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Decreases in high-fat and/or high added sugar food group intake occur when a hypocaloric, low-fat diet is prescribed within a lifestyle intervention: a secondary cohort analysis

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Abstract

Background—When a hypocaloric, low-fat diet is prescribed, intake of currently consumed foods can decrease, foods naturally low in fat and/or added sugar may increase, or fat- or sugar-modified foods may increase.

Objective—Examine food group intake change and its relation to reductions in energy and fat intake, and weight during a lifestyle intervention.

Design—Secondary cohort analysis.

Participants—One hundred sixty-nine participants (52.0 ± 8.6 years, 34.9 ± 4.5 kg/m², 92% white, 97.6% non-Hispanic, and 56.8% female) with complete data at 0 and 6 months collected in a research setting.

Main Outcome Measures—From 3, 24-hr phone dietary recalls, 165 food groups from NDSR software were coded into 25 larger food groups assessing intake of higher fat and/or added sugar food groups vs. naturally lower fat and/or added sugar food groups and into 17 larger food groups assessing intake of non-modified vs. fat- and/or sugar-modified food groups.

Statistical Analyses Performed—Repeated measures analyses of covariance (intervention group: covariate) assessed changes from 0 to 6 months. Hierarchical regressions examined changes in food group intake and changes in energy intake, percent energy from fat intake, and weight from 0 to 6 months.

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Conflict of Interest Disclosure No conflicts of interest to report for the authors of this paper.

Results—Significant reductions ($p < 0.05$) in intake of high-fat and/or high-added sugar food groups (Higher Fat Dairy, Higher Fat Eggs, Higher Fat Fats, Higher Fat Fruit, Higher Fat Meat, Non-Modified Higher Fat Fats Oils and Sweets, Non-Modified Higher Fat Sugar Sweetened Fats Oils and Sweets, Non-Modified Regular Fat Dairy, Non-Modified Regular Fat Sugar Sweetened Dairy) occurred. Decreases in Higher Fat Meat were significantly ($p < 0.05$) related to decreases in energy intake, percent energy from fat intake, and weight.

Conclusion—When a hypocaloric, low-fat diet is prescribed, reductions in high-fat and/or high-added sugar food groups occur. Targeting reductions in high-fat meats may improve outcomes.

Keywords

food group changes; lifestyle intervention; modified foods; weight loss; fat intake

Introduction

In 2013, the American Heart Association, American College of Cardiology, and The Obesity Society released guidelines for the management of overweight and obesity for adults.¹ The guidelines recommended a lifestyle intervention, which includes a diet that lowers energy intake, an increase in physical activity, and the use of behavioral strategies to change diet and physical activity.¹

One dietary strategy that has been shown to reduce energy intake within a lifestyle intervention, producing the recommended 5% of weight loss, is a hypocaloric (1,200 – 1,500 kcal/day), low-fat (< 30% energy from fat) diet.¹ There are several ways to reduce energy and fat intake when a hypocaloric, low-fat diet is prescribed. For example, one can reduce intake of currently consumed foods, which are higher in fat and added sugar, making few changes in the types of foods consumed. Foods naturally low in energy and fat and/or added sugar, such as fruits and vegetables, may be increased and replace foods naturally high in energy, fat, and/or added sugar, decreasing intake of these foods. Finally, modified foods, fat- or sugar-modified, may be used in place of full-fat or full-sugar counterparts.^{2–9} While a hypocaloric, low-fat diet is one of the dietary strategies currently recommended to assist with weight loss,¹ limited research has examined which of these strategies occur when this diet is prescribed. Therefore, this study investigated changes in food group servings consumed during the first six months of a lifestyle intervention, the active weight loss phase, when a hypocaloric, low-fat diet was prescribed to enhance understanding of how participants are reducing energy and fat intake. Furthermore, the relationship between changes in food group servings and reductions in energy and fat intake, and weight loss was also examined.

