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Do food provisions packaged in single-servings reduce energy intake at breakfast during a brief behavioral weight loss intervention?

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Abstract

Larger portion sizes increase energy intake, yet it is unclear if single-serving packages can reduce intake. This study examined the effect of providing breakfast foods in single-serving packages or in non-portioned packages on energy intake of these foods during an 8-week behavioral weight loss program. In fall 2005, 19 adults (mean body mass index [BMI] = 31.8 ± 4.0) were randomized to conditions that provided foods in single-serving packages (SINGLE-SERVING) or in non-portioned packages (STANDARD). Overall amounts and types of foods provided were consistent across conditions: cereal and peaches (weeks 1, 3, 5, 7) and applesauce and cheese (weeks 2, 4, 6, 8). Participants were instructed to eat one serving of each food for breakfast and to not consume the provided foods at other times. Mean daily energy intake of the provided foods was the primary dependent variable. SINGLE-SERVING ate less energy from the combined pairs of foods provided together as compared to STANDARD [(cereal + peaches, 117.0 ± 3.2 kcal/day vs. 143.5 ± 39.3 kcal/day; $p < 0.05$) (applesauce + cheese, 174.2 ± 13.5 kcal/day vs. 199.0 ± 29.4 kcal/day; $p < 0.05$)]. This effect was due to less energy consumed from cereal and applesauce in SINGLE-SERVING compared

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to STANDARD [(cereal, 80.2 ± 2.9 kcal/day vs. 106.3 ± 22.9 kcal/day; $p < 0.01$) (applesauce, 44.5 ± 0.6 kcal/day vs. 59.3 ± 5.0 kcal/day; $p < 0.01$)], with no differences in energy consumption for peaches and cheese ($p > 0.10$). This suggests single-serving packages may help reduce energy intake at breakfast within the context of a behavioral weight control program.

Keywords

single-serving; energy intake; portion control; package size; obesity

Introduction

Nearly two thirds of adults in the United States are overweight or obese (1,2). While the reasons for this obesity epidemic are complex, a contributing factor may be large food portion sizes (3,4). Previous research indicates that larger portions produce increased daily intake (5,6), which can lead to weight gain over time. For this reason, behavioral weight control programs encourage reducing portion size by measuring all foods and beverages consumed (7). A possible alternative approach is the utilization of pre-packaged individual servings of foods. When pre-packaged, single-serving foods are used, they eliminate the need for measuring, and also control the amount of food available to consume. In view of the increasing availability, as well as additional cost of single-serving packaged foods (8), it is important to determine the potential of such products to facilitate reducing energy intake.

Therefore, the purpose of this study was to determine the effect of providing food in single-serving packages as compared to non-portioned standard packages on intake of the provided foods within the context of a weight loss program. It was hypothesized that the participants in the condition receiving the single-serving packages of food would consume less energy from the provided foods at breakfast compared to the condition receiving the non-portioned packages of food.

Methods

Participants and Study Design

Participants were recruited during July 2005 via local newspaper advertisements, and from a database of individuals interested in participating in weight loss interventions. Eligibility criteria for the study were: age = 21 to 65 years; body mass index (BMI) = 25 to 40 kg/m², and consumption of breakfast of ≤ 4 days/week. Participants were phone-screened and were excluded if they were lactose intolerant; allergic to, or would not eat the provided foods; could not engage in physical activity; were participating in a weight loss program and/or taking weight loss medication or lost $\geq 5\%$ of body weight during the past 6 months; unavailable for meetings > 1 week during the program; or were either pregnant, lactating, or less than 6 months post-partum, or planned to become pregnant during the investigation.

Participants were randomized to receive single-serve packages or standard packages of foods to consume at breakfast as part of an 8-week behavioral weight control intervention. The dependent variable in the study was the mean energy intake/day of the provided foods over the course of the intervention. The study protocol was approved by The Miriam Hospital Institutional Review Board (Providence, RI).

Foods

The foods provided to participants packaged according to the assigned condition were typical breakfast foods and included cereal (i.e., Cheerios®), canned peaches, applesauce and cheddar

cheese. These foods were selected as manufacturer packaging of these foods was available in single-serving as well as non-portioned packages. A breakfast prescription, identical for both conditions, was given to all participants. This prescription was to eat a serving of each of the provided foods for breakfast daily along with 1 serving of low-fat or skim milk with the cereal and 1 serving of bread with the cheese, providing approximately 200 -300 kcal/breakfast, within 2 hours of awakening. Participants were instructed to not consume the provided foods at other times of the day. To increase adherence to consuming the provided foods, participants were informed that regularly consuming breakfast may be beneficial for weight loss, as eating consistently throughout the day may reduce hunger and prevent overconsumption later in the day. Every week, the foods provided to participants were alternated, so that they received cereal and peaches (weeks 1, 3, 5, and 7), or cheese and applesauce (weeks 2, 4, 6, and 8). One condition received the foods packaged in single servings (SINGLE-SERVING), while the other condition received the same foods packaged in non-portioned packages (STANDARD). Participants in both conditions received similar total quantities of the foods each week in the manufacturers' original packaging and in excess of anticipated consumption (cereal: 22×0.68 oz boxes vs. 1×15 oz box, peaches: 12×4 oz cans vs. 3×15 oz cans, applesauce: 12×4 oz cans vs. 3×15 oz cans, cheese: 16×1 oz blocks vs. 2×10 oz blocks; SINGLE-SERVING and STANDARD, respectively). Each week, participants were asked to return any food they did not consume, including food in which the packaging had been opened but not all food was eaten. Plastic containers were provided to help return opened food, as well as empty packaging from consumed foods.

