Eating frequency is higher in weight loss maintainers and normal weight individuals as compared to overweight individuals

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Abstract

Eating frequency has been negatively related to body mass index (BMI). The relationship between eating frequency and weight loss maintenance is unknown. This secondary analysis examined eating frequency (self-reported meals and snacks consumed/day) in weight loss maintainers (WLM) who had reduced from overweight/obese to normal weight, normal weight (NW) individuals, and overweight (OW) individuals. Data, collected July 2006-March 2007 in Providence, RI, included three, 24-hour dietary recalls (two weekdays, one weekend day) analyzed using NDS-R software from 257 adults (WLM = 96: 83.3 % female, 50.0 ± 11.8 years, BMI = 22.1 ± 1.7 kg/m^2; NW = 80: 95.0 % female, 46.1 ± 11.5 years, BMI = 21.1 ± 1.4 kg/m^2; OW = 81: 53.1 % female, 51.4 ± 9.0 years, BMI = 34.2 ± 4.1 kg/m^2) with plausible intakes. Participant-defined meals and snacks were ≥ 50 kcals and separated by more than one hour. Self-reported physical activity was highest in WLM followed by NW, and then OW (3097 ± 2572 kcals/week, 2062 ± 1286 kcals/week, and 785 ± 901 kcals/week, respectively; $p < 0.001$). Number of daily snacks consumed was highest in NW, followed by WLM, and then OW (2.3 ± 1.1 snacks/day; 1.9 ± 1.1 snacks/day; 1.5 ± 1.3 snacks/day, respectively; $p < 0.001$). No significant group differences were observed in mean number of meals consumed (2.7 ± 0.4 meals/day). Eating frequency, particularly in regards to a pattern of three meals and two snacks per day, may be important in weight loss maintenance.

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Keywords

eating frequency; snacks; weight loss maintenance; obesity

INTRODUCTION

The prevalence of overweight/obesity has reached epidemic levels in the United States, with more than 60% of adults being overweight (1). While lifestyle interventions are successful in achieving weight loss, prevention of weight regain remains elusive (2). Therefore, it is important to identify factors that aid with successful weight loss maintenance.

Increasing the structure of the diet, in which procedures are put into place to help limit the amount and type of food consumed, appears to be important for successful weight loss maintenance (3). For example, a recent review of long-term lifestyle interventions to prevent weight regain after weight loss found that use of meal replacements, which control portion size and reduce variety in the diet, was related to weight loss maintenance (4). Research examining eating patterns of the National Weight Control Registry, a registry of over 6000 individuals who have lost and maintained a significant amount of weight loss (on average participants have lost 30 kg and kept it off for 5.5 yrs), has found that these individuals have a fairly structured diet: they regularly consume breakfast, have a consistent diet across weekdays and weekends, limit the variety of foods consumed, and report consuming close to five eating occasions per day (2, 5, 6).

Number of daily eating occasions, meals and snacks consumed per day, which is often reported as eating frequency (EF), may be important in achieving a lower weight status (7, 8). Eating more frequently may help to control hunger, which is believed to decrease the chance of overeating (9). Research investigating the relationship between EF and weight has found mixed outcomes(10). Methodological limitations in previous investigations, such as not examining the potential influence of physical activity (11) and including dietary under-reporters in analyses (10), have been suggested as potential reasons for the unclear outcomes between EF and weight.

The purpose of this study was to examine the relationship between EF and weight loss maintenance. To achieve this purpose, comparisons between successful weight loss maintainers (WLM), normal weight (NW), and treatment-seeking overweight/obese (OW) individuals were made in the number of self-reported meals and snacks consumed per day. Additionally, to account for potential confounding variables, physical activity was controlled for and under-reporters of dietary intake were excluded from this analysis. It was hypothesized that WLM and NW would have a greater EF than OW.

METHODS

Participants

Participants for this secondary data analysis were part of two National Institutes of Health funded investigations. Data for both investigations were collected between July 2006 and March 2007 in Providence, RI. The first was an 18-month randomized controlled trial examining the influence of a dietary variety prescription, which limited the variety of sweet and salty energy-dense foods consumed, on weight loss maintenance during a standard behavioral intervention. Baseline data from OW participants were obtained from this investigation. This trial was registered at ClinicalTrials.gov (NCT00328744). The second investigation was a cross-sectional study examining weight control behaviors of successful long-term weight loss maintainers and normal weight controls. Data from WLM and NW

were obtained from this study. Both studies were approved by the Institutional Review Board at the Miriam Hospital in Providence, RI. Written informed consent was obtained from all participants for the respective studies of which they were participants.

