Associations between snacking and weight loss and nutrient intake among postmenopausal overweight-to-obese women in a dietary weight loss intervention

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Abstract
Snacking may play a role in weight control. The associations of timing and frequency of snacking with observed weight change and nutrient intake were assessed in an ancillary study to a 12-month randomized controlled trial in Seattle, WA. Overweight-to-obese postmenopausal women (n=123) enrolled in the two dietary weight loss arms from 2007–2008 with complete data at 12-months were included in these analyses. Generalized linear models were used to test the associations between snacking and weight loss (%) and nutrient intake at the 12-month time point. Participants were on average 58 years old and mainly non-Hispanic White (84%). Ninety-seven percent reported ≥ 1 snack/day. Weight loss (%) was significantly lower among mid-morning (10:30am–11:29am) snackers (7.0%, 95% CI 4.3, 9.7) compared to non-mid-morning snackers (11.4%, 95% CI 10.2, 12.6; p value: 0.004). A higher proportion of mid-morning snackers reported more than 1 snack/day (95.7%), compared to afternoon (82.8%) and evening (80.6%) snackers, though differences were not statistically significant. Women who reported ≥2 snacks/day vs. ≤ 1 snack/day had higher fiber intake (p=0.027). Afternoon snackers had higher fruit and vegetable intake compared to non-afternoon-snackers (p=0.035). These results suggest that snack meals can be a source for additional fruits, vegetables, and fiber-rich foods; however, snacking patterns might also reflect unhealthy eating habits and impede weight loss progress. Future dietary weight loss interventions should evaluate the effects of timing, frequency, and quality of snacks on weight loss.

Keywords
snacking; weight loss; women; nutrient intake

INTRODUCTION
Meal pattern characteristics such as frequency, timing (e.g. breakfast, late-night eating), or type (e.g. main meals, snacks) may play a role in weight control. Positive associations have been observed between snacking frequency and energy intake (1–5), suggesting snacking could contribute to weight gain. However, the relationship of snacking with weight is inconclusive (4, 6–10). In a recent review, 16/20 studies reported inverse associations between eating frequency and weight (11). However, if underreporting of energy intake is not appropriately accounted for, snack intake may be underestimated (11–13). A review of controlled feeding studies concluded that snacks offered little to no benefit to overall regulation of food intake (14). Furthermore, a prospective analysis of National Health and Nutrition Examination Survey (NHANES) data detected no association of eating frequency with weight change (8). Conflicting findings may be due to the lack of universal terms to define meals and snacks (4, 15) and may also vary by the setting and characteristics of the population studied (16).

The present study examined the relationships of between-meal snacking and snacking frequency with weight loss (%) and nutrient intake using a simple, reproducible meal pattern grid to assess snacking patterns(4) among postmenopausal overweight-to-obese women in a year-long dietary weight loss intervention. Little is known about snacking frequency and
weight change in this population, a group at high risk for obesity and for chronic diseases from obesity including diabetes, cardiovascular disease, and certain cancers such as breast, colon, and endometrium (17, 18). It was hypothesized that snacking would be positively related to weight loss, fiber, fruit and vegetable intake and inversely related to fat intake.

**METHODS**

**Participants**

Participants in this ancillary study were part of a larger, 4-arm randomized controlled trial, testing the effects of nutrition and exercise based interventions in breast cancer biomarkers and body composition (19). The 4-arms included: 1) diet-induced weight loss (Diet); 2) aerobic exercise; 3) both interventions combined (Diet + Exercise); and 4) control. The design of the parent trial was detailed previously (19). Women enrolled in either the Diet or Diet + Exercise arms from June 2007 to August 2008 formed the “Weight and Eating Behaviors (WEB) cohort” used for the current analyses. Women who completed the parent trial (n=92) prior to this ancillary study were not included in the WEB cohort. The Fred Hutchinson Cancer Research Center Institutional Review Board approved all study procedures and study participants provided written informed consent.

**Lifestyle-Based Interventions**

A detailed description of the lifestyle-based interventions has been described elsewhere (19). Briefly, the goal of the exercise intervention was ≥45 minutes of moderate-to-vigorous intensity aerobic exercise, 5 days per week for 12-months. Participants attended ≥ 3 sessions per week at the study facility, supervised by an exercise physiologist, and exercised the remaining sessions at home.

