Original Research

Evening Ready-to-Eat Cereal Consumption Contributes to Weight Management

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Objectives: Post dinner snacking may constitute a significant proportion of total daily energy intake and contribute to overweight and obesity in some individuals (night snackers). This study tested the hypothesis that providing a structured snack in the form of a "ready-to-eat" breakfast cereal would help regulate excess energy intake and contribute to weight loss in night snackers.

Methods: Adults (18 to 65 years of age, BMI kg/m^2 $\geq$ 25), with self-reported night snacking behaviors, were randomized into a cereal group (CR) and a no-cereal group (NC). During a period of 4 weeks, the cereal group was instructed to consume a serving of ready-to-eat cereal with low-fat milk 90 minutes after their evening meal. Concurrently, the non-cereal group continued their regular diet *ad libitum*.

Results: At baseline, there were no significant differences between groups for age, body weight, body mass index, daily caloric intake, or evening caloric intake. There was a correlation between number of days of compliance with post-dinner cereal consumption and weight loss ($r = -0.36$, $p = 0.057$). After 4 weeks, the compliant subjects (cereal intake $\geq$ 20 d) lost -1.85 ± 3.56 lbs *vs.* -0.39 ± 3.1 lb for the NC group ($p = 0.06$). Compared to baseline, the compliant CR group reduced their total daily caloric intake by -396.50 ± 641.6 kcal ($p < 0.02$), whereas, the NC group experienced a reduction of -23.22 ± 889.60 kcal/day during the same period ($p =$ ns). Reduction in post-dinner calorie intake for the compliant CR group was significantly greater compared to the NC group (-141.74 ± 385.58 kcal *vs.* 85.82 ± 374.70 kcal; $p = 0.042$).

Conclusion: Eating ready-to-eat cereal after the evening meal may attenuate caloric intake in night snackers and promote weight loss in compliant individuals.

INTRODUCTION

More than 60% of adults in the United States are overweight and more than 20% are obese [1,2]. Both, overweight and obesity are risk factors for a variety of chronic health conditions including heart disease, high blood pressure, diabetes mellitus, arthritis-related disabilities, and some cancers [2,3]. In addition, obese and overweight persons face numerous adverse psychosocial and psychological sequelae [4]. The estimated health care cost of overweight and obesity in the United States is $100 billion per year [3].

Although many factors contribute to overweight and obesity, snacking may be one source of excess caloric intake contributing to an undesirable weight profile. Zizza *et al.* [5] found that snacking among young adults increased from 77% to 84% between 1977–1978 and 1994–1996. The authors concluded that the large increase in total energy and energy density of snacks among young adults in the United States may be contributing to the obesity epidemic. Additional studies have identified snacking as a problematic behavior among the overweight and obese. Snacking was a common behavior among obese women seeking weight loss treatment. Moreover, women who snacked were more likely to be gaining weight and to have higher meal-time energy consumption than women who did not snack [6]. When the baseline eating patterns associated with excessive caloric consumption among obese adults attending a

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residential weight loss facility were characterized, the majority (73.1%) reported snacking "often" or "always" and 34.6% reportedly engaged in binge eating [7].

At this time, the degree to which evening snacking is associated with obesity is unknown. However, preliminary evidence indicates that excessive caloric intake during the evening hours is problematic. Russ *et al.* [8] identified several problematic eating habits among the participants of a university-affiliated weight loss program, including frequent snacking and consuming a majority of calories after 5:00 pm. Finally, an informal survey at a weight loss center revealed that 50% of the patients presenting for treatment listed post-dinner snacking as a behavior that contributed to their weight problems to a "large" or "very large" extent (Dhurandhar NV *et al.*, unpublished observation). Thus, it is important to find a method to decrease this behavioral pattern.

Behavioral modification is an effective treatment for weight loss, preventing weight gain, and regulating eating [9]. However, previous behavioral interventions that have specifically targeted snacking have had unsuccessful results. For instance, Dodd [10] evaluated the use of a behavioral point system with or without the use of a "fat" sheet that presented adverse information on the consequences of snacking that was presented immediately prior to or after snacking. Perhaps this intervention was unsuccessful because it didn't give participants an alternative behavior in which to engage or a means by which to satisfy their cravings.