Methods

Study Design

This secondary data analysis was conducted using data collected from a previous published 18-month lifestyle intervention trial examining a reduced variety dietary prescription.¹⁰ This study was approved by the institutional review board at the University of Tennessee, Knoxville. In brief, 202 overweight and obese consented participants were randomly

assigned to 1 of 2 conditions: Limited Variety (LV) and Lifestyle. Both conditions were given a standard hypocaloric, low-fat diet prescription (1,200 – 1,500 kcal/day, 30% energy from fat restriction), a physical activity prescription (200 minutes of moderate-intensity physical activity per week and 10,000 steps per day), and a cognitive behavioral intervention, delivered in weekly 60-minute group meetings for the first 6 months (weight loss phase) and bimonthly 60-minute group meetings for months 7–18 (weight loss maintenance phase). The LV condition was also provided with a limited variety prescription, which was designed to decrease the number of different non-nutrient-dense, high-energy-dense foods (NND-EDFs) (i.e., cookies, chips, candy) consumed to only 2 types, which were selected by the participants.¹⁰ Results of the study found that the LV group consumed less variety of NND-EDFs and less total energy daily at 6 months than the Lifestyle group. Percentage of weight at 6 months, –10.9%, loss was not different between the groups.¹⁰

The current study is a longitudinal cohort secondary data analysis, examining changes in dietary intake during the weight loss phase (0 to 6 months). Primary dependent variables were intake from food groups, energy, and percent energy from fat, and pounds of weight lost.

Participants

Participants were recruited from Providence, RI and Knoxville, TN between July 2006 and August 2008.¹⁰ Eligibility criteria required participants to be 21- to 65-years-old with a body mass index (BMI) (kg/m^2) between 27 and 45 kg/m^2 .¹⁰ Participants were excluded if they were not able to walk at least two blocks; reported a heart condition, chest pain, or loss of consciousness; were taking weight loss medication or participating in another weight loss program; had undergone bariatric surgery; were pregnant or lactating, less than 6 months postpartum, or planning to become pregnant during the study; or were consuming less than 5 different types of NND-EDFs.¹⁰ Only participants with complete dietary, physical activity, and weight data at 0 and 6 months were included in the analyses. One-hundred and sixty-nine of the 202 total participants had complete data based on these criteria.

Measures

Measures were collected in a research setting at 0 and 6 months by trained research staff blinded to randomization.¹⁰

Demographics—Demographic measures, such as sex and age, were collected at baseline by self-report surveys.¹⁰

Anthropometrics—A height measurement was taken at 0 months and weight measures were taken at 0 and 6 months to calculate BMI.¹⁰ Height measures were recorded to the nearest millimeter at baseline using a portable stadiometer (SECA, ITIN Scale Company, Brooklyn, NY).¹⁰ Weight was measured using a calibrated portable scale (Healthometer Professional, Sunbeam Production Inc., Raton, FL), with participants wearing light street clothes, and recorded to the nearest 0.05 kg.¹⁰ For this investigation, weight loss in pounds from 0 to 6 months was calculated.

Dietary Intake—Three, random 24-hour recalls, using the multi-pass method, were collected by phone from trained interviewers during a 1 week period at 0 and 6 months.¹⁰ The Nutrition Data System Software for Research (NDSR) developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN¹¹ was used to collect and analyze dietary data.¹⁰