OW were overweight and obese (BMI = 27 – 45 kg/m^2) individuals, aged 21 to 65 years, who could walk at least two blocks and regularly consumed at least five different sweet and salty energy-dense foods (assessed by a one-week food record). Participants were ineligible if they reported major psychiatric diseases or organic brain syndromes, had a food allergy to commonly consumed foods, recently lost weight, took weight loss medication, were less than six months post-partum, currently breastfeeding, or planned to move out of the area during the time frame of the investigation. Baseline data from the randomized controlled trial were used in this investigation. Participants were not paid for baseline measures.

WLM and NW were from the cross-sectional study in which participants were aged 18 years or older. WLM were overweight/obese (BMI > 25 kg/m^2) at some point in their life, normal weight (BMI = 19 – 24.9 kg/m^2) at entry into thetrial, had lost > 10% of their maximum body weight and maintained that for at least five years, and were weight stable (± 4.5 kg) within the previous two years. NW were normal weight (BMI = 19 – 24.9 kg/m^2) at entry into the trial, never overweight or obese (BMI ≥ 25 kg/m^2), and were weight stable (± 4.5 kg) within the previous two years. Participants were located in all different parts of the United States, but predominantly participants were from New England (>70%), the same area as OW participants. Participants were paid $50 for assessments. Participants who had completed measures at approximately the same time period in which measures were collected from OW were included in this investigation.

Measures

For OW participants, all measures were collected at baseline, prior to randomization to the start of the intervention. For WLM and NW participants, all measures were administered at study enrollment. All variables, except for anthropometric measures, were measured identically in the two studies.

Self-reported information on age, sex, race/ethnicity, highest level of education, and marital status was collected from all participants. For OW, weight and height were measured and documented by trained and blinded assessors with an electronic digital scale (Healthometer Professional 597KL, Pelstar LLC, Bridgeview, IL) and a stadiometer (Seca 214, Seca North America, East Hanover, MD), respectively, according to standard procedures (12). Height and weight from WLM and NW was collected via self-report, which has been validated previously (13).

Self-reported physical activity was assessed using the Paffenbarger Activity Questionnaire (PAQ) (14) for all three groups. This questionnaire yields estimates of the total energy (kcals) expended in physical activity per week. The PAQ has been shown to be significantly correlated with measures of cardiovascular fitness (15). Self-reported physical activity was used to help determine plausible dietary reporters and was included as a covariate in analyses to control for the effect of physical activity on EF.

Dietary intake was assessed via three, random, non-consecutive, 24-hour phone dietary recalls (two weekdays and one weekend day) for all three groups. Trained interviewers, blinded to group status, from the Cincinnati Center for Nutritional Research and Analysis at Children's Hospital Research Foundation of Cincinnati conducted interviews for both trials. Participants were given two-dimensional portion size estimation tools. Each 24-hour dietary recall was completed using the Nutrition Data System for Research software (version 2006, 2006, Nutrition Coordinating Center, University of Minnesota, Minneapolis, Minnesota).

The Goldberg cut-off equation (16) was used to identify under-reporters. The Goldberg equation assumes that energy intake equals energy expenditure, which can be calculated as basal metabolic rate times physical activity level, in weight stable individuals. Physical activity level, either 1.53 (inactive) or 1.76 (active), was coded for each participant based on energy expenditure from the PAQ (14) using guidelines from the joint report of the Food and Agriculture Organization/World Health Organization/United Nations University (17) and recommendations from the American College of Sports Medicine and the American Heart Association (18). A 99% confidence limit for reported energy intake: basal metabolic rate was calculated for each individual and those that were below the 99% confidence interval were classified as under-reporters (19).

Eating occasions were defined as any instance in which at least 50 kcals were consumed (food or drink). If two eating occasions were consumed within the same hour, they were combined and counted as one eating occasion. This method of calculating the number of eating occasions was based upon previous research (8). Meals and snacks were participant defined, however only one eating occasion per day was counted as breakfast, lunch, or dinner, with the second reported same meal coded as a snack. Dietary recalls were reviewed twice by Bachelor- and Master-level nutrition-trained personnel. Discrepancies in coding were resolved by a Doctoral-level registered dietitian.

Statistical Analysis

One-way analysis of variance and Chi-Square tests examined differences in baseline characteristics in the groups as well as between under-reporters and plausible reporters. With under-reporters removed from the analysis, age and sex were significantly different between the groups and were used as covariates in subsequent analyses. Analyses of covariance were conducted to examine group differences in energy and percent energy from macronutrients consumed, and EF variables (meals and snacks) consumed. These analyses were repeated with self-reported energy expenditure from physical activity as a covariate. For significant outcomes, post-hoc comparisons with Bonferroni corrections were conducted. Relationships between the EF variables and energy intake, self-reported energy expenditure from physical activity, and BMI for all participants combined were investigated using Pearson correlation coefficients. SPSS for Windows (version 17.0, 2008, SPSS Inc, Chicago, IL) was used to perform statistical analyses. Alpha level was set *a priori* at $p < 0.05$.