Although comprehensive behavioral strategies have been shown to be effective for weight loss, many people do not have the time, resources, or motivation to enroll in such a program. In addition, many marginally overweight people may not need such an intense level of intervention. Modest interventions to attenuate snacking may prove efficacious if readily available snacking-alternatives are made available, which could be adapted easily without having to join a formal program.

The purpose of the present study was to examine the effectiveness and efficacy of a short-term behavioral strategy to target a frequently endorsed problematic behavior of post-dinner snacking. The rationale was that a structured, healthful, after-dinner snack would replace consumption of more typical high-fat or high calorie snack foods, reduce post-dinner caloric intake, and facilitate weight loss.

METHODS

Participants

The study was approved by the human investigation committees of Wayne State University and Crittenton Hospital, MI. Respondents to the study announcements were screened via telephone for preliminary eligibility criteria, which included: (a) BMI kg/m^2 $\geq$ 25; (b) 18–65 years of age; (c) not endorsing a weight change of greater than 6.82 kg (15 lb) over the past 6 months, and (d) endorsing a 4 or 5 on the question, "To what extent does snacking after dinner contribute to your weight problem?" which was scaled from 1 "not at all," to 5 "to a very large extent." On average, subjects endorsed snacking an average of 6.19 evenings (SD = 1.58) per week. Potentially eligible respondents were then invited to an introductory session where informed consent was obtained. A physical examination eliminated participants based on self-reports of the exclusion criteria, which included being pregnant, lactating, or trying to conceive; having significant cardiac disease, uncontrolled diabetes or hypertension; active bulimia nervosa, binge eating disorder, or anorexia nervosa; presence of alcohol or substance abuse; history of infectious diseases; aversion or sensitivity to gluten or cereal products; or the presence of any condition for which weight loss or caloric restriction would be contraindicated.

Eighty-four males and females between 18 and 65 years of age were recruited for the study and randomly assigned according to a random numbers table into the No Cereal (NC) and Cereal (CR) groups. Of the 84 recruited, 62 elected to enter the study. Of the 62 who entered the study, 58 completed the first four weeks (44 women, 14 men), for a dropout rate of 6.45%. One woman dropped out of the control group and three women dropped out of the treatment group. Of the 58 who completed the first 4 weeks, 29 (21 women, 8 men) were in the CR group and 29 (23 women, 6 men) were in the NC group. The 29 subjects who were in the NC group at the end of the first 4 weeks were offered 4 additional weeks of cereal treatment as appreciation of their participation, but only 11 completed the second 4 weeks, providing insufficient data for any meaningful comparisons.

Procedures

A registered dietitian provided a cursory overview of the food guide pyramid to illustrate how the provision of a structured, healthful, post-dinner snack to replace more typical high calorie or high fat snacking alternatives might be beneficial. Only general information about the food guide pyramid was provided; no information on portion sizes, weight loss instructions, dietary recommendations, or individual dietary advice was given. The CR group was instructed to eat 1 cup of ready-to-eat-cereal along with 2/3 cup of low fat milk, at least 90 minutes after dinner. A selection of ready-to-eat cereals containing 100–135 kcal, 2–6 g protein, $<$ 0.5g fat, 23–32g carbohydrates, and 1–1.5 g dietary fiber per cup were provided by the Kellogg Company, Battle Creek, MI. Milk-intolerant individuals were instructed to use low fat soymilk. The NC group was instructed to continue their normal diet. Follow-up visits were on weeks 2 and 4, after the baseline visit (week 0).

Measures

Demographics. Demographic characteristics were ascertained at the physical examination, including age, height, and

weight. Height and weight were measured after removal of shoes and heavy outer garments.

Compliance. At weeks 2 and 4, participants in the CR group were asked to report the number of days on which they had consumed the cereal as directed. Participants in the NC group were asked to report the number of days on which they had eaten the cereal at week 6 and at week 8. Subjects consuming cereal on at least 5 out of 7 days each week ($\geq$ 20 day in 4 weeks) were considered to be compliant.