Intervention

At the baseline assessment session, height was measured by a stadiometer (Seca 214, Seca North America East, Hanover, MD) and weight was measured on a physician's digital scale (Healthometer Professional 597KL, Pelstar LLC, Bridgeview, IL) using standard procedures (9) allowing for calculation of BMI using the following formula: weight in kg divided by height in m^2 . At the baseline assessment session a demographic questionnaire was also completed by participants. Participants were then randomized, using a random number table, into one of the two treatment groups (SINGLE-SERVING or STANDARD). Weight measurements were repeated at a post-intervention assessment session.

The behavioral intervention was identical in both conditions, with separate 60 minute weekly group sessions for each condition, led by interventionists with expertise in weight management and delivered with the aid of a treatment manual. Interventionists were not blinded to study condition as they distributed food weekly to participants. Participants were instructed to consume a standard calorie and fat restricted diet following the American Heart and the American Diabetes Associations' recommendations (10,11) and were shown how to correctly measure and weigh all food consumed. Daily calorie prescriptions were based upon study entry weight (≤ 90.7 kg prescribed 1200 kcal/day, > 90.7 kg prescribed 1500 kcal/day), with fat restricted to $\leq 30\%$ energy from fat, and was intended to produce a weight loss of 0.45-0.90 kg/week (12). Participants were instructed to gradually increase their physical activity by 5 minutes per day each week until they reached the intervention goal of 30 minutes of activity 5 days per week. Behavioral and cognitive skills intended to help implement changes in eating and activity behaviors were taught to participants at each session. Participants were encouraged to eat breakfast daily and kept track of the number of days each week the provided foods were consumed at breakfast in a daily food diary.

Food Consumption Measures

All food provided to the participants was weighed in the original packaging on an electronic food scale (Denver Instruments SI-8001, Denver, CO) prior to distribution. Each week, all returned food, along with packaging from eaten food was counted and re-weighed. Participants

returned all packaging from eaten food. Food consumption was measured by subtracting the post-consumption weight from the pre-consumption weight, providing an objective measure of intake. Research assistants not involved in delivery of the intervention measured food intake. Energy intake was calculated by multiplying calories per gram of food, obtained from manufacturer information, by grams of food consumed. Mean intake of each food for each participant was calculated from energy content of the foods consumed per week divided by number of breakfasts each food had been consumed as recorded in the food diary. Mean intake of the two foods provided together each week was calculated as the sum of the mean energy intake per day from each food.

Data Analysis

Independent sample Student's *t* tests and Chi-Square were used to analyze differences between the conditions (SINGLE-SERVING vs. STANDARD) in baseline characteristics. Student's *t* tests examined the primary outcome variable, mean energy intake of each of the provided foods consumed per day, the number of days breakfast was eaten per week (SPSS for Windows, v. 16, Chicago, IL), and amount of weight loss. The α level was set a priori at $p < 0.05$.

Results and Discussion

Of the 94 individuals who completed the phone screening, 59 did not meet eligibility criteria. Twenty-four of the 35 eligible individuals attended an orientation session where informed consent/signed HIPAA forms were obtained. These 24 individuals were randomized into a condition, but 5 participants developed scheduling conflicts, and could not be given foods to consume each week. There were no significant ($p > 0.10$) differences in age, BMI, gender, race, education, and marital status in the completers and non-completers, but the non-completers had a greater percentage of Hispanic individuals than the completers (20% vs. 0%, $p < 0.05$). Complete consumption data from provided foods was obtained from 19 participants.

There were no differences in participant baseline characteristics between SINGLE-SERVING and STANDARD ($p > 0.10$) (Table 1). Participants in the SINGLE-SERVING condition ate significantly less energy/day from the provided foods than STANDARD when given cereal + peaches (117.0 ± 3.2 kcal/day vs. 143.5 ± 39.3 kcal/day; $p < 0.05$) or when given applesauce + cheese (174.2 ± 13.5 kcal/day vs. 199.0 ± 29.4 kcal/day; $p < 0.05$) (Figure 1). When foods were analyzed separately, SINGLE-SERVING consumed significantly less energy/day in cereal (80.2 ± 2.9 kcal/day vs. 106.3 ± 22.9 kcal/day; $p < 0.01$), and applesauce (44.5 ± 0.6 kcal/day vs. 59.3 ± 5.0 kcal/day; $p < 0.01$) than STANDARD. No significant differences were found for energy/day for peaches (36.8 ± 0.3 kcal/day vs. 37.2 ± 18.4 kcal/day, SINGLE-SERVING and STANDARD, respectively; $p > 0.10$) or cheese (129.7 ± 13.4 kcal/day vs. 139.6 ± 26.1 kcal/day, SINGLE-SERVING and STANDARD, respectively; $p > 0.10$). Number of days per week in which breakfast was consumed during treatment was not significantly different between the conditions (6.7 ± 0.4 day/wk) ($p > 0.10$), nor was weight loss over the 8-weeks (5.1 ± 2.3 kg) ($p > 0.10$).

