a weight loss of 30 lbs. for 1 year. As we had found that changes in food group variety, particularly in high-fat foods, were associated with changes in energy intake and weight during a lifestyle intervention, we hypothesized that successful weight loss maintainers would also have less variety in food groups that contained high-fat foods. To ascertain how food group variety intake was similar to successful weight losers, we compared food group variety in NWCR participants to overweight males and females who participated in a lifestyle intervention and who had lost at least 7% of their initial body weight at 6 months. Dietary intake was assessed in both groups with a FFQ and to compare food group variety consumed between the groups, only food items contained on both versions of the FFQs were counted. Variety in seven food groups, LFB, fruits, LFV, LFM, HFF, FOS, and combination foods, was examined in a similar way as previously reported [28].

Results indicated that energy and percent energy from fat intake was significantly greater in the successful weight losers at baseline than the NWCR participants, but there were no differences in these dietary variables between these groups when the diet was reassessed in the successful weight losers at 6 months, after they had lost −29.5 lbs. For food group variety, NWCR participants reported consuming significantly less variety in five food groups (LFB, LFV, LFM, HFF, FOS) than successful weight losers at 6 months (see Table 2). Moreover, significant positive associations between variety in each food group and energy intake from each food group occurred across both groups.

The results from both investigations suggest that changes in food group variety are related to changes in energy intake and weight change. Furthermore, limiting the number of different foods, particularly fat-dense foods, in the diet may help reduce energy intake, thereby helping with weight loss and weight loss maintenance.

4.2.2. The effect of limiting variety in an energy-dense, non-nutrient dense food group on hedonics and intake—

To begin to investigate limiting variety in energy-dense, non-nutrient-dense foods on hedonics and consumption across several days, we conducted an experimental study in which the amount of variety of “snack foods” (i.e., cakes, cookies, chips) consumed over a 4-day period was manipulated [32]. As this was not the first investigation to examine differences in variety across days, this study was also designed to address limitations in previous studies, such as controlling for differences in nutrient composition and having the ability to make comparisons between and within conditions.

Participants were 21, healthy, non-smoking, unrestrained college males randomly assigned to one of two conditions. In the first condition (Same Snack), participants received the same snack food (crumb cake) to consume in four laboratory sessions scheduled on four consecutive days. Additionally, they were given crumb cake to take home and consume between each of the sessions. In the second condition (Variety), participants received the crumb cake to consume in a laboratory session on days one and four, but received different snack foods, both sweet and salty (i.e., chocolate chip cookies and tortilla chips), to consume in the laboratory sessions on days two and three. Participants in the variety condition also received different sweet and salty snack foods to take home and consume between the sessions. Thus, the investigation used a framework of the habituation variety paradigm to test the effects of variety. Measures taken on days one and four included hedonics of all of the snack foods consumed in the sessions and the amount of crumb cake consumed on day one and four.

Results indicated that for hedonics, both monotony and long-term sensory-specific satiety occurred. A significant reduction in hedonic ratings occurred from day one to day four for the crumb cake, such that on day four, the Same Snack condition had a significantly lower hedonic rating than the Variety condition. For change in hedonic ratings from day one to day four, Same Snack had a significantly greater reduction in hedonic ratings for the crumb cake than the composite change in hedonic ratings for the salty snack foods. However, there was no significant difference between the two conditions in crumb cake consumed on day four.

Thus, while it was found that changes in hedonics did occur in a condition that limited variety, these changes were not associated with reductions in consumption. Potentially if the length of time of exposure to the crumb cake was longer (i.e., beyond the four days used in the design of this study) in the Same Snack condition, intake of this food may have been reduced. Limiting variety may influence eating in a two-step process: first hedonics decreases, followed by a reduction in consumption. Intuitively it seems that a decrease in hedonics needs to precede a change in consumption.

4.2.3. Can a limited food group variety prescription be implemented and does it alter energy intake?—

The next step in our experimental research was to implement a dietary prescription that limited the variety of snack foods consumed to reduce consumption of these types of foods and examine the prescription's impact on energy intake from snack foods [33]. The prescription was implemented in an 8-week lifestyle intervention in which a daily energy goal of 1200 to 1500 kcals per day. Ideally consumption of snack foods would be reduced to no more than one serving per day, thus we compared the effect of limiting snack food variety to only one chosen snack food (Reduced Variety) to the effect of

reducing daily servings of snack foods to <1, with no limit on snack food variety (Control). Measures of dietary intake (seven-day food diary), food hedonics, and weight were taken at 0 and 9 weeks.