Three-Day Dietary Recall. After receiving detailed instruction on how to complete a three-day dietary recall, participants in both groups completed three-day dietary recalls at baseline, week 2, and at week 4 which each participant then reviewed with the registered dietician. The recall consisted of 2 weekdays and one weekend day. The baseline and week 4 data were analyzed. Responses were analyzed with Total Dietary Assessment software for Saunders College Publishing, (Version 2.0; ISBN #0-03-025895-2; Science and Application 2000, Harcourt, 1997) and summary values, including caloric content, were then entered into SPSS for further analysis. Daily caloric intake was defined as the three-day average total daily calories consumed. Post-dinner caloric intake was defined as calories consumed in the form of snacks eaten after dinner.

Statistics

Data were analyzed with SPSS version 11.5. Demographic characteristics are described with means and standard deviations. Correlations were conducted to determine whether or not compliance was related to weight loss outcomes. Independent samples t-tests were conducted to determine whether the CR and NC groups differed on any basic demographic characteristics so that potential covariates could be identified. Paired samples t-tests were conducted to determine whether the groups significantly reduced their weight, daily or post-dinner caloric intake. Independent samples t-tests were then conducted to determine whether the CR group reduced their weight or daily or post-dinner caloric intake more than the NC group, a one-tailed test. Probability levels were set at alpha < 0.05. To illustrate the moderating effect of compliance, analyses were conducted from effectiveness and efficacy perspectives.

RESULTS

Descriptive Analyses: The CR and NC groups did not differ in gender composition, $\chi^2 = 0.38$, $p = 0.539$. Additional demographic characteristics of the study participants are presented in Table 1. At baseline, there were no significant differences in age, weight, BMI, daily caloric intake, or post-dinner caloric intake (Table 1).

Effect of Compliance

Data were analyzed to determine whether the level of compliance, as indexed by the number of days of cereal eaten, was correlated with weight loss among the treatment group. Results showed that as compliance increased, so did the amount of weight lost ($r = -0.36$, $p = 0.057$) (Fig. 1).

Effect on Weight Change and Caloric Intake

Paired samples *t*-tests were conducted to determine whether each group lost a significant amount of body weight, consumed fewer total daily calories or fewer post-dinner calories following the intervention. Mean changes in weight, total daily calories, and post-dinner calories are provided in Table 2. Within group significant differences ($p < 0.05$) between baseline and 4 week values as determined by the paired samples t-tests are indicated by asterisks, and the independent samples t-tests conducted to compare differences between the two groups are denoted in Table 2 with probability values (*p*).

Weight Change

The CR group lost a non-significant amount of weight during the first four weeks of the study, $t(28) = 1.72$, $p = 0.096$ as did participants in the NC group, $t(28) = 0.66$, $p = 0.551$. However, the response was different for the compliant group. Complete nutrition records were available for 17 participants in the CR group and for 23 participants in the NC group. Fourteen subjects from the CR group were considered "compliants," who lost -1.85 ± 3.56 lbs after 4 weeks ($p = 0.01$). This weight change was greater than that for the NC group (-0.39 ± 3.13 lbs, $p = 0.06$) during the same period.

Table 1. Baseline Demographic Characteristics of the Intervention and Control Groups

Variable	Intervention Group (CR)		Control Group (NC)		*t*	*p*
	Mean	SD	Mean	SD		
Age (years)	51.55	7.91	48.31	12.29	1.19	0.237
Weight (lbs)	230.97	54.60	218.82	47.48	0.90	0.370
BMI (kg/m^2)	36.35	8.10	34.38	6.99	0.99	0.326
Daily kcal intake	2139.90	772.27	2114.67	587.08	0.13	0.896
Evening kcal	420.00	273.43	321.41	251.67	1.34	0.187