Variables of dietary intake were calculated as means of three days. For regression analyses, changes in dietary intake from 0 to 6 months were calculated. Variables included energy and percent energy from fat. Additionally, servings consumed per day from food groups were examined. To determine intake from food groups, the 165 subgroups of foods, excluding infant/baby food, flour, and powdered milk, in NDSR were examined and coded into larger food groups.¹² NDSR uses the Food Guide Pyramid (FGP)¹³ to code foods into generalized food groups. This coding allows for food groups that are naturally lower and higher in fat and added sugar (i.e., fried chicken vs. lean poultry or sugar sweetened beverage vs. unsweetened beverage). Additionally, the coding system includes modified-fat and modified-sugar food groups (i.e., reduced-fat, low-fat, fat-free, and artificially sweetened). To examine the question of changes in food groups between those that were high or low in fat or added sugar, from the 165 subgroups of foods, 25 food groups were developed, 13 higher in fat and added sugar and 12 lower in fat and added sugar. Food groups developed for this comparison have the words “higher fat” or “sugar sweetened” for food groups higher in fat or added sugar, or “lower fat” for food groups lower in fat at the start of the food group name. For looking at non-modified vs. modified foods, from the 165 subgroups of foods, 17 food groups were coded (11 non-modified and 6 modified). Food groups that were developed for the non-modified and modified comparison have the word “non-modified” or “modified” at the start of the food group name.

Physical Activity—Self-reported physical activity was assessed by using the Paffenbarger Activity Questionnaire¹⁴ at 0 and 6 months. This questionnaire is scored as physical activity in energy expenditure during the week, based on flights of stairs climbed per day, city blocks walked per day (assesses for both structured walking and lifestyle walking), and minutes of structured moderate- to vigorous-intensity physical activity acquired within a typical week, and has been shown to be significantly correlated with an objective measure of physical activity.¹⁵ Changes in physical activity from 0 to 6 months were calculated.

Statistical Analyses

Independent t-tests and chi-squared tests were conducted to compare demographics and anthropometrics between participants included and not included in the secondary data analyses. For participants in this secondary data analysis, independent t-tests and chi-squared tests were used to compare demographics and baseline anthropometrics, dietary intake, and physical activity between LV and Lifestyle. Significant baseline group differences ($p < 0.05$) were found in several dietary variables and self-reported energy expenditure from physical activity. Due to these baseline differences, changes from 0 to 6 months in dietary intake, self-reported energy expenditure from physical activity, and weight were examined with repeated measures analyses of covariance (ANCOVA), with

intervention group as a covariate. Greenhouse-Geisser probability levels were used to adjust for sphericity where appropriate.

Next, hierarchical regression analyses were used to assess the relationship between changes in food group intake and changes in intake from energy and percent energy from fat, and weight from 0 to 6 months. To be able to compare choices between foods naturally high or low in fat and/or added sugar or between foods that were non-modified or modified, separate regression analyses were conducted for the two coding schemes. Residualized change scores of all variables were calculated to control for variance in change that may be due to the initial score of the measurement period. For the hierarchical regressions, sex, treatment group, and residualized physical activity were force entered into the first, second, and third block, respectively. To determine which food groups should be entered into the fourth block, linear regression analyses, controlling for sex and group assignment were conducted, with change in each food group as the independent variable and change in energy intake (or percent energy from fat intake or pounds of weight loss) as the dependent variable, with each food group run separately. The food groups with a significant association to energy intake (or percent energy intake from fat intake or pounds of weight loss) were included in the hierarchical regression. Food groups were entered by stepwise selection into the fourth block. The standard probability levels set by SPSS, at 95% confidence, with an alpha level $p < 0.05$, were used.

Results

Baseline Participant Characteristics

There were no significant differences in baseline characteristics for those included in the analyses ($n = 169$) compared to those that were excluded from the analyses ($n = 31$), or between Lifestyle and LV participants included in the analyses. Participants included in the analyses were aged 52.0 ± 8.6 years; had a BMI of 34.9 ± 4.5 kg/m²; self-reported expending 1079 ± 1329 kcal/week in physical activity; and were 92% white, 97.6% non-Hispanic, 56.8% female, 77.5% married, and 88.8% with at least some college education.

For baseline daily servings consumed from food groups, there were no significant differences between the Lifestyle and LV conditions for a majority of the food groups and the four food groups that significantly ($p < 0.05$) differed are shown in Table 1. There were no significant baseline differences between the conditions in energy intake and percent energy from fat intake. Self-reported baseline physical activity was significantly higher in Lifestyle than LV (1325 ± 1536 kcal/week vs. 805 ± 990 kcal/week, $p < 0.05$).