RESULTS AND DISCUSSION

Baseline Characteristics

Only participants reporting plausible dietary intakes were included in all analyses (total: n = 257; OW: n = 81; WLM: n = 96; NW: n = 80). Baseline characteristics of the 257 participants by group are shown in Table 1. Groups were predominantly White (94.1 %), non-Hispanic (97.3 %), had some college education (89.9%), and married (68.1%). OW was older than NW ($p < 0.01$) and had a lower ($p < 0.001$) percentage of female participants than NW and WLM. BMI was significantly ($p < 0.001$) different for all three groups. Energy expended from self-reported physical activity was also significantly different ($p < 0.001$) between all three groups, with OW expending the least (785 ± 901 kcals/week) and WLM expending the most (3097 ± 2572 kcals/week).

Under-reporters

Ten percent of participants were under-reporters, with OW having the largest percentage (OW: n = 16, 16.5%; WLM: n = 8, 7.7%; NW: n = 5, 5.9%, $p < 0.05$). There were no baseline differences between under-reporters and plausible reporters among NW and WLM.

In OW, under-reporters had a higher BMI then plausible reporters (36.9 ± 3.8 kg/m^2 vs. 34.2 ± 4.1 kg/m^2, $p < 0.05$).

Dietary Intake and EF with Age and Sex as Covariates

Energy intake was higher in OW than WLM (2020 ± 559 kcals/day vs. 1802 ± 505 kcals/day, $p < 0.05$) (see Table 2 for adjusted means). WLM consumed a significantly lower percent energy from fat and a greater percent energy from carbohydrate than the other groups (see Table 2 for detailed results). There was no difference in the reported number of meals consumed between the groups (2.7 ± 0.4 meals/day). Number of snacks reported was lower in OW than WLM (1.5 ± 1.2 snacks/day vs. 2.0 ± 1.0 snacks/day, $p < 0.01$) and NW (2.3 ± 1.1 snacks/day, $p < 0.001$).

Dietary Intake and EF with Age, Sex, and Physical Activity as Covariates

Analyses of dietary intake controlling for age, sex, and self-reported physical activity were consistent with analyses reported above (see Table 2 for adjusted means). There was no difference in reported number of meals consumed between the groups. Snacks consumed per day were significantly ($p < 0.001$) different between all three groups with OW (1.5 ± 1.3 snacks/day) consuming the least, WLM (1.9 ± 1.1 snacks/day) in the middle, and NW (2.3 ± 1.1 snacks/day) consuming the most.

Correlations Between EF Variables, Energy Intake, Physical Activity, and BMI

With all participants combined, a positive correlation was found between number of snacks and energy intake ($r = 0.18$, $p < 0.01$) and snacks and energy expenditure ($r = 0.13$, $p < 0.05$). BMI was negatively correlated with snacks ($r = -0.20$, $p < 0.01$). No significant correlations were found for meals.

This study was the first to compare EF between successful weight loss maintainers, normal weight, and overweight individuals. Findings indicated that WLM and NW had more frequent daily eating occasions than OW, due to a greater number of daily snacks consumed. Moreover, analyses across all three groups indicated that number of daily snacks consumed was negatively associated with BMI. These findings are consistent with previous cross-sectional studies that have found greater EF related to lower BMI (7, 8).

While there was a difference in snacking between WLM and NW as compared to OW, the difference was fairly small (approximately 0.5 – 0.8 snacks/per day), and does not suggest a "grazing" (eating every two to three hours) style of EF in those with lower BMI. For WLM and NW, the eating pattern was consuming approximately three meals plus two snacks per day. This eating pattern is consistent with the only other published report of EF in successful weight loss maintainers in which participants in the National Weight Control Registry reported consuming approximately five eating occasions per day (5). Therefore, it appears from observational research that this eating pattern may be beneficial for long-term weight loss maintenance.

The mechanisms by which increased EF is associated with lower BMI and weight loss maintenance remain unclear. This study suggests that physical activity may be an important factor in the relationship between EF and BMI. In this study when all groups were combined, greater frequency of snack episodes was associated with greater physical activity and energy intake, but a lower BMI. Thus, a higher level of activity may allow for maintenance of lower body weight despite greater energy intake from increased snack frequency. Clearly, as shown with the OW, a higher energy intake coupled with lower physical activity is not helpful with achieving a healthy weight or weight loss maintenance, while as demonstrated by the WLM, a lower energy intake combined with greater physical

activity is helpful for achieving and maintaining weight loss. More research is required to understand the relationship between EF, physical activity, weight status, and maintenance of weight loss, before clinical recommendations can be developed.