The design and curriculum of the diet intervention were based on the Look AHEAD (Action for Health in Diabetes) and Diabetes Prevention Program (DPP) studies(20, 21), with the following goals: total intake of 1200–2000 kcals/day based on baseline weight, < 30% calories from fat, and 10% reduction in weight by 6-months with maintenance to 12-months. While separate instruction groups were held for women in the Diet and Diet + Exercise groups to reduce contamination; registered dietitians (RDs) with training in behavior modification delivered the same curriculum to both groups. The curriculum covered topics such as reducing fat and improving fiber intake, self-monitoring of weight and food intake, goal setting, and problem solving. Women were asked to maintain a daily food journal for 6 months, or until they reached their weight loss goal (10%). No specific recommendations were made concerning snacking behavior. Women met individually with an RD on at least two occasions, followed by weekly group meetings, up to 6 months. Thereafter, women met with an RD at least semi-monthly (e.g. one in-person, plus email or phone contact), where self-monitoring of weight and food intake were still encouraged and sessions focused on staying motivated and dealing with barriers and lapses. However, those struggling with initial or maintenance of weight loss received additional RD assistance.

**Demographic and Anthropometric Variables**

Self-reported information on age, race/ethnicity, marital status, and education level were collected as baseline measures. Anthropometric measurements were collected at baseline and at 12-months and performed with the participant in a hospital gown. Trained technicians obtained height and weight using a balance beam scale (DETECTO, Web City, MO) and stadiometer (Perspective Enterprises, Portage, MI), rounding up to the nearest 0.1 cm and 0.5 kg, respectively.
Meal Pattern Grid

Meal pattern intake was measured at 12-months, using a self-administered, meal assessment grid used to describe typical frequency, types and temporal distribution of meals. The instrument, developed by Berteus-Forslund et al. to assess meal patterns in obese and normal weight individuals in a Swedish population, demonstrated reasonable reliability (r=0.70) (4) and ability to distinguish meal patterns between lean and obese adults(2, 4). This grid is currently being evaluated against 24-hour recalls in two collaborating work-site studies in the United States (SAA Beresford, personal communication, April 15, 2011).

To complete the grid, the women indicated when they ate or drank during a typical 24-hour weekday, noted the time, and type of meal (ie. main, light/breakfast, snack, beverage only). Participants were instructed to mark one box per line. If a respondent marked a meal and beverage box, the meal box was coded as the default. The grid provided examples of foods common to each meal type, but did not provide standard definitions. The only modification made to the original grid was to include foods familiar to an American audience (Appendix).

Dietary Intake

Percent calories from fat, fiber (g/d), and fruit and vegetable intake (servings/day) were estimated at 12-months using the Women’s Health Initiative (WHI) food frequency questionnaire (FFQ)(22). The WHI FFQ reasonably compares to food records and 24-hour recalls (mean intake based on 8 days worth of entries), with correlation coefficients for percent energy from fat of 0.62 and 0.70 for fiber (22). Women who reported values outside of the plausible range of energy intake (<600 kcals and >3500 kcals) (22) were excluded from the main analysis (n=5).

Statistical Analyses

The distribution of main, light, and snack meals over the course of a typical 24-hour period was examined to establish the time periods for main meals (i.e. breakfast, lunch, and dinner) and snacking (i.e. mid-morning, afternoon, evening). The time periods were: breakfast (5:00am–10:29am), mid-morning snack (10:30am–11:29am), lunch (11:30am–1:59pm), afternoon snack (2:00–5:29pm), dinner (5:30pm–8:59pm), and evening snack (9:00pm–12:00am). Frequencies for main, light, snack, and beverage only meals were tabulated. In this study, a snack was: 1) identified as a “snack meal” on the meal pattern grid; and 2) occurred between main meals. A cross tabulation between timing and frequency of snacking was conducted to further examine snacking patterns.