Changes in dietary intake, physical activity, and weight from 0 to 6 months

There were several significant ($p < 0.05$) changes in self-reported dietary intake occurring from 0 to 6 months (See Table 1). For the low- and high-fat and/or added sugar food groups, Lower Fat Fruit was the only food group that significantly increased in servings/day from 0 to 6 months, while six food groups (five high-fat and/or added sugar and one low-fat) decreased in servings/day from 0 to 6 months. For the non-modified and modified food groups, five food groups (four non-modified and one modified) decreased servings/day from

0 to 6 months. Energy and percent energy from fat significantly decreased, from 2019 ± 592 to 1376 ± 414 kcal/day and 35 ± 0.1 to 25 ± 0.1 percent kcal/day, respectively ($p < 0.05$). Significant ($p < 0.05$) changes in self-reported physical activity and weight occurred, with self-reported physical activity increasing, from 1079 ± 1328 to 2164 ± 1969 kcal/week and weight decreasing over time from 223.0 ± 41.3 to 197.0 ± 37.8 pounds.

Relationship between changes in food group intake and changes in energy, percent energy from fat, and weight from 0 to 6 months

Regressions with foods naturally high and low in fat and added sugar—

Hierarchical regressions found that the food group intake changes with a significant ($p < 0.05$) association to change in energy intake were Higher Fat Dairy, Higher Fat Fats, Higher Fat Meat, Higher Fat Nuts, Higher Fat Oils, and Lower Fat Refined Grains, as shown in Table 2. Food group changes had positive relationships with energy intake, indicating that reductions in food group intake were related to reductions in energy intake.

Food group intake changes with a significant ($p < 0.05$) association to change in percent energy from fat intake were Higher Fat Eggs, Higher Fat Fats, Higher Fat Meat, Higher Fat Oils, and Lower Fat Fruit, as shown in Table 2. Except for Lower Fat Fruit, the remaining food groups were positively associated with percent energy from fat intake. Increases in servings/day of Lower Fat Fruit intake were related to decreases in percent energy from fat intake.

Food group intake changes with a significant ($p < 0.05$) association to change in weight were Higher Fat Meat, Lower Fat Seafood, and Sugar Sweetened Sweets, as shown in Table 2. Decreases in servings/day of Sugar Sweetened Sweets and Higher Fat Meats and increases in servings/day of Lower Fat Seafood were associated with greater weight loss.

Regressions with non-modified and modified foods—Changes in intake of food groups with a significant ($p < 0.05$) association to change in energy intake were Non-modified Higher Fat Fats Oils and Sweets, Non-modified Regular Fat Dairy, Modified Lower Fat Dairy, Modified Lower Fat Fats Oils and Sweets, Modified Lower Fat Sugar Sweetened Beverages, Modified Lower Fat Sugar Sweetened Dairy, and Modified Lower Fat Sugar Sweetened Fats Oils and Sweets, as shown in Table 3. Food group changes had positive relationships with energy intake, indicating that reductions in food group intake were related to reductions in energy intake.

Changes in intake of food groups with a significant association to change in percent energy from fat intake were Non-modified Higher Fat Fats Oils and Sweets, Non-modified Regular Fat Dairy, and Modified Lower Fat Artificially Sweetened Dairy, as shown in Table 3. Changes in intake of these food groups, except Modified Lower Fat Artificially Sweetened Dairy, had positive relationships with change in percent energy from fat intake. Increases in servings/day of Modified Lower Fat Artificially Sweetened Dairy were associated with greater reductions in percent energy from fat intake.

Changes in intake of food groups with a significant association to change in weight were Modified Lower Fat Artificially Sweetened Beverages and Modified Lower Fat Sugar

Sweetened Fats Oils and Sweets, as shown in Table 3. Greater decreases in servings/day in intake of Modified Lower Fat Sugar Sweetened Fats Oils and Sweets and greater increases in servings/day of Modified Lower Fat Artificially Sweetened Dairy, were related to greater weight loss.