Limitations of this study include potential unmeasured differences between the groups as they were recruited for two different studies. However, the participants in these studies were recruited from the same geographical area and data were collected during the same time period, with most measures conducted identically in both studies. Additionally, dietary intake and energy expenditure from physical activity were self-reported by all groups Also, this was a cross-sectional study, and the generalizability of this study is limited by the primarily white, middle-class, middle-aged sample, as well as the treatment seeking OW group.

CONCLUSIONS

This preliminary investigation suggests that eating more frequently, characterized by an eating pattern of approximately three meals and two snacks, was related to lower BMI and maintenance of weight loss. However, as this investigation also found that greater frequency of snack episodes were positively related both to energy intake and physical activity, additional research is needed to examine the role of EF and physical activity in weight loss maintenance. As greater EF was associated with two different groups of normal weight individuals, further examination of this pattern as a part of a dietary prescription for weight gain prevention and weight loss maintenance is warranted.

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Table 1

Baseline characteristics of participants in a cross-sectional study on eating frequency and weight status in three subgroups: Weight Loss Maintainers, Normal Weight, and Overweight[ab]

Characteristic	Weight Loss Maintainers (n = 96)	Normal Weight (n = 80)	Overweight (n = 81)
Age (y)	$50.0 \pm 11.8^{1,2}$	46.1 ± 11.5^{1}	51.4 ± 9.0^{2}
Sex (% female)	83.3^{1}	95.0^{1}	53.1^{2}
BMI (kg/m^2)[c]	22.1 ± 1.7^{1}	21.1 ± 1.4^{2}	34.2 ± 4.1^{3}
Race (%)			
American Indian	0	1.3	0
Asian	0	1.3	0
Black	3.1	0	3.7
White	91.7	95	95.1
Other	5.2	2.5	1.2
Hispanic (%)			
Yes	2.1	2.5	3.7
No	97.9	97.5	96.3
Education (%)			
High school	8.3	2.5	6.2
Vocational school	5.2	2.5	4.9
Some college	6.3	11.3	17.3
College graduate	28.1	40	33.3
Graduate school	52.1	43.8	38.3
Marital status (%)			
Single	15.6	20	12.3
Married	67.7	70	66.7
Divorced	12.5	8.8	16
Separated	0	1.3	0
Widowed	4.2	0	4.9
Self-reported physical activity (kcals/week)	3097 ± 2572^{1}	2062 ± 1286^{2}	785 ± 901^{3}

[a] Results are reported as means ± standard deviation.

[b] Values in a row that do not have a shared superscript are significantly different ($p < 0.05$).

[c] BMI = body mass index.

Table 2

Adjusted self-reported dietary intake in a cross-sectional study on eating frequency and weight status in three subgroups: Weight Loss Maintainers, Normal Weight, and Overweight[a],[b]

Total Daily Intake		Weight Loss Maintainers (n = 96) (M ± SD)	Normal Weight (n = 80) (M ± SD)	Overweight (n = 81) (M ± SD)	p-value[c]
Energy intake (kcal/d)	age/gender controlled	1802 ± 505^1	$1900 \pm 426^{1,2}$	2020 ± 559^2	p < 0.05
	age/gender/activity controlled	1780 ± 539^1	$1897 \pm 426^{1,2}$	2049 ± 610^2	p < 0.05
% kcals from fat	age/gender controlled	28.7 ± 8.2^1	33.0 ± 8.3^2	35.2 ± 8.9^2	p < 0.001
	age/gender/activity controlled	29.4 ± 9.2^1	33.1 ± 8.3^2	34.3 ± 9.8^2	p < 0.01
% kcals from carbohydrate	age/gender controlled	55.0 ± 10.2^1	49.8 ± 10.1^2	47.4 ± 10.8^2	p < 0.001
	age/gender/activity controlled	54.3 ± 10.2^1	49.7 ± 10.1^2	48.3 ± 11.8^2	p < 0.01
% kcals from protein	age/gender controlled	18.5 ± 4.1^1	16.2 ± 4.6^2	$17.4 \pm 4.9^{1,2}$	p < 0.01
	age/gender/activity controlled	18.6 ± 5.1^1	16.2 ± 4.6^2	$17.4 \pm 4.9^{1,2}$	p < 0.01
Meals	age/gender controlled	2.7 ± 0.4	2.7 ± 0.4	2.8 ± 0.4	ns[d]
	age/gender/activity controlled	2.7 ± 0.4	2.7 ± 0.4	2.7 ± 0.5	ns
Snacks	age/gender controlled	2.0 ± 1.0^1	2.3 ± 1.1^1	1.5 ± 1.2^2	p < 0.001
	age/gender/activity controlled	1.9 ± 1.1^1	2.3 ± 1.1^2	1.5 ± 1.3^3	p < 0.001

[a] Results are reported as adjusted means ± standard deviation.

[b] Values in a row that do not have a shared superscript are significantly different (p < 0.05).

[c] p-values are for the main effect of group.

[d] ns = not significant