Generalized linear models were used to examine associations at 12-months for snacking (ie. timing and frequency) with weight loss (%) and nutrient intake. A minimum difference of 4.2 % in weight change (SD: 7%, two group samples of n=30, 93) could be detected at 80% power (type-I error 0.05). The models were also adjusted for baseline age, BMI, study arm (Diet, Diet + Exercise), race/ethnicity, and FFQ-estimated alcohol, sweetened beverage intake, and nutrient values, as well as for grid-estimated total number of main and light meals and snack occasions at other time periods. Fiber (g/d), % calories from fat, and fruit and vegetable intake (servings/day) were assessed because they were emphasized during the dietary weight loss intervention. Due to the skewed distribution of fiber, total fruit and total calories, these variables were log transformed and geometric means were reported. All statistical tests were two-sided with an alpha of <0.05 and all analyses were performed using STATA (version 11.1, 2010, STATA Corp, College Station, TX).
RESULTS AND DISCUSSION

Baseline characteristics are presented in Table 1. Women were on average 58 years old and had a mean BMI of 31.3 kg/m². Eighty four percent were non-Hispanic White, 58% were married or living with a partner, 67% had at least a college degree, and 59% were employed full-time. There were no significant differences in demographic characteristics between the Diet (n=59) vs. Diet+ Exercise (n=64) arms. No significant differences were observed between those enrolled (n=143) vs. not enrolled (n=92) in the WEB cohort; however, non-completers (i.e. enrolled in WEB cohort, but did not complete 12 month measures) (n=20) had significantly higher mean BMI’s than completers (n=123) (data not shown).

Participants had a mean (SD) % weight change of 8.8% (5.5) at 6 months and 10.7% (7.1) at 12 months (Table 1). No statistically significant differences were observed by study arm (Diet vs. Diet+ Exercise) at either time point. In the present study’s subsample of 123 women, approximately half met the 10% weight loss goal by 6 months, with no difference between Diet and Diet+ Exercise arms, and 75% were actively trying to lose weight between months 6 and 12 (either because they had not met goal by 6 months, or because they opted to lose more than 10% of baseline weight)(data not shown).

Participants reported a mean (SD) of 6(1.29) meals/day including beverage-only occasions: 1.4 (0.5) main meals/day, 1.5 (0.6) light meals/day, 2.1(1.0) snacks/day, and 1.00 (0.98) beverage only/day (data not shown). Snacking was highly prevalent: 97% (n=119) reported ≥ 1 “snack meal” per day (data not shown). The most common snacking period was in the afternoon: 76% (n=93) of women reported a “snack meal” in the afternoon period (2:00–5:29pm) (Figure). Only 19% (n=23) reported a mid-morning (10:30am–11:29am) snack and almost 30% (n=36) reported ≥ “snack meal” after 9pm (Figure). Compared to afternoon (82.8%) and late evening (80.6%) snackers, more mid-morning snackers (95.7%) reported > 1 snack/day (p > 0.05) (Figure).

Women who reported mid-morning snacking lost significantly less weight (7.0%, 95% CI 4.1, 9.8) compared to non-mid-morning-snackers (11.5%, 95% CI 10.2, 12.7 p=0.004)(Table 2). Afternoon snackers reported higher fiber intake (p=0.047) and fruit and vegetable intake (p=0.035) compared to non-afternoon-snackers.

There were no statistically significant differences in % weight loss, % fat intake, or fruit and vegetable intake by snacking frequency. Fiber intake was higher among women who reported 2 snacks/day (21.7 g/d, 95% CI 19.8, 24.9) and 3 snacks/day (23.2 g/d, 95% CI 19.7, 25.2) compared to women who reported 0–1 snacks/day (17.1 g/d, 95% CI 15.1, 20.3; p value: 0.027) (Table 2).

The prevalence of snacking in this study was comparable to 2003–2006 NHANES data, in which 97.3% of adults (≥ 65 years) reported snacking (23). In this study, less weight loss was observed among mid-morning snackers vs. non mid-morning snackers. Snacking frequency was associated with higher intake of fiber and in particular, afternoon snackers had greater intakes of fiber, fruits and vegetables.