Overall, as seen in Table 2 and 3, changes in intake of food groups show relatively low R^2 , less than 0.05. This indicates that the overall amount of variance in change in energy, percent energy from fat intake, and weight that can be attributed to change in food group intake is low.

Discussion

This study investigated changes in food group intake during a lifestyle intervention, which provided a hypocaloric, low-fat diet, and examined what food group changes were related to reductions in energy and fat intake and weight loss. Results indicated that intake of only one food group, Lower Fat Fruit, increased, and that the majority of food groups that decreased were higher in fat, refined grains, and added sugar. In the analyses of the naturally occurring high- and low-fat and/or added sugar foods, greater reduction in servings/day in High Fat Meats was related to greater reductions in energy, percent energy from fat, and weight. In the analyses of non-modified and modified food groups, no one food group was related to reductions in energy, percent energy from fat, and weight.

This study indicates that when a hypocaloric, low-fat diet is prescribed, participants generally reduce the number of servings consumed from foods, rather than switching to consuming other foods. Thus, if additional dietary changes are desired, specific goals, other than goals related to decreasing energy and fat, may need to be included in the dietary prescription. For example, to see an increase in vegetables, it may be important to include a goal that specifically targets increasing vegetables.

Additionally, across the analyses, reducing intake of naturally higher fat food groups was most commonly associated with reducing energy, percent energy from fat, and weight. Furthermore, decreases in High Fat Meat was the one food group in which changes in intake were related to all dietary and weight outcomes in the lifestyle intervention. Thus, targeting this one food group during intervention may be a beneficial additional dietary target during intervention to assist with improving outcomes. Lastly, since participants in general consumed fewer food group servings, this investigation agrees with existing research that has shown portion control to be important in weight loss.^{2,3}

Limitations of the study include a sample that was fairly homogenous with regards to race and ethnicity and the use of self-reported dietary intake. Additionally, the study design, a secondary data analysis, limits ability to draw cause and effect conclusions. While significance was found regarding changes in food group intake and changes in dietary intake and weight, the size of the sample limits the power available (< 80%) within the analyses to detect significance.

Despite the limitations of this study, this is the first study to examine changes in food group intake occurring when a hypocaloric, low-fat diet is prescribed and how these changes may

be related to energy and percent energy from fat intake and weight loss during a lifestyle intervention. In addition, while dietary intake was self-reported, the use of unannounced 24-hour dietary recalls, collected using the multi-pass method with NDSR assist in minimizing bias.

Conclusion

When a hypocaloric, low-fat diet is prescribed, participants generally reduce the number of servings consumed from foods, rather than switching to increasing intake of foods that are naturally low in fat and/or added sugar, or are modified to reduce energy, fat and/or added sugar intake. As reducing servings from high-fat food groups, and in particular meat, was associated with positive outcomes, future research should examine the effect of a dietary prescription that includes goals to reduce servings from higher fat food groups to see if the additional guidance would improve outcomes.

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Table 1

Significant outcomes, both between conditions (Lifestyle and Limited Variety [LV]) at baseline^a and across 0 and 6 months^a within the whole sample, in dietary intake from food groups naturally high or low in fat and/or added sugar and non-modified or modified food groups in participants in a lifestyle intervention (Mean $\pm$ Standard Deviation)