Participants were 27 females and 3 males, between the ages of 21 and 65 years, with a body mass index (BMI) between 25 and 40 kg/m². All participants were instructed to gradually increase moderate-intensity physical activity to at least 150 min/week and had the same energy and fat goals (1200 to 1500 kcals/day and 20% energy from fat). Both Reduced Variety and Control received eight, 60-minute group sessions. In the sessions, participants were taught behavioral and cognitive skills, including self-monitoring, stimulus control, problem-solving, social support and assertiveness training, goal setting, cognitive restructuring, and relapse prevention. Participants self-monitored their eating in diaries for the eight weeks of the study. Weekly feedback was provided on participants' diaries regarding adherence to the dietary prescriptions.

For the Reduced Variety condition, participants chose one highly liked, frequently eaten (i.e., at least once per week) snack food to continue to include in the diet. Participants were asked to be very specific in their selection of snack food, identifying the actual flavor and type of snack food (i.e., strawberry ice cream rather than just ice cream). The snack foods chosen by the 15 participants randomized to this condition fell into the following food categories: candy (5), cake (2), chips (2), ice cream (2), cookie (1), peanuts (1), buttered popcorn (1), and granola bar (1). This condition was instructed to limit their snack food consumption to only this one chosen food during the eight weeks. Participants were instructed to eat this food at least four times per week, while still meeting daily calorie and fat gram goals. To control for the focus on snack foods in the Reduced Variety condition, the Control condition also focused on snack foods, and reduced servings of snack foods consumed to < 1 per day. No limit on the number of different types of snack foods to consume was given to the Control condition.

Results found that the number of different snack foods consumed in both groups significantly decreased, and that there was a trend for a greater reduction in the number of different snack foods consumed in the Reduced Variety condition as compared to the Control condition (Fig. 1). Similar outcomes were found for energy intake from snack foods (Fig. 2). For hedonics, a Control participant was yoked to a Reduced Variety participant, with both participants receiving the Reduced Variety participant's chosen snack food for the taste-tests in which hedonic measures were taken. Analyses of change in hedonic measures found that over time the Reduced Variety condition had a greater reduction in hedonics of the snack food as compared to the control condition, indicating the occurrence of monotony. Finally, weight significantly decreased over time, with no difference in weight loss occurring between the two conditions. Mean weight loss was -7.4 ± 5.8 lbs. Thus, this proof-of-concept pilot study demonstrated that a prescription to reduce variety in snack foods could be implemented and appeared to help reduce energy intake for snack foods. Additionally, with a limited variety prescription in which regular consumption of the chosen food occurred, monotony did occur.

5. The role of dietary variety in weight loss

Research in the area of dietary variety shows that consuming greater variety increases consumption in the overall diet, within food groups, and within eating bouts. Thus, in those circumstances in which negative energy balance or maintenance of energy balance is desired (i.e., during weight loss and weight loss maintenance), consuming a diet with greater variety, particularly from food groups higher in energy-density due to their fat content, may make achieving weight loss and successful weight loss maintenance more challenging. Our

experimental research, which was designed to better understand how a limited variety dietary prescription could be implemented within a lifestyle intervention and the effects this prescription may have on intake, suggests a few things. The first is that repeated consumption (exposure) to a targeted food combined with a reduction in consumption of the number of different foods from which the targeted food is a part (reducing variety) produces monotony and long-term sensory-specific satiety. Importantly, changes in hedonics appear to occur prior to reductions in energy intake of the targeted food and/or food group, but that over a longer time frame (i.e., at least 8 weeks), consuming limited variety produces a reduction in both hedonics and energy intake from the food group targeted in the limited variety prescription. Interestingly, this reduction in energy intake from the food group with limited variety is occurring without a goal to reduce energy intake or self-monitor energy intake from that specific food group, suggesting the mechanism by which this reduction occurs is not purposeful or within awareness. Additionally, our research demonstrates that a prescription to reduce food group variety in energy-dense, non-nutrient-dense foods can be implemented within a short-term lifestyle intervention.