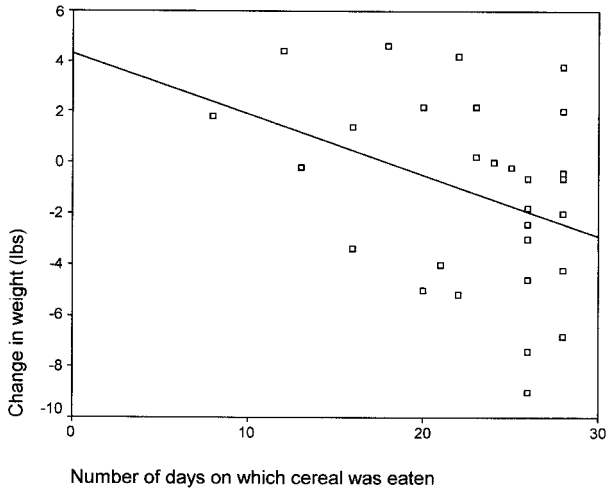

Fig. 1. Association between compliance and weight loss. Weight change in 4 weeks vs. the number of days of post-dinner cereal consumption in the CR group. Change in weight correlated ($r = -0.36$, $p = 0.067$) with the number of days of cereal consumption ($n = 29$).

Change in Total Daily Caloric Intake

The CR group consumed non-significantly fewer daily total calories $t(16) = 1.92$, $p = 0.073$ as did the NC group, $t(22) = 0.12$, $p = 0.902$. Then again, compared to their baseline intake, the CR group compliants reduced total daily caloric intake by -396.50 ± 641.55 kcal ($p < 0.02$). On the other hand, the NC group evidenced a reduction of only -23.22 ± 889.60 kcal/d ($p =$ ns) compared to their baseline. There was a trend for the CR group compliants to have reduced their daily caloric intake more than the NC group, $t(35) = 1.37$, $p = 0.09$.

Change in Post-Dinner Caloric Intake

After 4 weeks, the CR group reduced their post-dinner caloric consumption (Fig. 2). The CR group reduced their post-dinner caloric intake by -103.61 ± 358.48 kcal, compared to an increased intake of 85.82 ± 374.70 post-dinner kcal for the NC group after 4 weeks ($p = 0.058$). Overall, from baseline to 4 weeks, the CR group went from consuming 19.5% to 16.3% of their total daily calories after dinner, whereas the NC group evidenced an increase from 14.2% to 18.5%. The reduction in post-dinner calories in the CR group compliants was significantly greater compared to that for the NC group (-141.7 ± 385.6 kcal *vs.* 85.8 ± 374.7 kcal; $p = 0.042$).

DISCUSSION

After dinner snacks may constitute a large proportion of energy intake for night snackers and may contribute to weight gain. The evening snack criteria for food intake was based on Rand's definition of night eating syndrome, which includes excessive evening eating [11]. Night eating syndrome (NES) is associated with morning anorexia, evening hyperphagia and reduced weight loss in obese outpatient subjects [12]. In one month on a medically-supervised liquid formula diet, the subjects with NES had significantly less weight loss, which the authors attributed to insufficient compliance and overeating at night [12]. For this study, we hypothesized that a structured post-dinner snack would reduce post-dinner energy intake and additionally, contribute to weight loss. A relatively low energy snack such as ready-to-eat cereal was expected to provide a substitute for potentially high-energy post-dinner snacks and reduce the total post-dinner energy intake.

Of note, we chose to focus on a single component of night eating syndrome, night snacking, and not on the full syndrome which includes disturbances of mood and sleep. Although there is a consensus that night eating syndrome involves consuming a large proportion of one's daily calories during the evening and night time hours, operational definitions of "large" and "evening" differ greatly and may not take regional practices into consideration, such as consuming the evening meal after 6:00 or 7:00 pm, which may not be unusual for certain communities. Therefore, we were careful to include only persons who had difficulty with evening snacking (post-dinner) that did not constitute any portion of the evening meal.

As hypothesized, post-dinner energy intake in the CR group decreased after week 4. A correlation between weight loss and the number of days of post-dinner cereal intake further supports a contributory role for post-dinner cereal consumption in the weight loss of obese and overweight night snackers. Also, the CR group compliants showed a significant reduction in total daily caloric intake. The CR group consistently showed a greater reduction in the percentage of daily calories consumed during the evening than the NC group. The mean values had sizable standard deviations, indicative of the heterogeneity of the participants.