Previous research on morning time eating patterns and weight change have only focused on breakfast intake (24, 25), but not on morning-time snack intake. For example, a prospective observational study in 6874 European adults aged 40–75 years reported an inverse association between % energy intake consumed at breakfast and weight gain (25). Observing a lower % of weight loss in mid-morning snackers, while novel, may not relate necessarily to the time of day, but rather to the short interval between breakfast and lunch. In this study, most mid-morning snackers reported eating both breakfast and lunch, as well as eating > 1 snack/day, which suggests that snacking was an additional eating occasion. Recent research
has reported an increase in eating occasions among United States (US) adults in the past few
decades (1, 5). An analysis of NHANES data found that the time interval between meals was
one hour less in the 2003–2006 survey compared with the 1977 survey(5). Research
suggests that this may be a reflection of “recreational” or “mindless” eating habits, where
individuals are influenced to eat by a variety of situational and external cues (e.g. food
availability, time of day, other people) other than hunger and satiety (5, 15, 26, 27). In a
cross-over experiment in males between the ages of 20–25 years, snacks administered in a
non-hungry state did not influence satiety in the following meal; findings were consistent
regardless of the nutrient composition of the snack (e.g. high carbohydrate or high protein)
(28). This suggests, additional snacking occasions could contribute to excess calories,
particularly if they are not consumed in response to internal hunger cues. However, further
studies are needed to assess the effect of time between eating occasions on unhealthful
eating behaviors and on weight and evaluating the reasons for snacking.

Marginally higher reported intake of fiber and servings of fruits and vegetables were found
among afternoon snackers and higher fiber intake was observed among women who
reported greater snacking frequency (≥ 2 snacks/day vs. ≤ 1 snack/day). Previous use of the
meal pattern grid to examine snacking with fiber intake revealed an inverse (2) rather than
positive association. In the previous study, the relationship was assessed prior to the
intervention, which might help explain differences from this study. Additionally, in a weight
loss intervention context, participants are typically encouraged to choose fruits and
vegetables over higher energy dense options. If snacks are used to incorporate low-energy
density, high-fiber foods, eating more snacks may be less likely to contribute to weight gain.

Using the simple meal pattern grid (4) to assess meal and snack patterns had strengths and
limitations. The grid, can distinguish between various meal-types, which is helpful, given
the inconsistency of defining “snacking” across studies (1, 3, 29). The simplicity of the grid
also made it easy for participants to complete without much assistance. The developers
of this tool suggest that the risk of underreporting may be lessened since individuals do not
need to recall specific food items to complete the grid (4). Underreporting of energy intake
is of particular concern among individuals involved in weight loss interventions for the
following reasons: women in behavioral weight loss studies may underreport dietary intake
more at the end of the study (30), less successful dieters are more likely to underreport (31),
plus foods of low social desirability (e.g. certain snack foods, high fat foods, sweets, etc) are
often underreported (32). A limitation of the grid was that it did not include specific types
and amounts of foods, and therefore the types of foods associated with the main, light, or
snacking occasions could not be determined. While not previously validated against other
methods; it is currently being evaluated against 24-hour recalls in two other US populations
(SAA Berersford, personal communication, April 15, 2011).

CONCLUSIONS

In this study, both positive and negative outcomes related to snacking were observed.
Snacks can be used to incorporate healthful foods such as fruits and vegetables; however,
snacking patterns might also reflect unhealthy eating habits (e.g. mindless eating,
overeating) and impede weight loss progress. With the high prevalence of snacking in this
study population and among US adults, future dietary weight loss interventions should
evaluate of the effects of timing, frequency, and quality of snacks on weight loss.
Individuals undergoing dietary weight loss programs should be educated on ways to
healthfully incorporate snacks into the diet.
Acknowledgments

Acknowledgments/Funding Support

This study was funded by National Cancer Institute (NCI) NIH grants R01 CA105204-01A1 and U54-CA116847 (Transdisciplinary Research on Energetics and Cancer). KFS received support from NIH 5KL2RR025015-03 and AK was supported by NCI R25CA094880 at the time of this study and is currently supported by NCI 2R25CA057699-16. The authors wish to thank the participants and study staff for their time and dedication to the study.

APPENDIX

1. Describe how you eat during a typical 24 hour WEEKDAY. WRITE THE TIME that you ate or drank, and MARK WITH AN ‘X’ the type of meal which corresponds best. Please mark one box per line and DO NOT WRITE IN ACTUAL FOODS. Remember to include snacks, other ‘light meals’, and beverages.