However, while the limited variety prescription did reduce energy intake from the food group that was targeted by the limited variety prescription, this difference in energy intake was not large enough to produce greater weight loss during the 8-week intervention. Potentially, implementing the limited variety prescription over a longer time frame may produce a larger energy deficit than the standard intervention so that greater weight loss may occur. The length of exposure to a food needed to affect hedonics and intake may vary, and this may depend on the frequency of usual consumption of the food, the initial palatability and motivational value of the food, and if the food is consumed by itself or in combination with other foods in a meal [34,35]. Moreover, putting a prescription in place that may limit variety in more areas of the diet may be helpful. This could include limiting variety in other energy-dense, non-nutrient-dense food groups, as well as limiting meal and entrée variety. Limiting variety in other areas of the diet may again assist in increasing reductions in energy intake more so than standard lifestyle intervention prescriptions, which then should increase weight loss. Further research is needed to determine the degree by which variety should be limited to assist with weight loss and weight loss maintenance, without causing individuals to feel overly restrictive in their diet or limiting one's ability to meet overall nutrient needs. Additionally, as there are aspects of the diet that most Americans need to increase consumption of and that are low in energy density, such as fruits and vegetables, the impact of increasing variety in these areas needs to be investigated. Increasing variety in these types of food could increase their intake, which may increase the nutrient quality of the diet and assist with reducing energy intake via lowering energy density, and assist with weight loss.

In conclusion, a prescription to limit variety can be implemented and does reduce energy intake of the part of the diet that has limited variety. To incur a greater energy deficit than what occurs in a standard lifestyle intervention, this prescription needs to be in place for more than two months and may need to include other areas of the diet. As very little research has been conducted in the application of dietary variety within weight loss interventions, more research is needed to replicate our findings. Furthermore, future research is needed to ascertain the overall degree of variety that can be prescribed and adhered to within a lifestyle intervention and the length of time required by a variety prescription to be implemented to produce greater weight loss outcomes than what are currently achieved with a standard hypocaloric, low-fat diet used in lifestyle interventions.

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Fig. 1. Change in the number of different snack foods consumed during an 8-week lifestyle intervention assessed via a seven-day food diary ($M \pm SD$).

Fig. 2.
Change in the kcal consumed from snack foods during an 8-week lifestyle intervention assessed via a seven-day food diary ($M \pm SD$).

Table 1

Food group variety at 0, 6, and 18 months during a lifestyle intervention (M $\pm$ SD).

	0 Months	6 months	18 months	Comparison (p-values)		
				0-6	6-18	0-18
Variety LFB (%)	48.1 $\pm$ 20.4	56.7 $\pm$ 22.4	57.1 $\pm$ 20.7	<0.001	NS	<0.001
Variety fruits (%)	47.5 $\pm$ 27.0	48.8 $\pm$ 23.9	48.8 $\pm$ 26.4	NS	NS	NS
Variety LFV (%)	43.2 $\pm$ 21.6	49.8 $\pm$ 19.1	50.7 $\pm$ 19.8	0.001	NS	<0.001
Variety LFM (%)	34.4 $\pm$ 19.7	35.3 $\pm$ 18.7	36.1 $\pm$ 20.2	NS	NS	NS
Variety FOS (%)	52.2 $\pm$ 17.5	40.0 $\pm$ 19.5	46.0 $\pm$ 19.6	<0.001	0.001	0.001
Variety HFF (%)	31.3 $\pm$ 15.2	20.1 $\pm$ 14.0	25.9 $\pm$ 15.0	<0.001	<0.001	<0.001
Variety combination foods (%)	40.5 $\pm$ 25.1	32.2 $\pm$ 22.0	39.3 $\pm$ 25.2	0.001	<0.05	NS

Note. NS=not significant; LFB=low-fat breads; LFV=low-fat vegetables; LFM=low-fat meats; FOS=fats, oils, and sweets; HFF=high-fat foods.

Table 2

Food group variety in National Weight Control Registry participants and recent weight losers in participating in a lifestyle intervention (M $\pm$ SD).

	NWCR participants	Recent weight losers	Comparisons
	(n = 2237)	(n = 96)	(p-values)
Variety LFB (%)	45.6 $\pm$ 20.4	57.6 $\pm$ 21.8	<0.001
Variety fruits (%)	46.7 $\pm$ 27.3	49.5 $\pm$ 23.5	NS
Variety LFV (%)	45.4 $\pm$ 18.5	51.3 $\pm$ 19.1	<0.001
Variety LFM (%)	30.0 $\pm$ 17.4	36.5 $\pm$ 18.1	<0.001
Variety FOS (%)	19.1 $\pm$ 16.4	38.5 $\pm$ 18.2	<0.001
Variety HFF (%)	12.0 $\pm$ 10.8	18.2 $\pm$ 12.6	<0.001
Variety combination foods (%)	27.1 $\pm$ 21.5	32.6 $\pm$ 20.3	NS

Note. NWCR=National Weight Control Registry; LFB=low-fat breads; NS=not significant; LFV=low-fat vegetables; LFM=low-fat meats; FOS=fats, oils, and sweets; HFF = high-fat foods.