Food group servings (servings/day)	0 mos	6 mos
Food Groups Naturally High or Low in Fat and Added Sugar		
Higher Fat Dairy		
Whole sample (n = 169)	0.58 $\pm$ 0.59	0.32 $\pm$ 0.39 ^b
LV (n = 89)	0.66 $\pm$ 0.61	
Lifestyle (n = 80)	0.51 $\pm$ 0.56	
Higher Fat Eggs		
Whole sample (n = 169)	0.44 $\pm$ 0.50	0.31 $\pm$ 0.47 ^b
LV (n = 89)	0.56 $\pm$ 0.58 ^c	
Lifestyle (n = 80)	0.34 $\pm$ 0.39 ^c	
Higher Fat Fats		
Whole sample (n = 169)	1.95 $\pm$ 1.61	0.70 $\pm$ 0.85 ^b
LV (n = 89)	2.08 $\pm$ 1.80	
Lifestyle (n = 80)	1.83 $\pm$ 1.42	
Higher Fat Fruit		
Whole sample (n = 169)	0.02 $\pm$ 0.10	0.00 $\pm$ 0.03 ^b
LV (n = 89)	0.03 $\pm$ 0.13	
Lifestyle (n = 80)	0.01 $\pm$ 0.06	
Higher Fat Meat		
Whole sample (n = 169)	1.47 $\pm$ 1.48	0.65 $\pm$ 1.05 ^b
LV (n = 89)	1.55 $\pm$ 1.63	
Lifestyle (n = 80)	1.39 $\pm$ 1.35	
Higher Fat Nuts		
Whole sample (n = 169)	0.60 $\pm$ 0.96	0.31 $\pm$ 0.78
LV (n = 89)	0.33 $\pm$ 0.61 ^c	
Lifestyle (n = 80)	0.84 $\pm$ 1.14 ^c	
Higher Fat Other Vegetables		
Whole sample (n = 169)	0.03 $\pm$ 0.14	0.01 $\pm$ 0.07
LV (n = 89)	0.06 $\pm$ 0.19 ^c	
Lifestyle (n = 80)	0.01 $\pm$ 0.07 ^c	
Lower Fat Fruit		
Whole sample (n = 169)	1.19 $\pm$ 1.11	1.65 $\pm$ 1.25 ^b

Food group servings (servings/day)	0 mos	6 mos
LV (n = 89)	1.19 ± 1.11	1.94 ± 1.58 ^b
Lifestyle (n = 80)	1.18 ± 1.12	
Lower Fat Refined Grains		
Whole sample (n = 169)	3.11 ± 2.16	
LV (n = 89)	3.58 ± 2.41 ^c	
Lifestyle (n = 80)	2.69 ± 1.83 ^c	
Non-modified or Modified Food Groups		
Non-modified Higher Fat Fats Oils and Sweets		0.59 ± 0.75 ^b
Whole sample (n = 169)	1.73 ± 1.50	
LV (n = 89)	1.87 ± 1.72	
Lifestyle (n = 80)	1.59 ± 1.26	0.05 ± 0.17 ^b
Non-modified Higher Fat Sugar Sweetened Fats Oils and Sweets		
Whole sample (n = 169)	0.20 ± 0.37	
LV (n = 89)	0.22 ± 0.38	0.27 ± 0.35 ^b
Lifestyle (n = 80)	0.18 ± 0.36	
Non-modified Regular Fat Dairy		
Whole sample (n = 169)	0.54 ± 0.56	0.23 ± 0.39 ^b
LV (n = 89)	0.63 ± 0.58	
Lifestyle (n = 80)	0.46 ± 0.54	
Non-modified Regular Fat Sugar Sweetened Dairy		1.02 ± 0.94 ^b
Whole sample (n = 169)	0.37 ± 0.61	
LV (n = 89)	0.41 ± 0.60	
Lifestyle (n = 80)	0.33 ± 0.62	
Modified Lower Fat Fats Oils and Sweets		
Whole sample (n = 169)	1.36 ± 1.78	
LV (n = 89)	1.41 ± 1.81	
Lifestyle (n = 80)	1.31 ± 1.75	

^aIndependent t-tests were conducted between conditions at baseline, and repeated measures analyses of covariance (ANCOVA), with intervention group as a covariate, were conducted between 0 and 6 months.

^bDenotes statistical significance from baseline, $p < 0.05$.

^cDenotes statistical significance between conditions at baseline, $p < 0.05$.