It should be noted that the participants were not provided with personalized instructions to lose weight or to induce negative energy balance, nor was their habit of post dinner food intake emphasized during interviews. Although the CR group did receive a cursory overview of the food guide pyramid as a component of their introduction to the study protocol whereas the NC group did not, this slight difference, which could be accomplished by looking at many food labels in a grocery story, was unlikely sufficient to produce the observed changes. In addition, the presence of a dose-response relationship between the number of days of post-dinner cereal consumption and subsequent weight loss provides strong support for the effect of the intervention.

Although the mean weight loss even for the compliant group was only 1.85 lbs, it was nearly 5-fold greater than that of the NC group. While evaluating the biological significance of the weight loss produced, consideration should be given to the ease and simplicity of the design. Dietary management of obesity is sound in theory, but difficult to practice and help should be offered in as many ways possible. In addition to other

Table 2. Changes in Body Weight and Caloric Intake after 4 Weeks, Compared to Baseline

	CR			NC			*t*	*p*
	N	Mean	SD	N	Mean	SD		
Changes in Weight								
Total Sample	29	−1.17	3.66	29	−0.39	3.13	0.88	0.191
20 d Compliant (CR)	23	−1.85*	3.56	29	−0.39	3.13	1.58	0.060
Changes in total daily calories								
Total Sample	17	−293.13	628.63	23	−23.22	889.60	1.07	0.146
20 d Compliant (CR)	14	−396.50*	641.55	23	−23.22	889.60	1.37	0.090
Changes in post-dinner calories								
Total Sample	17	−103.61	358.48	23	85.82	374.70	1.61	0.058
20 d Compliant (CR)	14	−141.74	385.58	23	85.82	374.70	1.77	0.042

Paired samples *t* tests were conducted to determine whether each group lost a significant amount of weight, consumed fewer total daily calories or fewer post-dinner calories. Mean changes in weight, total daily calories, and calories consumed after dinner are provided. Within group significant differences ($p < .05$) between baseline and 4 week values as determined by paired samples *t* tests are indicated by * and independent sample *t* tests conducted to compare differences between the two groups are denoted as probability values (*p*) in the Table.

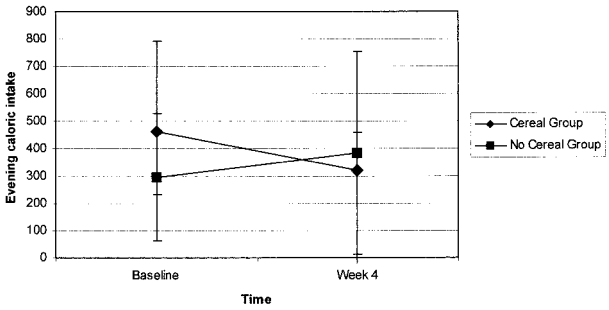

Fig. 2. Post-dinner caloric consumption for the CR and NC groups. Consumption of evening calories in the compliant CR (n = 14) and the NC groups (n = 23).

treatment considerations such as reduced kcal intake and nutrient composition and adequacy, simple changes in familiar daily foods may enhance weight loss.

It is significant to note that a simple and minimal intervention such as the addition of a structured evening snack of ready-to-eat cereal helped these night snackers to lose weight. Such a regimen may not produce large weight loss for severely obese night snackers. However, often obesity is a refractory condition and the current treatment requires remarkable willpower to follow a regimented weight loss diet. Even a modest weight loss resulting from a minimal intervention outlined in this study should provide help in the weight management struggle.

Although the sample size was sufficient for the original purpose of detecting a 3 pound differential between group weight loss with an 84% probability at the $p < .05$ level (assuming a within group variance of 100 lbs per group, and a within group correlation of 0.90), the sample size was rather small for the analysis of daily and evening caloric intake. This was mainly because only a fraction of the participants returned completed 3-day dietary recall forms.

In summary, the results of this short-term study show that offering a structured post-dinner snack to overweight or obese night snackers reduces post-dinner energy intake and the total daily caloric intake and results in weight loss, which is proportional to compliance. Further research is required to assess if long-term studies aimed at reducing night snacking will maximize the weight loss benefits.

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