EXAMPLE:

<table>
<thead>
<tr>
<th>Time</th>
<th>Main Meal (e.g. cooked dish, hearty soup/stew with bread, large salad with bread, full sandwich)</th>
<th>Light meal/breakfast (e.g. cooked or cold cereal, soup, side salad, half sandwich)</th>
<th>Snack meal (e.g. fruit, cheese, cookie, vegetable, ice cream, energy or granola bar) (meal can be with or without beverage)</th>
<th>Beverage only (e.g. coffee, tea, soft drink, juice, milk, beer, wine, etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:30am</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00am</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00pm</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:00pm</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6:00pm</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00pm</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30am</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES


Proportion of weight loss participants reporting either 1 snack/day, 2 snacks/day, or >=3 snacks/day within the following time intervals: midmorning (10:30am–11:29am), afternoon (2:00pm–5:29pm), and evening (9:00pm to 12:00am). The dark gray bar represents the proportion of participants who reported 1 snack/day, the light gray bar represents 2 snacks/day, and the white bar represents 3 snacks/day or more.

Chi square p > .05; proportions not statistically significantly different.
Table 1

Baseline demographic and anthropometric characteristics of postmenopausal women participating in a year-long dietary weight-loss intervention and the percent weight loss experienced at 6 and 12 months, stratified by intervention arm

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Total (n=123)</th>
<th>Diet (n=59)</th>
<th>Diet+Exercise (n=64)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>58.0±5.1</td>
<td>57.7±6.0</td>
<td>58.2±4.2</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>103 (83.7)</td>
<td>49 (83.1)</td>
<td>54 (84.4)</td>
</tr>
<tr>
<td>Non-white</td>
<td>20 (16.3)</td>
<td>10 (16.9)</td>
<td>10 (15.6)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College graduate or more</td>
<td>82 (66.7)</td>
<td>36 (61.0)</td>
<td>46 (71.9)</td>
</tr>
<tr>
<td>Some college or less</td>
<td>41 (33.3)</td>
<td>23 (39.0)</td>
<td>18 (28.1)</td>
</tr>
<tr>
<td>Employment (n=109)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not employed</td>
<td>15 (13.8)</td>
<td>9 (14.1)</td>
<td>6 (9.4)</td>
</tr>
<tr>
<td>Part-time</td>
<td>30 (27.5)</td>
<td>14 (23.7)</td>
<td>16 (25.0)</td>
</tr>
<tr>
<td>Full-time</td>
<td>64 (58.7)</td>
<td>29 (49.2)</td>
<td>35 (54.7)</td>
</tr>
<tr>
<td>Marital status (n=122)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presently married/living</td>
<td>71.0 (58.2)</td>
<td>25 (42.4)</td>
<td>26 (41.3)</td>
</tr>
<tr>
<td>with partner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single/divorced/widowed</td>
<td>51.0 (41.8)</td>
<td>34 (57.6)</td>
<td>37 (58.7)</td>
</tr>
<tr>
<td>Body mass index</td>
<td>4.3 (31.3)</td>
<td>3.8 (30.8)</td>
<td>4.7 (31.6)</td>
</tr>
<tr>
<td>% Weight loss at 6 mo</td>
<td>8.8±5.5</td>
<td>8.3±6.2</td>
<td>9.2±4.8</td>
</tr>
<tr>
<td>% Weight loss at 12 mo</td>
<td>10.7±7.1</td>
<td>9.6±7.7</td>
<td>11.6±6.5</td>
</tr>
</tbody>
</table>

\(^a \) P value >0.05; no differences were found by group for any of the characteristics or percent weight change.

\(^b \) SD=standard deviation; comparisons were made between Diet and Diet+Exercise groups.

\(^c \) (Baseline weight–6 months weight)/baseline weight.

\(^d \) (Baseline weight–12 month weight)/baseline weight.
Table 2

Mean comparison of percent weight loss, percent calories from fat, fiber (g/day), and servings of fruit and vegetables between snackers and nonsnackers during between-meal snack periods and by snacking frequency categories among postmenopausal women participating in a year-long dietary weight-loss intervention.