The primary finding of this study was that providing foods to consume at breakfast in single-serving packages resulted in a reduction in energy intake of these foods as compared to intake from the same foods provided in non-portioned packages during a behavioral weight control program. These results are consistent with previous studies which indicate that food provisions in portion-controlled sizes may aid with reducing intake (13-16). Unlike previous food provision studies, however, this study controlled for all factors except for the manipulation of food packaging size. These results support the postulate that foods packaged in single-serving packages independently aid in the reduction of energy intake.

A number of potential mechanisms by which single-serving packages affect intake have been proposed (17). For instance, the single-serving packaged portions may reduce intake by limiting the amount of food available for consumption. Single-serving packages may also influence consumption norms by altering perceptions of the appropriate amount of food to consume (18,19). The visual cues provided by the single-serving packages improve consumption awareness and monitoring, thereby preventing unintentional overeating (18). Interestingly, the effect of the single-serving packages on intake was attributable to differences in intake from amorphous foods that do not inherently provide visual cues to aid in consumption monitoring (i.e. cereal and applesauce), rather than foods with a distinct shape (i.e. peaches and cheese).

In this investigation, the condition receiving foods in single-serving packages consumed ~15 % less energy from these foods at breakfast as compared to the condition which received these same foods in non-portioned packages. Although single-serving packages of food were successful at reducing intake of these foods in this investigation, not all studies have found this effect. It has been shown that in non-dieting unrestrained eaters, package size of provided snack foods does not influence intake (20,21).

There are several notable aspects in the design of the present study. First, energy intake from the provided foods was objectively measured rather than self-reported. Also, by providing food to both conditions, it was possible to isolate the effect of single-serving packages on intake independently of the influence of food provision. Finally, the naturalistic eating conditions of this study increased the external validity of the results. There are, however, some limitations in this study. Because only energy intake from the provided foods was measured, it is not known if participants in the SINGLE-SERVING condition compensated for the reduced intake of these foods at any other time in the day. Also, because of the naturalistic eating conditions of the study, outside factors that may influence intake were not controlled in this study and it is possible that participants consumed foods other than those prescribed for breakfast. However, compliance with the study protocol was monitored by review of daily food diaries completed by all study participants. Additionally, the small, white, and predominantly female sample limits the generalizability of the study. Finally, given that the instructions and the provided foods encouraged their consumption at breakfast, it is not clear if the same outcomes would be seen with provision of different types of foods, including snack foods, eaten throughout the day.

Conclusions

This study suggests that energy intake of foods, particularly amorphous foods, at breakfast is reduced when packaged in single-servings and consumed by individuals consciously trying to reduce and monitor intake. Future investigations should determine if providing single-serving packages for all meals and snacks decreases daily energy intake, as well as determine types of foods and populations that maximize the efficacy of single-serving packages on intake.

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Figure 1.

Energy intake from the provided breakfast foods per breakfast during an 8-weight behavioral weight loss program where breakfast foods were provided to participants in either single-serving packages (SINGLE-SERVING) or non-portioned packages (STANDARD). Independent t-tests showed significant differences between conditions in energy intake from cereal, cereal + peaches, applesauce, and applesauce + cheese ($p < 0.05$).

* Significant difference between conditions ($p < 0.05$).

Table 1

Baseline demographic characteristics of participants who completed an 8-week behavioral weight loss program where breakfast foods were provided in either single-serving packages (SINGLE-SERVING) or non-portioned packages (STANDARD) ($M \pm SD$).

	SINGLE-SERVING (n=11)	STANDARD (n=8)
Age (years)	50.6 $\pm$ 8.7	50.5 $\pm$ 10.8
Gender (M/F)	1/10	0/8
Height (cm)	162.0 $\pm$ 8.7	161.1 $\pm$ 4.5
Weight (kg)	84.9 $\pm$ 13.3	80.5 $\pm$ 8.0
BMI (kg/m ²)	32.4 $\pm$ 4.6	31.0 $\pm$ 3.1
Education (% some college and above)	90.9	87.5
Marital Status (% married)	63.6	62.5
Race (% White)	100	100
Ethnicity (% non-Hispanic)	100	100

Notes: M = males; F = females; BMI = body mass index

Data are expressed as mean $\pm$ SD

Groups were not significantly different on any baseline measure ($p > 0.10$)