Table 2

Hierarchical regressions of change in intake of food groups naturally high or low in fat and/or added sugar and change in intake of energy and percent energy from fat and weight from 0 to 6 months in lifestyle intervention participants (n = 169)

Change in energy intake				
Hierarchical Regression Block	Variables	Beta	R ²	P value
I	Sex	−0.068	0.079	0.233
II	Group Assignment	0.128	0.023	0.019
III	Physical Activity	−0.024	0.001	0.674
IV	Food Group Changes		0.043	<0.001
	Higher Fat Dairy	0.237		
	Higher Fat Fats	0.216		
	Higher Fat Meat	0.218		
	Higher Fat Nuts	0.313		
	Higher Fat Oils	0.275		
	Lower Fat Refined Grains	0.209		
	R ² _{cum} =0.593, F(9, 142)=15.179, P<0.000			
Change in percent energy from fat intake				
I	Sex	0.092	<0.001	0.173
II	Group Assignment	−0.070	<0.001	0.285
III	Physical Activity	−0.006	0.004	0.927
IV	Food Group Changes		0.026	0.012
	Higher Fat Eggs	0.165		
	Higher Fat Fats	0.392		
	Higher Fat Meat	0.291		
	Higher Fat Oils	0.277		
	Lower Fat Fruit	−0.201		
	R ² _{cum} =0.413, F(8, 143)=12.570, P<0.000			
Change in weight				
I	Sex	0.039	0.007	0.612
II	Group Assignment	0.117	0.009	0.120
III	Physical Activity	−0.289	0.088	<0.001
IV	Food Group Changes		0.022	0.049
	Higher Fat Meat	0.150		

Change in energy intake				
Hierarchical Regression Block	Variables	Beta	R ²	P value
	Lower Fat Seafood	-0.161		
	Sugar Sweetened Sweets	0.177		
	R ² _{cum} =0.197, F(6, 145)=5.934, P<0.000			

Table 3

Hierarchical regressions of change in intake of non-modified and modified food groups and change in intake of energy and percent energy from fat and weight from 0 to 6 months in lifestyle intervention participants (n = 169)

Change in energy intake				
Hierarchical Regression Block	Variables	Beta	R ²	P value
I	Sex	−0.205	0.079	<0.001
II	Group Assignment	0.102	0.023	0.054
III	Physical Activity	0.041	0.001	0.771
IV	Food Group Changes		0.015	0.048
	Non-modified Higher Fat Fats Oils and Sweets	0.131		
	Non-modified Regular Fat Dairy	0.264		
	Modified Lower Fat Dairy	0.218		
	Modified Lower Fat Fats Oils and Sweets	0.175		
	Modified Lower Fat Sugar Sweetened Beverages	0.168		
	Modified Lower Fat Sugar Sweetened Dairy	0.129		
	Modified Lower Fat Sugar Sweetened Fats Oils and Sweets	0.239		
	R ² _{cum} =0.457, F(10, 141)=6.962, P<0.000			
Change in percent energy from fat intake				
I	Sex	0.083	<0.001	0.257
II	Group Assignment	−0.036	<0.001	0.609
III	Physical Activity	−0.002	0.004	0.973
IV	Food Group Changes		0.042	0.004
	Non-modified Higher Fat Fats Oils and Sweets	0.231		
	Non-modified Regular Fat Dairy	−0.209		
	Modified Lower Fat Artificially Sweetened Dairy	0.392		
	R ² _{cum} =0.286, F(6, 145)=9.691, P<0.000			
Change in weight				
I	Sex	−0.022	0.007	0.779
II	Group Assignment	0.107	0.009	0.153
III	Physical Activity	−0.307	0.088	<0.001
IV	Food Group Changes		0.043	0.006
	Modified Lower Fat Artificially Sweetened Beverages	−0.211		
	Modified Lower Fat Sugar Sweetened Fats Oils and Sweets	0.222		

Change in energy intake				
Hierarchical Regression Block	Variables	Beta	R ²	P value
	R ² _{cum} =0.197, F(5, 146)=7.175, P<0.000			

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