<table>
<thead>
<tr>
<th>Between-meal snacking periods</th>
<th>% Weight Loss&lt;sup&gt;b&lt;/sup&gt;</th>
<th>% Fat Intake&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Fiber (g/day)&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Fruits/Vegetables (Servings/Day)&lt;sup&gt;e&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n&lt;sup&gt;f&lt;/sup&gt;</td>
<td>Mean 95% CI</td>
<td>P value&lt;sup&gt;g&lt;/sup&gt;</td>
<td>Mean 95% CI</td>
</tr>
<tr>
<td>Mid-morning: 10:30 AM to 11:29 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Snacks</td>
<td>100</td>
<td>11.5</td>
<td>10.2–12.7</td>
<td>0.005</td>
</tr>
<tr>
<td>≥1 Snacks</td>
<td>23</td>
<td>7.0</td>
<td>4.1–9.8</td>
<td></td>
</tr>
<tr>
<td>Afternoon: 2:00 PM to 5:29 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Snacks</td>
<td>30</td>
<td>12.3</td>
<td>9.7–15.0</td>
<td>0.18</td>
</tr>
<tr>
<td>≥1 Snacks</td>
<td>93</td>
<td>10.3</td>
<td>9.0–11.6</td>
<td></td>
</tr>
<tr>
<td>Evening: 9:00 PM to 12:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Snacks</td>
<td>87</td>
<td>10.3</td>
<td>88–11.7</td>
<td>0.30</td>
</tr>
<tr>
<td>≥1 snacks</td>
<td>36</td>
<td>11.7</td>
<td>9.5–14.0</td>
<td></td>
</tr>
<tr>
<td>Total snacking frequency&lt;sup&gt;h&lt;/sup&gt;</td>
<td>n&lt;sup&gt;i&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥1 Snacks/day</td>
<td>33</td>
<td>11.2</td>
<td>8.7–13.7</td>
<td>0.66</td>
</tr>
<tr>
<td>2 Snacks/day</td>
<td>50</td>
<td>10.0</td>
<td>8.2–11.9</td>
<td></td>
</tr>
<tr>
<td>≥3 Snacks</td>
<td>40</td>
<td>11.1</td>
<td>9.0–13.2</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Weight loss reflects percent change from baseline to 12 months; means reported for dietary variables reflect data collected at 12 months. The following dietary variables were log-transformed: fiber (baseline and 12 months), total calories (12 months), total fruits and vegetables (servings/day—at baseline and 12 months).

<sup>b</sup>Adjusted for study arm, baseline body mass index (BMI), number of main and light meals, other snacking periods (except for total snacking frequency model), alcohol, sweetened-beverage intake, and demographic covariates (ie, age, education, marital status, race/ethnicity).

<sup>c</sup>Adjusted for study arm, baseline BMI, number of main and light meals, other snacking periods (except for total snacking frequency model), and demographic covariates, plus baseline percent fat intake.

<sup>d</sup>Geometric mean reported and adjusted for study arm, baseline BMI, demographic covariates, log of total calories (12 months), log of baseline fiber (g/day), number of main and light meals, and other snacking periods (except for total snacking frequency model).
Geometric mean reported and adjusted for study arm, demographic covariates, log of total calories (12 months), log of baseline fruit and vegetable (servings/day), number of main and light meals, and other snacking periods (except for total snacking frequency model).

Sample sizes for nutrient variables (percent fat intake, fiber, fruit/vegetables) and midmorning snacks: no snacks, n=94; ≤1 snack, n=22; afternoon snack: no snack, n=25; ≤1 snack, n=92; evening snack: no snack, n=83; ≤1 snack, n=34; snacking frequency: ≤1 snack, n=29; 2 snacks, n=48; ≥3 snacks, n=40.

No snacks or 1 snack (where appropriate) was used as a reference group. *P* value based on Wald test and reported whether coefficients were equal to 0.

Total snacking frequency includes individuals who reported snack intake between and during regular meals.

i=number of women who reported snack meals reported at any time period (includes snack meals reported during regular meal periods).

2 snacks/day group was significantly different from reference (0 to 1 snacks/day) (*P*=0.008) and 3 snacks/day group was significantly different from reference group (*P*=0.002), but not significant for trend.